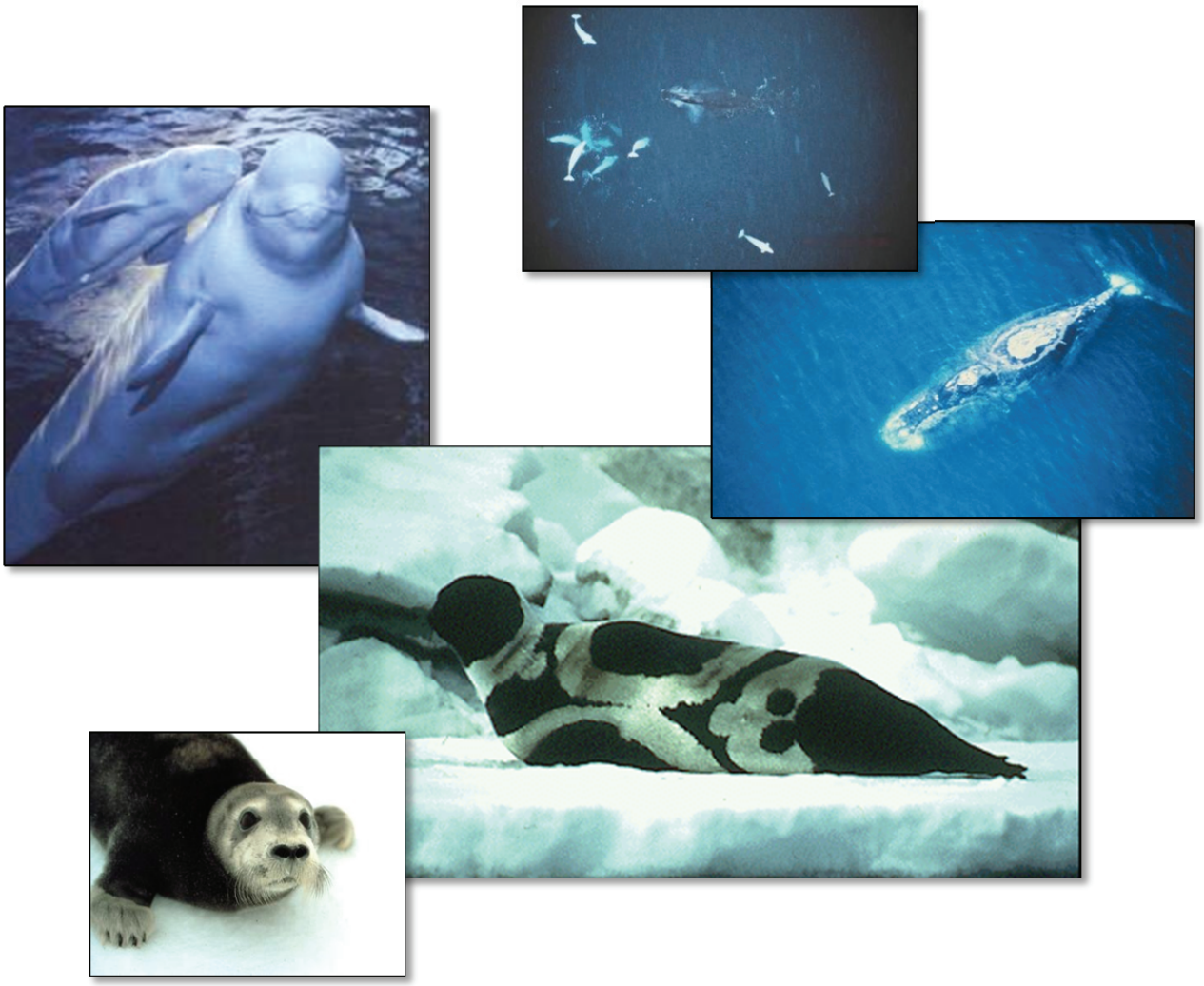
# Effects of Oil and Gas Activities in the Arctic Ocean

## Draft Environmental Impact Statement

### Volume 1: Chapters 1-3



**December 2011**


**United States Department of Commerce**
**National Oceanic and Atmospheric Administration**
**National Marine Fisheries Service**
**Office of Protected Resources**

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
PROGRAM PLANNING AND INTEGRATION
Silver Spring, Maryland 20910

DEC 19 2011

Dear Reviewer:

In accordance with provisions of the National Environmental Policy Act (NEPA), we enclose for your review the National Oceanic and Atmospheric Administration (NOAA) *Draft Environmental Impact Statement (DEIS) for Effects of Oil and Gas Activities in the Arctic.*

This DEIS is prepared pursuant to NEPA to assess the environmental impacts associated with NOAA proceeding with the issuance of Marine Mammal Protection Act (MMPA) incidental take authorizations for the take of marine mammals incidental to conducting oil and gas exploration activities in the U.S. Arctic Ocean. The intended effect of carrying out the proposed action is to ensure compliance with Section 101(a)(5) of the MMPA.

Additional copies of the DEIS may be obtained by contacting the responsible official at the address shown below or by accessing the project website at: http://www.nmfs.noaa.gov/pr/permits/eis/arctic.htm.

Written comments on the DEIS should be directed via mail, fax, or electronic mail to the responsible official identified below by Monday, February 13, 2012.

Responsible Official:

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Director
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National Marine Fisheries Service
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Sincerely,

Patricia A. Montanio
NOAA NEPA Coordinator

Enclosure

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# Effects of Oil and Gas Activities in the Arctic Ocean

Draft Environmental Impact Statement

December 2011

**Prepared by:**

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Office of Protected Resources

# EXECUTIVE SUMMARY

## 1.0 INTRODUCTION

The National Marine Fisheries Service (NMFS) and the Bureau of Ocean Energy Management (BOEM) have prepared this Environmental Impact Statement (EIS) to describe the effects of offshore oil and gas exploration activities in the U.S. Beaufort and Chukchi seas. This EIS analyzes a range of management alternatives to assist NMFS and BOEM in carrying out their statutory responsibilities to authorize or permit these activities within the five year period of 2012 through 2017.

The statutory responsibilities include BOEM's issuance of permits and authorizations under the Outer Continental Shelf Lands Act (OCS Lands Act) for seismic surveys and NMFS' issuance of incidental take authorizations (ITAs) under Section 101(a)(5) of the Marine Mammal Protection Act (MMPA). A geological and geophysical (G&G) permit must be obtained from BOEM in order to conduct G&G exploration activities for oil, gas, and sulphur resources when operations occur on unleased lands or on lands leased to a third party.

NMFS issues ITAs for oil and gas exploration activities because it is likely that seismic and exploratory drilling activities result in the disturbance of marine mammals through sound, discharge of pollutants, and/or the physical presence of vessels. Because of the potential for these activities to "take" marine mammals, oil and gas operators may choose to apply for an ITA.

### 1.1 Background

On April 6, 2007, NMFS and the U.S. Mineral Management Service (MMS [now BOEM]) published a Draft Programmatic EIS (DPEIS) that assessed the impacts of MMS' issuance of permits and authorizations for seismic surveys in the Beaufort and Chukchi seas off the coast of Alaska, and NMFS' issuance of ITAs to take marine mammals incidental to conducting those permitted activities. Since the DPEIS was published, new information that alters the scope, set of alternatives, and analyses in the DPEIS has become available. In addition, NMFS determined that an EIS must also address the potential effects of issuing authorizations for take that would occur incidental to exploratory drilling, which were not addressed in the 2007 DPEIS. Therefore, MMS and NMFS filed a Notice of Withdrawal of the PDEIS on October 28, 2009 and announced their decision to prepare a new EIS to be called, *Effects of Oil and Gas Activities in the Arctic Ocean*, with MMS as a cooperating agency. The new EIS would address:

- Effects of both geophysical surveys and exploratory drilling;
- Cumulative effects over a longer time frame;
- A range of more reasonable alternatives consistent with the agencies' statutory mandates;
- A range of practicable mitigation and monitoring measures for marine mammals and their availability for subsistence uses;
- Anticipated levels of G&G activities in the Beaufort and Chukchi seas, Alaska, including:
    - Deep penetration and high-resolution seismic surveys as permitted under 30 CFR Part 551 regulations.
    - Exploratory drilling (in accordance with BOEM and BSEE regulations at 30 CFR Part 550 Subpart B and 30 CFR Part 250 Subpart B, respectively), deep penetration surveys and site clearance and high resolution shallow hazards surveys as authorized under regulations found at 30 CFR 551 as ancillary activities.

## 1.2 Process

NMFS, as the lead federal agency, prepared this EIS to evaluate a broad range of reasonably foreseeable levels of exploration activities that may occur within the five-year period of 2012 through 2017. BOEM and the North Slope Borough (NSB) are serving as formal cooperating agencies; the Environmental Protection Agency (EPA) is serving as a consulting agency; and NMFS is coordinating with the Alaska Eskimo Whaling Commission (AEWC) pursuant to our co-management agreement under the MMPA.

NMFS has published this EIS to disclose the potential impacts associated with their issuance of ITAs, and invites all interested parties to comment. The EIS will allow NMFS and BOEM to comprehensively assess activities that may occur in a given season before receiving applications. This will allow them to issue permits and authorizations more quickly and efficiently.

A brief summary of the agencies' regulatory requirements follows:

### 1.2.1 MMPA Requirements

Sections 101(a)(5)(A) and (D) of the MMPA (16 United States Code [U.S.C.] § 1361 *et seq.*) direct the Secretary of Commerce to allow, upon request, the incidental, but not intentional taking of small numbers of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region, if certain findings are made and either regulations are issued or, if the taking is limited to harassment, a notice of proposed authorization is provided to the public for review. Authorization for incidental takings shall be granted if:

- NMFS finds that the taking will have a negligible impact on the species or stock(s);
- NMFS finds that the taking will not have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses (where relevant); and
- the permissible methods of taking and requirements pertaining to the mitigation, monitoring, and reporting of such takings are set forth.

### 1.2.2 OCS Lands Act Requirements

The OCS Lands Act, 43 U.S.C. § 1331 et seq. prescribes a four stage process for development of offshore federal mineral resources: (1) a 5-year oil and gas leasing program; (2) lease sales; (3) exploration pursuant to exploration plans; and (4) development and production plans. Environmental reviews are conducted for each of these stages.

The OCS Lands Act directs BOEM and the Bureau of Safety and Environmental Enforcement (BSEE) to oversee the "expeditious and orderly development [of OCS resources] subject to environmental safeguards" (43 U.S.C. §§ 1332(3), (6), 1334(a)(7)). Critical to the potential development of OCS resources is the ability to gather geological and geophysical data on the resource potential of the OCS. BOEM, which has rights to all data collected under the OCS Lands Act and implementing regulations, needs the best available data to ensure that the federal government, i.e. the American people, receives fair market value for leased resources. The OCS Lands Act establishes U.S. Department of Interior authority, delegated to BOEM by regulation, to issue G&G permits or notice approvals for G&G, ancillary, and exploration activities, and approve exploratory drilling plans for these and related purposes. BOEM's regulations for G&G permits, ancillary activities, and Exploration Plans are at 30 CFR Parts 551 and 550.

BOEM regulations (30 CFR Part 551) specifically state that G&G activities cannot:

- interfere with or endanger operations under any lease or right-of-way, easement, right-of-use, Notice, or permit issued or maintained under the OCS Lands Act;

- cause harm or damage to life (including fish and other aquatic life), property, or to the marine, coastal, or human environment;
- cause harm or damage to any mineral resource (in areas leased or not leased);
- cause pollution;
- create hazardous or unsafe conditions; or
- unreasonably interfere with or cause harm to other uses of the area.

Pursuant to 30 CFR Part 551.4, a G&G permit must be obtained from BOEM to conduct G&G exploration for oil, gas, and sulphur resources when operations occur on unleased lands or on lands leased to a third party. Ancillary activities are regulated under 30 CFR Part 550.207 through 550.210, which also states that a notice must be submitted before conducting such activities pursuant to a lease issued or maintained under the OCS Lands Act.

## 1.3 Project Overview

The proposed action considered in this EIS is:

- The issuance of ITAs under Section 101(a)(5) of the MMPA, by NMFS, for the incidental taking of marine mammals during G&G permitted activities, ancillary activities, and exploratory drilling activities in the U.S. Beaufort and Chukchi seas, Alaska, and
- The authorization of G&G permits and ancillary activities in the U.S. Beaufort and Chukchi seas, Alaska, by BOEM under the OCS Lands Act.

This EIS will also evaluate the potential effects to the environment of authorizing takes of marine mammals incidental to such activities occurring in either federal or State of Alaska waters. Activities that could occur in state waters include on-ice and open water seismic surveys, high-resolution site clearance/shallow hazards surveys, and exploratory drilling. The oil and gas exploration activities that are addressed and evaluated in this EIS are grouped into the following three categories:

- Deep penetration geophysical surveys – (e.g. seismic surveys, including open-water, towed streamer 2-dimensional [2D] or 3-dimensional [3D] surveys, in-ice towed streamer 2D surveys, on-ice 2D or 3D surveys or Ocean-Bottom- Receiver [ cable or node; OBC] surveys; gravity and gradiometry surveys; and controlled source electromagnetic surveys [CSEM]). These surveys are conducted to identify prospective blocks for bidding in lease sales and to optimize drilling sites on leases acquired in sales.
- Shallow hazards surveys – (also called high-resolution or site clearance surveys) These activities use either acoustic sources to provide imagery of the sub-seafloor to a depth of less than 1,500 meters (0.9 miles), or use sediment sampling devices to identify hazards.
- Exploratory drilling – Any drilling conducted by a lessee to search for commercial quantities of oil, gas, or sulfur authorized under 30 CFR Parts 250 and 550.

The project area (Figure 1.1) covers an area of approximately 200,331 square miles within the Alaskan portion of the Beaufort and Chukchi seas. It includes State of Alaska and OCS waters adjacent to the North Slope of Alaska, and transit areas of the Chukchi Sea north of the Bering Straits.

## 1.4 Project Purpose and Need

### 1.4.1 Purpose

The federal actions considered in this EIS are the issuance of G&G permits and ancillary activity notice approvals by BOEM for the Beaufort and Chukchi seas and the issuance of ITAs under the MMPA for G&G surveys, ancillary activities, and exploratory drilling activities in the Beaufort and Chukchi seas by NMFS. ITAs could be issued for these activities in either federal or State of Alaska waters. Given the widespread presence of several species of marine mammals in the Beaufort and Chukchi seas and the nature of oil and gas exploration activities, it is likely that some amount of seismic and exploratory drilling activities may result in the disturbance of marine mammals through sound, discharge of pollutants, and/or the physical presence of vessels. Because of the potential for these activities to "take" marine mammals, oil and gas operators may choose to apply for an ITA.

Sections 101(a)(5)(A) and (D) of the MMPA direct NMFS to allow, upon request, the incidental, but not intentional, taking of small numbers of marine mammals of a species or population stock by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region if certain findings are made and either regulations are issued or, if the taking is limited to harassment, a notice of proposed authorization is provided to the public for review. Authorization for incidental taking shall be granted if NMFS finds that the taking will have a negligible impact on the affected species or stock(s) and will not have an unmitigable adverse impact on the availability of the species or stock(s) for taking for subsistence uses. NMFS must also prescribe: the permissible methods of taking pursuant to the activity; other means of effecting the "least practicable adverse impact" on the affected species or stock and its habitat and on the availability of such species or stock for subsistence uses; and requirements pertaining to the monitoring and reporting of such taking.

### 1.4.2 Need

NMFS anticipates receipt of applications to take marine mammals incidental to oil and gas industry exploration activities (i.e. G&G and ancillary surveys and exploratory drilling) pursuant to Sections 101(a)(5)(A) and (D) of the MMPA. This EIS is intended to assist NMFS in its MMPA decision-making process related to projected requests for ITAs in the U.S Beaufort and Chukchi seas for future years and may be revised as necessary. NMFS intends to use this EIS as the required NEPA documentation for the issuance of ITAs for Arctic oil and gas exploration activities. However, if necessary, NMFS may tier from this EIS to support future Arctic MMPA oil and gas permit decisions if such activities fall outside the scope of this EIS.

BOEM anticipates receipt of applications to conduct exploration surveys pursuant to the OCS Lands Act. BOEM intends to conduct site-specific NEPA analyses that either tier from this EIS or incorporate this EIS by reference. To fulfill statutory mandates for proposed exploratory drilling projects, BOEM requires the collection of high-resolution shallow hazards data to: (a) ensure safe operations, which refers to detection of shallow gas pockets, faults, channel boundaries or other geological or man-made features that could be hazards to drilling; (b) support environmental impact analyses; (c) protect resources through avoidance measures, such as prohibiting anchor locations within a boulder patch area or a potential archeological site; and (d) perform other statutory responsibilities.

## 1.5 Scoping

The scoping period for the *Effects of Oil and Gas Activities in the Arctic Ocean EIS* began on February 8, 2010 and ended April 9, 2010. Public scoping meetings were held during February and March 2010 in the communities of Kotzebue, Point Hope, Point Lay, Wainwright, Barrow, Nuiqsut, Kaktovik, and Anchorage. Scoping comments were received verbally and in writing through discussion, testimony, fax, regular mail, and electronic mail.

Of the issues identified during scoping, those that were most commonly raised included:

- Concerns regarding the NEPA process;
- Impacts to marine mammals and habitats;
- Risks of oil spills;
- Climate change;
- Protection of subsistence resources and the Iñupiat culture and way of life;
- Availability of research and monitoring data for decision-making;
- Monitoring requirements; and
- Suggestions for, or implementation of, mitigation measures.

For more detail on the issues raised during the scoping process, please refer to Appendix C of the EIS.

Executive Order 13175 (*Consultation and Coordination with Indian Tribal Governments*), states that the U.S. Government will "*work with Indian tribes on a government-to-government basis to address issues concerning Indian Tribal self-government, trust resources, and Indian Tribal treaty and other rights.*" For government-to-government consultation during the scoping process for this EIS, Tribal governments in each community, with the exception of Anchorage, were notified of the EIS process and invited to participate. The Tribal Organizations that received invitations to participate are listed below. Native Village of Point Hope declined to participate because they received less than one month of prior notification.

- Native Village of Nuiqsut
- Iñupiat Community of the Arctic Slope
- Native Village of Point Hope
- Native Village of Point Lay
- Native Village of Barrow
- Native Village of Wainwright
- Native Village of Kotzebue

## 2.0 ALTERNATIVES

A total of nine alternatives were initially considered for this EIS, with the No Action Alternative and four action alternatives carried forward for analysis. The alternatives dismissed and not considered for analysis focused on: permanent closures of areas; caps on levels of activity and/or noise; elimination of duplicative surveys; and zero discharge. Aspects of the dismissed alternatives have been incorporated into the four remaining action alternatives and/or mitigation measures to be considered for analysis.

NMFS and BOEM identified alternatives by:

- Evaluating alternative concepts suggested during the scoping period (such as using alternative technologies to airguns for seismic surveys).
- Reviewing potential alternatives in the context of NMFS and BOEM's regulatory requirements.
- Assessing potential levels of seismic exploration and exploratory drilling activities, and a suite of Standard Mitigation Measures.
- Identifying a range of potential Additional Mitigation Measures that need further analysis and may be applied to alternatives pursuant to the MMPA ITA process and the BOEM OCS Lands Act permitting process.

Alternatives were developed based on NMFS' desire to proactively analyze both the effects of multiple exploration activities and effectiveness of mitigation measures, and to anticipate regulatory compliance needs over the timeframe of this EIS.

Past ITAs have been issued for individual G&G surveys, ancillary activities, and exploratory drilling projects in the Beaufort and Chukchi seas in the form of Incidental Harassment Authorizations (IHAs) for periods of no more than one year at a time. This EIS analyzes the effects from multiple oil and gas industry exploration activities, the potential effects of authorizing takes from concurrent activities, and whether the standard mitigation and monitoring measures stipulated in the past are appropriate for current and reasonably foreseeable oil and gas activities. The analysis also includes additional mitigation measures suggested by the public or other agencies.

Based upon past lease sales, G&G permits, ancillary activity notices, exploration drilling exploration activities, and requests for ITAs, NMFS and BOEM have determined a reasonable range and level of activities for which permits and authorizations may be requested in the foreseeable future (i.e. five years [2012 to 2017]). While the level of activity proposed may vary from one year to the next, the action alternatives represent a reasonable range of exploration activities for which permits and authorizations may be requested.

In this EIS, NMFS and BOEM present and assess a reasonable range of G&G, ancillary, and exploratory drilling activities expected to occur, as well as a reasonable range of mitigation measures, in order to accurately assess the potential consequences of issuing ITAs under the MMPA and permits under the OCS Lands Act.

The five alternatives evaluated are:

- **Alternative 1:** No Action
- **Alternative 2:** Authorization for Level 1 Exploration Activity
- **Alternative 3:** Authorization for Level 2 Exploration Activity
- **Alternative 4:** Authorization for Level 2 Exploration Activity with Additional Required Time/Area Closures
- **Alternative 5:** Authorization for Level 2 Exploration Activity with Use of Alternative Technologies

The potential level of activity described by each alternative is based on recent federal and state lease planning and recent industry plans for both seismic surveys and exploratory drilling programs in the Beaufort and Chukchi seas.

For analysis in this EIS, one “program” entails however many surveys or exploration wells a particular company is planning for that season. Each “program” would use only one source vessel (or two source vessels working in tandem, e.g. OBC surveys) or drilling unit (i.e. drillship, jackup rig, SDC, etc.) to conduct the program and would not survey multiple sites or drill multiple wells concurrently. Survey vessels and drilling units are generally self-contained, with the crew living aboard the vessel. For surveys in the Beaufort Sea, support operations would likely occur out of West Dock or Oliktok Dock near Prudhoe Bay. Chukchi Sea surveys could be supported either from Wainwright or Nome. Helicopters stationed at either Barrow (for operations in either the Beaufort Sea or Chukchi Sea) or Deadhorse (for operations in the Beaufort Sea) would provide emergency or search-and-rescue support, as needed.

Site clearance and shallow hazards survey programs are contemplated in each action alternative and typically also include ice gouge and strudel scour surveys and are often referred to as marine survey programs by oil and gas industry operators. The ice gouge and strudel scour surveys do not involve the use of airguns but do involve the use of smaller, higher-frequency sound sources, such as multibeam echosounders and sub-bottom profilers. The area of a site clearance and shallow hazards survey, which is tied to a lease plan, is typically determined by the number of potential, future drill sites in the area. Table 2.4 outlines the typical types of sound sources used in these programs.

Table ES-1 presents a summary of the alternatives.

## Table ES-1 Summary of Alternatives

| Element | Alternative 1 – No Action | Alternative 2 | Alternative 3 | Alternative 4 | Alternative 5 |
|---|---|---|---|---|---|
| **Level of Activity** | No ITAs issued; No G&G permits or ancillary activity notices issued | Up to four 2D/3D seismic or CSEM surveys in the Beaufort Sea (Beaufort) and up to three 2D/3D seismic or CSEM surveys in the Chukchi Sea (Chukchi) per year. Up to one of the total number of surveys in each sea can include ice breaking if necessary. | Up to six 2D/3D seismic or CSEM surveys in the Beaufort and up to five 2D/3D seismic or CSEM surveys in the Chukchi per year. Up to one of the total number of surveys in each sea can include ice breaking if necessary | Same as Alternative 3 | Same as Alternative 3 |
| | | Up to three site clearance and high resolution shallow hazards survey programs in the Beaufort and up to three site clearance and high resolution shallow hazards survey programs in the Chukchi per year. | Up to five site clearance and high resolution shallow hazards survey programs in the Beaufort and up to five site clearance and high resolution shallow hazards survey programs in the Chukchi per year | Same as Alternative 3 | Same as Alternative 3 |
| | | One on-ice seismic survey in the Beaufort per year. | Same as Alternative 2 | Same as Alternative 2 | Same as Alternative 2 |
| | | One exploratory drilling program in the Beaufort and one exploratory drilling program in the Chukchi per year. | Up to two exploratory drilling programs in the Beaufort and up to two exploratory drilling programs in the Chukchi per year. | Same as Alternative 3 | Same as Alternative 3 |
| | | | | | |
| **Required Standard Mitigation Measures** | None needed | Full range of those measures described in Section 2.4.9 of the EIS for consideration as needed. | Same as Alternative 2 | Same as Alternative 2 | Same as Alternative 2 |
| | | | | | |
| **Additional Mitigation Measures** | None needed | Full range of those measures described in Section 2.4.10 of the EIS for consideration as needed. | Same as Alternative 2 | Same as Alternative 2 | Same as Alternative 2 |
| | | | | Additional required time/area closures for:<br>• Camden Bay<br>• Barrow Canyon/ Western Beaufort Sea<br>• Shelf Break of the Beaufort Sea<br>• Hannah Shoal<br>• Kasegaluk Lagoon/ Ledyard Bay Critical Habitat Unit | Additional Mitigation Measures that focus on the use of alternative technologies that have the potential to augment or replace traditional airgun-based seismic exploration activities. |

## 2.1 Alternative 1 – No Action

NEPA's implementing regulations require that the No Action Alternative be evaluated. Under the No Action Alternative, NMFS would not issue any ITAs under the MMPA for seismic surveys or exploratory drilling in the Beaufort and Chukchi seas, and BOEM would not issue G&G permits or authorize ancillary activities in the Beaufort and Chukchi seas. If companies proceeded to operate in this area without MMPA authorizations, any takes of marine mammals would occur in violation of the MMPA.

## 2.2 Alternative 2 – Authorization for Level 1 Exploration Activity

Alternative 2 is defined as the following:

### 2.2.1 Level of Activity

- Up to **four** 2D/3D seismic or CSEM surveys in the Beaufort Sea and up to **three** 2D/3D seismic or CSEM surveys in the Chukchi Sea per year, with up to **one** of that total number of surveys in each sea including ice breaking if necessary.
- Up to **three** site clearance and high resolution shallow hazards survey programs in the Beaufort Sea and up to **three** site clearance and high resolution shallow hazards survey programs in the Chukchi Sea per year.
- **One** on-ice seismic survey in the Beaufort Sea per year.
- **One** exploratory drilling program in the Beaufort Sea and **one** exploratory drilling program in the Chukchi Sea per year.

### 2.2.2 Mitigation

- Including *required* Standard Mitigation Measures (described in Section 3.6) that are part of every action alternative.
- Including a full analysis of a wide range of Additional Mitigation Measures (described in Section 3.6) that *could potentially* be required through the MMPA process and could vary by alternative (i.e. some might be different based on level and/or type of activity in a given year)

### 2.2.3 Assumptions

Seismic work in the Arctic has traditionally been conducted in ice-free months (July through November); although this analysis addresses the possibility of one survey utilizing an icebreaker and potentially continuing through mid-December. Seismic surveys are also conducted on-ice in areas where there is bottom fast ice in the winter. These surveys generally occur from January through May. Each survey takes between 30 and 90 days, depending on ice conditions, weather, equipment operations, size of area to be surveyed, timing of subsistence hunts, etc. Because of the limited time period of open water, it is likely that concurrent surveys would be conducted in the same general time frame and may overlap in time, but will not overlap in space (i.e. within a minimum of approximately 24 km [15 mi] of each independent survey operation) for reasons regarding data integrity. It is assumed for analytical purposes that at least one of the authorized 2D/3D seismic surveys in the Beaufort Sea and one in the Chukchi Sea would utilize an ice breaker.

Exploratory activities (including deep penetration seismic, site clearance and high resolution shallow hazards, and exploratory drilling) in the next five years will be concentrated in areas of recently purchased leases. This does not mean that there will not be exploratory activities in other areas of the U.S. Arctic Ocean, especially if BOEM's next Five Year Lease Plan schedule includes sales in the Arctic

OCS. In the U.S. Beaufort Sea, the two primary areas of interest for exploration are nearshore in Camden Bay and Harrison Bay. In the U.S. Chukchi Sea, the areas of interest are all well offshore in the lease areas, particularly around drill sites from the late 1980s, including Shell's Burger, Crackerjack, and Shoebill sites; ConocoPhillips' Klondike site; and Statoil's leases in the northeast part of the Lease Sale 193 area.

## 2.3 Alternative 3 – Authorization for Level 2 Exploration Activity

Alternative 3 is defined as the following:

### 2.3.1 Level of Activity

- Up to **six** 2D/3D seismic or CSEM surveys in the Beaufort Sea and up to **five** 2D/3D seismic or CSEM surveys in the Chukchi Sea per year, with up to **one** of that total number of surveys in each sea including ice breaking if necessary.
- Up to **five** site clearance and high resolution shallow hazards survey programs in the Beaufort Sea and up to **five** site clearance and high resolution shallow hazards survey programs in the Chukchi Sea per year.
- **One** on-ice seismic survey in the Beaufort Sea per year.
- Up to **two** exploratory drilling programs in the Beaufort Sea and up to **two** exploratory drilling programs in the Chukchi Sea per year.

### 2.3.2 Mitigation

- Including *required* Standard Mitigation Measures (described in Section 3.6) that are part of every action alternative.
- Including a full analysis of a wide range of Additional Mitigation Measures (described in Section 3.6) that *could potentially* be required through the MMPA process and could vary by alternative (i.e. some might be different based on level and/or type of activity in a given year).

Assumptions for the analysis of Alternative 3 would be the same as those listed for Alternative 2.

## 2.4 Alternative 4 – Authorization for Level 2 Exploration Activity <u>With Additional Required Time/Area Closures</u>

Alternative 4 is defined as the following:

### 2.4.1 Level of Activity

- Same level of activity as Alternative 3.

### 2.4.2 Mitigation

- Including *required* Standard Mitigation Measures (described in Section 2.4.9) that are part of every action alternative.
- Including *required* time/area closures for specific areas important to biological productivity, life history functions for specific species of concern, and subsistence activities. Activities would not be permitted to occur in any of the areas listed here during the specific time/area closure periods identified. Additionally, buffer zones around these time/area closures could potentially be included. Buffer zones would require that activities emitting pulsed sounds would need to

operate far enough away from these closure areas so that sounds at 160 dB re 1 µPa rms do not propagate into the area or that activities emitting continuous sounds would need to operate far enough away from these closure areas so that sounds at 120 dB re 1 µPa rms do not propagate into the area. In the event that a buffer zone of this size was impracticable, a buffer zone avoiding the ensonification of the important habitat above 180 dB could be used.

- Camden Bay – An area of high biological productivity, including kelp communities; a feeding and resting area for bowhead whales (including subadults and females with calves); fall subsistence bowhead whale hunting area.
    - Bowhead whales: September 1 – October 15 for primary migration and feeding (Huntington and Quakenbush 2009, Koski and Miller 2009, Quakenbush et al. 2010a)
    - Subsistence (bowhead whale hunting): late August – early October (Huntington and Quakenbush 2009)
    - Except for emergencies or human/navigation safety, oil and gas exploration operations shall not occur within Camden Bay or the designated buffer zones during the dates noted here.
- Barrow Canyon and the Western Beaufort Sea – An area of high biological productivity; a feeding area for bowhead and beluga whales; fall subsistence bowhead whale hunting area.
    - Bowhead whales: late August – early October
    - Beluga whales: mid-July through late August
    - Except for emergencies or human/navigation safety, oil and gas exploration operations shall not occur within the Barrow Canyon area or the designated buffer zones from August 1 to the close of the fall bowhead whale hunt in Barrow.
- Shelf Break of the Beaufort Sea – A feeding area for beluga whales.
    - Beluga whales: mid-July through late-September
- Hanna Shoal – An area of high biological productivity (benthic organisms); a feeding area for various marine mammals (walrus, gray whales, and bearded seals).
    - Walrus: July – August (USGS 2011)
    - Gray whales: late August – early October
    - Except for emergencies or human/navigation safety, oil and gas exploration operations shall not occur within the Hanna Shoal area or the designated buffer zones from September 1 through October 15.
- Kasegaluk Lagoon/Ledyard Bay Critical Habitat Unit – An important habitat for beluga whales, spotted seals, and spectacled eiders; subsistence beluga whale hunting area.
    - Subsistence (Kasegaluk Lagoon beluga whale hunting): mid-June through mid-July
    - Except for emergencies or human/navigation safety, oil and gas exploration operations shall not occur within the Ledyard Bay Critical Habitat Unit or the designated buffer zones between July 1 and November 15.

- To the maximum extent practicable, aircraft supporting seismic operations shall avoid operating below 1,500 ft (457 m) over the Unit between July 1 and November 15.

- Including a full analysis of a wide range of Additional Mitigation Measures (described in Section 2.4.10) that *could potentially* be required through the MMPA process and could vary by alternative (i.e. some might be different based on level and/or type of activity in a given year). The time/area closures that are described in this section that are optional for Alternatives 2, 3, and 5 would not be optional but rather required under Alternative 4.

Assumptions for the analysis of Alternative 4 would be the same as those listed for Alternative 2.

## 2.5 Alternative 5 – Authorization for Level 2 Exploration Activity <u>With Use of Alternative Technologies</u>

Alternative 5 is defined as the following:

### 2.5.1 Level of Activity

- Same level of activity as Alternative 3.

### 2.5.2 Mitigation

- Including *required* Standard Mitigation Measures (described in Section 2.4.9) that are part of every action alternative.
- Including a full analysis of a wide range of Additional Mitigation Measures (described in Section 2.4.10) that *could potentially* be required through the MMPA process and could vary by alternative (i.e. some might be different based on level and/or type of activity in a given year), potentially including new mitigations developed to apply to new technologies.
- Including specific additional measures that focus on the use of alternative technologies that have the potential to augment or replace traditional airgun-based seismic exploration activities.

Assumptions for the analysis of Alternative 5 would be the same as those listed for Alternative 2.

## 2.6 Standard Mitigation Measures

### 2.6.1 Standard Required Mitigation Measures

The mitigation measures (and the identified mitigation monitoring needed to support them) listed below will be included as a requirement under every ITA issued for the type of activity identified. In addition, some or all of these measures may also be included in G&G permit or ancillary activity approvals by BOEM. Full descriptions of these measures are contained in Appendix A.

**a) Detection-based measures intended to reduce near-source acoustic exposures and impacts on marine mammals within a given distance of the source**

*<u>2D/3D seismic surveys, including In-ice Seismic; Site Clearance and High Resolution Shallow Hazards Surveys</u>*

- Establishment of 180 dB shutdown/power down radius for cetaceans and 190 dB shutdown/power down radius for pinnipeds.
- Specified ramp-up procedures for airgun arrays.

- Protected Species Observers (PSOs; formerly referred to as Marine Mammal Observers [MMOs]) required on all seismic source vessels and ice breakers, as well as on support (chase) vessels.

*On-ice Seismic Surveys*

- All activities must be conducted at least 150 m (490 ft) from any observed ringed seal lair.
- No energy source may be placed over a ringed seal lair.

*Exploratory Drilling Activities*

- PSOs required on all drill ships and ice management vessels.

**b) Non-detection-based measures intended to more broadly lessen the severity of acoustic impacts on marine mammals or reduce overall numbers taken by acoustic source**

*This measure would be required for all activities that occur during the open-water season and In-ice (i.e. 2D/3D Seismic, including In-ice Surveys, Site Clearance and High Resolution Shallow Hazards Surveys, and Exploratory Drilling Activities).*

- Specified flight altitudes for all support aircraft except for take-off, landing, and emergency situations.

**c) Measures intended to reduce/lessen non-acoustic impacts on marine mammals**

*These measures would be required for all activities that occur during the open-water season and In-ice (i.e. 2D/3D Seismic, including In-ice surveys, CSEM surveys, Site Clearance and High Resolution Shallow Hazards Surveys, and Exploratory Drilling Activities).*

- Specified procedures for changing vessel speed and/or direction to avoid collisions with marine mammals.
- Notification of lost equipment that could pose a danger to marine mammals.

*On-ice Seismic Surveys*

- When traveling on ice-roads, the area shall be monitored for marine mammals.

*Exploratory Drilling Activities ONLY*

- Operators are required to have a plan(s) in place that a) minimize the likelihood of a spill; b) outline the response protocol in the event of the spill; and c) identify the means of minimizing impacts to marine mammals following a spill.

**d) Measures intended to ensure no unmitigable adverse impact to subsistence uses**

*These measures would be required for all activities that occur during the open-water season and In-ice (i.e. 2D/3D Seismic, including In-ice Surveys, CSEM surveys, Site Clearance and High Resolution Shallow Hazards Surveys, and Exploratory Drilling Activities).*

- Shutdown of activities occurring in specific areas of the Beaufort Sea corresponding to the start and conclusion of the fall bowhead whale hunts in Nuiqsut (Cross Island) and Kaktovik beginning on or around August 25.
- Establishment and utilization of Communication Centers in subsistence communities to address potential interference with marine mammal hunts on a real-time basis throughout the season.

- Required flight altitudes and paths for all support aircraft in areas where subsistence occurs, except during take-off, landing, and emergency situations.

## 2.7 Additional Mitigation Measures

The mitigation measures (and mitigation monitoring needed to support them) listed below are evaluated in Chapter 4, which could lead to some of these measures becoming Standard Mitigation Measures in the Final EIS. In the future, these Additional Mitigation Measures will be evaluated in the context of each specifically described activity to determine whether they should be required by NMFS in a specific ITA or by BOEM in a specific G&G permit or ancillary activity notice approval to make the necessary findings under the MMPA or the OCS Lands Act. In short, these measures may, or may not, be incorporated in future permits and authorizations, depending on the specific activity and the analysis conducted pursuant to the MMPA and the OCS Lands Act.

**a) Detection-based measures intended to reduce near-array acoustic exposures and impacts on marine mammals within a given distance of the source**

*2D/3D Seismic, and In-ice Surveys; Site Clearance and High Resolution Shallow Hazards Surveys; Exploratory Drilling Activities*

- Sound source verification tests for sound sources and vessels at the start of the season.
- Measures to assess efficacy and improve detection capabilities in low visibility situations (e.g. Forward Looking Infrared [FLIR] imaging devices, 360° thermal imaging devices).
- Limiting activities in situations of low visibility.
- Measures to increase detection probability for real-time mitigation (e.g. to maintain 180 dB shutdown zones), such as passive and active acoustic monitoring.
- Enhancement of monitoring protocols and mitigation shutdown zones to minimize impacts in specific biologic situations (e.g. cow/calf groups and feeding or resting aggregations).

**b) Non-detection-based measures intended to more broadly lessen the severity of acoustic impacts on marine mammals or reduce overall numbers taken by acoustic source**

*These measures would be required for all activities that occur during the open-water season and In-ice (i.e. 2D/3D seismic, including In-ice Surveys, Site Clearance and High Resolution Shallow Hazards Surveys, and Exploratory Drilling Activities).*

- Temporal/spatial limitations to minimize impacts in particular important habitats, including Camden Bay, Barrow Canyon/Western Beaufort Sea, Hanna Shoal, the shelf break of the Beaufort Sea, and Kasegaluk Lagoon/Ledyard Bay Critical Habitat Unit.
- NMFS restricting number of surveys (of same level of detail) that can be conducted in the same area in a given amount of time (i.e. to avoid needless collection of identical data).

*2D/3D Seismic, including In-ice Surveys ONLY*

- Separate seismic surveys are prohibited from operating within 145 km (90 mi) of one another.

**c) Measures intended to reduce/lessen non-acoustic impacts on marine mammals**

*These measures would be required for all activities that occur during the open-water season and In-ice (i.e. 2D/3D seismic, including In-ice seismic, CSEM surveys, Site Clearance and High Resolution Shallow Hazards Surveys, and Exploratory Drilling Activities).*

- Vessel and aircraft avoidance of concentrations of groups of ice seals, walrus, and polar bears.

- Specified shipping or transit routes to avoid important habitat in areas where marine mammals may occur in high densities.

*Exploratory Drilling Activities ONLY*

- Requirements to ensure reduced, limited, or zero discharge of any or all of the specific discharge streams identified with potential impacts to marine mammals or marine mammal habitat.
- Operators are required to recycle drilling muds.

*On-ice Seismic Surveys*

- Use trained seal-lair sniffing dogs for areas with water deeper than 3 m (9.8 ft) depth contour to locate seal structures under snow in the work area and camp site before initiation of activities.
- Use trained seal-lair sniffing dogs to survey the ice road and establish a route where no seal structures are present.

**d) Measures intended to ensure no unmitigable adverse impact to subsistence uses**

*These measures would be required for all activities that occur during the open-water season and In-ice (i.e. 2D/3D seismic, including In-ice surveys, CSEM surveys, Site Clearance and High Resolution Shallow Hazards Surveys, and Exploratory Drilling Activities).*

- No transit of exploration vessels into the Chukchi Sea prior to July 15 or until the beluga hunt is completed at Point Lay.
- Vessels transiting east of Bullen Point to the Canadian border should remain at least 8 km (5 mi) offshore during transit along the coast, provided ice and sea conditions allow.
- Shutdown of exploration activities in the Beaufort Sea for the Nuiqsut (Cross Island) and Kaktovik bowhead whale hunts based on real-time reporting of whale presence and hunting activity rather than a fixed date.
- Shutdown of exploration activities in the Beaufort Sea for the Barrow bowhead whale hunts from Pitt Point on the east side of Smith Bay to a location about half way between Barrow and Peard Bay from September 15 to the close of the fall bowhead whale hunt in Barrow.
- Shutdown of exploration activities in the Chukchi Sea for the Barrow (the area circumscribed from the mouth of Tuapaktushak Creek due north to the coastal zone boundary, to Cape Halkett due east to the coastal zone boundary) and Wainwright (the area circumscribed from Point Franklin due south to the coastal zone boundary, to the Kuk River mouth due west to the coastal zone boundary) bowhead whale hunts based on real-time reporting of whale presence and hunting activity rather than a fixed date.
- Shutdown of exploration activities in the Chukchi Sea for the Point Hope and Point Lay bowhead whale hunts based on real-time reporting of whale presence and hunting activity rather than a fixed date.
- Transit restrictions into the Chukchi Sea modified to allow offshore travel under certain conditions (e.g. 32 km [20 mi] from the coast) if beluga whale, fall bowhead whale (Barrow and Wainwright), and other marine mammal hunts would not be affected.

*Exploratory Drilling Activities ONLY*

- For exploratory drilling operations in the Beaufort Sea west of Cross Island, no drilling equipment or related vessels used for at-sea oil and gas operations shall be moved onsite at any location outside the barrier islands west of Cross Island until the close of the bowhead whale hunt in Barrow.

# 3.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

Chapter 3 of the EIS describes the current condition of the physical, biological, and social environment in the EIS project area to serve as a baseline to compare the potential impacts of the alternatives. Chapter 4 of the EIS analyzes the potential impacts of each alternative on physical, biological, and social resources. Impact levels were determined in consideration of the following four criteria:

**Intensity (Magnitude)**

Low: A change in a resource condition is perceptible, but it does not noticeably alter the resource's function in the ecosystem or cultural context.

Medium: A change in a resource condition is measurable or observable, and an alteration to the resource's function in the ecosystem or cultural context is detectable.

High: A change in a resource condition is measurable or observable, and an alteration to the resource's function in the ecosystem or cultural context is clearly and consistently observable.

**Duration**

Temporary: Impacts would be intermittent, infrequent, or last no more than a single season.

Long-term: Impacts would be frequent or extend up to several years.

Permanent: Impacts would cause a permanent change in the resource that would perpetuate even if the actions that caused the impacts were to cease.

**Extent**

Local: Impacts would be limited geographically; impacts would not extend to a broad region or a broad sector of the population.

Regional: Impacts would extend beyond a local area, potentially affecting resources or populations throughout the EIS project area.

State-wide: Impacts would potentially affect resources or populations beyond the region or EIS project area.

**Context**

Common: The affected resource is considered usual or ordinary in the locality or region; it is not depleted in the locality and is not protected by legislation. The portion of the resource affected does not fill a distinctive ecosystem role within the locality or the region.

Important: The affected resource is protected by legislation or is depleted either within the locality or the region. The portion of the resource affected fills a distinctive ecosystem role within the locality or the region.

Unique: The affected resource is protected by legislation and the portion of the resource affected fills a distinctive ecosystem role within the locality or the region.

Separate impact criteria tables were developed and used to guide the analysis of impacts for each of the resources discussed under the physical, biological, and social environments. The impact criteria tables use terms and thresholds that are quantified for some components and qualitative for other components.

The terms used in the qualitative thresholds are relative, necessarily requiring the analyst to make a judgment about where a particular effect falls in the continuum from "negligible" to "major".

Summary impact levels were then determined using the following guidance.

Negligible: Impacts are generally extremely low in intensity (often they cannot be measured or observed), are temporary, localized, and do not affect unique resources.

Minor: Impacts tend to be low in intensity, of short duration, and limited extent, although common resources may experience more intense, longer-term impacts.

Moderate: Impacts can be of any intensity or duration, although common resources may be affected by higher intensity, longer-term, or broader extent impacts while unique resources may be affected by medium or low intensity, shorter-duration, local or regional impacts.

Major: Impacts are generally medium or high intensity, long-term or permanent in duration, a regional or state-wide extent, and affect important or unique resources.

The following summary (Sections 3.1 to 3.3 of this Executive Summary) addresses only those resources that may experience greater than minor impacts, were identified during scoping as being of concern, or that highlight differences among the alternatives. Table ES-2 provides a summary of impacts to all resources for Alternative 1 through Alternative 5.

Because most of the alternative technologies associated with Alternative 5 have not yet been built and/or tested, it is difficult to fully analyze the level of impacts from them. The amount of traditional seismic surveys (i.e. use of airgun arrays) that can be replaced or augmented by these technologies is unknown; therefore, the level of impact reduction cannot be determined. This EIS examines a projected amount of use of these technologies but the actual amount that might be used between 2012 and 2017 is not fully known at this time. Therefore, NMFS has determined that additional NEPA analyses would likely be required if applications are received requesting to use these technologies.

## Table ES-2 Comparison of Impacts

| Impact Topic | Alternative 1- No Action Alternative | Alternative 2- Authorization for Level 1 Exploration Activity | Alternative 3- Authorization for Level 2 Exploration Activity | Alternative 4- Authorization for Level 2 Exploration Activity with Additional Required Time/Area Closures | Alternative 5- Authorization for Level 2 Exploration Activity with Use of Alternative Technologies | Very Large Oil Spill Scenario in Beaufort or Chukchi Sea |
|---|---|---|---|---|---|---|
| **PHYSICAL ENVIRONMENT** | | | | | | |
| **Physical Oceanography** | No effect | Minor impacts from deposition of materials during exploratory drilling, construction of artificial island, ice-breaking, and on-ice seismic surveys. | Same types of impacts as Alternative 2, intensity and extent of the impact would be doubled, level of impact still minor. | Same as Alternative 3 | Same as Alternative 3 | Moderate impact from the viscosity and stickiness of oil floating at the sea surface, temporary duration. |
| **Climate** | No effect | Minor impacts due to low contribution to GHG emissions. | Although the projected direct GHG emissions are higher than those projected for Alternative 2, impacts would be minor due to their low magnitude. | Same as Alternative 3 | Same as Alternative 3 | Minor to moderate impact from activities associated with a VLOS that would cause a temporary increase in GHG emissions |
| **Air Quality** | No effect | Minor impacts due to emissions from fuel combustion for oil and gas exploration activities. | Moderate impacts because the increase in detrimental effects on air quality is expected to be minimal. | Same as Alternative 3 | Same as Alternative 3 | Minor impact, as associated activities could cause temporary increase in emissions. |
| **Acoustics** | No effect | Moderate impacts from sound of exploration activities. | Moderate, although the number of exploration programs is increased from Alternative 2, the same types of noise-generating sources are to be used. | Same as Alternative 3 | Same as Alternative 3 | Effects of spill response and cleanup on the acoustic environment would be considered minor to moderate. |
| **Water Quality** | No effect | Impacts reduced to negligible by mitigation measures. | Impacts reduced to negligible by mitigation measures. | Same as Alternative 3 | Same as Alternative 3 | Major impact from sustained degradation of water quality by hydrocarbon contamination exceeding state and federal water and sediment quality criteria. |
| **Environmental Contaminants and Ecosystem Functions** | No effect | Negligible impacts, they could be medium intensity but would be local and temporary. | Minor impacts due to the greater level of activity increasing the potential volume of contaminants introduced to the project area. | Same as Alternative 3 | Same as Alternative 3 | Major impact from contamination caused degradation of ecosystems functions. |
| **BIOLOGICAL ENVIRONMENT** | | | | | | |
| **Lower Trophic Levels** | No effect | Minor impacts from disturbance of habitat and displacement of organisms from drilling, sediment sampling, ship anchoring, or platform installation; toxicity due to production discharge; increased productivity due to ice breaking. Introduction of invasive species from ship traffic could cause moderate impacts. | Minor impacts, the increased levels of activity would not generate different types or level of impacts.<br>Introduction of invasive species from ship traffic could cause moderate impacts. | Same as Alternative 2, the time/area closures would not affect lower trophic levels. | Same as Alternative 2, the use of alternative technologies would not affect lower trophic levels. | Moderate to major impact depending on if the spill persists or affects unique resources. |
| **Fish/Essential Fish Habitat** | No effect | Negligible impacts, small scale and temporary only. | Negligible impacts, increased activities would not change the impact level. | Negligible impacts. The time/area closures would reduce the impacts to lower than Alternative 2. | Negligible impacts. The use of alternative technologies may reduce any impact. | Moderate impact from toxic exposure and habitat contamination. |
| **Marine and Coastal Birds** | No effect | Negligible impacts from temporary and localized disturbance, injury/mortality, and changes in habitat. | Negligible impacts, increased activities would not change the impact level. | Same as Alternative 3 | Same as Alternative 3 | Major impact from toxic exposure to prey and individuals, mortality of individuals, and contamination of habitat. |

| Impact Topic | Alternative 1- No Action Alternative | Alternative 2- Authorization for Level 1 Exploration Activity | Alternative 3- Authorization for Level 2 Exploration Activity | Alternative 4- Authorization for Level 2 Exploration Activity with Additional Required Time/Area Closures | Alternative 5- Authorization for Level 2 Exploration Activity with Use of Alternative Technologies | Very Large Oil Spill Scenario in Beaufort or Chukchi Sea |
|---|---|---|---|---|---|---|
| **Marine Mammals: Bowhead Whales** | No effect | Minor to moderate impacts from noise disturbance, possible ship strikes, or habitat degradation. | Moderate impacts from noise disturbance, possible ship strikes, or habitat degradation. | Moderate impacts. Although the Time/Area closures could reduce adverse impacts in particular times and locations, the impact level would not change. | Moderate impacts. Despite possible localized mitigating capabilities of alternative technologies the impact level would not change. | Major impact from toxic exposure, loss of seasonal habitat, reduction and contamination of prey, and disturbance from increased human activity. |
| **Marine Mammals: Beluga Whales** | No effect | Minor to moderate impacts from noise disturbance, possible ship strikes, or habitat degradation. | Moderate impacts from noise disturbance, possible ship strikes, or habitat degradation. | Moderate impacts. The effects on beluga whales would be similar to Alternative 3 but may occur in different times and places. | Moderate impacts. Although the gradual introduction of these alternative technologies could eventually reduce the amount of seismic noise introduced into the marine environment, alternative technologies would not completely replace the existing technology, so moderate impacts would remain. | Major impact from toxic exposure, loss of seasonal habitat, reduction and contamination of prey, and disturbance from increased human activity. |
| **Marine Mammals: Other Cetaceans** | No effect | Minor impacts from temporary, local disturbance. | Minor impacts from temporary, local disturbance. Increased activities would not change the impact level. | Minor impacts. Although the time/area closures could reduce adverse impacts in particular times and locations, the overall exploration effort may not be reduced, but, rather, redistributed and possibly concentrated in other areas, so the impact would not change. | Minor impacts. Alternative technologies could reduce the extent to localized areas on a small scale; it is not currently possible to assess potential behavioral reactions and determine if intensity level would change as a result. | Major impact from toxic exposure, loss of seasonal habitat, reduction and contamination of prey, and disturbance from increased human activity. |
| **Marine Mammals: Pinnipeds** | No effect | Minor impacts from temporary localized disturbance. | Minor impacts from temporary localized disturbance. Increased activities would not change the impact level. | Minor impacts. Although the time/area closures would reduce potentially adverse effects on seals in those areas, the impact level would not change. | Minor impact. Alternative technologies would presumably reduce the amount of noise introduced but would still use marine vessels which are at least as important for disturbance to seals in the water. | Minor to moderate impact from toxic exposure, loss of seasonal habitat, reduction and contamination of prey, and disturbance from increased human activity. |
| **Marine Mammals: Pacific Walrus** | No effect | Minor impacts from disturbance, risk of injury or mortality, and changes in habitat in the Chukchi Sea.<br>No impact from activities in the Beaufort Sea as they are uncommon there. | Minor impacts from disturbance, risk of injury or mortality, and changes in habitat in the Chukchi Sea. Despite the increased activity, there would be no increase in the impact level.<br>No impact from activities in the Beaufort Sea as they are uncommon there. | Minor impacts, although time/area closures would reduce potentially adverse effects on walrus in those areas.<br>No impact from activities in the Beaufort Sea as they are uncommon there. | Minor impacts. Alternative seismic technologies for in-ice surveys would likely still require the use of ice and would therefore have similar disturbance effects on walrus as those technologies currently in use.<br>No impact from activities in the Beaufort Sea as they are uncommon there. | Minor to moderate impact from VLOS in Chukchi sea from toxic exposure, loss of seasonal habitat, reduction and contamination of prey, and disturbance from increased human activity.<br>Negligible effect from VLOS in the Beaufort as walrus are uncommon there. |
| **Marine Mammals: Polar Bears** | No effect | Minor impacts from temporary localized disturbance. | Minor impacts from temporary localized disturbance. Despite the increased activity, there would be no increase in the impact level. | Minor impacts. The time/area closures may protect ice seals, a primary food source for polar bears. | Minor impacts. Alternative technologies would presumably reduce the amount of noise introduced but would still use marine vessels which are at least as important for disturbance to polar bears in the water. | Moderate to major impacts from toxic exposure, habitat loss, contamination of prey, and increased human activity. |
| **Terrestrial Mammals** | No effect | Minor impacts from temporary localized disturbance, risk of vehicle strikes, and habitat alternations. | Minor impacts. Despite the increased activity, there would be no increase in the impact level. | Minor impacts. The time/area closures would not affect terrestrial mammals. | Minor impacts. The use of alternative technologies would not affect terrestrial mammals. | Minor to moderate impact from toxic exposure, habitat loss, and temporary disturbance. |
| **SOCIAL ENVIRONMENT** | | | | | | |
| **Socioeconomics** | Minor adverse impact from unrealized local employment and tax revenue. | Minor beneficial impact from temporary rise in regional personal income and employment rates. | Minor beneficial impact. Despite the increased activity, there would be no increase in the impact level because the increases in income and employment rates are not more than 5 percent. | Minor beneficial impact. The time/area closures could reduce total local employment rates and personal income so the positive impact would be less than Alternative 2. | Minor beneficial impact. The alternative technologies could result in additional costs from lost productivity so the positive impact would be less than Alternative 2. | Major impact from changes in employment, revenues, workforce, demographics, subsistence, and local and state agency spending. |
| **Subsistence** | No effect | Negligible to moderate impacts from disturbance. | Negligible to moderate impacts from disturbance. Even with the increased activities, the impacts to subsistence resources and harvest would be similar in type, intensity, and duration, but would occur in more locations. | Negligible to moderate impacts from disturbance. However time/area closures would reduce impacts from disturbance on subsistence harvest and use for certain communities. | Negligible to moderate impacts from disturbance. The effectiveness of these alternative technologies to reduce adverse impacts to subsistence uses is unknown. If alternative technologies reduce disturbance to marine mammals, that would reduce impacts to subsistence users. | Major impact from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices. |

| Impact Topic | Alternative 1- No Action Alternative | Alternative 2- Authorization for Level 1 Exploration Activity | Alternative 3- Authorization for Level 2 Exploration Activity | Alternative 4- Authorization for Level 2 Exploration Activity with Additional Required Time/Area Closures | Alternative 5- Authorization for Level 2 Exploration Activity with Use of Alternative Technologies | Very Large Oil Spill Scenario in Beaufort or Chukchi Sea |
|---|---|---|---|---|---|---|
| **Public Health** | No effect | Negligible impacts from changes to:<br>• Diet and nutrition<br>• Contamination<br>• Safety<br>• Acculturative stress<br>• Economic impacts<br>• Health care services | Negligible impacts from changes to:<br>• Diet and nutrition<br>• Contamination<br>• Safety<br>• Acculturative stress<br>• Economic impacts<br>• Health care services<br>Despite the increased activity, there would be no increase in the impact level. | Negligible impacts. If the time/area closures improve the likelihood of maintaining a strong subsistence harvest, there will also be resulting reduction in adverse impacts to public health. If the closures allow hunters to complete their hunts with less travel time, it will benefit safety. However, these benefits do not affect the overall impact criteria rating, as it is are already negligible. | Negligible impacts. The alternative technologies may reduce disturbance to marine mammals, which could reduce adverse impacts to subsistence users. However, the effectiveness of the alternative technologies in reducing adverse impacts to subsistence uses is unknown. Therefore, the impact rating remains the same. If the alternative technologies are demonstrated to be effective, they would benefit public health. | Moderate to major impacts from introduced diseases from outside workers, strain on local health care system, poor air quality, increased stress, potentially contaminated food, and change to subsistence harvest patterns. |
| **Cultural Resources** | No effect | Negligible impact. | Negligible impact. | Minor impact. The time/area closures would not affect cultural resources. | Minor impact. The alternative technologies would not affect cultural resources. | Minor to moderate impact from onshore clean-up activities. |
| **Land and Water Ownership, Use, and Management** | Major adverse impacts from loss of opportunity to explore for oil and gas. | Moderate impacts to land and water use from activity in new areas and potential long-term development.<br>Negligible impacts to land and water ownership and management as no changes in management or ownership would occur. | Moderate impacts to land and water use from possible conflict between subsistence use and seismic surveys, changes in industrial, transportation, and commercial land use and management. Slightly higher possibility of new facilities and infrastructure, higher levels of air and vessel traffic, and commercial activity associated with survey support.<br>Minor impacts to land and water management - as activities increase, the possibility for conflicts with borough offshore development policies goes up as well.<br>Negligible impacts to land and water ownership as no changes in ownership would occur. | Moderate impacts to land and water use.<br>As time/area closures are implemented, the likelihood of conflicts decreases because the closures would lessen the exposure of subsistence species to seismic activities and exploratory drilling at critical locations and during critical seasons of the year. Time/area closures would shorten the timeframe available for oil and gas exploration activities and potentially impede exploration activity. As a result, there may be a reduction in transportation and commercial uses during certain times of the year.<br>Minor impacts to land and water management. Constraining exploration to certain times and locations may result in more moderate state and federal resource development goals, while promoting management practices to protect the human, marine and coastal environments, and improve consistency with North Slope Borough and Northwest Arctic Borough comprehensive plans and Land Management Regulations. Therefore, because these techniques reflect balanced management and do not prohibit resource development, no inconsistencies or changes in federal or state land or water management are anticipated.<br>Negligible impacts to land and water ownership as no changes in ownership would occur. | Moderate impacts to land and water use from activity in new areas and potential long-term development.<br>Minor impacts to land and water management.<br>Negligible impacts to land and water ownership as no changes in ownership would occur. | Major impact to land and water use and management from changes in resource use/values, and high response activity level, and changes in management to accommodate response.<br>Negligible impact to land and water ownership. |
| **Transportation** | No effect | Negligible (aircraft and vehicle) to minor (vessel) impacts from increased traffic. | Minor to moderate impacts from increased traffic. | Minor to moderate impacts from increased traffic. The time/area closures would limit the amount of aircraft overflights in these areas. | Minor to moderate impacts from increased traffic. It is assumed that these new alternative technologies would require the same levels of aircraft and surface and vessel support as under Alternative 3, and, therefore, the impacts are expected to be similar. | Moderate to major impacts from increased levels of air, vessel, and surface traffic from spill response activities. |
| **Recreation and Tourism** | No effect | Minor impacts from temporary and local effects on recreational setting. | Minor impacts from temporary and local effects on recreational setting. The increased levels of activity would not generate different types or level of impacts. | Minor impacts from temporary and local effects on recreational setting. If the time/area closures benefit marine mammals, they would also benefit recreation and tourism based on wildlife viewing. | Minor impacts from temporary and local effects on recreational setting. The alternative technologies would not affect recreation or tourism. | Major impact from displacement of recreationists and reduction in tourism |
| **Visual Resources** | No effect | Moderate impacts from high contrast of drill sites and associated activities. | Moderate impacts from high contrast of drill sites and associated activities. | Same as Alternative 3. | Same as Alternative 3. | Major impact from acute disturbance in visual resources. |

| Impact Topic | Alternative 1- No Action Alternative | Alternative 2- Authorization for Level 1 Exploration Activity | Alternative 3- Authorization for Level 2 Exploration Activity | Alternative 4- Authorization for Level 2 Exploration Activity with Additional Required Time/Area Closures | Alternative 5- Authorization for Level 2 Exploration Activity with Use of Alternative Technologies | Very Large Oil Spill Scenario in Beaufort or Chukchi Sea |
|---|---|---|---|---|---|---|
| **Environmental Justice** | No effect | Minor adverse impacts from disruption of subsistence activities and potential contamination of subsistence food.<br>Minor beneficial impacts from local employment opportunities. | Minor adverse impacts from disruption of subsistence activities and contamination of subsistence food.<br>Minor beneficial impacts from local employment opportunities. | Minor impacts. With the time/area closures, the impacts to subsistence activities could be further minimized but would remain minor. | Minor impacts. With the alternative technologies, the impacts to subsistence foods and human health could be further minimized but would remain minor. | Moderate to major impacts from disproportionate adverse effect on minority populations from impacts to subsistence foods and human health. |

## 3.1 Physical Environment

### 3.1.1 Air Quality

The EIS project area is in attainment (or unclassifiable) for all air quality criteria pollutants. The maximum measured concentrations are all well below the National Ambient Air Quality Standards and Alaska State Standards. These values are indicative of the relatively good air quality in the area, and indicate that future development would not likely jeopardize the region's ability to meet the federal and State of Alaska air quality standards.

**Impacts**

- All action alternatives would cause minor to moderate impacts to air quality from air pollutant emissions. The majority of emissions are from fuel combustion for vessel propulsion and power generation. The expected emission levels would equal but not exceed air quality regulatory limits.
- The increase in emissions from the additional activities under Alternatives 3, 4, and 5 would be minimal so the impact remains moderate.

### 3.1.2 Acoustics

The existing airborne and underwater noise environment in the EIS project area is influenced by sounds from natural and anthropogenic sources. The primary natural source of airborne noise on the offshore, nearshore, and onshore regions is wind, although wildlife can produce considerable sound during specific seasons in certain nearshore and onshore regions. Anthropogenic noise levels in the Beaufort Sea region are higher than the Chukchi Sea due to the oil and gas developments of the nearshore and onshore regions of the North Slope, particularly in the vicinity of Prudhoe Bay. Noise sources consist of regular air traffic, vehicular traffic on the numerous roads within the development areas (such as around Deadhorse). Noise is also produced by the operations of heavy construction and industrial equipment that service the wells, processing facilities, pipelines, and camps. Industrial activities occur throughout the region on a year-round basis.

Anthropogenic noise levels in the nearshore and onshore region will be higher in populated areas – the coastal communities of Wainwright, Point Lay, Point Hope, Kivalina, and Barrow – with increasing noise levels associated with the larger communities. Community noise consists of aircraft, vehicular traffic (including all-terrain vehicles and snow machines), construction equipment, people talking/yelling, dogs barking, power plants, skiffs used for hunting, generators, etc.

Underwater noise is comprised of natural and anthropogenic sources. It varies temporally (daily, seasonally, annually) depending on weather conditions and the presence of anthropogenic and biological sources. Natural sound sources in the Arctic Ocean include earthquakes, wind, ice, and sounds from several animal species. Anthropogenic noise sources include vessel traffic, oil and gas exploration, and other miscellaneous sources.

**Impacts**

- While high sound levels do not constitute an effect, the presence of high sound levels from anthropogenic activity and consequent exposures of marine wildlife to these conditions could potentially cause effects. The impact criteria for acoustics are based on the existence of sound levels that could cause effects.
- All action alternatives would cause moderate impacts to acoustics because they produce underwater sound levels that could exceed ambient noise levels or exceed disturbance and injury thresholds.

- The increased activity under Alternatives 3, 4 and 5 would not raise the sound level above the moderate impact level.
- The time/area closures that characterize Alternative 4 are intended to avoid the ensonification above injury or disturbance thresholds of areas where marine mammals concentrate at higher densities to conduct specific important behaviors or in areas of typical subsistence hunts, which should result in a reduction in the total number of individuals taken, as well as avoiding the more potentially severe impacts that could be associated with disturbances to the identified biologically important behavior. Moderate impacts remain, as the exploration activities in non-closure areas/periods will introduce sources that produce underwater sound levels that exceed disturbance and injury thresholds.
- Under Alternative 5, the use of alternative technologies that reduce sound levels from seismic survey sources would not reduce the impact level which would be moderate. This is because it is unlikely the technologies will entirely preclude the generation of sound levels exceeding the injury and disturbance criteria.

## 3.2 Biological Environment

### 3.2.1 Marine Mammals

Bowhead and belugas whales are discussed below. The alternatives would be expected to have only minor impacts to other marine mammals (other cetaceans, pinnipeds, Pacific walrus, and polar bear) which are not discussed here. Please see Chapter 4 of the EIS for a complete discussion of impacts to these species.

Both bowhead and beluga whales could be present in the EIS project area throughout the spring, summer, and fall. Both species use the area during migration and for feeding. Bowhead whales are known to concentrate in the Barrow area for feeding during the spring and fall, in Camden Bay in the fall, and on the western Beaufort Sea shelf off Point Barrow in the late summer and fall. Beluga whales are known to feed in Barrow Canyon, the Shelf Break of the Beaufort Sea, and in Kasegaluk Lagoon/Ledyard Bay Critical Habitat.

The primary impact on bowhead and beluga whales resulting from the action alternatives would be from noise exposure. Noise can cause behavioral disturbance and, in specific limited circumstances, auditory impairment. Disturbance to feeding, resting, or migrating bowhead or beluga whales could cause whales to leave areas of exploration activity during the activity and potentially avoid them in the future as well, effectively reducing their available habitat. Ship strikes and habitat degradation are also possible. Oil and gas exploration activities that may alter whale habitat include: disturbance of sea ice from icebreaking, disturbance of benthic sediments during drilling, contamination of the marine environment from discharge of drilling muds and other waste streams from ships and support facilities.

**Impacts**

- All action alternatives would cause minor to moderate impacts to bowhead and beluga whales from noise disturbance, risk of ship strikes, and habitat degradation.
- The increased activity under Alternatives 3, 4 and 5 would not increase the impact level above moderate for bowhead and beluga whales.
- The time/area closures under Alternative 4 would reduce the potential disturbance to bowhead and beluga whales in the closure areas during time periods specified. Exploration activities could, however, occur during different time periods within these areas, leading to a short-term reduction of effects. In addition, industry may relocate exploration activities to other, possibly adjacent, areas until the closure areas are available. Exploration effort may not be reduced, but,

rather, redistributed and possibly concentrated in other areas. The time/area closures that mitigate adverse impacts on concentrations of bowhead whales, mothers and calves, and important life history functions, such as feeding, could reduce impacts to a lower intensity, shorter duration and more localized areas than would result if the closures were not implemented. However, bowhead whale habitat use in the EIS project area is dynamic and, when migration corridors are considered includes large portions of the Beaufort and Chukchi seas that are not included in the time/area closures. Although the time/area closures could mitigate adverse impacts in particular important times and locations (lessening the intensity of the impacts), the total impact on (in terms of number of takes of) bowhead whales and beluga whales from oil and gas exploration activities allowed under Alternative 4 would be similar to Alternative 3 and would be considered moderate.

- The use of alternative technologies under Alternative 5 may reduce adverse impacts associated with the use of airgun arrays, but the results are difficult to determine and the overall reduction would likely be minimal. Airgun noise would not be eliminated, however, since these alternative technologies would not completely replace the existing technology, and what may be replaced is limited. In addition, surveys conducted with alternative technologies would still use marine vessels to tow or deploy equipment which could disturb bowhead whales, beluga whales, and other cetaceans. While the use of the alternative technologies described here in lieu of, or as a mitigation for, seismic airguns would be expected to reduce the extent of impacts somewhat; due to the fact that some of the technologies are still in the development phase, which means that neither their effects nor potential date of availability are well known, it is not currently possible to predict to what degree impacts on marine mammals will be reduced.

## 3.3 Social Environment

### 3.3.1 Socioeconomics

Exploration, development, production, and transportation of oil and gas are the major contributors to the economy of Alaska and the NSB. Other sectors include government, transportation, and mining.

**Impacts**

- Alternative 1 (No Action) would cause minor adverse impacts from unrealized local employment and tax revenue. The potential unrealized revenue for state and federal governments is unknown since the likelihood of exploration resulting in production cannot be predicted.
- All four action alternatives would cause minor beneficial impacts from a temporary rise in regional personal income and employment rates.
- Alternatives 3, 4, and 5 would not cause an increase in the level of beneficial impact because income and employment rates are not expected to rise more than five percent.
- The time/area closures under Alternative 4 could reduce total income and employment rates and therefore the beneficial impact would be less than Alternative 3, but would still be minor.
- The alternative technologies requirement under Alternative 5 could cause additional costs from lost productivity so the beneficial impact would be less than Alternative 3, but would still be minor.

### 3.3.2 Subsistence

Subsistence resources in the EIS project area are harvested by the communities of Kaktovik, Nuiqsut, Barrow, Wainwright, Point Lay, Point Hope, Kivalina, and Kotzebue. Resources harvested include the bowhead whale, beluga whale, seals (bearded, ribbon, ringed, and spotted), walrus, polar bear, fish, migratory waterfowl (including their eggs), and caribou.

Oil and gas exploration activities could disturb and displace subsistence resources, causing them to move away from coastal waters and become less readily available to subsistence hunters. Contamination of subsistence resources through discharge of drilling muds and other waste streams from ships and support facilities industrial pollution would be possible.

**Impacts**

- All action alternatives except Alternative 4 (time/area closures) would have impacts ranging from negligible to moderate depending on the species to be harvested. Minor to moderate impacts are expected for bowhead and beluga whales, negligible to minor impacts for seals, walrus, polar bears, fish, birds, and caribou.
- Alternative 4 would see a slight reduction in adverse impacts on subsistence uses from Alternative 3 because the time/area closures that protect whales would be required for all activities rather than being considered as an additional mitigation measure. Minor impacts are expected for bowhead and beluga whales, negligible to minor impacts for seals, walrus, polar bears, fish, birds, and caribou.
- The impact level under Alternative 5 would be reduced if the alternative technologies are successful in reducing disturbance to marine mammals.

### 3.3.3 Land and Water Ownership, Use, and Management

The lands and waters within the EIS project area are owned and managed by many different entities including: the federal government, state government, borough government, Alaska Native corporations, and Alaska Native allottees. Land and water uses in the area include; recreation, subsistence, industrial, residential, mining, protected natural areas, transportation, and commercial activities.

Oil and gas exploration activities could affect land and water ownership, use, or management by causing a change in the ownership, use, or management of land or water in the EIS project area. These changes could include; rezoning, increases in transportation activity, construction of infrastructure, and seismic surveys in subsistence hunting areas.

**Impacts**

- The No Action alternative would have a major impact on land and water use and management because it would be a significant change from existing conditions. This alternative would be contrary to current federal and state management of offshore waters. This alternative would cause a change in activity levels and affect management plans and would change federal, state, and private development rights by preventing exploration for oil and gas resources.
- Impacts to land and water use would be moderate for all four action alternatives due to changes in use patterns.
- Impacts to land and water management would be as follows for the four action alternatives: negligible for Alternative 2 as no changes are expected; minor for Alternative 3 as the increased activity level may cause conflicts with management plans; minor for Alternative 4 because the time/area restrictions are a change in management; and minor for Alternative 5.
- Impacts to land and water ownership would be negligible for Alternatives 2, 3, 4 and 5 as no changes in ownership would occur.

### 3.3.4 Visual Resources

Visual resources within the EIS project area are dominated by characteristics of the Beaufort and Chukchi seas. The visual characters of these waterbodies undergo dramatic changes across seasons, due in large part to the dynamic seasonal cycle of sea ice. During the fall, winter, and spring seasons, both the Beaufort and Chukchi seas are covered by sea ice. The scenic quality of the EIS project area (separated into the east/west portions of the Beaufort and Chukchi seas) was ranked using the following seven key factors: landform, vegetation, water, color, adjacent scenery, scarcity, and cultural modification. All four sections were ranked as having Class A scenery during summer months and Class B scenery during the winter months.

Oil and gas exploration activities would affect impact visual resources by creating visual contrast that may change the scenic quality of the area.

**Impacts**

- All four action alternatives would have short-term, moderate impacts on scenic quality and visual resources.
- Alternatives 3, 4, and 5 could have higher intensity impacts because of the greater number of support vessels used in the two exploratory drilling programs if both programs are implemented close to each other. However, impacts would not increase above the moderate level.
- Neither the implementation of time/area closures nor the use of alternative technologies would affect visual resources.

## 3.4 Comparison of Impacts by Alternative

Alternative 1 would have adverse direct or indirect impacts on two resources: socioeconomics and land and water ownership, use, and management. If NMFS did not issue any ITAs and BOEM did not issue G&G permits or ancillary activity notices as discussed under Alternative 1, it would effectively prevent offshore exploration for oil and gas resources causing a loss of local employment and tax revenue, and a major change in land use.

None of the four action alternatives would have major impacts on any resource. The biggest difference among the four action alternatives is between Alternatives 2 and 3, due to the difference in the level of activity. To illustrate this, it is useful to compare the number of resources that would experience a summary level of moderate impacts: Alternative 2 would moderately impact four resources, while Alternatives 3 and 5 would impact seven, and Alternative 4 would impact six. Alternative 2 also has the highest number of resources that would have negligible impacts at nine, compared to five resources under the other alternatives.

The time/area closures under Alternative 4 would reduce the summary level of impact for subsistence resources. Although it would also reduce impacts to bowhead and beluga whales and other marine mammals, the amount of benefit gained would not reduce the summary impact levels from moderate to minor.

The impacts of Alternatives 3 and 5 would be the same because the effectiveness of the alternative technologies to reduce impacts is currently unknown, and it is expected that some level of existing technology would still be used during the timeframe of this EIS.

NMFS analyzed the impact of each alternative on 25 different resource categories. Table ES-3 shows the number of resources impacted at each level by alternative.

**Table ES-3 Impact Conclusions by Alternative**

| Impact Conclusion | Alternative 1 | Alternative 2 | Alternative 3 | Alternative 4 | Alternative 5 |
|---|---|---|---|---|---|
| Negligible | 0 | 9 Resources | 5 Resources | 5 Resources | 5 Resources |
| Minor | 1 Resource | 10 Resources | 12 Resources | 13 Resources | 12 Resources |
| Minor to Moderate | 0 | 2 Resources | 1 Resource | 1 Resource | 1 Resource |
| Moderate | 0 | 4 Resources | 7 Resources | 6 Resources | 7 Resources |
| Major | 1 Resource | 0 | 0 | 0 | 0 |

The following sections summarize the impacts of each action alternative.

### 3.4.1 Alternative 2 Impact Levels

Alternative 2 would have moderate impacts on four resources: acoustics; land and water ownership, use, and management; subsistence, and visual resources. Minor to moderate impacts would occur to bowhead whales and beluga whales. Minor impacts would occur to: physical oceanography; climate; air quality; lower trophic levels; other cetaceans; pinnipeds; polar bears; terrestrial mammals; and socioeconomics. Impacts to all other resources would be negligible. A summary of this information can be seen in Table ES-4.

**Table ES-4 Alternative 2 Impact Levels**

| Minor | Minor to Moderate | Moderate |
|---|---|---|
| Physical Oceanography<br>Climate<br>Air Quality<br>Lower Trophic Levels<br>Other Cetaceans<br>Pinnipeds<br>Pacific Walrus (Chukchi)<br>Polar Bears<br>Terrestrial Mammals<br>Socioeconomics | Bowhead Whales<br>Beluga Whales | Acoustics<br>Visual<br>Land and Water Ownership, Use, and Management<br>Subsistence |

### 3.4.2 Alternative 3 Impact Levels

Alternative 3 would have moderate impacts to seven resources: air quality; acoustics; bowhead whales; beluga whales; land and water ownership, use, and management; subsistence; and visual resources. Minor to moderate impacts would occur to transportation. Minor impacts would occur to physical oceanography, climate, environmental contaminants and ecosystem functions, lower trophic levels, other cetaceans, pinnipeds, Pacific walrus, polar bears, terrestrial mammals, socioeconomics, recreation and tourism, and environmental justice. Impacts to all other resources would be negligible. A summary of this information can be seen in Table ES-5.

**Table ES-5 Alternative 3 Impact Levels**

| Minor | Minor to Moderate | Moderate |
|---|---|---|
| Physical Oceanography<br>Climate<br>Environmental Contamination<br>Lower Trophic Levels<br>Other Cetaceans<br>Pinnipeds<br>Polar Bears<br>Terrestrial Mammals<br>Environmental Justice<br>Pacific Walrus<br>Socioeconomics (beneficial)<br>Recreation and<br>Tourism | Transportation | Acoustics<br>Visual<br>Land and Water Ownership, Use, and Management<br>Subsistence<br>Air Quality<br>Beluga Whales<br>Bowhead Whales |

### 3.4.3 Alternative 4 Impact Levels

Alternative 4 would have moderate impacts on five resources: air quality; acoustics; beluga whales, land and water ownership, use, and management; and visual resources. Subsistence resources would benefit from the time/area closures, so the impact level would be minor and beneficial. Minor to moderate impacts would occur to transportation. Minor impacts would occur to physical oceanography, climate, environmental contaminants and ecosystem functions, lower trophic levels, other cetaceans, pinnipeds, Pacific walrus, polar bears, terrestrial mammals, socioeconomics, recreation and tourism, and environmental justice. Impacts to all other resources would be negligible. A summary of this information can be seen in Table ES-6.

**Table ES-6 Alternative 4 Impact Levels**

| Minor | Minor to Moderate | Moderate |
|---|---|---|
| Physical Oceanography<br>Climate<br>Environmental Contamination<br>Lower Trophic Levels<br>Other Cetaceans<br>Pinnipeds<br>Polar Bears<br>Terrestrial Mammals<br>Environmental Justice<br>Pacific Walrus<br>Socioeconomics<br>Subsistence<br>Recreation and Tourism | Transportation | Acoustics<br>Visual<br>Land and Water Ownership, Use, and Management<br>Air Quality<br>Beluga Whales |

### 3.4.4 Alternative 5 Impact Levels

Alternative 5 would have the same level of impacts as Alternative 3. The use of alternative technologies would not change the level of impact for any of the resources.

## 3.5 Cumulative Impacts

Cumulative effects of development are a major concern of many stakeholders in the Chukchi and Beaufort seas. The nature and level of activities in the Arctic have been increasing over time, particularly in offshore areas. Changes in climate characteristics are also factors in potential cumulative effects. Past, present, and reasonably foreseeable future actions and activities considered for the cumulative effects analysis include: oil and gas exploration, development, and production activities; scientific research; mining exploration, development, and production; military facilities and training exercises; air and marine transportation; major community development projects; subsistence activities; recreation and tourism; and climate change. Commercial whaling in the late 19th century is also a past effect specific to bowhead whales that still influences population levels.

Alternative 1 would have minor cumulative impacts to socioeconomics, and major cumulative impacts to land and water ownership, use and management.

Any of the four action alternatives would have major cumulative impacts on visual resources and moderate impacts on climate, air quality, lower trophic levels, bowhead whales, beluga whales, subsistence, and visual resources.

# 4.0 OIL SPILL ANALYSIS

While not considered part of any of the proposed alternatives, NMFS analyzed the potential environmental effects of a low-probability, high impact event, a hypothetical very large oil spill (VLOS) in the Chukchi and Beaufort seas. For the Chukchi Sea, the discussion relies heavily on the recent BOEM Lease Sale 193 Revised Draft Supplemental EIS (BOEM 2011b) and other publicly available information. For the Beaufort Sea, the discussion and analysis is incorporated from the recent BOEM 2012-2017 OCS Oil and Gas Leasing Program Draft Programmatic EIS (BOEM 2011d).

In summary, a VLOS in either the Chukchi or Beaufort seas would have:

- Major adverse impacts to water quality; environmental contaminants and ecosystem functions; marine and coastal birds; bowhead whales; beluga whales; other cetaceans; socioeconomics; subsistence; land and water ownership, use, and management; recreation and tourism; and visual resources.
- Moderate to major adverse impacts to acoustics, lower trophic levels, polar bears, public health, transportation, and environmental justice.
- Moderate adverse impacts to physical oceanography and fish/essential fish habitat.
- Minor to moderate adverse impacts to climate, seals, walrus, terrestrial mammals, and cultural resources.
- Minor adverse impacts to air quality.

# 5.0 IMPLEMENTATION, MONITORING AND REPORTING, AND ADAPTIVE MANAGEMENT

## 5.1 EIS Implementation and NEPA Compliance

The Final EIS will identify the Preferred Alternative. The Record of Decision (ROD) will provide a listing of activities addressed by the Preferred Alternative and will identify any conditions of approval that are relevant to industry authorization requests. The EIS and ROD together constitute a decision document to be used for ongoing and future permitting activities addressed by this EIS. NMFS and BOEM will use the EIS when issuing ITAs and G&G permits and ancillary activity notices for oil and gas exploration that may occur within the five-year period of 2012 through 2017. Because the EIS addresses general effects and is not specific to the request for an ITA for a particular activity, additional NEPA review may be required for each application for authorization. The form of the additional review will depend on the nature and scope of the proposed activity. The review may take the form of:

- Categorical Exclusion and/or a Memorandum to the File;
- An Environmental Assessment (EA);
- A Supplemental EIS; or
- A new EIS.

BOEM intends to conduct site-specific NEPA analyses that either tier from the EIS or incorporate it by reference. BOEM would also use the EIS to assist in carrying out other statutory responsibilities such as working with NMFS and the U.S. Fish and Wildlife Service to ensure compliance with the Endangered Species Act and Magnuson-Stevens Fishery Conservation and Management Act, and where needed could modify permit conditions or lease operation to meet the requirements of any Endangered Species Act or MMPA authorization.

## 5.2 Monitoring and Reporting

The MMPA mandates that an authorization issued for the incidental take of marine mammals include a requirement that the taking be monitored and reported. The purposes, goals, and objectives of monitoring and reporting under the MMPA are summarized below.

Monitoring measures should be designed to accomplish or contribute to one or more of the following goals:

To increase the understanding of –

- The likely occurrence of marine mammal species in the vicinity of the action, i.e., presence, abundance, distribution, and/or density of species.
- The nature, scope, or context of the likely exposure of marine mammal species to any of the potential stressor(s) associated with the action (e.g. sound or visual stimuli), through a better understanding of one or more of the following: 1) the action itself and its environment (e.g. sound source characterization, propagation, and ambient noise levels); 2) the affected species (e.g. life history or dive patterns); 3) the likely co-occurrence of marine mammal species with the action (in whole or part) associated with specific adverse effects, and/or; 4) the likely biological or behavioral context of exposure to the stressor for the marine mammal (e.g. age class of exposed animals or known pupping, calving or feeding areas).
- How individual marine mammals respond (behaviorally or physiologically) to the specific stressors associated with the action (in specific contexts, where possible, e.g., at what distance or received level).

- How anticipated individual responses, to individual stressors or anticipated combinations of stressors, may impact either: 1) the long-term fitness and survival of an individual; or 2) the population, species, or stock (e.g. through effects on annual rates of recruitment or survival).
- The effectiveness of mitigation and monitoring measures.
- The manner in which the authorized entity complies with the incidental take authorization and incidental take statement.
- An increase in the probability of detecting marine mammals (through improved technology or methodology), both specifically within the safety zone (thus allowing for more effective implementation of the mitigation) and in general, to better achieve the above goals.

Applicants should target questions that have been identified as priorities (i.e. to fill data gaps). Proposed monitoring plans are evaluated using the above guidance, considering the likelihood of effectively answering the questions. Regulations prescribe that monitoring plans undergo an independent peer review.

### 5.2.1 Monitoring Plan Peer Review

The MMPA requires that monitoring plans be independently peer reviewed "where the proposed activity may affect the availability of a species or stock for taking for subsistence uses." NMFS's regulations written to implement this requirement state, "Upon receipt of a complete monitoring plan, and at its discretion, [NMFS] will either submit the plan to members of a peer review panel for review or within 60 days of receipt of the proposed monitoring plan, schedule a workshop to review the plan." Although the MMPA only includes this requirement for IHAs, in its implementing regulations, NMFS extended this requirement to include LOAs as well.

In the 1980s and 1990s, NMFS convened a meeting each year between the applicable Federal agencies, ITA applicants for the upcoming open-water season, industry and agency scientists, and Native Alaskan subsistence hunters to discuss best ways to monitor the effects of the upcoming programs on marine mammals. These meetings would typically last a few days where there would be a robust discussion between all parties involved. ITA applicants would then adjust their monitoring programs based on the discussions. At that time, these meetings served to meet the requirement for an independent peer review via the workshop option described in the regulations.

In the late 1990s and early 2000s, these meetings were not held because there was very little activity during the open-water season in the U.S. Arctic Ocean. NMFS began to reconvene the meetings in 2006 when the level of activities for the open-water season began to increase. These annual meetings came to be known as the Arctic Open-Water Meeting. However, while these meetings were initially small gatherings of 15 to 30 people in the 1980s and early 1990s, from 2006 through 2011 the meetings drew approximately 150 to 250 participants each day, thus making it difficult to include the focused and detailed reviews of the applicants' monitoring plans.

In order to ensure the focused independent peer review of the monitoring plans prescribed by the regulations, in 2010, NMFS divided the annual meeting into two separate parts, one larger and more open to stakeholder input, and one smaller meeting where a group of scientists specifically gathers to review the monitoring reports. In 2010 and 2011, after soliciting nominations from the industry ITA applicants, the Marine Mammal Commission, and the affected subsistence communities and representative organizations, NMFS convened panels of approximately five to seven scientists to provide an independent scientific review of the plans. During these reviews, NMFS charged the peer review panel members with determining whether or not the monitoring plans put forth by the applicants are appropriate. After the meeting, the panel members provided a final report to NMFS with their recommendations. NMFS reviews the peer review panel report in the context of the applicants' activities and the requirements of the MMPA and selects those that were appropriate for potential inclusion in the applicant's final monitoring

plans. NMFS then works with the applicants regarding the practicability of including these measures and protocols, and then includes the selected measures as requirements in the issued IHAs.

This process is still developing, and some strengths and weaknesses have been identified. Utilizing a smaller group chosen from nominated scientists allows for a true scientific, and more independent, review of the monitoring plans. The peer review panel report (which was not provided prior to 2010) provides NMFS with concrete recommendations that can be put forth to the applicants to improve the plans. Panel members have suggested that the time allotted for interaction with the applicants in 2010 and 2011 was too short, and as a result NMFS plans to allow for longer interactions. Also, at the request of the applicants, questions will be provided to them in advance so that they can come prepared to discuss specific issues identified by the panel members. Generally, both scientist reviewers and applicants have expressed that this more focused method for peer review of the monitoring reports is more effective than past methods. However, it is an iterative process, and NMFS intends to continue modifying the methods as necessary to most effectively solicit input and ensure implementation of the best monitoring plans.

### 5.2.2 Potential Improvements for Monitoring and Reporting Plans

Recommendations from improvements to monitoring plans have been made to NMFS at the Arctic Open-Water Meetings, through public comments on NEPA and MMPA documents, and at Plan of Cooperation (POC) meetings. The new peer review format that has been development includes:

- focused prioritization of needs, and
- guidance to applicants before they develop their initial applications.

In the last two years, the independent peer reviewers have included in their report, recommendations (related to both the goals of monitoring, in addition to methodology) that could be more broadly applied to multiple applicants. This type of comprehensive consideration of multiple monitoring activities across multiple years is what was identified as a mechanism to accomplish combined monitoring in the U.S. Arctic.

NMFS is considering several methods to more comprehensively prioritize and plan ITA monitoring:

- Developing and maintaining (on the NMFS website) a list of monitoring priorities and data gaps for Arctic oil and gas development projects;
- Soliciting input for this list from Open-Water Meetings, peer review panels, public comment periods, or, potentially, a longer term panel convened specifically to develop these priorities;
- Including specific recommendations for discrete monitoring projects (with suggested methodologies) that could be adopted by new applicants; and
- Considering and describing how to best build on existing monitoring results and best integrate data collection, analysis, and reporting with simultaneous monitoring efforts.

NMFS intends to explore the possibility of using the existing public input tools to develop an iterative and systematic annual means of identifying and prioritizing the monitoring goals for Arctic oil and gas exploration activities. These priorities could be available to potential applicants on the NMFS website along with specific methodology recommendations summarized from previous peer review recommendations to provide direction and guidance to applicants and allow for the most effective use of resources to answer the most pressing questions related to the effects of oil and gas exploration on marine mammals. NMFS would evaluate this method of providing guidance through public input received on this EIS and at the 2012 Open-Water Meeting and beyond.

### 5.2.3 BOEM's Environmental Studies Program

The OCS Lands Act authorizes an Environmental Studies Program (ESP) to establish the information needed for assessment and management of environmental impacts on the human, marine, and coastal environments of the OCS. The Alaska Studies Plan complements and reinforces the goals of the ESP. The ESP is guided by several broad themes:

- Monitoring Marine Environments;
- Conducting Oil-Spill Fate and Effects Research;
- Minimizing Seismic and Acoustic Impacts;
- Understanding Social and Economic Impacts; and
- Maintaining Efficient and Effective Information Management;

The Alaska OCS Region continually proposes new studies and pursues information needs in conjunction with ESP goals in order to answer the following fundamental questions:

- What is the expected change in the human, marine, and coastal environment due to offshore activity?
- Can undesirable change be minimized by mitigation measures?

Currently, the Alaska ESP is primarily focused on upcoming developments, exploration activities, and existing and potential future lease sales in the Beaufort Sea and Chukchi Sea Planning Areas. The Alaska ESP maintains a long list of ongoing and proposed studies in both seas.

## 5.3 Tools for Mitigating Impacts on Subsistence

Several processes and programs have evolved to facilitate interaction between the industry and the affected local communities to ensure that the Arctic subsistence culture can continue to thrive in conjunction with oil and gas exploration and development. Some of these processes are Federally-mandated while others have been voluntary between the industry and local communities. This section discusses three of these tools:

(1) Plans of Cooperation (POC), which are required by NMFS' implementing regulations;

(2) Open Water Season Conflict Avoidance Agreements (CAA), which are voluntary and not required by any statute or regulation; and

(3) The annual Arctic Open-Water Meeting.

For the purposes of protecting the subsistence uses of marine mammals, the MMPA implementing regulations require that for an activity that will take place near a traditional Arctic hunting ground, or may affect the availability of marine mammals for subsistence uses – an applicant for MMPA authorization must either submit a POC or information that identifies the measures that have been taken to minimize adverse impacts on subsistence uses. The regulations provide further guidance by describing that a POC must include the following:

- a statement that the applicant has notified the affected subsistence community and provided them a draft POC;
- a schedule for meeting with the communities to discuss proposed activities and resolve potential conflicts regarding any aspects of the operation or POC;
- a description of measures the applicant has taken or would take to ensure that proposed activities would not interfere with subsistence hunting; and
- what plans the applicant has to continue to meet with the communities, prior to and during the activity, to resolve conflicts and notify the community of any changes in the activity.

### 5.3.1 Conflict Avoidance Agreement and Plan of Cooperation

In 1985, the AEWC and a number of arctic offshore oil and gas operators began working together to identify and mitigate sources of industrial interference with bowhead whale subsistence hunting. Recognizing the need to facilitate the co-existence of marine mammal subsistence uses and arctic offshore industrial activities, in 1986, Congress amended the MMPA to require that the issuance of ITAs rest on a Secretarial finding of "no unmitigable adverse impact to the availability" of marine mammal subsistence resources. The AEWC and offshore operators undertook an annual initiative to develop mitigation measures, which came to be known as the Open Water Season Conflict Avoidance Agreement (CAA) Process, with each year's CAA Process resulting in an agreement, the CAA, signed by the participants. Input from the impacted bowhead whale subsistence communities indicates that they have historically found that the CAA process, through its highly interactive aspects, has effectively resulted in the development and implementation of measures that will ensure no unmitigable adverse impact. Based on this, for many years, NMFS generally assumed, with some associated analysis, that if a company and the AEWC signed a CAA (which typically contained the components of a POC), then it was possible for a company to conduct their activity without having an unmitigable adverse impact on the subsistence hunt. However, in more recent years, some companies have become reluctant to sign a CAA with the AEWC, suggesting that the agreement requires more from the industry than is necessary to ensure no unmitigable adverse impact to the hunt. Additionally, some stakeholders have raised the issue that a CAA developed by the AEWC does not represent the interests of subsistence hunts of species other than bowhead whales. Last, NMFS and BOEM have no authority to require agreements between third parties, and neither NMFS nor BOEM would be able to enforce the provisions of CAAs because the federal government is not a party to the agreements. These concerns highlight NMFS' responsibility to conduct a rigorous and comprehensive independent analysis of the likely subsistence impacts and to specifically review the contents of each company's POC. However, the AEWC has raised concerns about the POCs, asserting that while the CAA process traditionally provided content for the regulatory POC process, the POC process as currently implemented by some companies takes place in a one-way fashion, i.e., the company develops a POC without meaningful input from the subsistence communities.

To date, individual companies conducting activities in a given year, as well as the impacted subsistence communities, are involved in meetings related to both the negotiation of CAAs (regardless of whether they are ultimately signed by either party) and the development of POCs. Participating in both of these processes necessitates a lot of work on the part of all parties. With input from both subsistence communities and the applicants for MMPA authorization, NMFS plans to explore methods of clarifying the requirements of the MMPA (as they relate to the POC and ensuring no unmitigable adverse impact) that would incorporate the effective pieces of the CAA negotiations, while continuing to ensure compliance with the MMPA as it relates to the subsistence hunt of all affected species.

### 5.3.2 Arctic Open-Water Meeting

The Arctic Open-Water Meeting is the stakeholder meeting that is conducted to ensure NMFS' understanding of the effects of industry activity on the subsistence uses of marine mammals, with input from the subsistence users. The Arctic Open-Water Meeting has typically attracted members of industry, Federal, state, and local government officials and scientists, Native Alaskan marine mammal commissions, affected Native Alaskan hunters and community members, environmental non-governmental organizations, and other interested members of the public. Typically, the industry presents the results of their marine mammal monitoring programs from the previous year and activities proposed for the upcoming season along with the associated monitoring plans. Alaska Native subsistence group representatives (e.g. whaling captains and AEWC members) present information related to impacts that industry activities may have had (either in the past year or historically) on their ability to effectively hunt a given species. There have also been presentations of ongoing western and traditional science programs conducted in the region.

The Artic Open-Water Meeting is not specifically required by statute or regulation. However, NMFS has continued to organize this annual meeting because of the importance of stakeholder input and interaction in NMFS' determination of whether a specific activity will likely have an unmitigable adverse impact on subsistence uses. The meeting allows the public to provide input on industry proposals while the federal agencies that are responsible for authorizing the activity itself and the incidental take of marine mammals can listen to those comments and participate in the interaction.

There is a separate monitoring plan peer review session that is required to be held. The meeting usually occurs immediately after the Arctic Open-Water meeting.

## 5.4 Adaptive Management

NMFS and BOEM historically used, and will likely use in the future, adaptive management principles in the issuance of permits and authorizations and any adaptive adjustments of mitigation and monitoring. The intent of adaptive management here is to ensure:

(1) The minimization of adverse impacts to marine mammals, subsistence uses of marine mammals, endangered species, and other protected resources, within the context of the associated regulations and statutes;

(2) The maximization of value of the information gathered via required monitoring; and

(3) Industry compliance with environmental protection statutes and regulations.

Following are some of the specific sources of information upon which adaptive management decisions could be based in the next five years (2012 through 2017):

(1) Results of monitoring required pursuant to MMPA ITAs or other Federal statutes for Arctic oil and gas development activities;

(2) Stakeholder input during the annual Arctic Open-Water Meetings;

(3) Scientific input from the independent peer review;

(4) Public input during comment periods on MMPA authorizations;

(5) Results from BOEM's Environmental Studies Program;

(6) Results from general marine mammal and sound research;

(7) Results from the efforts of the NOAA Working Groups working on Underwater Soundmapping and Cetacean Mapping in the Arctic and elsewhere;

(8) Results of the BP Cumulative Impact modeling of multiple sound sources in the Beaufort Sea; and

(9) Any information that reveals that marine mammals may have been taken in a manner, extent, or number not authorized.

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Appendix B: Acoustics Technical Report

Appendix C: Final Scoping Report

Appendix D: Cooperating Agencies and Government to Government Letters

# LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| 1D | One-dimensional |
| 2D | Two-dimensional |
| 3D | Three-dimensional |
| 4D | Four-dimensional |
| AAC | Alaska Administrative Code |
| ACP | Arctic Coastal Plain Physiographic Province |
| ACMP | Alaska Coastal Management Act of 1977 |
| ACP | Arctic Coastal Plain |
| ADCCED | Alaska Department of Commerce, Community, and Economic Development |
| ADCP | Acoustic Doppler Current Profile |
| ADEC | Alaska Department of Environmental Conservation |
| ADF&G | Alaska Department of Fish and Game |
| ADLWD | Alaska Department of Labor and Workforce Development |
| ADNR | Alaska Department of Natural Resources |
| AEWC | Alaska Eskimo Whaling Commission |
| AF | Arctic Foothills Physiographic Province |
| AHRS | Alaska Heritage Resource |
| AMNWR | Alaska Maritime National Wildlife Refuge |
| AN(SW)T | Ambient-Noise (Surface-Wave) Tomography |
| ANCSA | Alaska Native Claims Settlement Act |
| ANIMIDA | Arctic Nearshore Impact Monitoring in Development Area |
| ANILCA | Alaska National Interest Lands Conservation Act |
| ANOs | Alaska Native Organizations |
| ANWR | Arctic National Wildlife Refuge |
| AO | Arctic Oscillation |
| AOOS | Alaskan Ocean Observing system |
| APD | Application for Permit to Drill |
| APP | Alaska Pipeline Project |
| AQRV | air quality related values |
| ARRT | Alaska Regional Response Team |
| ASNA | Arctic Slope Native Association |

| | |
|---|---|
| ASRC | Arctic Slope Regional Corporation |
| BACT | Best Available Control Technology |
| bbl | barrels |
| BIA | U.S. Bureau of Indian Affairs |
| BLM | U.S. Bureau of Land Management |
| BOEMRE | U.S. Bureau of Ocean Energy Management, Regulation and Enforcement |
| BOWFEST | Bowhead Whale Feeding Ecology Study |
| BSEE | Bureau of Safety and Environmental Enforcement |
| BWASP | Bowhead Whale Aerial Survey Program |
| °C | Degrees-Celcious (spelling?) |
| CAA | Conflict Avoidance Agreement |
| CAH | Central Arctic Caribou Herd |
| cANIMIDA | Continuation of Arctic Nearshore Impact Monitoring in Development Area |
| CAR | Comment Analysis Report |
| CatExs | Categorically Excludes |
| CDS | conical drilling unit |
| CEQ | Council on Environmental Quality |
| CERCLA | Comprehensive Environmental Response Compensation and Liability Act of 1980 |
| CFR | Code of Federal Regulations |
| $CH_4$ | Methane |
| CBS | Chukchi/Bering Seas stock |
| CIDS | Concrete Island Drilling Structure |
| CLRD | Chronic lower respiratory disease |
| cm | Centimeter |
| $cm^3$ | Cubic centimeter |
| cm/s | Centimeters per second |
| CO | carbon monoxide |
| $CO_2$ | Carbon Dioxide |
| $CO_2e$ | carbon dioxide equivalent |
| COA | corresponding onshore area |
| COMIDA | Chukchi Offshore Monitoring in Drilling Area Survey Project |
| CSPA | Chukchi Sea Planning Area |

| | |
|---|---|
| CPAI | ConocoPhillips Alaska, Inc |
| CPUE | Catch Per Unit Effort |
| CSEM | Controlled Source Electromagnetic |
| CWA | Clean Water Act |
| CZMA | Coastal Zone Management Act |
| D | Drilling |
| DAO | Department Administrative Order |
| dB | Decibel |
| dBA | A-weighted sound level |
| dB re 1 µPa rms | Decibels Relative to 1 micropascal Root Mean Square |
| DCOM | Division of Coastal and Ocean Management |
| DCRA | Division of Community and Regional Affairs |
| DDT | dichlorodiphenyltrichloroethane |
| deg. | Degrees |
| DEIS | Draft Environmental Impact Statement |
| Detritus | Dead |
| DEW | Distant Early Warning |
| DLI | Daylight Imaging |
| DMLW | Division of Mining, Land and Water |
| DO&G | Department of Oil and Gas |
| DOC | U.S. Department of Commerce |
| DPEIS | Draft Programmatic Environmental Impact Statement |
| DS | Deep Seismic Survey |
| DTAGS | Deep-towed Acoustics/Geophysics System |
| DPP | Development and Production Plan |
| DWG | Supplemental Final EIS |
| EA | Environmental Assessment |
| Ecotone | salinity transition zone |
| EEZ | Exclusive Economic Zone |
| EFH | Essential Fish Habitat |
| EIS | Environmental Impact Statement |
| EP | Exploration Plan |
| EPA | U.S. Environmental Protection Agency |

| | |
|---|---|
| EMS | Emergency Medical Services |
| EO | Executive Order |
| EP | Exploration Plan |
| EPA | U.S. Environmental Protection Agency |
| ERD | Extended Reach Drilling |
| ERM | Effects Range Median |
| ERL | Effects Range Low |
| ESA | Endangered Species Act |
| ESP | Environmental Studies Program |
| EVOS | Exxon Valdez Oil Spill |
| °F | Degrees-Fahrenheit |
| FEIS | Final Environmental Impact Statement |
| FLIR | Forward Looking Infrared |
| FM | frequency-modulated |
| FMPs | Fishery management plans |
| FOSC | Federal On-Scene Coordinator |
| FONSI | Finding of No Significant Impact |
| FR | Federal Register |
| ft | Feet |
| FY | fiscal year |
| g | gram |
| G&G | Geological and Geophysical |
| GAO | Government Accountability Office |
| GHG | Greenhouse Gas |
| GIS | Geographic Information System |
| Gm | geographic mile |
| GPS | Global Positioning System |
| GTP | gas treatment plant |
| HAP | hazardous air pollutants |
| Hg | elemental mercury |
| $HgCl_2$ | Mercuric chloride |
| HIV | Human Immunodeficiency Virus |
| HRS | High Resolution Seismic |

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| HyMAS | Hydrocarbon Microtremor Analysis |
| Hz | Hertz |
| IAP | Integrated Activity Plan |
| IB | Icebreaking |
| ICAS | Inupiat Community of the Arctic Slope |
| IHA | Incidental Harassment Authorization |
| in | Inch |
| $in^3$ | Cubic Inch |
| IMPROVE | Interagency Monitoring of Protected Visual |
| ISER | Social and Economic Research |
| ITA | Incidental Take Authorization |
| IVI | Industrial Vehicle International |
| IWC | International Whaling Commission |
| Kg | kilograms |
| kHz | kilohertz |
| KIC | Kikiktagruk Inupiat Corporation |
| km | Kilometer |
| $km_2$ | square kilometers |
| kn | Knot |
| LACS | Low Level Acoustic Combustion Source |
| Lb | pounds |
| LBCHU | Ledyard Bay Critical Habitat Unit |
| LCU | Lower Cretaceous Unconformity |
| $L_{eq}$ | Equivalent sound level |
| LET | Local Earthquake Tomography |
| LME | Large Marine Ecosystem |
| $L_{min}$ | RMS maximum noise level |
| $L_{min}$ | RMS minimum noise level |
| LOA | Letters of Authorization |
| LFS | Low-Frequency Spectroscopy |
| LRI | lower respiratory tract infections |
| m | Meter |
| mg/kg | milligrams per kilograms |

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|---|---|
| Mg/L | Milligrams per liter |
| $Mg/m^3$ | Milligrams per cubic meter |
| mi | Mile |
| min. | Minutes |
| MIRIS | Michigan Resource Information System |
| mm | Millimeter |
| MMbbls | million barrels |
| MMO | Marine Mammal Observer |
| MMPA | Marine Mammal Protection Act |
| MMS | Minerals Management Service |
| MMt | million metric tons |
| MODU | Mobile Offshore Drilling Unit |
| Mph | Miles per hour |
| MSFCMA | Magnuson Stevens Fishery Conservation and Management Act |
| my | million years |
| myBP | million years before present |
| µPa | Micro Pascal |
| NAAQS | National Ambient Air Quality Standards |
| NAB | Northwest Arctic Borough |
| NANA | NANA Regional Corporation |
| NAO | North Atlantic Oscillation |
| NCP | National Oil and Hazardous Substances Pollution Contingency Plan |
| NEP-A | National Environmental Policy Act |
| Ng/L | parts per trillion |
| NGO | non-governmental organization |
| NH | ammonia |
| NM | Nautical Miles |
| NMFS | National Marine Fisheries Service |
| NMI | nautical miles |
| NO | nitrogen oxides |
| $N_2O$ | Nitrous Oxide |
| NOAA | National Oceanic and Atmospheric Administration |
| NOI | Notice of Intent |

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| NPDES | National Pollutant Discharge Elimination System |
| NPFMC | North Pacific Fisheries Management Council |
| NPR-A | National Petroleum Reserve–Alaska |
| NRC | National Research Council |
| NSR | New Source Review |
| NTL | Notice to Lessees |
| NTU | Nephelometric Turbidity Units |
| NVDs | Night Vision Devices |
| NPFMC | North Pacific Fisheries Management Council |
| NPS | National Park Service |
| NRHP | National Register of Historic Places |
| NSB | North Slope Borough |
| NSB DHHS | North Slope Borough Department of Health and Social Services |
| NSR | New Source Review |
| $O_3$ | ozone |
| OBC | Ocean-bottom-cable |
| OBN | ocean bottom node |
| OCRM | Office of Ocean and Coastal Resource Management |
| OCS | Outer Continental Shelf |
| ODPCP | Oil Discharge Prevention and Contingency Plan |
| OMB | U.S. Office of Management and Budget |
| OPEC | Organization of Petroleum-Exporting Countries |
| OSRB | Oil Spill Response Barge |
| OSRO | Oil Spill Removal Organizations |
| OSRP | Oil Spill Response Plan |
| OSRV | Oil Spill Response Vessels |
| Pa | Pascals |
| PAH | polycyclic aromatic hydrocarbons |
| Pb | lead |
| PCB | Polychlorinated Biphenyl |
| PCH | Porcupine Caribou Herd |
| PDO | Pacific Decadal Oscillation |
| PEA | Programmatic Environmental Assessment |

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| PEIS | Programmatic Environmental Impact Statement |
| PILT | payment in lieu of tax |
| PGS | Petroleum Geo-Services |
| $PM_{2.5}$ | Particulate matter 10 microns in diameter |
| $PM_{10}$ | Particulate matter 10 microns in diameter |
| *P* | Pressure |
| $P_1$ | Sound having pressure |
| POC | Plan of Cooperation |
| $P_{ref}$ | Standard Reference Pressure |
| ppm | parts per million |
| ppt | parts per thousand |
| PSD | Prevention of Significant Deterioration |
| Psi | per square inch |
| PSO | Protected Species Observer |
| psu | practical salinity units |
| PTE | potential-to-emit |
| PTS | permanent threshold shifts |
| R/B | biomass ratio |
| RDD | Resource Development Districts |
| RFFA | reasonably foreseeable future actions |
| RMS | root-mean-square |
| ROD | Record of Decision |
| RSC | reduced sulfur compounds |
| RUSALCA | Russian-American Long-term Census of the Arctic |
| s | Second |
| SA | Subsistence Advisor |
| SAR | Search and Rescue |
| SBI | Shelf Basin Interactions |
| SBS | Southern Beaufort Sea stock |
| SCR | Selective catalytic control |
| SEL | sound exposure level |
| SEIS | Supplemental Environmental Impact Statement |
| SEMS | Safety and Environmental Management Systems |

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| SFEIS | Supplemental Final EIS |
| SO | sulfur dioxide |
| SOPCs | Stressors of Potential Concern |
| SQRU | Scenic Quality Rating Unit |
| SSV | Sound Source Verification |
| SDC | Steel Drilling Caisson |
| SLRU | Sensitivity Level Rating Unit |
| SPLASH | Structure of Populations, Levels of Abundance, and Status of Humpbacks |
| SQRU | Scenic Quality Rating Unit |
| STI | Sexually transmitted infection |
| TA&R | Technology Assessment & Research |
| TAPS | Trans-Alaska Pipeline System |
| TB | Tuberculosis |
| TCH | Teshekpuk Caribou Herd |
| TCP | Traditional cultural properties |
| TK | Traditional Knowledge |
| TPY | tons per year |
| TTS | temporary threshold shifts |
| µPa | Micro Pascal |
| ULSD | ultra-low sulfur diesel |
| URI | Upper respiratory tract infection |
| U.S. | United States of America |
| USACE | U.S. Army Corps of Engineer |
| USCG | U.S. Coast Guard |
| USDOI | U.S. Department of the Interior |
| USFWS | United States Fish and Wildlife Service |
| USGS | U.S. Geological Survey |
| USPS | U.S. Park Service |
| VLCC | Very Large Crude Carrier |
| VLOS | Very Large Oil Spill |
| VOC | volatile organic compounds |
| WAH | Western Arctic Caribou Herd |
| WCD | Worst Case Discharge |

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# 1.0 PURPOSE AND NEED

This chapter establishes the purpose and need for the Effects of Oil and Gas Activities in the Arctic Ocean Environmental Impact Statement (EIS). It also contains background information on previous planning processes related to this EIS. The information contained in the following sections is intended to provide an analysis of management alternatives and help set the stage for informed decision-making for future management actions. The overall organization of the document is outlined in Section 1.9.

## 1.1 Background

Pursuant to the National Environmental Policy Act (NEPA), the U.S. Department of Commerce (DOC), National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS) and the U.S. Department of the Interior (USDOI), Bureau of Ocean Energy Management (BOEM) formerly known as the Minerals Management Service (MMS) have prepared an EIS to describe and analyze the potential impacts to the human environment related to oil and gas industry offshore exploration activities (e.g. seismic surveys and exploratory drilling activities) in the U.S. Beaufort and Chukchi seas, Alaska.

**MMS / BOEMRE / BOEM & BSEE**

Pursuant to Secretarial Order No. 3299 (May 19, 2010), MMS began a reorganization process toward establishing three separate and independent management structures to carry out the functions once performed by MMS. To facilitate this reorganization, on June 18, 2010, MMS was given the interim name, Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE). On October 1, 2010, the revenue collection arm of BOEMRE became the Office of Natural Resources Revenue (ONRR), and one year later, on October 1, 2011, BOEMRE completed the final step in its reorganization by establishing the Bureau of Ocean Energy Management (BOEM) and the Bureau of Safety and Environmental Enforcement (BSEE). BOEM is now the cooperating agency for this EIS, and designations for MMS, BOEMRE, and BOEM are used interchangeably below, but in accordance with the historical context.

On April 6, 2007, NMFS and MMS published a Notice of Availability (NOA) for a Draft Programmatic Environmental Impact Statement (DPEIS) (72 *Federal Register* [FR] 17117). The DPEIS assessed the impacts of MMS' issuance of permits and authorizations under the Outer Continental Shelf Lands Act (OCS Lands Act) for seismic surveys in the U.S. Beaufort and Chukchi seas off the coast of Alaska, and NMFS' issuance of incidental take authorizations (ITAs) under Section 101(a)(5) of the Marine Mammal Protection Act (MMPA) to take marine mammals incidental to conducting those permitted activities.

The scope and effects of the seismic survey activities analyzed in the DPEIS were based on the best available information at the time. However, since 2007, new information that alters the scope, set of alternatives, and analyses in the DPEIS has become available (e.g. scientific study results, changes in projections of level and types of offshore exploration activities). In addition, NMFS determined that an EIS should also address the potential effects of exploratory drilling, which was not addressed in the 2007 DPEIS. Therefore, NMFS and MMS filed a Notice of Withdrawal of the DPEIS on October 28, 2009 (74 FR 55539) and announced their decision to prepare a new EIS, the *Effects of Oil and Gas Activities in the Arctic Ocean*. A Notice of Intent (NOI) to prepare the new EIS was announced in the *Federal Register* on February 8, 2010 (75 FR 6175). The purpose of the NOI was to announce the preparation of a new EIS that would analyze the potential effects of both geophysical surveys and exploratory drilling, address cumulative effects over a longer time frame, consider a range of reasonable alternatives consistent

with the agencies' statutory mandates, and analyze the range of practicable mitigation and monitoring measures for protecting marine mammals and their availability for subsistence uses. The NOI asked for public comments and stated that MMS (now BOEM) would be a cooperating agency on this EIS.

This EIS will evaluate the potential effects to the environment of anticipated levels of geological and geophysical exploration activities in the U.S. Beaufort and Chukchi seas, Alaska, including: 1) deep penetration and high-resolution seismic surveys as permitted under 30 Code of Federal Regulations (CFR) Part 551 regulations; and 2) exploratory drilling, deep penetration surveys, and high-resolution site clearance/shallow hazards surveys as authorized under 30 CFR Part 550 regulations. Geological and Geophysical (G&G) permitted operations are conducted primarily off lease or on another lease holder's area, by the lessee or a third party under 30 CFR Part 551. Ancillary activities are conducted on-lease under 30 CFR Part 550. BSEE permits and regulates the exploratory drilling activities under 30 CFR Part 250 regulations. Deep penetration and high resolution seismic surveys can be performed as either G&G permitted or ancillary activities. This EIS will also evaluate the potential effects to the environment of authorizing takes of marine mammals incidental to such activities occurring in either federal or State of Alaska waters. Activities that could occur in state waters include on-ice and open water seismic surveys, high-resolution site clearance/shallow hazards surveys, and exploratory drilling. To avoid confusion regarding the terminology associated with geological and geophysical data collection, the oil and gas exploration activities that will be assessed and evaluated throughout the EIS for potential environmental impacts are categorized as:

- **Deep penetration geophysical surveys** (e.g. seismic surveys, including open-water, towed streamer 2-dimensional [2D] or 3-dimensional [3D] surveys, in-ice towed streamer 2D surveys, on-ice 2D or 3D surveys or Ocean-Bottom- Receiver [ cable or node; OBC] surveys; gravity and gradiometry surveys; and controlled source electromagnetic surveys [CSEM]). These surveys are conducted to identify prospective blocks for bidding in lease sales and to optimize drilling sites on leases acquired in sales. On average, data from deep penetration geophysical surveys provide imagery to a depth of approximately 10,000 meters (m) (6.2 miles [mi]) below the seafloor. However, penetration may be deeper or shallower depending on the equipment used and the depth to the geologic formations to be imaged. Companies can submit requests to conduct these types of deep penetration surveys to BOEM for approval under the regulations found at 30 CFR Parts 550 and 551.
- **Shallow hazards surveys** (also called high-resolution or site clearance surveys) and geological studies are considered ancillary activities when conducted on-lease under the 30 CFR Part 550 regulations. These surveys are used to examine the area of potential drill sites for geologic hazards, man-made hazards, prehistoric and historic archaeological resources, and biological populations. These types of activities either use acoustic sources to provide imagery of the sub-seafloor to a depth of less than 1,500 m (0.9 mi) or sediment sampling devices. A suite of instruments could be used depending upon the information needed. Standard equipment for shallow hazards surveys includes: single beam and multibeam echosounders; side scan sonar; magnetometer; subbottom profiler; and other seismic sources. Sediment sampling devices include grab samplers and coring equipment. Shallow hazards activities can also be authorized under the regulations found at 30 CFR Part 551.
- **Exploratory drilling**. Any drilling conducted by a lessee for the purpose of searching for commercial quantities of oil, gas, and sulfur authorized under 30 CFR Parts 250 and 550.

The specific equipment used will determine the sound levels and frequencies associated with each activity. Information on various sound sources and characteristics of sounds related to the activities listed above are governed by the specific equipment being used. This information is provided in Chapter 2, Sections 2.3.2 and 2.3.3, and Appendix B.

The environmental effects associated with deep penetration geophysical surveys, shallow hazards surveys, and exploratory drilling activities, as well as current and proposed mitigation measures, are evaluated in this EIS. This will allow NMFS and BOEM to comprehensively assess activities that may occur in a given season in advance of receiving applications to authorize incidental takes of marine mammals associated with deep penetration geophysical surveys, shallow hazards, and exploratory drilling activities. The analyses aid BOEM and BSEE in the environmental review required before issuing permits or authorizations. This analysis evaluates the direct, indirect and cumulative impacts that could occur under each of the proposed alternatives and decisions will be based on the best available science regarding all of the resources potentially impacted. Moreover, the EIS will include an analysis of potential mitigation and monitoring measures that could be included in future authorizations to allow the issuance of multiple MMPA ITAs during a given season.

The EIS will assist NMFS and BOEM in carrying out other statutory responsibilities and serve to support future decisions relating to the agencies' roles in authorizing or permitting deep penetration geophysical surveys, shallow hazards surveys, and exploratory drilling activities or incidental take of marine mammals (e.g. assessing environmental impacts on listed species under the Endangered Species Act [Section 7 consultation] and effects of the proposed action on essential fish habitat [EFH] under the Magnuson-Stevens Fishery Conservation and Management Act). BOEM will coordinate closely with NMFS and the U.S. Fish and Wildlife Service (USFWS) to ensure compliance with these statutes and, where needed, will modify permit conditions or OCS operations to meet the requirements of Endangered Species Act (ESA) or MMPA authorizations. BOEM will also coordinate with BSEE to ensure compliance with OCS authorizations.

The EIS will assist NMFS in performing NEPA evaluations for MMPA ITAs for G&G, ancillary, and exploratory drilling activities and will assist BOEM in performing NEPA evaluations for G&G permit applications and ancillary activity notices. NMFS intends to use this EIS as the required NEPA documentation for the issuance of ITAs for Arctic oil and gas exploration activities. NMFS may tier from this EIS to support future Arctic MMPA authorization decisions if proposed oil and gas activities fall outside the scope of this EIS. BOEM intends to conduct site-specific NEPA analyses that either tier from this EIS or incorporate this EIS by reference.

### 1.1.1 NMFS Statutory and Regulatory Mandates Relevant to EIS Scope of Analysis

Sections 101(a)(5)(A) and (D) of the MMPA (16 United States Code [U.S.C.] § 1361 *et seq.*) direct the Secretary of Commerce to allow, upon request, the incidental, but not intentional taking of small numbers of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region, if certain findings are made and either regulations are issued or, if the taking is limited to harassment, a notice of proposed authorization is provided to the public for review. Authorization for incidental takings shall be granted if:

- NMFS finds that the taking will have a negligible impact on the species or stock(s);
- NMFS finds that the taking will not have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses (where relevant); and
- the permissible methods of taking and requirements pertaining to the mitigation, monitoring, and reporting of such takings are set forth.

NMFS has defined "negligible impact" in 50 CFR § 216.103 as "... an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival." Additionally, NMFS has defined "unmitigable adverse impact" in 50 CFR § 216.103 as:

> *…an impact resulting from the specified activity: (1) That is likely to reduce the availability of the species to a level insufficient for a harvest to meet subsistence needs by: (i) Causing the*

*marine mammals to abandon or avoid hunting areas; (ii) Directly displacing subsistence users; or (iii) Placing physical barriers between the marine mammals and the subsistence hunters; and (2) That cannot be sufficiently mitigated by other measures to increase the availability of marine mammals to allow subsistence needs to be met.*

The geographic scope of exploration activities requiring compliance with the MMPA includes both federal and state marine waters.

### 1.1.2 BOEM and BSEE Statutory and Regulatory Mandates Relevant to EIS Scope of Analysis

The OCS Lands Act, 43 U.S.C. § 1331 *et seq.* prescribes a four stage process for development of offshore federal mineral resources: (1) a 5-year oil and gas leasing program; (2) lease sales; (3) exploration pursuant to exploration plans; and (4) development and production plans. Environmental reviews are conducted for each of these stages.

The OCS Lands Act directs BOEM and BSEE to oversee the "expeditious and orderly development [of OCS resources] subject to environmental safeguards" (43 U.S.C. §§ 1332(3), (6), 1334(a)(7)). Critical to the potential development of OCS resources is the ability to gather geological and geophysical data needed to assess the resource potential of the OCS. BOEM, which has rights to all data collected under the OCS Lands Act and implementing regulations, needs the best available data to ensure that the federal government (i.e. the American people) receives fair market value for leased resources. The OCS Lands Act establishes U.S. Department of Interior authority, delegated to BOEM by regulation, to issue G&G permits or notice approvals for G&G, ancillary, and exploration activities, and approve exploratory drilling plans for these and related purposes. BOEM's regulations for G&G permits, ancillary activities, and Exploration Plans are at 30 CFR Parts 551 and 550.

The OCS Lands Act (43 U.S.C. §§ 1340(a)(1) (g)), and BOEM's and BSEE's implementing regulations, require that OCS data and information collected be obtained in a technically safe and environmentally sound manner. BOEM conducts NEPA analyses for proposed OCS activities and includes measures, if necessary, in permits, plan approvals, and other authorizations to minimize potential adverse effects to the human, marine, and coastal environment (30 CFR Parts 550 and 551). BSEE is responsible for technical review and approval of Applications for Permits to Drill (APDs), for ensuring safe OCS operations, and for monitoring OCS activities to ensure compliance with Federal laws, regulations, lease stipulations, permit or plan conditions, and required mitigation. BSEE is also responsible for oversight of pollution prevention and oil spill contingency and response planning for OCS operations. BSEE's regulations are at 30 CFR Parts 250 and 254.

BOEM regulations for G&G permit activities (30 CFR Part 551) specifically state that such activities cannot:

- interfere with or endanger operations under any lease or right-of-way, easement, right-of-use, Notice, or permit issued or maintained under the OCS Lands Act;
- cause harm or damage to life (including fish and other aquatic life), property, or to the marine, coastal, or human environment;
- cause harm or damage to any mineral resource (in areas leased or not leased);
- cause pollution;
- create hazardous or unsafe conditions; or
- unreasonably interfere with or cause harm to other uses of the area.

Pursuant to 30 CFR Part 551.4, a G&G permit must be obtained from BOEM to conduct G&G exploration for oil, gas, and sulphur resources when operations occur on unleased lands or on lands leased to a third party. Ancillary activities are regulated under 30 CFR Part 550.207 through 550.210, which also states that a notice must be submitted before conducting such activities pursuant to a lease issued or maintained under the OCS Lands Act.

## 1.1.3 Recent Guidance on Offshore Oil and Gas Development

### 1.1.3.1 Government Accountability Office

In March 2010, a Government Accountability Office (GAO) report entitled "*OFFSHORE OIL AND GAS DEVELOPMENT: Additional Guidance Would Help Strengthen the Minerals Management Service's Assessment of Environmental Impacts in the North Aleutian Basin*" made two executive recommendations to help MMS meet federal requirements in assessing environmental impacts of offshore oil and gas development in the Alaska Region. The GAO advised that the Secretary of the Interior direct MMS "to strengthen the agency's NEPA procedures and ensure implementation of its agency wide April 2008 information-sharing policy."

The first GAO recommendation was to develop a comprehensive handbook that provides guidance on how to implement NEPA. This guidance will be periodically updated and revised as necessary and will detail procedures for conducting and documenting NEPA-required analyses, including how determinations of significance are to be made and how scientific findings are to be reviewed. The Secretary of the Interior directed BOEM to complete the NEPA handbook by December 31, 2010, which was subsequently extended to March 31, 2011. This deadline was met. A digital version of the NEPA Handbook is kept on the internal BOEM website. It is flexible, updatable, and can be revised to reflect changing circumstances within the agency. However, not all of the guidance has been approved and is therefore still in draft form. On September 8, 2011, the Associate Director for Offshore Energy and Minerals Management issued a memorandum to the Regional Directors stating that 21 chapters and 22 appendices of the NEPA handbook is officially approved, and the remainder of the guidance must be followed, even though it is in draft form. This memorandum also provided a plan for reviewing and revising the remaining chapters, which is to be completed by October 2012. After this deadline, it is BOEM's intent to finish the internal approval process, so that it can then go through the required steps to have it officially adopted as a "NEPA Handbook." This process will include review by the Office of Environmental Policy and Compliance and CEQ followed by a *Federal Register* Notice and publication of the Environmental Guidance on the Internet.

The second recommendation requested MMS take appropriate steps to ensure that the Alaska Region follows the policy for sharing or otherwise making information, including proprietary information, available to all staff involved in the technical or environmental review of that information. This recommendation was addressed by the BOEM Alaska Regional Director when he issued a directive for information sharing to the Alaska Region in June 2010. Among other things, the directive detailed procedures for processing and accessing proprietary information and supervisory consultation with subject matter experts when finalizing management revisions to ensure the scientific quality of the analysis. This directive closed the action item and implemented the recommendation identified by GAO.

### 1.1.3.2 Council on Environmental Quality

BOEM is committed to using the guideposts put forth in The Council on Environmental Quality's (CEQ) report, entitled *Report Regarding the Minerals Management Service's National Environmental Policy Act Policies, Practices, and Procedures as They Relate to Outer Continental Shelf Oil and Gas Exploration and Development*, dated August 16, 2010. The guideposts provide recommendations with respect to: 1) tiering and site-specific analysis; 2) transparency, public accountability, and sound decision making;

3) categorical exclusions; and 4) changed circumstances. An explanation on the steps BOEM has taken to respond to CEQ's recommendations is provided next.

BOEM has consistently applied and followed the four stage process created by the OCS Lands Act to ensure the safe and orderly development of oil and gas resources on the OCS in both shallow and deep water. This four stage process consisting of planning, exploration, leasing, and production and decommissioning of oil and gas resources in federal waters requires a careful and comprehensive NEPA review at each and every stage, whether it be via an EIS or an Environmental Assessment (EA). To further ensure that comprehensive NEPA reviews take place at all of the four stages mentioned above, BOEM no longer Categorically Excludes (CatExs) Exploration Plans (EPs) for deepwater. EAs are now required for all deepwater EPs. To further improve the safety and environmental protection in deepwater of offshore drilling, BOEM has required enhanced drilling safety measures as outlined in Notice to Lessee-06, issued in June 2010 (NTL-06) where operators must demonstrate that they are fully prepared to deal with the potential for a bow-out and worst case discharge. Two new rules were issued in September 2010 specifically targeted at reducing the risks associated with offshore energy operations: the Drilling Safety Rule and the Workplace Safety Rule, which are both part of broader reforms undertaken by BOEM as part of its dynamic regulatory response and reform efforts to continue to allow for the orderly and responsible development of offshore energy resources on the OCS. New guidance implemented through NTL-10 issued in November 2010 requires a corporate compliance statement and a review of subsea blowout containment resources for deepwater drilling specifically.

BOEM will continue to ensure that the various NEPA analyses conducted at all stages of offshore oil and gas energy development on the OCS both provide decision-makers with all the relevant information needed to accurately analyze proposed actions and make fully informed decisions on those proposed actions. BOEM has sought to accurately follow CEQ's Regulations for Implementing NEPA by applying "§1502.20 – Tiering" of those implementing regulations. By applying the tiering framework to BOEM's NEPA analyses, when appropriate, to all stages of oil and gas resource development on the OCS, BOEM continues to make certain that repetitive discussions of the same issues are not the focus of subsequent NEPA analyses but instead, that the actual issues ripe for decisions at each level of environmental review are the focus of the relevant underlying data and analysis so that those subsequent analyses provide both the decision-maker and the public with the most relevant and up-to-date information needed to make a fully informed decision on a particular action or set of actions. BOEM believes that public input is critical to the safe and responsible exploration and development of offshore resources. BOEM has always provided the public with the opportunity to participate in scoping meetings, public meetings and to provide comments on all NEPA documents and will continue to do so. Further, to enhance transparency and public participation in BOEM's NEPA analyses, all NEPA documents, such as EISs, EAs, and CatExs are posted to the BOEMRE website for the public's review, including programmatic NEPA documents such as the Five-Year Plan. BOEM will continue to solicit public comment and input into all of its environmental reviews and regulatory programs for all of its offshore energy resource proposals. BOEM will also continue to consult and work with cooperating agencies (Tribes, State governments, NOAA, etc.) as part of the NEPA process.

Following the release of the CEQ Report (August 16, 2010), regarding MMS' (now BOEM's) NEPA policies, practices, and procedures as they relate to OCS oil and gas exploration and development, BOEMRE announced that it would limit its use of CatExs for offshore oil and gas development, while it undertakes a comprehensive review of its NEPA process and the use of CatExs for OCS decisions. On October 8, 2010, BOEMRE published an NOI to conduct a review of CatExs for OCS decisions (75 FR 62418). On November 23, 2010, CEQ published final guidance for establishing, applying, and revising CatExs under NEPA (75 FR 75628), which encouraged agencies to pursue opportunities for public involvement beyond publication of the proposed amendments in the *Federal Register* in cases where there is likely to be significant public interest and additional outreach would facilitate public input. Therefore, BOEM intends to publish the analysis and recommendations regarding CatExs in the *Federal*

*Register* and invite further public and agency involvement in the review. After considering all comments received, the results will be published in the *Federal Register*, posted on the Internet at http://www.regulations.gov, and updated in the Department of the Interior Manual. During this review process BOEM is working with CEQ, the Office of Management and Budget, the Department of the Interior, and other federal agencies.

Due to circumstances surrounding the BP Oil Spill in April 2010, BOEM continues to ensure that a comprehensive yet dynamic NEPA process continues to be implemented for the responsible review, analysis, and development of offshore energy. BOEM has included an analysis of impacts to resources such as sensitive biological areas and archeological sites from a Catastrophic Spill Event and a Very Large Oil Spill as part of its Lease Sale EISs and Supplemental EAs. BOEM continues to investigate and incorporate how a possible changed environmental baseline post-BP Oil Spill may impact offshore energy oil and gas exploration and development in the Gulf of Mexico and how a possibly altered baseline would in turn inform NEPA analyses provided for the decision-makers and BOEM oil and gas actions on the OCS in the Gulf of Mexico and its other regions. BOEM continues to consult and work with all cooperating agencies and engage the public at multiple phases throughout the NEPA process, as well as increasing the opportunities for the public to participate and comment.

### 1.1.4 New Requirements for OCS Offshore Oil and Gas Exploration and Development Drilling Operations

Following the Deepwater Horizon explosion and resulting oil spill in the Gulf of Mexico, comprehensive reforms to offshore oil and gas regulation and oversight were developed and implemented by BOEM. The reforms strengthen requirements for everything from well design and workplace safety to corporate accountability.

The Secretary's Safety Measures Report, dated May 27, 2010, presents recommendations for immediate and long-term requirements to improve the safety of oil and gas operations in shallow and deep waters. In light of the Safety Measures Report, the MMS issued Notice to Lessees and Operators (NTL) 2010-N05, Increased Safety Measures for Energy Development on the OCS.

Pursuant to 30 CFR Part 550.213(g) and 30 CFR Part 550.219, an Exploration Plan must be accompanied by a blowout scenario description and information regarding oil spills, including calculations of the worst case discharge scenario. Under the new requirements for enhanced drilling safety (NTL 2010-N06, Information Requirements for Exploration Plans, Development and Production Plans, and Development Operations Coordination Documents on the OCS), operators must demonstrate that they are prepared to deal with the potential for a blowout and worst-case discharge.

NTL 2010-N10, Statement of Compliance with Applicable Regulations and Evaluation of Information Demonstrating Adequate Spill Response and Well Containment Resources, requires to be included with every APD a statement signed by an authorized company official stating that the operator will conduct all authorized activities in compliance with all applicable regulations, including the Increased Safety Measures for Energy Development on the Outer Continental Shelf rulemaking (75 FR 62246, October 7, 2010). In compliance with the NTL and pursuant to 30 CFR Part 254, each operator using subsea blowout preventers (BOPs) or BOPs on floating facilities must submit information demonstrating that it has access to and can deploy surface and subsea containment resources that would be adequate to promptly respond to a blowout or other loss of well control.

The new Drilling Safety Rule imposes requirements that will enhance the safety of OCS oil and gas drilling operations. It addresses both well bore integrity and well control equipment and procedures. Well bore integrity provides the first line of defense against a blowout by preventing a loss of well control through the appropriate use of drilling fluids and the well bore casing and cementing program. Applications for Permits to drill must meet new standards for well-design, casing, and cementing, and be independently certified by a professional engineer.

The new Workplace Safety Rule covers all offshore oil and gas operations in federal waters, including equipment, safety practices, environmental safeguards, and management oversight of operations and contractors. The Workplace Safety Rule makes mandatory the previously voluntary practices in the American Petroleum Institute's Recommended Practice 75 (RP 75). Companies are required to develop and maintain a Safety and Environmental Management System (SEMS). A SEMS program is a comprehensive management program for identifying, addressing, and managing operational safety hazards and impacts, with the goal of promoting both human safety and environmental protection.

## 1.2 Proposed Action

The proposed action considered in this EIS is:

- The issuance of ITAs under Section 101(a)(5) of the MMPA, by NMFS, for the incidental taking of marine mammals during G&G permitted activities, ancillary activities, and exploratory drilling activities in the U.S. Beaufort and Chukchi seas, Alaska, and
- The authorization of G&G permits and ancillary activities in the U.S. Beaufort and Chukchi seas, Alaska, by BOEM under the OCS Lands Act.

## 1.3 Purpose and Need for Action

### 1.3.1 Purpose

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.

The term "take" under the MMPA means "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." The MMPA further 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]."

ITAs issued by the Secretary of Commerce, pursuant to Section 101(a)(5) of the MMPA, as indicated above, provide a limited exception to the take prohibition in the MMPA. Therefore, NMFS and BOEM have, through this EIS, analyzed the environmental impacts associated with authorizing the take of marine mammals incidental to oil and gas exploration activities in the U.S. Beaufort and Chukchi seas, Alaska, using the best available science and including impacts to marine mammals and the subsistence uses of these species. The analysis considers the effects associated with issuing ITAs for oil and gas activities such as seismic surveys, exploratory drilling activities, and aircraft and support vessel activity (including, for example, icebreaking and resupply). This EIS also includes an analysis of the environmental impacts associated with authorizing seismic surveys under the OCS Lands Act.

ITAs may be issued as either (1) regulations and associated Letters of Authorization (LOAs) or (2) Incidental Harassment Authorizations (IHAs). An IHA can only be issued if the proposed action will not result in a potential for serious injury and/or mortality or where any such potential can be negated

through required mitigation measures. Where the proposed activity has the potential to result in serious injury and/or mortality (that cannot be negated through mitigation measures), only regulations and associated LOAs may be used to authorize take. However, regulations and LOAs may also be issued when there is no potential for serious injury and/or mortality if the applicant requests it, which applicants sometimes do for multi-year activities because it offers some administrative streamlining benefits. The Secretary of Commerce is required to authorize the take of small numbers of marine mammals incidental to a specified activity if the taking would have no more than a "negligible impact" on marine mammal species or stocks and not have an "unmitigable adverse impact" on the availability of such species or stocks for taking for subsistence uses.

The OCS Lands Act directs the Secretary of the Interior to oversee the "expeditious and orderly development" of OCS resources subject to environmental safeguards (43 U.S.C. §§ 1332(3), (6), 1334(a)(7)). Critical to the potential development of OCS resources is the ability to gather geological and geophysical data on the resource potential of the OCS. Pursuant to 30 CFR Part 551.4, a G&G permit must be obtained from BOEM to conduct G&G exploration for oil, gas, and sulphur resources when operations occur on unleased lands or on lands leased to a third party. Ancillary activities are regulated under 30 CFR Part 250, which states that a notice must be submitted before conducting G&G data collection pursuant to a lease issued or maintained under the OCS Lands Act (30 CFR Part 550.208).

### 1.3.2 Need

NMFS anticipates receipt of applications to take marine mammals incidental to oil and gas industry exploration activities (i.e. G&G and ancillary surveys and exploratory drilling) pursuant to Sections 101(a)(5)(A) and (D) of the MMPA. This EIS is intended to assist NMFS in its MMPA decision-making process related to projected requests for ITAs in the U.S Beaufort and Chukchi seas for future years and may be revised as necessary. NMFS intends to use this EIS as the required NEPA documentation for the issuance of ITAs for Arctic oil and gas exploration activities. However, if necessary, NMFS may tier from this EIS to support future Arctic MMPA oil and gas permit decisions if such activities fall outside the scope of this EIS.

BOEM anticipates receipt of applications to conduct exploration surveys pursuant to the OCS Lands Act. BOEM intends to conduct site-specific NEPA analyses that either tier from this EIS or incorporate this EIS by reference. To fulfill statutory mandates for proposed exploratory drilling projects, BOEM requires the collection of high-resolution shallow hazards data to: (a) ensure safe operations, which refers to detection of shallow gas pockets, faults, channel boundaries or other geological or man-made features that could be hazards to drilling; (b) support environmental impact analyses; (c) protect resources through avoidance measures, such as prohibiting anchor locations within a boulder patch area or a potential archeological site; and (d) perform other statutory responsibilities.

## 1.4 Scope and Objectives

The scope of the proposed action involves two parts: (1) to continue permitting or authorizing exploration activities that will provide the oil and gas industry and BOEM with the best available data on the location, extent, and properties of hydrocarbon resources, as well as information on shallow geological hazards and seafloor geotechnical properties; and (2) to support MMPA authorizations for the take of marine mammals incidental to conducting deep penetration seismic surveys, shallow hazards surveys, and exploratory drilling activities under the Proposed Action. Therefore, the objectives of the EIS are to:

1. Evaluate a broad range of reasonably foreseeable levels of exploration activities (e.g. deep penetration seismic surveys, shallow hazards surveys, and exploratory drilling activities), including the use of alternative technologies and methodologies intended to reduce the amount and/or intensity of sound output, in state and federal waters in the U.S. Beaufort and Chukchi seas. The

EIS may be used, based on a case-by-case evaluation, as the sole NEPA compliance document for future agency actions covered by this EIS, or it may serve as a tiering document (as contemplated by the CEQ regulations) where it is determined that further NEPA analysis may be required.

2. Provide environmental information that can be used to help NMFS evaluate whether to issue ITAs under the MMPA for activities in state and federal waters in the U.S. Beaufort and Chukchi seas and to help BOEM evaluate whether to grant G&G permits or other authorizations under the OCS Lands Act for proposed activities.
3. Project the amount and extent of OCS and state water G&G, ancillary, and exploratory drilling activities that are likely to occur in the U.S. Beaufort and Chukchi seas based on the best available information.
4. Identify and analyze any direct, indirect, and cumulative impacts that may result from the proposed action, including the benefits of one or more measures to mitigate adverse environmental effects.
5. Evaluate a range of monitoring and mitigation measures that might be implemented relative to the level of deep penetration geophysical surveys, shallow hazards surveys, and exploratory drilling to minimize impacts to marine resources and to ensure no unmitigable adverse impact to subsistence users.

The analyses contained in this EIS provide decision-makers and the public with an evaluation of the potential environmental, social, and economic effects of a range of reasonable alternatives, including the proposed action. The EIS also includes an analysis of the potential cumulative impacts of the proposed action, particularly as they relate to marine resources (e.g. marine mammals, fish, etc.) and subsistence harvest activities.

Specifically, NMFS and BOEM have, through this EIS:

- Described the Proposed Action and a range of reasonable alternatives, including a suite of proposed mitigation measures, as well as consideration of other mitigation measures;
- Assessed the direct and indirect effects of the Proposed Action and alternative approaches to authorize oil and gas deep penetration geophysical surveys and shallow hazards surveys under the OCS Lands Act and the taking of marine mammals incidental to seismic and shallow hazards surveys and exploratory drilling activities under the MMPA;
- Assessed the effects on the marine mammal species and the availability of those species for subsistence uses, as well as other components of the marine ecosystem and human environment;
- Assessed the cumulative impacts associated with the Proposed Action; and
- Analyzed the effects of obtaining geotechnical data for pre-feasibility analyses of shallow sub-sea sediments associated with identifying potential shallow geophysical hazards, as part of proposed exploratory drilling.

NMFS will use the EIS to support the consideration of future MMPA authorizations for deep penetration geophysical surveys, shallow hazards surveys, and exploratory drilling activities in state and federal waters in the U.S. Beaufort and Chukchi seas. There are multiple regulatory scenarios under which NMFS can issue MMPA authorizations (e.g. IHA versus LOA, or through the structure of the Open Water Meeting or Monitoring peer review). The history and known strengths and challenges of the various scenarios will be discussed in Chapter 5. The EIS will assist BOEM in identifying and evaluating potential adverse effects to the environment and in developing appropriate mitigation measures. The EIS will assist BOEM and BSEE in the analysis needed to ensure safe operations, meet regulatory requirements, and protect benthic habitat in federal waters.

## 1.5 Issues and Concerns to be Addressed in the EIS

The NOI to prepare the EIS (75 FR 6175, February 8, 2010) provided a list of issues on which NMFS was seeking public input. These issues included:

- Protection of subsistence resources and Iñupiat culture and way of life;
- Disturbance to bowhead whale migration patterns;
- Impacts of seismic operations on marine fish reproduction, growth, and development;
- Harassment and potential harm of wildlife, including marine mammals and marine birds, by vessel operations, movements, and noise;
- Impacts on water quality;
- Changes in the socioeconomic environment;
- Impacts to threatened and endangered species;
- Impacts to marine mammals, including disturbance and changes in behavior;
- Incorporation of traditional knowledge in the decision-making process; and
- Effectiveness and feasibility of marine mammal monitoring and other mitigation and monitoring measures.

The scoping period for the *Effects of Oil and Gas Activities in the Arctic Ocean EIS* began on February 8, 2010 and ended April 9, 2010. Public scoping meetings were held during February and March 2010 in the communities of Kotzebue, Point Hope, Point Lay, Wainwright, Barrow, Nuiqsut, Kaktovik, and Anchorage. Scoping comments were received verbally and in writing through discussion, testimony, fax, regular mail, and electronic mail.

Of the issues identified during scoping, those that were most commonly raised included:

- Concerns regarding the NEPA process;
- Impacts to marine mammals and habitats;
- Risks of oil spills;
- Climate change;
- Protection of subsistence resources and the Iñupiat culture and way of life;
- Availability of research and monitoring data for decision-making;
- Monitoring requirements; and
- Suggestions for, or implementation of, mitigation measures.

For more detail on the issues raised during the scoping process, please refer to Appendix C of the EIS.

Issues and concerns associated with oil and gas related activities in the marine environment have also been documented for decades by the scientific community, in government publications, at scientific symposia, and through scoping and public meetings/comments, and other NMFS and BOEM NEPA analyses. In addition, public testimony and Traditional Knowledge from Alaska Natives have provided valuable information about seismic survey operations and exploratory drilling activities. Where appropriate, NMFS and BOEM will address this information in the relevant sections of the EIS.

## 1.6 Description of the Project Area

The project area for this EIS, illustrated in Figure 1.1, covers a total area of approximately 200,331 square miles within the Alaskan portion of the Beaufort and Chukchi seas. It includes State of Alaska and OCS waters adjacent to the North Slope of Alaska and transit areas of the Chukchi Sea north of the Bering Straits. The oceanographic area extends from Kotzebue on the west to the U.S.-Canada border on the east. The offshore boundary is the OCS Beaufort Sea and Chukchi Sea Planning Areas, approximately 322 km (200 mi) offshore. Onshore locations included within the EIS project area include communities of the North Slope: Kotzebue; Kivalina; Point Hope; Point Lay; Wainwright; Barrow; Nuiqsut; Kaktovik; and the Prudhoe Bay area. Areas of special importance for this EIS are identified in Figures 3.2-25 and 3.2-26, and are typically associated with important biological areas.

## 1.7 Recent Chronology of NEPA Activities and Documents that Influence the Scope of the EIS

The effects of oil and gas related deep penetration geophysical surveys, shallow hazard surveys, and exploratory drilling activities in the U.S. Beaufort and Chukchi seas have been evaluated to some degree in previous NEPA documents produced by both the NMFS and MMS. Summaries of these documents are contained herein. Portions of these NEPA documents are appropriately incorporated by reference in other chapters of this EIS, as directed by 40 CFR 1502.21 of the CEQ's regulations.

- In 2003, MMS prepared the ***Beaufort Sea Planning Area Oil and Gas Lease Sales 186, 195, 202 Final Environmental Impact Statement (OCS EIS/EA MMS 2003-001)***. The Final EIS analyzed the environmental effects of these three sales – Sale 186 in 2003, Sale 195 in 2005 and Sale 202 in 2007 – all of which consider leasing the same geographical area in the Beaufort Sea.
- In 2006, MMS prepared Draft and Final Programmatic Environmental Assessments (PEAs) on the *Arctic Ocean Outer Continental Shelf Seismic Surveys - 2006* (MMS 2006, or PEA) for permitting up to four seismic surveys to be conducted in the open water season in both the Beaufort and Chukchi seas, for a total of up to eight annual surveys. NMFS was a cooperating agency in the preparation of the MMS PEA. A Final PEA was released by MMS on June 22, 2006 and adopted by NMFS.
- On November 17, 2006, NMFS and MMS issued a NOI to jointly prepare a **Programmatic EIS (PEIS) for *Seismic Surveys in the Chukchi and Beaufort seas, Alaska***. The PEIS assessed the impacts of MMS' six annual authorizations under the OCS Lands Act to the U.S. oil and gas industry, to conduct a higher level of offshore geophysical seismic surveys in the Beaufort and Chukchi seas off Alaska over a longer time frame than evaluated in the PEA, and to assess the impacts of NMFS' authorizations under the MMPA to incidentally harass marine mammals while conducting those surveys. The Draft PEIS assumed that up to six offshore geophysical seismic surveys would be conducted annually in both the Beaufort and Chukchi seas off Alaska (for a total of up to 12 annual surveys) and evaluated the environmental effects of the increased level of seismic effort (which represents a 50 percent increase in activity compared to the level of seismic effort analyzed in the MMS 2006 PEA). On March 30, 2007, the Environmental Protection Agency (EPA) announced the availability for comment of the MMS/NMFS Draft PEIS (MMS 2007a). However, on October 28, 2009, NMFS published a notice of withdrawal of the 2007 PEIS (74 FR 55539).
- In May 2007, MMS issued the **Final EIS for the *Chukchi Sea Planning Area Oil and Gas Lease Sale 193 and Seismic Surveying Activity in the Chukchi Sea*** and also examined a proposal for exploration seismic survey permitting in 2007 in the proposed sale area and two alternatives for the 2007 seismic surveys (OCS EIS/EA MMS 2007-026).

- In August 2007, NMFS prepared a **Supplemental EA** (SEA; NMFS 2007a) and issued a new Finding of No Significant Impact (FONSI) to update the 2006 Final PEA for analysis of an **Arctic seismic survey ITA**, including NMFS' issuance of an IHA to Shell Offshore Inc. (Shell) for the 2007 season. The 2007 SEA analyzed the effects on the human environment of issuing an IHA to Shell for the take of marine mammals incidental to conducting deep penetration 3D seismic surveys in both the Beaufort and Chukchi seas and marine surveys, including site clearance and shallow hazards surveys, in the Beaufort Sea during the 2007 Arctic open-water season. Where appropriate, sections of the 2006 Final PEA and 2007 Draft PEIS were incorporated into the 2007 SEA by reference.
- In October 2007, NMFS prepared an **EA for the issuance of an IHA to Shell** to take marine mammals incidental to conducting an offshore drilling project in the U.S. Beaufort Sea (NMFS 2007b) and issued a FONSI on October 24, 2007. This EA analyzed the effects on the human environment of issuing an IHA to Shell for the take of marine mammals incidental to conducting open-water offshore exploratory drilling in OCS blocks of the U.S. Beaufort Sea.
- For the 2008 Arctic open-water season, NMFS received applications from five oil and gas companies requesting IHAs to conduct various types of seismic and site clearance and shallow hazards surveys in the Arctic Ocean. In July 2008, NMFS prepared a new **seismic/site clearance survey SEA** (2008 SEA; NMFS 2008) to update analyses contained in the 2006 Final PEA since it was determined that the 2008 surveys would have environmental impacts similar to the activities analyzed in the 2006 Final PEA. Where appropriate, sections of the 2006 Final PEA and 2007 Draft PEIS, as well as NMFS' 2007 SEA, Arctic Regional Biological Opinion, MMS' 2007 *Chukchi Sea Planning Area Oil and Gas Lease Sale 193 and Seismic Surveying Activities in the Chukchi Sea - Final Environmental Impact Statement* (MMS 2007b), and MMS' *Beaufort Sea Planning Area Oil and Gas Lease Sales 186, 195, 202 Final Environmental Impact Statement* (MMS 2003), were incorporated into the 2008 SEA by reference. After completion of the 2008 SEA, NMFS issued five FONSIs in July and August 2008 for each of the five IHAs issued by NMFS.
- In November 2008, MMS published a **Draft EIS for the *Beaufort and Chukchi Sea Planning Areas Oil and Gas Lease Sales 209, 212, 217, and 221*** (*Arctic Multiple Sale Draft EIS*). This Draft EIS evaluated several alternatives for leasing (lease block configurations) and the direct and indirect effects to the human, physical, and biological resources from activities associated with exploration, development, and production scenarios, as well as accidental oil spills. The cumulative-effects analysis evaluated the environmental effects of the proposed action and alternatives with past, present, and reasonably foreseeable future actions occurring in these regions. The Secretary of the Interior cancelled these lease sales for further consideration in the Preliminary Revised Program for the 2007-2012 Five Year Oil and Gas Leasing Program on March 31, 2010. Therefore, a Final EIS was not issued for these lease sales.
- In August 2009, NMFS published an **EA for the issuance of an IHA to Shell**, which analyzed the impacts to the human environment that may result from the take of marine mammals incidental to conducting an open water marine survey program in the Chukchi Sea, Alaska, during 2009. Portions of several of the NEPA documents mentioned above were incorporated by reference into the 2009 EA. Among other things, the 2009 EA updated information on the potential impacts to marine mammals based on previous years of monitoring. NMFS issued a FONSI on August 14, 2009.
- In October 2009, MMS published an **EA for the Shell *2010 Exploration Drilling Program-Camden Bay, Beaufort Sea, Alaska* (OCS EIS/EA MMS 2009-052)**, which analyzed the environmental impacts of exploration drilling. Shell proposed to drill two exploration wells during the July to October 2010 open-water-drilling season. The EA tiered from existing

environmental documents and incorporated by reference other environmental documents (see EA pages 2 and 3 for the list of environmental documents).

- In December 2009, MMS published an EA for the Shell 2010 Exploration Drilling Program—Burger, Crackerjack, and Southwest Shoebill Prospects in the Chukchi Sea Outer Continental Shelf, Alaska (OCS EIS/EA MMS 2009-061). Shell proposed to drill exploration wells at up to three of five possible drill sites during the July to October 2010 open-water-drilling season. The EA tiered from existing environmental documents and incorporated by reference other environmental documents (see EA pages 6 and 7 for the list of environmental documents).
- In June 2010, BOEMRE published an **EA for Statoil's *Proposed Seismic Survey Activity in the Chukchi Sea Planning Area* (OCS EIS/EA BOEMRE 2010-020)**. The EA tiered from two previous environmental documents: (1) Final PEA, Arctic Ocean Outer Continental Shelf, Seismic Surveys—2006 (OCS EIS/EA MMS 2006-038) June 2006; and (2) Final EIS, Chukchi Sea Planning Area, Oil and Gas Lease Sale 193 EIS and Seismic Surveying Activities in the Chukchi Sea (OCS EIS/EA MMS 2007-026) May 2007.
- In July 2010, BOEMRE published an **EA for Shell *Exploration & Production Proposed Ancillary Activities—Marine Surveys in the Beaufort Sea, Alaska* (OCS EIS/EA MMS 2010-022)**. Ancillary activities are activities conducted by a leaseholder on BOEMRE-issued leases for the purposes of obtaining data and information to develop an Exploration Plan or Development and Production Plan. Shell proposed shallow hazard and site clearance surveys, ice gouge surveys, strudel scour surveys, marine baseline studies, and seafloor soil sampling. The EA tiered from existing environmental documents and incorporated by reference other environmental documents (see EA pages 2 and 3 for the list of environmental documents).
- In July 2010, NMFS prepared an EA for the issuance of IHAs to take marine mammals incidental to conducting open-water seismic and marine survey programs in the U.S. Beaufort and Chukchi seas (NMFS 2010). This EA analyzed the impacts to the human environment from the issuance of an IHA to Shell for the take of marine mammals incidental to conducting an open-water marine survey program in the U.S. Beaufort and Chukchi seas and the issuance of an IHA to Statoil for the take of marine mammals incidental to conducting 3D and 2D open-water seismic surveys in the Chukchi sea. Several of the earlier NEPA documents mentioned in this list were incorporated into NMFS' 2010 EA by reference. After completion of the EA, NMFS issued two FONSIs for each of the IHAs issued by NMFS.
- In September 2010, BOEMRE issued an **EA for ION's *Geological and Geophysical Surveys* (OCS EIS/EA BOEMRE 2010-027)**. The EA analyzed the environmental impacts associated with an airgun array and echosounders operated during 2D seismic survey, as well as potential impacts from icebreaking during the survey. The survey in the U.S. Beaufort and Chukchi seas would extend from the U.S.-Canada border in the east to Point Barrow in the west. The EA incorporated by reference past NEPA documents that provided a comprehensive characterization of the Arctic Ocean's physical, biological, and socioeconomic resources and Alaska Native subsistence activities, and evaluated a broad spectrum of potential seismic survey-related impacts (see EA page 2 for the list of these documents).
- In August 2011, BOEMRE issued the ***Final Supplemental EIS for the Chukchi Sea Planning Area Oil and Gas Lease Sale 193***. The 2008 FEIS for Lease Sale 193 was challenged in the U.S. District Court for the District of Alaska. On July 21, 2010, the District Court issued an Order remanding Sale 193 to BOEMRE to satisfy its obligations under NEPA in accordance with the Court's opinion. The District Court's Order was amended on August 5, 2010, and guidelines for compliance with the Order were established by the Court on September 2, 2010. The Draft Supplemental EIS augments the analysis in the Final EIS for Lease Sale 193 by analyzing the environmental impact of natural gas development and evaluating incomplete, missing, or

unavailable information pursuant to 40 CFR 1502.22 to respond to the Court's remand. A Draft Supplemental EIS was made available to the public on October 15, 2010. In March 2011, BOEMRE announced that a Very Large Oil Spill analysis would also be included in the Supplemental EIS. The analysis was completed and integrated within the Revised Draft Supplemental EIS, which was released for public comment on May 27, 2011.

- In July 2011, NMFS prepared an SEA and issued a FONSI for the issuance of an IHA to Statoil for the take of marine mammals incidental to open-water shallow hazards surveys in the U.S. Chukchi Sea (NMFS 2011). This 2011 SEA was a supplement to the July 2010 EA prepared by NMFS regarding oil and gas exploration activities conducted by Shell and Statoil in the U.S. Chukchi Sea. This SEA analyzed the impacts to the human environment from the issuance of an IHA to Statoil for the take of marine mammals incidental to conducting an open-water marine survey program in the Chukchi Sea.
- In July 2011, BOEMRE issued and EA and issued a FONSI on the **Statoil USA E&P Inc.** ***2011 Ancillary Activities, Chukchi Sea, Alaska*** **(OCS EIS/EA BOEMRE 2011-020)**. The EA analyzed potential environmental impacts resulting from an open-water shallow hazards seismic survey program. The proposed activity area encompasses the 16 leases owned by Statoil and three leases jointly owned by Statoil and CPAI in the Chukchi Sea. All leases were obtained in Lease Sale 193 held in February 2008.
- In August 2011, BOEMRE issued an EA and issued a FONSI on the **Shell Offshore Inc.** ***Revised Outer Continental Shelf Lease Exploration Plan Camden Bay, Alaska*** **(OCS EIS/EA BOEMRE 2011-039)**. The purpose of the EA is for Shell to evaluate the mineral resource potential of three lease tracts within two distinct oil and gas prospects: "Sivulliq" (NR 06-04 Flaxman Island, block 6658, OCS-Y-1805) and "Torpedo" (NR 06-04 Flaxman Island, block 6659, OCS-Y-1936 and NR 06-04 Flaxman Island, block 6610, OCS-Y-1941). The proposed action calls for two wells each to be drilled into the two prospects (Sivulliq and Torpedo) during the open-water season beginning in 2012.
- In November 2011,BOEM issued the ***Outer Continental Shelf Oil and Gas Leasing Program 2012-2017 Draft Programmatic EIS***. The DPEIS evaluates the potential impacts from oil and gas exploration and development on six planning areas of the OCS, including Western Gulf of Mexico, Central Gulf of Mexico, Eastern Gulf of Mexico, Cook Inlet, Beaufort Sea, and Chukchi Sea. The analysis adopts a broad regional perspective; BOEM intends for more detailed and geographically-focused analyses to be done as the five-year program progresses from the planning stage through the leasing, exploration, and development stages.

## 1.8 Federal Laws and Other Requirements Applicable to Oil and Gas Activities in the Arctic Ocean

The federal issuance of permits and authorizations under the OCS Lands Act in the U.S. Beaufort and Chukchi seas off the coast of Alaska and NMFS' authorizations under the MMPA are subject to a number of federal laws and regulations and Executive Orders. There are also relevant State laws and regulations for oil and gas exploration activities in State of Alaska waters. These are briefly summarized below.

### 1.8.1 National Environmental Policy Act of 1969

NEPA establishes a nationwide policy and goal of environmental protection, and provides legal authority for federal agencies to carry out that policy (40 CFR 1500.1(a)). It requires federal agencies to study and consider the environmental consequences of their actions and to use an interdisciplinary framework for environmental decision-making, which includes the consideration of environmental amenities and values (42 U.S.C. § 4332(B)).

NEPA also requires federal agencies to make environmental information available to the public and to public officials and to consider their comments before making decisions that could affect the environment. Documents prepared by federal agencies in compliance with NEPA must be streamlined to focus on the issues that are truly significant to the action in question and present alternatives in a way that allows potential environmental consequences to be clearly distinguished, along with "advice and information useful in restoring, maintaining, and enhancing the quality of the environment" (43 FR 55990, November 28, 1978, and 40 CFR 1502.1, 1502.2, and 1502.14).

The provisions of NEPA require that an EIS contain the following elements:

1. Statement of Purpose and Need for the Proposed Action;
2. Description of Alternatives Evaluated in the EIS, including the Proposed Action, the No Action Alternative, and Alternatives Evaluated but Eliminated from Further Consideration;
3. Description of the Affected Environment;
4. Analysis of Environmental Consequences of Alternatives Carried Forward in the EIS;
5. The Relationship Between Local Short-Term Uses of Man's Environment and the Maintenance and Enhancement of Long-Term Productivity; and
6. Any Irreversible and Irretrievable Commitments of Resources Which Would be Involved in the Proposed Action Should it be Implemented.

The preparation of an EIS must include the following five basic steps:

1. **Scoping**. As the first step in the NEPA process, scoping provides an opportunity for the public, government agencies, and other interested groups to provide information and advice on issues that might be associated with the proposed project, so that the lead federal agency can decide whether and how to address them in the EIS. Scoping can also identify new alternatives to be considered in the EIS.
2. **Draft Environmental Impact Statement (DEIS)**. After scoping is completed, a DEIS is prepared. The DEIS describes and evaluates a range of reasonable alternative actions, including no action. If the lead agency has decided upon a preferred alternative by the time a DEIS is prepared, it is identified. The DEIS evaluates physical, biological, socioeconomic, and environmental impacts that might result from the alternatives carried forward for analysis, and it describes the significance of environmental effects surrounding the various alternatives, including the proposed action. Finally, it identifies ways to mitigate the potential impacts – to avoid, minimize, rectify, reduce, or eliminate those impacts over time or to compensate for any potential harm to the environment that might be caused by any of the alternatives.
3. **Public Comment on the DEIS**. Following publication of a DEIS, a public NOA for review is published in the FR, which begins a public comment period of no less than 45 days. A public hearing may be conducted to provide an opportunity for interested parties to provide oral comments on the DEIS. Following the public comment period, the lead agency considers all of the comments received and prepares a final EIS (FEIS) and includes responses to the comments on the DEIS.
4. **Final Environmental Impact Statement (FEIS)**. The FEIS must identify the lead agency's preferred alternative (unless another law prohibits the expression of such a preference) and may identify the environmentally preferable alternative, which may be different. Once the FEIS is completed and published, there is a 30-day "wait" period before an agency may issue its Record of Decision (ROD) (see below).
5. **Record of Decision**. Following completion of the FEIS process as described above, the lead agency prepares a ROD. The ROD must: (1) state what the decision was; (2) identify all

alternatives considered in reaching the decision and which were considered to be environmentally preferable; and (3) state whether all practicable means to avoid or minimize environmental harm have been adopted, and if not, why not (40 CFR 1505.2). If a monitoring and enforcement program is applicable for any mitigation, it must be adopted and summarized in the ROD (40 CFR 1505.2).

### 1.8.2 National Oceanic and Atmospheric Administration Administrative Order (NAO) 216-6

NAO 216-6 describes NOAA's policies, requirements, and procedures for complying with NEPA and the implementing regulations issued by CEQ as codified in Parts 1500-1508 of Title 40 of the CFR (40 CFR Parts 1500-1508) and those issued by the DOC in Department Administrative Order (DAO) 216-6, *Implementing the NEPA*. NAO 216-6 incorporates the requirements of Executive Order (EO) 12898, federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations. Also, the Order reiterates provisions to EO 12114, *Environmental Effects Abroad of Major Federal Actions*, as implemented by DOC in DAO 216-12, *Environmental Effects Abroad of Major Federal Actions* (NAO 216-6).

### 1.8.3 Endangered Species Act

NMFS and BOEM have shared mandates under the Endangered Species Act (ESA). Section 7 (16 U.S.C. § 1536) of the ESA states that all federal agencies shall, in consultation with, and with the assistance of the Secretary of the Interior or Commerce (Secretary), ensure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species, which is determined by the Secretary to be critical. Section 9 (16 U.S.C. § 1538) of the ESA identifies prohibited acts related to endangered species and prohibits all persons, including all federal, state and local governments, from taking listed species of fish and wildlife, except as specified under provisions for exemption (16 U.S.C. §§1535(g)(2) and 1539). Generally, the USFWS manages land and freshwater species while NMFS manages marine species, including anadromous salmon. However, the USFWS has responsibility for some marine animals such as nesting sea turtles, walrus, polar bears, sea otters, and manatees.

For actions that may result in prohibited "take" of a listed species, federal agencies must obtain authorization for incidental take through Section 7 of the ESA's formal consultation process. Under the ESA, "take" means to "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt any such conduct to species listed as threatened or endangered in 50 CFR 402.12(b)." NMFS has further defined harm as follows: "harm" is "…an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including, breeding, spawning, rearing, migrating, feeding or sheltering" (50 CFR 222.102). NMFS has not defined the term "harass".

Under Section 7 of the ESA, federal agencies consult with the USFWS and/or NMFS and submit a consultation package for proposed actions that may affect listed species or critical habitat. If a listed species or critical habitat is likely to be affected by a proposed federal action, the federal agency must provide the USFWS and NMFS with an evaluation whether or not the effect on the listed species or critical habitat is likely to be adverse. The USFWS and/or NMFS uses this documentation along with any other available information to determine if a formal consultation or a conference is necessary for actions likely to result in adverse effects to a listed species or its designated critical habitat. If a federal action is likely to adversely affect endangered or threatened species or designated critical habitat, then USFWS and/or NMFS prepares a Biological Opinion, which makes a determination as to whether the action is likely to jeopardize an endangered or threatened species. If take is anticipated, the USFWS and/or NMFS

must also issue an Incidental Take Statement, which includes terms and conditions and reasonable and prudent measures which must be followed.

### 1.8.4 Marine Mammal Protection Act

Under the MMPA (16 U.S.C. § 1361 *et seq.*), the taking of marine mammals without a permit or exception is prohibited. The term, "take" under the MMPA, means "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." 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]".

In order to obtain an exemption from the MMPA's prohibition on taking marine mammals, a citizen of the U.S. who engages in a specified activity (other than commercial fishing) within a specified geographic region must obtain an ITA under Section 101(a)(5)(A) or (D) of the MMPA. An ITA shall be granted if NMFS finds that the taking of small numbers of marine mammals of a species or stock by such citizen will have a negligible impact on the affected species or stock(s) and will not have an unmitigable adverse impact on the availability of the species or stock(s) for taking for subsistence uses. NMFS must base its findings on the best scientific information available (50 CFR Part 216.102(a)). NMFS shall also prescribe, where applicable, the permissible methods of taking and other means of affecting the least practicable impact on the species or stock and its habitat (i.e. mitigation, monitoring and reporting of such takings). ITAs may be issued as either (1) regulations and associated LOAs or (2) IHAs. IHAs can be issued only when there is no potential for serious injury and/or mortality or where any such potential can be negated through required mitigation measures.

As part of the MMPA authorization process, applicants are required to provide detailed mitigation plans that outline what efforts will be taken to reduce negative impacts to marine mammals, and their availability for subsistence use, to the lowest level practicable. In addition, MMPA authorizations require that operators conduct monitoring, which must be designed to result in an increased knowledge of the species and an understanding of the level and type of takings that result from the authorized activities. Where the proposed activity may affect the availability of a species or stock of marine mammal for taking for subsistence uses, the proposed monitoring plan must be independently peer reviewed pursuant to 16 U.S.C. § 1371(a)(5)(D), prior to issuance of the ITA.

### 1.8.5 Outer Continental Shelf Lands Act

The OCS Lands Act of 1953 (67 Stat. 462), as amended (43 U.S.C. § 1331 *et seq.* [2006]), established federal jurisdiction over submerged lands on the OCS, seaward of State boundaries. Under the OCS Lands Act, the USDOI is required to manage the leasing, exploration, development, and production of mineral resources on the federal OCS. The OCS Lands Act established that OCS development proceed in a safe and efficient manner that provides for environmental protection, fair and equitable returns to the public, State and local participation in policy and planning decisions, and resolution of conflicts related to other ocean and coastal resources and uses. In 1978, Congress amended the OCS Lands Act, 43 U.S.C. §§ 1331-1356a, 1801-1802, to provide for the "expedited exploration and development of the [OCS]," in a manner that balances the need "to make such resources available to meet the Nation's energy needs as rapidly as possible… with protection of the human, marine, and coastal environments." BOEM and BSEE regulations implementing the OCS Lands Act are at 30 CFR Chapters II and V.

### 1.8.6 Magnuson-Stevens Fishery Conservation and Management Act

Federal agencies are required to consult with the Secretary of Commerce with respect to any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken, by such agency

that may adversely affect essential fish habitat (EFH) identified under the Magnuson Stevens Fishery Conservation and Management Act (MSFCMA).

### 1.8.7 Coastal Zone Management Act

The Coastal Zone Management Act (CZMA) encourages coastal states to develop comprehensive programs to manage and balance competing uses of and impacts to coastal resources. The CZMA emphasizes the primacy of state decision-making regarding the coastal zone. Section 307 of the CZMA (16 U.S.C. § 1456), called the federal consistency provision, is a major incentive for states to join the national coastal management program and is a powerful tool that states use to manage coastal uses and resources and to facilitate cooperation and coordination with Federal agencies.

Federal consistency is the CZMA requirement where federal agency activities that have reasonably foreseeable effects on any land or water use or natural resource of the coastal zone (also referred to as coastal uses or resources and coastal effects) must be consistent to the maximum extent practicable with the enforceable policies of a coastal state's federally-approved coastal management program.

As of 12:01 AM, Alaska Standard Time, on July 1, 2011, the Alaska Coastal Management Program (ACMP) authorities in AS 46.39, AS 46.40, and other uncodified laws relating to the ACMP were automatically repealed. At that point, the regulations at 11 Alaska Administrative Code (AAC) 110, 11 AAC 112, and 11 AAC 114 and the local coastal management plans lost their statutory authority and became unenforceable. As such, coastal zone management will not be carried forward for analysis in Chapter 4

### 1.8.8 Clean Air Act

The Clean Air Act (43 U.S.C. § 7401, et seq.) governs the control of air pollutant emissions from both stationary and mobile sources. Under the Clean Air Act, EPA is authorized to establish National Ambient Air Quality Standards (NAAQS) to limit the concentration of harmful air emissions that, when occurring in sufficient concentrations, can harm human life and wildlife. The Clean Air Act established two types of national air quality standards. Primary standards set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards set limits to protect public welfare, including protection against visibility impairment, damage to animals, crops, vegetation, and buildings.

The Clean Air Act has been amended several times since the first version in 1963. The jurisdiction for approving air quality permits depends on the location of the proposed federal action. Jurisdiction for air pollution control on the OCS is divided into three areas: those within the state’s seaward boundary (0 to 5 km [0 to 3 mi]); those within 40 km (25 mi) of a state’s seaward boundary (i.e., 5 to 45 km [3 to 28 mi] from the coast); and those beyond 40 km (25 mi) of a state’s seaward boundary (i.e., 45 to 322 km [28 to 200 mi] from the coast). The Alaska Department of Environmental Conservation (ADEC) issues permits for proposed actions within the state seaward boundary while the EPA issues permits for proposed federal action within and beyond 40 km (25 mi) of a state’s seaward boundary. Permits issued by EPA for sources within the 40-km (25-mi) state boundary must comply with state air standards.

Under the 1990 Amendments, the Clean Air Act Title V operating permit program was established. EPA regulations implementing Title V are promulgated at 40 CFR Part 71 (for permits issued by EPA) and 40 CFR Part 70 (for permits issued by states). The Title V air quality operating permit, or Title V permit, is an enforceable compilation of all air pollution requirements that are applicable to an air emission source and is typically issued after the major stationary source has begun to operate (post-construction). While most Title V permits are issued by state and local permitting authorities, the EPA also issues Title V permits for special circumstances, such as in Indian country and on the OCS (within and beyond 40 km [25 mi] of a state’s seaward boundary).

On the Alaskan OCS, a combination of air permits such as Owner Requested Limits (minor source pre-construction), Prevention of Significant Deterioration (PSD), nonattainment New Source Review (NSR), and Title V permits may be issued by ADEC or the EPA(Clean Air Act Section 328(a)(1)). Regardless of the type of federal permit, actions on the OCS are regulated under 40 CFR Part 55.13. This regulation directs the project sponsor to comply with 40 CFR 52.21, the PSD permit regulation, and 40 CFR Parts 70 and 71, the Title V regulation. The PSD permit must be obtained before construction begins (pre-construction permit), and the Title V operating permit is typically applied for following implementation of the Proposed Action, and thereafter on a regular recurring basis.

### 1.8.9 Clean Water Act

The Clean Water Act (CWA) has several sections or programs applicable to activities in offshore waters, including U.S. Coast Guard (USCG) implementing regulations (33 CFR Part 151).

The EPA has promulgated regulations (40 CFR Part 125) to ensure the discharges it regulates through the National Pollution Discharge Elimination System (NPDES) program, pursuant to Section 402 of the CWA, would not cause an unreasonable degradation of the marine environment. The EPA's NPDES Arctic General Permit for Offshore Oil and Gas Exploration on the OCS and contiguous State Waters (Permit Number AKG280000) authorizes certain discharges from oil and gas exploration facilities and establishes effluent limitations, monitoring requirements, and other conditions. Permitted discharges related to exploration drilling include drilling fluids and cuttings, deck drainage, sanitary waste, domestic wastes, desalination unit wastes, blowout-preventer fluid, boiler blowdown, fire control system test water, non-contact cooling water, uncontaminated ballast water, bilge water, excess cement slurry, muds, cuttings, cement at seafloor, and test fluids. The current Arctic general permit expired on June 26, 2011. The EPA plans to reissue separate NPDES exploration General Permits for the Beaufort Sea and the Chukchi Sea in October 2012. EPA expects that tribal consultation and public comment on the new proposed Beaufort and Chukchi oil and gas exploration permits would occur in early 2012. Coverage has been administratively extended under the expired Arctic General Permit until the new General Permits are issued.

### 1.8.10 Executive Order 12898: Environmental Justice

EO 12898, signed by the President on February 11, 1994, and published February 16, 1994 (59 FR 7629), requires that federal agencies make achieving "environmental justice" part of their mission by identifying and addressing disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low income populations in the U.S. Many Alaska Natives harvest marine mammals for subsistence purposes and benefit from their continued existence. There is the potential for a disproportionately high level of impact and adverse human health or environmental effects on Alaska Natives resulting from authorizing incidental takes. The effects of the federal action on minority populations are described in Chapter 4.

### 1.8.11 Executive Order 13175: Consultation and Coordination with Indian Tribal Governments

This EO, signed by the President on November 6, 2000, and published on November 9, 2000 (65 FR 67249), is intended to establish regular and meaningful consultation and collaboration between federal agencies and federally-recognized tribal governments in the development of federal regulatory practices that significantly or uniquely affect their communities. In preparing this EIS, NMFS has initiated a government-to-government consultation process with affected federally-recognized tribal governments. On January 29, 2010, letters were sent from NMFS to federally-recognized Alaska Native tribes within the EIS project area, including the Native Village of Point Hope, the Native Village of Point Lay, the Inupiat Community of the Arctic Slope, the Native Village of Barrow, the Native Village of Kaktovik, the

Native Village of Nuiqsut, and the Wainwright Traditional Council, initiating government-to-government consultations and inviting those governments to participate in the EIS process. The letters provided some background information on the history of the project and the proposed action. The stated goal is to work collaboratively with tribal governments in the area of the U.S. Beaufort and Chukchi seas in order to explore ways that the energy development in the Arctic can best co-exist with the subsistence culture and way of life. NMFS has worked with several ANOs during the development of this EIS. Both BOEM and NMFS value the contribution that Alaska Native traditional ecological knowledge and experience can provide with regard to understanding marine mammals and the environment in general.

### 1.8.12 Alaska Administrative Code (Title 18, Chapter 50 – Air Quality Control)

Certain Alaska Department of Environmental Conservation (ADEC) rules are applicable to offshore areas within 25 kilometers (km) (16 mi) of Alaska's seaward boundary. The EPA applies the corresponding onshore area rules to these areas. Title 18 of Alaska Administrative Code (AAC) Chapter 50 provides for air quality control including permit requirements, permit review criteria, and regulation compliance criteria. These regulations also may apply to possible onshore facilities as well.

### 1.8.13 Co-management Agreements

Through Section 119 of the MMPA, NMFS and the USFWS were granted authority to enter into cooperative agreements with ANOs, including, but not limited to, Alaska Native Tribes and tribally authorized co-management bodies. Individual co-management agreements shall incorporate the spirit and intent of co-management through close cooperation and communication between federal agencies and the ANOs, hunters, and subsistence users. Agreements encourage the exchange of information regarding the conservation, management, and utilization of marine mammals in U.S. waters in and around Alaska.

Under Section 119 agreements, marine mammal stocks should not be permitted to diminish beyond the point at which they cease to fulfill their role in their ecosystem or to levels that will not allow for sustainable subsistence harvest. Agreements may involve: (1) developing marine mammal co-management structures and processes with federal and state agencies; (2) monitoring the harvest of marine mammals for subsistence use; (3) participating in marine mammal research; and (4) collecting and analyzing data on marine mammal populations.

NMFS currently has three co-management agreements with Native Alaskan groups specific to species found in the U.S. Beaufort and Chukchi seas and which are relevant to the scope of this EIS. Those agreements are with the Alaska Beluga Whale Committee for Western Alaska beluga whales, with the AEWC for the Western Arctic stock of bowhead whales (also known as the Bering-Chukchi-Beaufort stock), and with the Ice Seal Committee for the Alaska stocks of ringed, bearded, spotted, and ribbon seals. The NOAA-AEWC cooperative agreement is entered into under Section 112(c) of the MMPA and the Whaling Convention Act.

## 1.9 Organization of the Document

The format and content of this document was guided by the CEQ regulations at 1502.10 and NOAA NEPA guidance. The EIS includes the following sections:

**Cover Page**

**Dear Reviewer Letter**

**Executive Summary**

**Table of Contents**

**Acronym List**

**1.0 Purpose and Need**

- Summarizes the purpose and need for the Proposed Action, the major issues, background actions, pertinent laws and regulations, and the decisions to be made.

**2.0 Proposed Action and Alternatives**

- Describes and compares the Proposed Action and a range of reasonable alternatives.
- Lists alternatives considered but rejected from detailed analysis.
- Describes project activities that will be considered, as well as potential mitigation measures to be applied.

**3.0 Affected Environment**

- Describes the current condition of relevant resources in the EIS project area and establishes the baseline for comparing the predicted effects of the alternatives.

**4.0 Environmental Consequences**

- Analytically predicts and compares the consequences to relevant resources from implementing each alternative.
- The predictions include the direct, indirect, and cumulative effects of each alternative.

**5.0 NEPA Compliance Implementation and Recommendations**

- Outlines how NMFS will implement the EIS procedurally, including descriptions of adaptive management components and additional mitigation measures that could be utilized.

**6.0 Consultation and Coordination**

- Documents scoping, meetings, compliance with consultation requirements, and preparers of the EIS.

**7.0 References**

- Lists the documents and other sources used to prepare the EIS.

**8.0 Glossary**

- Contains useful definitions of terms found in the EIS.

**Figures**

- Contains all project figures and maps.

**Appendices**

- Includes important documents concerning the Proposed Action, public involvement, and consultation and coordination activities.

# 2.0 PROPOSED ACTION AND ALTERNATIVES

## 2.1 Introduction

This chapter describes the range of potential alternatives evaluated and those determined reasonable to meet the purpose and need of the proposed action as described in Chapter 1. These alternatives include the No Action alternative (no issuance of geological and geophysical (G&G) permits or authorizations of ancillary activity notices by the Bureau of Ocean Energy Management (BOEM) under the Outer Continental Shelf (OCS) Lands Act and no marine mammal take authorizations incidental to oil and gas exploration activities issued by the National Marine Fisheries Service (NMFS)) and four action alternatives that would allow for the issuance of G&G permits and authorization of ancillary activity notices under the OCS Lands Act and marine mammal incidental take authorizations (ITAs) under the Marine Mammal Protection Act (MMPA) associated with a range of oil and gas exploration activities.

## 2.2 Scoping Issues Considered in Developing the Alternatives

The first step in preparing an environmental impact statement (EIS) is publishing a Notice of Intent (NOI) in the Federal Register (FR). On February 8, 2010, the NOI announcing the preparation of this EIS was published (75 FR 6175), requesting public participation in the scoping process for 60 days. The public comment period ended on April 9, 2010. In addition to providing background information on the purpose of issuing MMPA authorizations for the incidental take of marine mammals, the NOI provided a list of issues on which NMFS was seeking public input. These issues included:

- Protection of subsistence resources and Iñupiat culture and way of life;
- Disturbance to bowhead whale migration patterns;
- Impacts of seismic operations on marine fish reproduction, growth, and development;
- Harassment and potential harm of wildlife, including marine mammals and marine birds, by vessel operations, movements, and noise;
- Impacts on water quality;
- Changes in the socioeconomic environment;
- Impacts to threatened and endangered species;
- Impacts to marine mammals, including disturbance and changes in behavior;
- Incorporation of traditional knowledge in the decision-making process; and
- Efficacy and feasibility of marine mammal monitoring and other mitigation and monitoring measures.

Public scoping meetings were held in all of the coastal Alaskan communities affected by the proposed action, as well as Anchorage, on the following dates:

- Kotzebue – February 18, 2010
- Point Hope – February 19, 2010
- Point Lay – February 22, 2010
- Wainwright – March 9, 2010
- Barrow – March 10, 2010
- Nuiqsut – March 11, 2010
- Kaktovik – March 12, 2010
- Anchorage – March 23, 2010

In a separate but parallel process for government-to-government consultation, federally- recognized Tribal governments in each community, with the exception of Anchorage, were notified of the EIS process and invited to participate. The first contact was via letter, dated January 29, 2010; follow-up calls were made with the potentially affected Tribal governments, and each entity was visited during the

scoping process. The Scoping Comment Analysis Report (CAR) (Appendix C) includes comments received in the scoping period during government-to-government consultation between NMFS, BOEM, and the Tribal governments.

Table 2.1 presents a summary of the substantive comments about alternatives and mitigation measures NMFS may require in their ITAs that were raised during public scoping meetings and submitted to NMFS during the public comment period. A more complete presentation of formal comments is included in Appendix C.

## Table 2.1 Summary of the Substantive Comments on the Alternative Development Process Received During Scoping

| Category | Comment |
|---|---|
| **No Action Alternative** | NMFS should explain why it is including a No Action Alternative because that option is not within the authority of the agency to enforce. |
| | There are significant economic consequences to the No Action Alternative that need to be analyzed, including importing oil from foreign nations. |
| | |
| **Flexibility in Managing and Authorizing Seismic and Exploratory Activities** | NMFS should consider a sufficient range of alternatives to provide for maximum flexibility in determining the final course of action pursuant to the purpose and need statement. |
| | The alternatives should treat the Beaufort and Chukchi seas separately and adopt a flexible program with realistic operating scenarios. |
| | The alternatives should adopt a flexible approach to the various seismic and drilling activities taking place within a defined area and evaluate the impacts of proposed operations on an annual basis. |
| | NMFS should consider a broader range of exploration scenarios, given that industry estimates are not always reflective of actual activity into the future. |
| | Alternatives that consider five-year permits should provide for notice and public comment on an annual basis, particularly with concern to subsistence users. |
| | Establish a cap to limit the total number of oil and gas activities that may occur in a planning area on a per season basis. |
| | Arbitrary restrictions on concurrent operations could undermine a lessee's ability to explore its leases. |
| | Because BOEM regulations (30 CFR Part 551) state that G&G activities cannot create or cause hazardous or unsafe conditions, any mitigation and monitoring measures imposed on seismic surveys by NMFS and BOEM must not result in hazardous or unsafe conditions. |
| | |
| **Protection of Sensitive Areas** | Areas of high ecological or biological significance should be protected with seasonal restrictions on the types of activities that can occur there. Specific areas suggested include:<br>◊ Critical feeding and resting grounds near Camden Bay in the mid-Beaufort Sea;<br>◊ Critical feeding grounds in the eastern Alaskan Beaufort Sea and near Barrow Canyon in the western Beaufort Sea;<br>◊ Nearshore areas (within 50 miles of the coast);<br>◊ Areas that are important for denning, feeding, and/or migration for Arctic marine mammal species such as Pacific walrus, bowhead whales, beluga whales, or polar bears; and<br>◊ Ledyard Bay critical habitat area for spectacled eiders. |
| | Subsistence use areas should also be protected with seasonal restrictions on the types of activities that can occur there, such as:<br>◊ Areas used by the Village of Kaktovik in the eastern Beaufort Sea;<br>◊ Areas around Cross Island used by the Village of Nuiqsut;<br>◊ Areas used by the Village of Barrow in the western Beaufort Sea;<br>◊ Areas used by Wainwright and Point Lay along the Chukchi Sea coast; and Kotzebue Sound (through July 10); and<br>◊ Proposed access routes should be surveyed for ice seal lairs, breathing holes, and resting locales to avoid disturbance of these animals. |

| Category | Comment |
|---|---|
| **Monitoring and Mitigation Measures** | NMFS should not issue ITAs unless they can ensure that mitigation measures will remove the potential for serious injuries or mortality to marine mammals from activities associated with oil and gas operations. |
| | The proposed EIS should consider alternatives that address shortcomings in monitoring and mitigation measures. |
| | The EIS should include a list of Conflict Avoidance Agreements for all Native groups in Alaska and adopt similar requirements to minimize impacts on subsistence hunting activities. |
| | Required mitigation measures, specifically safety and exclusion zones, should be adaptive and based on sound research and must be reasonable and feasible. Specific suggestions include:<br>◊ Exclusion zones and other regulatory threshold criteria for the implementation of mitigation measures (e.g. 180/190 dB safety and exclusion zones) should be adjusted upwards to 230 dB re:1 uPa (peak, flat) for cetaceans and 218 dB re:1 uPa (peak, flat) for pinnipeds.<br>◊ NMFS should use the noise exposure criteria proposed in Southall et al. (2007) to determine the thresholds for sound exposure and exclusion zones for marine mammals during seismic surveys. |
| | Marine mammal monitoring should be required for oil and gas activities. Technologies and methods suggested include:<br>◊ Acoustic recorders;<br>◊ Aerial monitoring;<br>◊ Satellite tagging; and<br>◊ On-board marine mammal observers. |
| | A sound cap or budget that limits the total amount of noise allowed per season should be considered as a mitigation measure. |
| | Safety and exclusion zone distances should be calculated based on peak levels of sound generated by the oil and gas equipment. |
| | Mitigation measures are needed to minimize or avoid ship strikes of marine mammals. Suggested measures include:<br>◊ Designating specific shipping lanes;<br>◊ Implementing seasonal restrictions to protect marine mammals during their migration; and<br>◊ Establishing speed restrictions. |
| | Require the use of fish finding equipment and procedures to shut down seismic activity when large schools of fish are encountered. |
| | |
| **Best Available Technology for Exploratory Activities** | The best available technology should be used to minimize impacts. Specific suggestions include:<br>◊ Vibroseis;<br>◊ Extended reach drilling;<br>◊ Zero discharge technology (as implemented in Norway);<br>◊ Gravity, magnetic, and gravity gradiometry data collection; and<br>◊ Low-sulfur fuel. |

## 2.3 Oil and Gas Exploration Activities Evaluated in the EIS

### 2.3.1 BOEM Process for Permitting

In addition to applying for an ITA from NMFS, industry applicants will work closely with other federal and state agencies to obtain additional permits and authorizations. The permits and authorizations required by BOEM guide the progression of exploration activities. It is important to understand this progression of activities as they are approved and permitted, as it can help explain the timing, stages, and sequence of exploration for offshore oil and gas resources. The following summarizes these processes, as it pertains to a description of these types of exploratory activities:

- **Geological & Geophysical (G&G) Exploration Permits** – In accordance with 30 CFR Part 551, a permit must be obtained from BOEM prior to conducting geological or geophysical exploration on unleased lands or on lands under lease by a third party (someone other than the applicant). On-lease G&G exploration can be conducted under a G&G permit or an Ancillary Activity Notice in accordance with 30 CFR Part 550 Subpart B.
- **Ancillary Activities** – These on-lease geological and geophysical activities include shallow hazards and site clearance surveys and two-dimensional (2D) and/or three-dimensional (3D) deep penetration seismic. Ancillary activities also include on-lease geotechnical sampling; however, these activities are not addressed in this EIS. A notice of proposed ancillary activities must be submitted to BOEM for technical and environmental review. BOEM must authorize the proposed ancillary activities before they can be conducted. The data and information acquired through the ancillary activities are required in support of an Exploration Plan (EP). Ancillary activities are conducted in accordance with 30 CFR Part 550.
- **Exploration Plans** – Before exploration drilling can be conducted on a lease(s), an EP must be submitted to BOEM (30 CFR Part 550 Subpart B). The EP must be approved by BOEM before an Application for Permit to Drill (APD) can be approved by the Bureau of Safety and Environmental Enforcement (BSEE) (30 CFR Part 250 Subpart B). The EP must include information on the timing and location(s) of the proposed activity, a plan of operations, the affected environment, and the potential effects on the environment. BOEM conducts a technical and environmental review of the proposed EP. Ancillary activities, as described above, are conducted to support the preparation of the geotechnical portions of an EP and associated APDs. Data and information acquired through the ancillary activities support these reviews, as well as required consultations under the National Historic Preservation Act. Data and information from the ancillary activities are also used to determine the suitability of the proposed drilling locations and for planning for drilling operations. An EP is not required for a G&G permit or an ancillary activities notice.
- **Application for Permit to Drill** – Once an operator has received approval for their EP and received all other necessary federal permits for their proposed activity, then an APD for each planned well must be reviewed and approved by BSEE prior to conducting drilling operations. Information acquired from the ancillary activities and submitted with the EP is used to determine the safety of the proposed drilling location. Any permitted well must have been included in the approved EP.

The permitting process listed above shows a general progression or sequence of events that occurs during OCS oil and gas leasing, exploration, and development as companies seek to locate and develop hydrocarbon deposits. The data and information gathered during OCS activities determines the activities likely to occur in subsequent years. The following is a summary of the probable progression:

- The first step is to search for prospective areas that could contain hydrocarbon deposits. This is primarily accomplished using deep penetration seismic surveying techniques. Companies conduct 2D or 3D geophysical seismic surveys to identify areas of interest. Two-dimensional deep penetration seismic surveying techniques are used to provide broad-scale information over a relatively large area. The results of these surveys may indicate areas of potential hydrocarbon deposits. Companies can invest in these surveys either in advance of a lease sale (to help advise their bidding or other decisions) or on speculation to sell to other companies later. Lessees may also conduct these surveys to further evaluate leases acquired in a lease sale and the surrounding area prior to drilling. Gravity, magnetic, and electromagnetic surveys may also be conducted. Under the OCS Lands Act, BOEM has the right to copies of any data and information results from exploration activities conducted under a G&G permit. BOEM in turn uses these data to determine the fair market value of a potential lease block bid for the lease sale.
- Once companies have identified potential hydrocarbon prospects, they submit bids for leases in a lease sale, where exploration and development rights are conveyed. The competitive lease sale awards leases on individual blocks to winning bidders. Some companies bid on and acquire leases on contiguous blocks that cover what they consider a large prospect. Other companies may win leases in or near these prospective areas as well. Past lease sales in the Beaufort and Chukchi seas have resulted in a mosaic of lease ownership somewhat clustered over prospects. After obtaining a lease, companies now generally conduct 3D deep penetration seismic surveys and may also add controlled source electromagnetic (CSEM) studies to further define prospects and select proposed drilling locations.
- Prior to submitting an EP and drilling a well, companies are required to conduct shallow hazards surveys (also called “site clearance” or “high-resolution geophysical surveys”) to provide information on water depth, seafloor morphology, near-surface morphology, potential shallow faults or gas zones, depth and distribution of ice gouges in the seabed, and other natural or manmade hazards. These shallow hazards surveys are used to evaluate the near-surface geology, locate shallow hazards, obtain engineering data for drilling or placement of structures (platforms and pipelines), and detect archaeological resources and certain types of benthic communities. These surveys may be conducted over portions of individual lease blocks (about 3 mi x 3 mi) or several contiguous lease blocks, depending on the exploration targets of the company. These surveys would typically need to be completed at least one season in advance of submittal of an EP and a drilling operation. Companies may also use high resolution geophysical equipment to survey off-lease areas for possible subsea pipeline routes.
- Based on the evaluation of 2D/3D seismic data and shallow hazard surveys, companies may propose in the EP to drill one or more exploration (test) wells in the area of interest. The type of drilling rig used depends on water depth, sea ice conditions, ice-resistance of the rigs, and unit availability. Data obtained from drill cuttings, well cores, and various tests in the borehole are used by industry to evaluate the properties of the geologic formations (porosity, permeability, fluid content, potential flow rates, etc.) to inform decisions on whether to pursue additional drilling and eventually possible economic development. Vertical seismic profiling (VSP) of the well would be conducted to verify the acoustic properties of the various geologic formations to facilitate correlations with the seismic survey data.

All of these operations require some form of additional support, such as crew change vessels, ice-management vessels, oil spill response equipment, fuel barges, aircraft, and staging areas. Therefore, the description of each activity in the following sections will identify the associated typical support operations. Table 2.2 summarizes the support vessels and operations associated with each activity.

**Table 2.2 Summary of Typical Support Operations for Exploration Activities**

| Activity | Typical Support Operations |
|---|---|
| Marine streamer 2D and 3D surveys | • 1 source/receiver vessel<br>• 1 support vessel<br>• Likely 1 vessel for monitoring |
| Multi-azimuth seismic survey (multiple passes in different directions with one source/receiver vessel) | • 1 source /receiver vessel<br>• 1 support vessel<br>• Likely 1 vessel for monitoring |
| Wide-azimuth seismic survey (multiple passes with multiple source vessels and at least one receiver vessel | • 2 to 4 source vessels<br>• 1 to 2 receiver vessels<br>• 1 support vessel<br>• 1 vessel for monitoring |
| Rich-azimuth seismic survey (multiple passes with multiple source vessels and at least 1 receiver vessel) | • 2 to 4 source vessels<br>• 1 to 2 receiver vessels<br>• 1 support vessel<br>• 1 vessel for monitoring |
| Full-azimuth coil-pattern seismic survey (single source/receiver vessel) | • 1 source/receiver vessel<br>• 1 support vessel<br>• Likely 1 vessel for monitoring |
| In-ice seismic survey | • 1 source/receiver vessel<br>• 1 icebreaker<br>• Possible 1 support vessel |
| Ocean-bottom cable surveys | • 2 vessels for cable layout/pickup<br>• 1 recording vessel<br>• 1 to 2 source vessels<br>• 1 to 2 small support vessels |
| Ocean-bottom node survey | • 2 source vessels<br>• 1-3 node deployment vessels<br>• 1 vessel for support monitoring |
| High-resolution airgun surveys | • 1 source/receiver vessel<br>• Possible 1 vessel for monitoring |
| High-resolution sonar surveys | • 1 source vessel |
| On ice vibroseis | • Truck-mounted vibrators over ice<br>• No vessels |
| Electromagnetic surveys | • 1 receiver/layout/pickup source vessel |
| Artificial island drilling | • Sea lift or ice road operations to transport drilling rig and support modules<br>• Drilling on island<br>• Small support vessels<br>• Aircraft for crew changes |
| Steel-drilling caisson drilling | • Modified very large crude carrier vessel<br>• 2-3 tugs and supply to and from drill site<br>• Aircraft for crew changes |

| Activity | Typical Support Operations |
|---|---|
| Exploratory Drilling Program from a Drillship | • Drillship<br>• 1 or 2 icebreakers<br>• 1 anchor handler<br>• 1 or 2 oil spill response barge and tug<br>• Tank vessel for spill storage<br>• 2-3 support vessels<br>• Aircraft for crew changes |
| Exploratory Drilling Program from a Jackup rig | • Jackup rig<br>• 1 or 2 icebreakers<br>• 1 or 2 oil spill response barge and tug<br>• Tank vessel for spill storage<br>• 2-3 support vessels<br>• Aircraft for crew changes |

## 2.3.2 Overview of Commercially-Available Geophysical Survey Methods

### 2.3.2.1 Background

Seismic exploration is used in the search for commercially and economically valuable subsurface deposits of crude oil, natural gas, and minerals. Recording, processing, and interpreting reflected seismic waves, created by introducing controlled source energy (such as seismic airgun impulses, and vibratory waves) into the earth, provides a means to develop geological models to aid in resource evaluation.

Seismic surveys can be characterized by the type of data being collected (e.g. 2D, 3D, high-resolution, etc.) or by the type of survey being conducted (e.g. open-water towed marine streamer, ocean-bottom cable, in-ice towed streamer, over ice, etc.). Survey data may be described by the acoustic sound source (e.g. airgun, water gun, sparker, pinger) or by the purpose for which the data are being collected (e.g. speculative shoot, exclusive shoot, site clearance).

Seismic surveys may also be described by the configuration of the survey and/or the location of the receivers. Vertical seismic profiling, in which the hydrophone is located in a borehole, and vertical cable surveys are conducted only as part of a drilling program. Both use standard seismic sources and do not need to be discussed in detail separately from standard seismic surveys.

Multi-azimuth and full-azimuth coil pattern surveys also use a standard source and single source/receiver vessel. During multi-azimuth surveys, the survey is designed so the vessel acquires data in several directions over the same survey location. The lines are not necessarily perpendicular. Full-azimuth coil patterns are run in circles like a spirograph around a center point. These two survey patterns do not need to be discussed separately from the standard seismic surveys.

A wide-azimuth survey consists of multiple source vessels and at least one receiver vessel run in a typical parallel survey configuration. A rich-azimuth survey incorporates both the multiple source vessel wide-azimuth type survey with a multi-azimuth survey configuration. None of the azimuth style surveys have been performed in the Arctic OCS to date primarily because of the cost of these types of surveys and no significant information gain for the extra cost. However, they are common in the rest of the world. No wide- or rich-azimuth surveys are expected to be conducted in the Arctic in the foreseeable future; therefore, they will not be discussed further in this document.

The most commonly used marine energy sources are airguns, which emit highly compressed air bubbles that transmit acoustic energy though the water column into the subsurface. Seismic waves reflect and refract off subsurface rock formations and travel back to acoustic receivers called hydrophones.

Streamers are passive listening equipment, consisting of multiple hydrophone elements, which are towed behind the vessel. The characteristics of the reflected seismic waves (such as travel time and intensity) are used to evaluate geologic structures, subsurface deposits, and natural resources to help facilitate the location of prospective drilling targets and provide the information for a company to determine their bidding strategy for an OCS lease sale.

An individual airgun size can range from five to 1,500 cubic inches ($in^3$) (0.081 to 24.58 liters). A combination of airguns is called an array; operators vary the source-array size to optimize the resolution of the geophysical data collected. Airgun array sizes for 2D/3D deep penetration seismic surveys in the Arctic Seas are expected to range from 1,800 to 5,000 $in^3$ (29.50 to 81.94 liters) but may range up to 6,000 $in^3$ (98.32 liters). Appendix B provides details on the acoustic characteristics of each of these exploration methods, including source levels, frequency, propagation, and the effect of environmental factors on these characteristics. However, in general, broadband peak source levels of a typical full-scale array range from 248 to 255 dB re 1 µPa at 1 m with most of the energy emitted between 10 and 120 Hz, although pulses may contain energy up to 1,000 Hz (Richardson et al. 1995).

#### 2.3.2.2 Marine Deep Penetration Towed-Streamer 3D and 2D Surveys

Marine deep penetration towed-streamer 3D seismic surveys vary markedly depending on client specifications, subsurface geology, water depth, and target reservoir(s). Individual survey parameters may vary from the descriptions presented here. The vessels conducting these surveys generally are 70 to 120 meters (m) (230 to 394 feet [ft]) long. Vessels typically tow one to three source arrays, of six to nine airguns each, depending on the survey design specifications required for the geologic target. Most operations use a single source vessel. However, more than one source vessel will be used in wide or rich azimuth surveys or when using smaller vessels, which cannot provide a large enough platform for the total seismic gun array necessary to obtain target depth. The overall energy output for the permitted activity will be the same, but the firing of the source arrays on the individual vessels will be alternated.

Vessel transit speeds are highly variable, ranging from 8 to 20 knots (kn) (14.8 to 37.0 kilometers [km]/hour) depending on a number of factors including, but not limited to, the vessel itself, sea state, urgency (the need to run at top speed versus normal cruising speed), and ice conditions. Marine 3D and 2D surveys are acquired at typical vessel speeds of approximately 4.5 kn (8.3 km/hour).

The source array is triggered approximately every 10 to 15 seconds (s), depending on vessel speed. The timing between shots varies and is determined by the spacing required to meet the geological objectives of the survey; typical spacing is either 25 or 37.5 m (82 or 123 ft) but may vary depending on the design and objectives of the survey. Airguns can be fired between 20 and 70 times per km. Modern marine-seismic vessels tow up to 20 streamers with an equipment-tow width of up to approximately 1,500 m (4,921 ft) between outermost streamers. Biodegradable liquid paraffin, kerosene, and solid/gel are materials used to fill the streamer and provide buoyancy.

The 3D survey data are acquired along a survey grid of pre-plotted tracklines (i.e. a pre-determined line along which the source vessel travels at a constant speed to effectively transmit sound to the bottom in a manner that allows for predictable receipt of acoustic reflections at the receiver cable) within a specific, permitted, survey area. Adjacent tracklines for a 3D survey are generally spaced parallel to each other several hundred meters apart. The areal extent of the equipment limits both the turning speed and the area a vessel covers in one pass. It is, therefore, common practice to acquire data using an offset racetrack pattern, whereby the next acquisition line is several km away from, and traversed in the opposite direction of, the track line just completed. Seismic vessels operate day and night, and a survey may continue for days, weeks, or months, depending on the size of the survey, data-acquisition capabilities of the vessel, and weather or ice conditions. Vessel operation time includes not only data collection but also deployment and retrieval of gear, line turns between survey lines, equipment repair, and other planned or unplanned operations.

The 2D and 3D surveys use similar survey methods but different operational configurations. Three dimensional survey lines are spaced closer together and are concentrated in a specific area of interest. These surveys provide the resolution needed for detailed geological evaluation. A 2D survey provides less detailed geological information because the survey lines are spaced farther apart. These surveys are used to cover wider areas to map geologic structures on a regional scale.

The 2D seismic survey vessels generally are smaller than 3D survey vessels; however, the larger 3D survey vessels are also able to conduct 2D surveys. The source array typically consists of three or more sub-arrays of six to eight airgun sources each, but may vary as newer technology is developed. Only one streamer is towed during 2D operations. Figure 2.1 illustrates a typical 2D marine towed-streamer seismic survey.

Seismic vessels acquiring 2D data are able to acquire data at four to five kn (7.4 to 9.3 km/hour), 24 hours a day, and collect between 85 to 110 line-miles (mi) (137 to 177 line-km) per day, depending on the distance between line changes, weather conditions, and downtime for equipment problems. Typically, a survey vessel can collect 5,000 to 8,000 line-mi (8,047 to 12,875 line-km) during an open water seismic operational season in Arctic waters.

At least one support vessel would be used for safety considerations, general support, maintenance, and resupply of the main vessel, but it would not be directly involved with the collection of seismic data. Crew changes, refueling, and resupply for the seismic vessels are generally on a four to six week schedule. Helicopters, when available, also may be used for vessel support and crew changes, if there are no safety concerns. An additional support vessel may be used to monitor for marine mammals ahead of the survey vessel. For operational purposes, BOEM requires that all deep penetration seismic surveys maintain a minimum spacing of 24.1 km (15 mi) between source vessels when actively shooting. This is an operational constraint to prevent acoustic interference during data acquisition and has no special biological significance.

#### 2.3.2.3 In-Ice Towed-Streamer 2D Surveys

A change in technology has allowed geophysical (seismic reflection and refraction) surveys to be conducted in greater sea ice concentrations. Sea ice concentration is defined in terms of percent coverage in tenths. An area with 1/10 coverage of ice means the area contains sporadic ice floes that provides for easy vessel navigation; whereas, 10/10 coverage of ice means there is no open water in the area. This new technology uses a 2D seismic source vessel and an icebreaker. The icebreaker generally operates ~0.5 to 1 km (~0.3 to 0.62 mi) ahead of the seismic acquisition vessel, which follows at speeds ranging from 4 to 5 kn (7.4 to 9.3 km/hour). Like open-water 2D surveys, in-ice surveys operate 24 hours a day or as conditions permit. A third vessel may be used for one or more support trips as conditions allow during the length of the survey.

The in-ice seismic airgun arrays are similar to those used in open water marine surveys, as is the streamer. A single hydrophone streamer, which uses a solid fill material to produce constant and consistent streamer buoyancy, is towed behind the vessel. The streamer receives the reflected signals from the subsurface and transfers the data to an on-board processing system. The survey vessel has limited maneuverability while towing the streamer and thus requires a 10 km (6.2 mi) run-in for the start of a seismic line, and a 4 to 5 km (2.5 to 3.1 mi) run-out at the end of the line.

#### 2.3.2.4 Ocean-Bottom Receiver Seismic Surveys

**<u>Ocean-bottom Cable Seismic Surveys</u>**

Ocean-bottom cable (OBC) seismic surveys are used in Alaska primarily to acquire seismic data in transition zones where water is too shallow for a towed marine streamer seismic survey vessel and too deep to have grounded ice in the winter. The OBC seismic survey requires the use of multiple vessels. A

typical survey includes: (a) two vessels for cable layout/pickup; (b) one vessel for recording; (c) one or two source vessels; and (d) possibly one or two smaller utility boats.

Most operations use a single source vessel, but multiple source vessels may be used if size prohibits loading the full airgun array required for the survey on one vessel. The overall energy output for the permitted activity would be the same for a two vessel shoot, as the source arrays alternate vessels when firing. These vessels are generally, but not necessarily, smaller than those used in towed-streamer operations. OBC seismic arrays are frequently smaller in size than the towed marine streamer arrays due to the shallower water depths in which OBC surveys are usually conducted. The utility boats can be small, in the range of 10 to 15 m (33 to 49 ft).

An OBC operation begins by laying cables off the back of the layout boat. Cable length typically is 4 to 6 km (2.5 to 3.7 mi) but can be up to 12 km (7.5 mi). Groups of dual component (2C) or multiple component (4C) seismic-survey receivers (a combination of both hydrophones and vertical-motion geophones) are attached to the cable in intervals of 12 to 50 m (39 to 164 ft). Multiple cables are laid on the seafloor parallel to each other using this layout method, with a cable spacing of between hundreds of meters to several kilometers, depending on the geophysical objective of the seismic survey. When the cable is in place, a vessel towing the source array passes over the cables with the source being activated every 25 m (82 ft). The source array may be a single or dual array of multiple airguns, which is similar to the 3D marine seismic survey. Figure 2.2 illustrates an OBC operation.

After a survey line is completed, the source ship takes about 10 to 15 minutes to turn around and pass over the next cable. When a cable is no longer needed to record seismic survey data, it is recovered by the cable-pickup ship and moved to the next recording position. A particular cable can lay on the seafloor anywhere from two hours to several days, depending on operation conditions. Normally, a cable is left in place for about 24 hours.

An OBC seismic survey typically covers a smaller area (approximately 16 by 32 km [10 by 20 mi]) and may spend days in an area. In contrast, 3D towed-streamer seismic surveys cover a much larger area (thousands of square miles) and stay in a particular area for hours. While OBC seismic surveys could occur in the nearshore shallow waters of the Beaufort Sea, they are not anticipated to occur in the Chukchi Sea OCS because of its greater water depths and the exclusion of the near shore OCS area from leasing. Recent technological developments have been introduced that provide improved operational flexibility for equipment deployment, recovery, and data collection in the field, but the costs are high compared to streamer-collected data.

### *Ocean-bottom Node Seismic Surveys*

Ocean-bottom Node (OBN) surveys, like the OBC surveys presented above, place receivers on the seafloor instead of towing them behind a survey vessel. Seafloor seismometers, precursors to modern day nodes, have been used in the academic community for crustal exploration for more than 70 years (Fisher 2004). However, the seismographs typically used to conduct these studies are not the best choice for exploration/production seismic operations as they do not have the required precision (Ronen et al. 2007). In the late 1990s, SeaBird Geophysical developed the first commercially available OBN system, specifically tailored to the oil and gas industry (Durham 2010).

The OBNs used in oil and gas operations are four component (4C) receivers that include three orthogonal geophones and one hydrophone, capable of measuring both shear (S) and compressional (P) waves, which cannot be done using 2C cables or towed streamers. The nodes are typically deployed in groupings called patches, using Remotely Operated Vehicles in deep water and ropes/cables in shallower water. The geologic target depth determines the node spacing and size of the patch. Generally, node spacing ranges between 50 m and 500 m (164 ft and 1,640 ft). If enough nodes are available, large patches (160 to 250 $km^2$) are collected as a single survey. However, a larger area can also be surveyed using smaller patches (10 to 30 $km^2$) with fewer nodes, which are combined to complete the entire survey (Ray et al.

2004, Beaudoin and Ross 2007, Chopra 2007, Duey 2007). An Ultra Short Baseline system (which measures the distance and bearing from a transceiver mounted on a survey vessel to an acoustic transponder at the node and combines these data with GPS, vessel heading and attitude) is commonly used to calculate the node position.

To utilize the 4C nodes to their fullest capabilities, survey lines are not only run directly above the nodes in the patch. Additional lines can be run at distances offset from the patch (at least 3 km to 20 km [1.9 mi to 12.4 mi]) to provide wide-azimuth data. If lines are run in several different directions, multi-azimuth data can also be collected. The distance between airgun shots is typically 50 m (164 ft) (Beaudoin and Ross 2007, Smit et al. 2008, Smit 2010, Vázquez Garcia 2005).

Node technology has been used in the deepwater Gulf of Mexico in areas with abundant infrastructure to image below salt (Smit et al. 2008, Baudoin 2010) and to perform 4D surveys (Reasnor 2010, Smit 2010). Nodes have also been used to image offshore fields internationally in: Mexico (Vázquez Garcia 2005); Angola (Lecerf 2010); Nigeria (Subsea World 2009); and West of the Shetland Islands (Oil Voice 2010).

In Alaska, OBNs in conjunction with land based nodes have been successfully tested in Cook Inlet to evaluate the technology's capability to image the transition zone, between shallow water and land, for oil and gas exploration (Fairfieldnodal 2011). These nearshore/transition zone surveys typically require two source vessels, up to three node deployment vessels, and a separate mitigation vessel. While this technology has only been used in Cook Inlet so far, it is easily transferrable to the Beaufort or Chukchi Sea.

This technology has the potential to: improve imagery associated with complicated oil and gas fields; clarify lithology and predict fluids in reservoir rocks; increase oil recovery; and decrease development risks (Enovation Resources 2011). It is reasonable to project that nodes could be used in the Arctic during the life of this EIS.

#### 2.3.2.5 High-Resolution Shallow Hazards Geophysical Surveys

Prior to submitting an exploration or development plan, oil and gas industry operators are required to evaluate any potential geological hazards and document any potential cultural resources or benthic communities pursuant to 30 CFR Part 550 Subpart B. BOEM provides guidelines in Notices to Lessees (NTLs) that require the collection of high-resolution shallow hazards surveys to ensure safe conduct and operations in the OCS at drill sites and along pipeline corridors, unless the operator can demonstrate there is enough previously collected data to evaluate the site.

The suite of equipment used during a typical shallow hazards survey consists of: single beam and multibeam echosounders which provide water depths and seafloor morphology; a side scan sonar that provides acoustic images of the seafloor; a subbottom profiler which provides 20 to 200 m (66 to 656 ft) sub-seafloor penetration with a 6 to 20 cm (2.4 to 7.9 inches [in]) resolution; a single channel seismic system with 40 to 600 m (131 to 1,969 ft) sub-seafloor penetration; and a multichannel seismic system with 1,000 to 2,000 m (3,280 to 6,562 ft) sub-seafloor penetration. Magnetometers, that detect ferrous items, have not been required in the Alaska OCS to date. Typical acoustic characteristics of these sources are:

- Single beam echosounders: 180 to 205 dB re 1 µPa at 1 m between 3.5 and 1,000 kHz (Koomans 2009);
- Multibeam echosounders: 216 to 242 dB re 1 µPa at 1 m between 180 kHz and 500 kHz (Hammerstad 2005, HydroSurveys 2010);
- Side scan sonar: 194 to 249 dB re 1 µPa at 1 m between 100 and 1,600 kHz (HydroSurveys 2008, Dorst 2010);
- Subbottom profilers and single channel seismic: 200 to 250 dB re 1µPa at 1 m between 0.2 kHz and 200 kHz (Laban et al. 2009, Richardson et al. 1995); and

- Multichannel seismic: 196 to 217 dB re 1 µPa at 1 m between 0 and 200 Hz (NMFS 2008a, 2009, 2010; Richardson et al. 1995).

The echosounders and subbottom profilers are generally hull-mounted. All other equipment is usually towed behind the vessel. The multichannel seismic system consists of an acoustic source which may be a single small airgun 10 to 65 $in^3$ (0.16 to 1.1 liters) or an array of small airguns usually two or four 10 $in^3$ (0.16 liter) guns. The source array is towed about 3 m (9.8 ft) behind the vessel with a firing interval of approximately 12.5 m (41 ft) or every 7 to 8 s. A single 300 to 600 m (984 to 1,969 ft), 12 to 48 channel streamer with a 12.5 m (41 ft) hydrophone spacing and tail buoy is the passive receiver for the reflected seismic waves. Biodegradable liquid paraffin, kerosene, and solid/gel are materials used to fill the streamer and provide buoyancy.

The ship travels at 3 to 4.5 kn (5.6 to 8.3 km/hour). These survey ships are designed to reduce vessel noise, as the higher frequencies used in high-resolution work are easily masked by the vessel noise if special attention is not paid to keeping the ships quiet. Surveys are site specific and can cover less than one lease block. The survey extent is determined by the number of potential drill sites in an area. BOEM recommends data be gathered on a 150 by 300 m (492 by 984 ft) grid within 600 m (1,969 ft) of the drill site, a 300 by 600 m (984 to 1,969 ft) grid out to 1,200 m (3,937 ft) from the drill site, and a 1,200 by 100 m (3,937 by 328 ft) grid out to 2,400 m (7,874 ft) from the well site.

A single vertical well site survey will collect about 46 line-miles (74 line-km) of data per site and take approximately 24 hours. If there is a high probability of archeological resources, the 150 m by 300 m (492 ft by 984 ft) grid must extend to 1,200 m (3,937 ft) around the drill site.

#### 2.3.2.6 On-Ice Winter Vibroseis Seismic Surveys (also referred to as over-ice or hard water surveys)

Winter vibroseis seismic operations use truck-mounted vibrators that systematically put variable frequency energy through the ice and into the seafloor. At least 1.2 m (3.9 ft) of sea ice is required to support heavy vehicles used to transport equipment offshore for exploration activities. These ice conditions vary, but generally exist from sometime in January until sometime in May in the Arctic. The exploration techniques are most commonly used on landfast ice (ice attached to the shoreline), but they can be used in areas of stable offshore pack ice near shore. Several vehicles are normally associated with a typical vibroseis operation. One or two vehicles with survey crews move ahead of the operation and mark the source receiver points. Occasionally, bulldozers are needed to build snow ramps to smooth offshore rough ice within the survey area.

With the vibroseis technique, activity on the surveyed seismic line begins with the placement of geophones (receivers). All geophones are connected to the recording vehicle by multi-pair cable sections. The vibrators move to the beginning of the line and recording begins. The vibrators move along a source line, which is at some distance or angle to a receiver line. The vibrators begin vibrating in synchrony via a simultaneous radio signal to all vehicles.

In a typical survey, each vibrator will vibrate four times at each location. The entire formation of vibrators subsequently moves forward to the next energy input point (e.g. approximately 67 m [220 ft] in most applications) and repeats the process. Most energy is beamed downward. In a typical 16- to 18-hour day, a survey will complete three survey tracks of 6 to 16 linear km (3.7 to 9.9 mi) in a 2D seismic survey, and 24 to 64 linear km (15 to 40 mi) in a 3D seismic survey. Vibroseis signals typically sweep from 10 to 70 Hz at an estimated source level of 187 dB re 1 µPa at 1 m (Richardson et al. 1995).

#### 2.3.2.7 Vertical Seismic Profiling

Vertical seismic profiling (VSP) is conducted as part of a drilling program in the wellbore. These programs use hydrophones suspended in the well at intervals which receive signals from external sound

sources; usually an airgun(s) is suspended from the drill rig or a nearby supply vessel. Data are used to aid in determining the structure of a particular petroleum-bearing zone. Purely defined, VSP refers to measurements made in a vertical wellbore using geophones inside the wellbore and a source at the surface near the well. In the more general context, VSPs vary in the well configuration, the number and location of sources and geophones, and how they are deployed. Most VSPs use a surface seismic source, which is commonly a vibrator on land and an airgun in offshore or marine environments. VSPs include the zero-offset VSP, offset VSP, walk away VSP, walk-above VSP, salt-proximity VSP, shear-wave VSP, and drill-noise or seismic-while-drilling VSP. A VSP is a much more detailed survey than a check-shot survey because the geophones are more closely spaced, typically on the order of 25 m (82 ft), whereas a check-shot survey might include measurements at intervals hundreds of meters apart. Also, a VSP uses the reflected energy contained in the recorded trace at each receiver position, as well as the first direct path from source to receiver. The check-shot survey uses only the direct path travel time. In addition to tying well data to seismic data, the vertical seismic profile also allows for converting seismic data to zero-phase data and distinguishing primary reflections from multiples. VSP operations are not considered to be a seismic survey for analysis purposes in this EIS but rather as part of an exploratory drilling program, even though airguns are used for a short time.

#### 2.3.2.8 Controlled Source Electromagnetic Survey

Measurements of electrical resistivity beneath the seafloor have been used in oil and gas exploration, but historically have been collected through the wire-logging of wells. Since 2002, several electromagnetic methods have been developed for mapping sub-seafloor resistivity, including marine controlled source electromagnetic (CSEM) sounding (Eidesmo et al. 2002). This method uses a mobile horizontal electric dipole source and an array of seafloor electric receivers. The transmitting dipole emits a low frequency (typically 0.5 to 10 Hertz [Hz]) electromagnetic signal into the water column into the underlying sediments. Electromagnetic energy is attenuated in the conductive sediments, but in higher resistive layers (such as hydrocarbon-filled reservoirs), the energy is less attenuated. This contrast is what is detected to provide data on potential areas of interest.

The length of the dipole varies between 10 to 50 m (33 to 164 ft) and the system is towed at approximately 24 to 40 m (79 to 131 ft) above the seafloor at a speed of 5 km/hr (3.1 mi/hr). Figure 2.3 illustrates a CSEM survey.

#### 2.3.2.9 Gravity and Gradiometry Surveys

Gravity surveys have been used for years in the oil and gas industry. Measurements taken at the Earth's surface express the acceleration of gravity of the total mass of the Earth. State of the art gravity meters can sense differences in the acceleration (pull) of gravity to one part in one billion. Because of their high sensitivity, these instruments can detect mass variations in the crustal geology, possible indicators of fault displacement and geologic structures favorable to hydrocarbon production.

In 1994, the U.S. Defense Department declassified the 3D full tensor gradiometer. This allowed the gravity field gradient to be determined by using accelerometers to measure the spatial multi-components of gravity. The equipment utilized for gradiometry surveys is much more complex than that of traditional gravity surveys. The new gravity data are evaluated in three dimensions instead of the two dimensions in traditional gravity surveys and can better define subsurface bodies of varying densities.

The increase in data resolution provided by the new technology has allowed the geology below salt to successfully be imaged in the Gulf of Mexico. This technology could be used in the Arctic Seas as a method for identifying features such as basins and edges, but would not replace 3D seismic.

## 2.3.3 Exploratory Drilling

Exploratory drilling activities conducted on the OCS must be conducted in accordance with BOEM and BSEE regulations at 30 CFR Part 550 Subpart B and 30 CFR Part 250 Subpart B, respectively. These regulations establish comprehensive requirements for well design based on site specific shallow hazards site clearance information and deep penetration seismic data, redundant pollution prevention equipment, testing and verification that equipment is working properly, and training and testing of personnel in well control procedures. These regulations also establish requirements on the technical specifications for the specific drilling rig and the drilling unit.

No drilling activity can be conducted until the BOEM has approved an EP and BSEE has approved the well-specific APD. BSEE engineers and geoscientists are required by law to review each APD for proper engineering considerations, site specific engineering and geologic conditions, and compliance with BSEE regulations. Any changes to an approved APD must be submitted, reviewed, and approved by the BSEE.

There are currently three principal forms of exploratory drilling platforms used in offshore exploration: artificial or natural islands; bottom-founded structures; and floating vessels.

Exploratory wells are generally drilled vertically to simplify well design and maximize benefits from subsurface data collection (i.e. well logs, cores). Directional wells (any well that is not vertical) may be drilled if a suitable surface location cannot be used or if there is a subsurface anomaly that should be avoided. A well is considered to be directional when the inclination of the well bore path is over three degrees from vertical. Directional drilling is different than extended reach drilling (ERD). ERD is a term used for wells drilled with significant horizontal departures from the surface location; on the order of several km (10,000s of feet). ERD is an evolving technology for production wells but currently is not used for exploration.

### 2.3.3.1 Artificial Islands

Artificial islands are constructed in shallow offshore waters for use as drilling platforms. In the Arctic, artificial islands have been constructed from a combination of gravel, boulders, artificial structures (e.g. caissons which are watertight retaining structures), and/or ice. Artificial islands can be constructed at various times of the year. During summer, gravel is removed from the seafloor or onshore sites and barged to the proposed site and deposited to form the island. In the winter, gravel is transported over ice roads from an onshore site to the island site. After the artificial island is constructed to its full size, slope protection systems are installed, as appropriate for local oceanographic conditions, to reduce ice ride-up and erosion of the island. Once the island is complete, a drilling rig is transported to the island. On average, approximately 100 people operate a typical rig site. Due to economic and engineering considerations, gravel island construction has historically been restricted to waters less than 15 m (49 ft) deep. It is anticipated that artificial islands could be constructed in the Beaufort Sea but not in the Chukchi Sea.

### 2.3.3.2 Caisson-Retained Island

Caisson-retained islands are similar in construction and design to other artificial islands with one significant exception. Rather than relying entirely on gravel or large boulders for support, the island contains one or more floatable concrete or steel caissons, which rest on an underwater gravel berm or on the ocean floor in water less than 6 m (19.7 ft) deep. The berm is constructed with dredged or deposited material to within 6 m (19.7 ft) of the sea surface. When each caisson is in place, the resulting concrete or steel ring is filled with sand to give the structure stability. This design, like the gravel island, allows drilling to occur all year. When drilling is completed, the center core of sand can be dredged out, the caissons refloated, and the structure moved to a new location. The berm is left to erode by the natural action of the ocean.

#### 2.3.3.3 Steel Drilling Caisson

The Steel Drilling Caisson (SDC), a bottom-founded structure, is a "fit for purpose" drilling unit constructed typically by modifying the forward section of an ocean-going Very Large Crude Carrier (see Figure 2.4). The main body of the structure is approximately 162 m (531 ft) long, 53 m (174 ft) wide, and 25 m (82 ft) high. The SDC is designed to conduct exploratory year-round drilling under arctic environmental conditions.

On its first two deployments in the Canadian Beaufort, the SDC was supported by subsea gravel berms. For its third deployment in Harrison Bay in 1986, a steel component was constructed to support the SDC in lieu of the gravel berms. It was also used in 2002 by EnCana on the McCovey prospect. The steel base configuration adds 13 m (42.7 ft) to the design height of the structure and allows deployment of the SDC in water depths of 8 to 24 m (26 to 79 ft) without bottom preparation. The SDC requires minimal support during the drilling season. It is typically stocked with supplies before being moved to a drill site. Two or three tugs and/or supply vessels tow the SDC to or from the drill site during open water periods. Deployment and recovery of the SDC require less than one week each. Personnel (typically a maximum of 100) and some smaller equipment are transported to and from the SDC by helicopter. Fuel and larger items, if required, are transported by supply vessel.

The SDC is the only existing man-made bottom founded structure that could be used in the U.S. Beaufort Sea. The water depths for existing leases in the U.S. Chukchi Sea are too deep for the SDC. A Concrete Island Drilling Structure was used to drill an exploratory well in Camden Bay; however, it has been converted into a permanent development platform offshore Sakhalin, Russia and would not be available for exploratory drilling in the U.S.

#### 2.3.3.4 Floating Drilling Vessels

Floating drilling vessels that have a reasonable probability to be employed in the Arctic include drillships (e.g. *Northern Explorer II, Noble Discoverer*), semi-submersibles, or other floating vessels (e.g. *Kulluk*) in which the hull does not rest on the seafloor. These types of drilling vessels can typically be used in water depths greater than 18 m (59 ft) in the Beaufort and Chukchi seas. This range makes them more suitable for the deeper water exploratory prospects than the "bottom founded" units such as the islands or the SDC mentioned in previous sections. Floating drilling vessel crews typically range from 100 to 200 people to operate the marine and drilling systems and ensure the safety of the operation (not including support or ice management vessels). These types of floating drilling vessels are held over a well drilling location either by a mooring system (consisting of an anchor, chain, and wire rope) or by the use of dynamic positioning (omni-directional thrusters coupled with a computer control system).

Sounds generated from vessel-based drilling operations occur at low frequencies (below 600 Hz), although tones up to 1,850 Hz were recorded by Greene (1987) during drilling operations in the Beaufort Sea. For the drillship *Explorer I*, sound levels of 122 to 125 dB re 1 Pa between 20 to 1,000 Hz band level were measured at a range of 0.17 km (0.10 mi) (Greene 1987). Sound levels from the drillship *Explorer II* were slightly higher (134 dB) at a range of 0.20 km (0.12 mi) although tones were only recorded below 600 Hz (Greene 1987). Sounds from the *Kulluk* at 0.98 km (0.61 mi) were higher (143 dB) than from the other two vessels (Greene 1987).

**<u>Drillship</u>**

A drillship is a maritime vessel that has been equipped with a drilling apparatus. Most are built to the design specification of the company, but some are modified tanker hulls that have been equipped with a dynamic positioning system. Drillships are completely independent, and some of their greatest advantages are their ability to drill in water depths of more than 2,500 m (8,202 ft) and their ability to sail between areas worldwide.

Shell Oil has proposed, in prior applications, to use the *M/V Noble Discoverer* for drilling in both the Chukchi and Beaufort seas (Shell Incidental Harassment Authorization [IHA] application 2010a). The *Discoverer* is a drillship, built in 1976, that has been retrofitted for operating in Arctic waters. It is a 156 m (512 ft) conventionally-moored drillship with drilling equipment on a turret. It mobilizes under its own power, so it can be moved off the drill site with help of its anchor handler. Depending on the circumstances of the situation, the procedure and time needed to move off a drill site can change. In extreme emergencies, this process can be completed in less than one hour. In the event that operations must be temporarily curtailed due to the advance detection of a hazard, the process could take from 4 to 12 hours. Typical transit speed of the *M/V Noble Discoverer* is 8 kn (14.8 km/hour). The vessel has full accommodations for a crew of up to 124 persons (quarters, galley and sanitation facilities). Figure 2.5 is a photograph of the *M/V Noble Discoverer*. As provided in Shell's 2012 Exploration Plan, measurements of sounds produced by the Discoverer in the South China Sea were performed in 2009. Broadband source levels of the Discoverer ranged from 177 to 185 dB re 1 μPa rms (Shell 2011a).

Support vessels are used to assist the drillship with ice management, anchor handling, oil spill response, refueling, resupply, and servicing. The total number of support vessels depends on the local conditions and the design of the exploration program (see Table 2.2). The ice management vessels typically consist of an icebreaker and an anchor handler, as well as an auxiliary ice management vessel. The oil spill response vessels (OSRV) include an ice-capable oil spill response barge (OSRB) and associated tug, a tank vessel for storage of liquids, and smaller workboats. A re-supply ship would travel to and from the drilling site as needed. Additional vessels for marine mammal monitoring/scientific research may be used. There is also the potential for re-supply to occur via a support helicopter from the shore to the drill site, and fixed-winged aircraft may be used for marine mammal monitoring. Unmanned aerial drones could also potentially be used for marine mammal observation and monitoring of ice conditions but would require approval from the Federal Aviation Administration (FAA).

## Jackup Rig

A jackup rig is an offshore structure composed of a hull, support legs, and a lifting system that allows it to be towed to a site, lower its legs into the seabed and elevate its hull to provide a stable work deck. Because jackup rigs are supported by the seabed, they are preloaded when they first arrive at a site to simulate the maximum expected support leg load to ensure that, after they are jacked to full airgap (the maximum height above the water) and experience operating loads, the supporting soil will provide a reliable foundation. Figure 2.6 is a photograph of a jackup rig.

There are three main components of a jackup rig: the hull; the legs and footings; and the equipment. The hull is a watertight structure that houses the equipment, systems, and personnel. When the jackup is afloat, the hull provides buoyancy and supports the weight of the legs and footings, equipment, and variable load. The legs and footings are steel structures that support the hull when elevated and provide stability to resist lateral loads. Most jackup rigs have no more than four legs. Three legs are the minimum required for stability. Units with three legs are arranged in a triangular form, while units with four legs are typically arranged in a rectangular form. Most jackup rigs in use today are equipped with rack and pinion systems for continuous jacking operations.

The actual dimensions of a jackup rig would depend on the environment in which the unit would be operating and the maximum operating water depth. A typical jack up rig with a maximum operating depth of 50 m (164 ft) is approximately 50 m (164 ft) in length, 44 m (144 ft) beam, and 7 m (23 ft) deep. ConocoPhillips has proposed in prior applications to use a jackup rig for drilling in the Chukchi Sea (ConocoPhillips air permit application 2010).

The jackup rig could have two OSRV and four workboats; each EP may call for different numbers of vessels within regulation requirements. One OSRV and workboat would remain within 16 km (10 mi) of the jackup rig during drilling and one OSRV would be at a distance of at least 40 km (25 mi) from the jackup rig. Two icebreakers would be in proximity of the rig and offshore supply vessels or ware vessels

would be used for resupply. An anchor handling supply tug would be needed to tow the jackup rig to the site and would remain within 40 km (25 mi) of the rig for when it needs to be moved.

Noise levels from jackup rigs have not been measured in the Arctic or any other environment (Wyatt 2008), but would be similar to or less than noise levels produced by the drillship discussed above, as jackup rigs use the same general drilling machinery that is the source of underwater noise for drillships. Sound levels transmitted into the water from bottom-founded structures are typically less than sound levels from a drillship because the vibrating machinery is not in direct contact with the water because the platform is above water. Because the jackup rig has fewer structures in direct contact with the water (because they are "jacked" above the water), noise levels are expected to be less. However, as noted above, sound level measurements have not been conducted to date. It is assumed that the first time a jackup rig is in operation in the Arctic, detailed measurements will be conducted to determine the acoustic characteristics. Noise from icebreakers would also be the same as described above.

#### 2.3.3.5 Exploratory Drilling Activity Discharges and Emissions

Certain discharges from oil and gas exploration facilities in the Chukchi and Beaufort seas are authorized by the U.S. Environmental Protection Agency (EPA) under the Clean Water Act (CWA) Section 402, National Pollutant Discharge Elimination System (NPDES) permitting authority. Prior to issuance of NPDES discharge permits for these actions, EPA is required to comply with the Ocean Discharge Criteria (40 CFR Part 125 Subpart M) for preventing unreasonable degradation of ocean waters; and to consult with the U.S. Fish and Wildlife Service and NMFS to ensure that any action it authorizes is not likely to jeopardize the continued existence of any species listed under the Endangered Species Act, or result in the destruction or adverse modification of critical habitat required by a listed species. EPA also regulates air emissions in the OCS under the Clean Air Act Title V and Prevention of Significant Deterioration (PSD) permit programs.

EPA issued the Arctic NPDES General Permit, AKG-28-0000, in 2006 that authorized discharges of wastewater from exploratory operations in the Chukchi and Beaufort seas, subject to the permit terms and conditions. It is currently EPA's practice to utilize general permits for exploration activities, with the intention of issuing individual permits for any proposed development or production in the future. In addition to drilling muds and drill cuttings, discharge streams may include deck drainage; sanitary wastes; domestic wastes; desalination unit wastes; blowout preventer fluid; boiler blowdown; fire control system test water; non-contact cooling water; uncontaminated ballast water; bilge water, excess cement slurry; and test fluids (EPA 2006). Oil and gas operators may request permit coverage from EPA by submitting a Notice of Intent. The 2006 Arctic NPDES General Permit expired on June 26, 2011, and EPA is reissuing the Arctic General Permit as two separate exploration general permits: one for the Beaufort Sea and one for the Chukchi Sea. EPA expects to reissue the Beaufort and Chukchi Exploration NPDES General Permits in October 2012.

For Shell's proposed upcoming exploration drilling program in 2012 in the Beaufort Sea, Shell has made a voluntary commitment to collect and transport drilling muds and drill cuttings, sanitary wastes, domestic wastes, ballast water, and bilge water to a disposal site in the Pacific Northwest. This EIS will analyze the reduction of those discharge streams that have been identified as having an impact on marine mammals or their habitats as a mitigation measure in all of the action alternatives.

Air quality in Alaska is regulated by the EPA and the Alaska Department of Environmental Conservation (ADEC). Emission of air pollutants, such as nitrogen dioxide, sulfur dioxide, and carbon monoxide would be limited using best available control technology to ensure compliance with provisions of the required air quality permits and National Ambient Air Quality Standards (NAAQS) issued by the EPA. The NAAQS specify maximum allowable concentrations for six principal criteria pollutants (EPA 2011b). Air pollutant sources located offshore are regulated under Section 55.2 of the OCS Air Regulations as specified in 40 CFR Part 55 (BOEM 2011a, EPA 2011a). Sources to be located (or

modified) in either the outer OCS or inner OCS require permitting under these regulations. For operations outside the 25 km (16 mi) seaward boundary (outer OCS), the federal 40 CFR Part 71 Operating Permit rules apply. For operations within the seaward boundary (inner OCS), EPA applies the corresponding onshore area rules, in this case the Alaska permitting rules in 18 Alaska Administrative Code (AAC) 50, which also cover potential onshore facilities. Depending on the magnitude of the potential emissions from a proposed activity, it may qualify as a Major Source subject to the federal PSD permitting requirements, which include implementation of Best Available Control Technology, air quality impact analysis (dispersion modeling) and evaluation of impacts to air quality-related values such as visibility, acid deposition, and effects on soils and vegetation. In addition, an associated Title V operating permit under Alaska rules may also be required for a new emission source, depending on the specific source/facility. In each case, the permit must contain limits in order to ensure that the project will not result in NAAQS violations.

#### 2.3.3.6 Oil Spill Contingency and Response Planning

Oil spill contingency and response plans in Alaska Arctic OCS regions are regulated by a combination of both state and federal requirements. EPA, the State of Alaska (ADEC), BSEE, and the U.S. Coast Guard (USCG) each have a set of requirements for oil spill contingency and response planning. The requirements of the different agencies overlap with each other to some degree. However, in some cases each agency requires independent documentation in order to ensure that the applicable requirements are met.

EPA requires Facility Response Plans (FRPs) and Spill Prevention, Control and Countermeasure (SPCC) plans (40 CFR Part 112). A FRP demonstrates a facility's preparedness to respond to a worst case oil discharge. Under the Clean Water Act (CWA), as amended by the Oil Pollution Act (OPA), certain facilities that store and use oil are required to prepare and submit these plans. Under 40 CFR Part 112 FRPs must: identify a qualified individual having full authority to implement removal actions and require immediate communication between that person and the appropriate federal authorities and responders; identify and ensure availability of resources to remove, to the maximum extent practicable, a worst-case discharge; and describe training, testing, drills, and response actions of persons on the vessel or at the facility. FRPs must also be updated periodically and be resubmitted for approval of each significant change (40 CFR Part 112). The SPCC rule includes requirements for oil spill prevention, preparedness, and response to prevent oil discharges to navigable waters and adjoining shorelines. The rule requires specific facilities to prepare, amend, and implement SPCC Plans. The SPCC rule is part of the Oil Pollution Prevention regulation, which also includes the FRP rule.

In addition to the EPA requirements, ADEC regulations (18 AAC 75.400) require that operators prepare Oil Discharge Prevention and Contingency Plans (ODPCPs, or C-plans) for activities within State waters. ODPCPs must set forth measures designed to prevent spills and must demonstrate that sufficient resources are available to contain or control and clean up any spills that may occur. Key components of the ODPCP required by ADEC include (18 AAC 75.425): an emergency action checklist including the immediate response and notification steps to be taken if an oil discharge occurs, to clearly guide responders in an emergency event; a description of the steps necessary to develop an incident-specific safety plan for conducting a response; a description of field communications procedures; procedures for the transport of equipment, personnel, and other resources; and a detailed written description of a hypothetical spill incident and response that demonstrates the plan holder’s ability to respond to a discharge. In addition, the ODPCP is required to include detailed information about blowout prevention, fuel transfer procedures, equipment maintenance programs, and operating requirements for exploration. The ODPCP must also present analysis of potential discharges, potential areas for discharge, spill trajectory analysis, and a description of any priority protection sites. Specific information must be provided about procedures to stop the discharge, fire prevention and control, containment, and disposal strategies. Particularly relevant to this EIS, the ODPCP must provide trajectories for the transport and

disposition of potential spills, identify strategies for the protection of sensitive areas and wildlife, and detail plans for minimizing the impact of a spill on wildlife resources and subsistence activities.

Overlapping with the ADEC requirements, BSEE requires that every operator operating seaward of the coastline, whether in state or federal waters, must submit an oil-spill-response plan (OSRP) for their facilities to BSEE for approval (30 CFR Part 254). Required components of the OSRP include: an emergency response-action plan; equipment inventory; contractual agreements for spill-response services; worst-case discharge scenario; dispersant-use plan; in situ burning plan, and a training and drills plan. As required by 30 CFR Part 254.30, OSRPs must be reviewed at minimum every two years and resulting changes submitted to BSEE. If no changes are required, the operator must submit written notification that the plan has been reviewed and that no changes are required. The operator is required to submit revisions of the plan to BSEE within 15 days of any changes that negatively impact spill response capabilities or increase the worst case discharge scenario.

Also overlapping with the ADEC and BSEE requirements, operators are required to submit "Response Plans for Oil Facilities Transferring Oil or Hazardous Material in Bulk" (33 CFR Part 154) to the USCG, Department of Homeland Security. The USCG response plans must include detailed descriptions of equipment, facility operations, vapor control systems, methods of ensuring the availability of response resources by contract or other approved means, description of worst case discharge, and information on training, exercises, and inspection and maintenance of response resources. Many of the requirements described in 33 CFR Part 154 are analogous to the ADEC (18 AAC 75.425) and BSEE (30 CFR Part 254) requirements, and operators may opt to fulfill requirements of multiple agencies with a single response plan document (see Beaufort Sea Regional Exploration ODPCP, Shell Offshore Inc., January 2010 [Shell 2010b]). However, oil spill contingency and response planning documents are reviewed independently by each agency to ensure that spill-response resources are appropriate to respond to any spill that might occur.

Section 311 of the CWA provides the overall regulatory framework for oil spills and designated hazardous substances, including national policy and responsibilities. Policy specific to oil spills is further defined in the Oil Pollution Act of 1990 (OPA), Public Law (P.L.) 101-380. Under the OPA, liability for actual costs of removal rests with the responsible party. The OPA establishes oil-spill response planning and preparedness requirements for offshore facilities. Executive Order 12777 implementing OPA assigned regulatory oversight for offshore oil and gas to the Department of the Interior, with oversight delegated to BSEE.

Environmental protection from oil spills is also regulated under the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 CFR Part 300) as required by Section 105 of the Comprehensive Environmental Response Compensation and Liability Act of 1980 (CERCLA), 42 USC 9605 as amended by the Superfund Amendments and Reauthorization Act of 1986, P.L. 99-499 and by Section 311(d) of the CWA, 33 USC 1321(d) as amended by the OPA, P.L. 101-380. CERCLA broadens the scope of spill reporting and response requirements by specifically requiring responsible parties to immediately notify the National Response Center in the event of a release of a reportable quantity of a hazardous substance to the environment and sets penalties in place for failure to provide notification as required (MMS 2008).

The National Oil and Hazardous Substances Pollution Contingency Plan, more commonly called the NCP, is the federal government's blueprint for responding to both oil spills and hazardous substance releases. The NCP is the result of efforts to develop a national response capability and promote overall coordination among the hierarchy of responders and contingency plans. The NCP and the Alaska Federal and State Preparedness Plan for Response to Oil and Hazardous Substance Discharges and Releases (Unified Plan) have been developed in compliance with the CWA, Section 311(c)(2); CERCLA, Section 105; and the OPA, Section 1321(d). In addition to the Unified Plan, Alaska has divided the State into 10 geographic regions and developed subarea contingency-response plans for each area. The North

Slope Subarea Contingency Plan addresses specific response issues for the Alaska Arctic OCS regions. These plans identify spill-sensitive biological and cultural resources and geographic response scenarios. The subarea contingency plans also identify shoreline types in the subarea and list spill-response tactics that can be used to protect those areas. The subarea contingency plans provide for coordinated and integrated response by departments and agencies of the federal and state governments to protect human health and the environment and to minimize adverse effects due to oil and hazardous substance discharges (MMS 2008).

Responsibility for developing the regional contingency plan rests with the Regional Response Team (RRT) for that area. The Alaska RRT (ARRT) is composed of representatives from USCG, EPA, and State of Alaska as co-chairs of the RRT, and the following federal departments: Agriculture, Commerce, Defense, Energy, Health and Human Services, Homeland Security, Interior, Justice, Labor, and State. The ARRT provides the appropriate regional mechanism for planning and preparedness activities before a response action is taken and for coordination and advice during an event (MMS 2008).

Under the NCP a federal On-Scene Coordinator (FOSC) is pre-designated by the EPA or the USCG to direct and coordinate the response to incidents under the authority of federal laws and regulations. For spill events occurring on the OCS, the USCG will act as the FOSC. The FOSC maintains a responsibility to ensure that the proper initiation of containment countermeasures, cleanup, and disposal actions take place. The State of Alaska also pre-designates a State On-Scene Coordinator (SOSC) to direct and coordinate the response to incidents under the authority of state laws and regulations. A Local On-Scene Coordinator (LOSC) representing the NSB also ensures that local concerns are addressed during a spill response. The FOSC, SOSC, and LOSC join the Responsible Party On-Scene Coordinator, representing the operator, and form a Unified Command (UC), which will direct the spill response. The LOSC is part of the Unified Command as long as there is an immediate threat to public safety, or as pre-identified in the applicable Subarea Contingency Plan. The UC jointly establishes goals and objectives, ensures that agency priorities are addressed, and produces a single-incident-action plan to respond to the spill. In the event the FOSC determines that spill-response efforts by the responsible party are inadequate to properly respond to the spill, the FOSC has the authority to "federalize" the response and use federal assets to continue cleanup activities. The responsible party is financially liable for the costs incurred from a federal response (MMS 2008).

The Resource Conservation and Recovery Act (RCRA) addresses issues pertaining to hazardous-waste management. The RCRA requires an EPA identification number for generators, transporters, and disposers managing hazardous waste generated in the course of oil-spill-response activities and use of appropriate hazardous waste manifests creating a "cradle-to-grave" audit trail to ensure proper disposal at an approved treatment, storage, and disposal facility (MMS 2008).

### 2.3.4 Local Community Interaction

Over the years, through the federal processes the industry has engaged in with BOEM and NMFS to obtain the permits and authorizations needed to conduct their activities, several processes and programs have evolved to facilitate interaction between the industry and the local communities to ensure that the Arctic subsistence culture can continue to thrive in conjunction with oil and gas development.

Industry interacts with local communities through a local hire program and through community-wide meetings. Local residents are typically trained and hired through several programs to assist with exploration activities, including the Protected Species Observer (PSO) program (formerly referred to as the Marine Mammal Observer program), Subsistence Advisor (SA) program, Communication and Call Centers (Com Centers) program, and Oil Spill Response. The PSO program would employ, among others, local Iñupiat residents to monitor and document protected species in the EIS project area. The PSOs are trained to identify marine mammals and other protected species, document interactions using computers, and comply with health and safety regulations. The SA program recruits local residents to

communicate local concerns and subsistence issues to the oil and gas operators. The SA coordinates with other village members and documents subsistence information, which may then be used to develop appropriate mitigation measures, address concerns related to subsistence activities, and to avoid potential conflicts. The Com Center program involves hiring local residents to monitor and relay radio transmissions between subsistence vessels and industry vessels. This sharing of information is intended to reduce or eliminate the potential for conflict between subsistence users and industry vessels. Providing these employment opportunities to local residents creates the potential for positive economic benefits to local communities and provides a vector for communication between industry and local residents.

The three mechanisms that have been or that are currently used for communication, cooperation, and conflict avoidance between industry and local communities include: the Open Water Season Conflict Avoidance Agreement (CAA); Com Centers; and Plans of Cooperation (POC).

The Open Water Season CAA is a private agreement between the industry and the Alaska Eskimo Whaling Commission (AEWC). In order to ensure that potential adverse impacts to the bowhead whale subsistence hunt are mitigated, the AEWC requests that any operator intending to conduct activities related to offshore oil and gas exploration, development, or production during the open-water season and prior to or during the fall bowhead whale subsistence hunts in the Beaufort and Chukchi seas enter into the CAA. While the CAA is not required by the MMPA, mitigating potential adverse impacts to the availability of marine mammals for subsistence uses is a requirement of the MMPA. The CAA includes measures and procedures regarding the timing and areas of the operator's planned activities necessary to mitigate potential adverse impacts of the planned oil and gas operations on fall bowhead whale subsistence hunting (i.e. times and places where effects of seismic and/or drilling operations will be monitored and prospectively mitigated to avoid potential conflicts with active subsistence whaling). In addition to time and area measures, the CAA provides for, among other mitigation measures, a communications system between operators' vessels and whaling and hunting crews (i.e. the communications center will be located in strategic areas); provisions for marine mammal observers/Iñupiat communicators aboard all project vessels; conflict resolution procedures; and provisions for rendering emergency assistance to subsistence hunting crews. The mitigation measures contained in the CAA have been developed by offshore operators and bowhead whale subsistence hunters through an annual negotiation process (the CAA process), which dates to 1985. Neither NMFS nor BOEM can require agreements between third parties. Neither NMFS nor BOEM is able to enforce the provisions of such agreements because the federal government is not a party to the agreements. While federal statute or regulations do not require a CAA, NMFS' regulations require that operators develop a POC containing mitigation measures that are agreed to both by the operator and the subsistence hunters. The CAA is a long-established means of supporting this regulatory requirement. For example, NMFS has included measures specific to protecting marine mammals or the availability of marine mammals for subsistence uses in previous ITAs.

To minimize potential interference with marine mammal hunts on a real-time basis, exploration companies have been asked to participate in the establishment of and interaction with Com Centers in affected subsistence communities. The Com Centers are a component of the CAA, are established prior to exploration activities in the vicinity of a potentially affected community, and are operated on a 24-hour basis during the fall bowhead whale subsistence hunt. Companies may contribute to the establishment of Com Centers whether or not they sign a CAA.

Where the proposed activity would take place in or near a traditional Arctic subsistence hunting area and/or may affect the availability of a species or stock of marine mammal for Arctic subsistence uses, NMFS requires an applicant to submit a POC or information that identifies what measures have been taken and/or will be taken to minimize any adverse effects on the availability of marine mammals for subsistence uses (50 CFR Part 216.104(a)(12)). A POC requires consultation and community meetings with potentially affected communities. It must also describe the measures the applicant has taken and/or will take to ensure that the proposed activities will not interfere with subsistence whaling or sealing.

These mitigation measures should be agreed to by both the operators and the subsistence users. In the case of the bowhead whale subsistence hunt and the communities represented by the AEWC, the CAA helps support the POC process.

The previous paragraphs describe these programs and processes as they currently exist. Chapter 5 contains an evaluation of these programs and processes, as well as potential modifications to these programs or the addition of new programs to accomplish some of the same goals.

### 2.3.5 Alternative Technologies for Hydrocarbon Exploration

The impulsive airgun has been under scrutiny as a sound source for seismic exploration due to concerns that the propagated sound waves may harm marine life during operations. Alternative acoustic source technologies generally put the same level of useable energy into the water as airguns, but over a longer period of time with a resulting reduced acoustic footprint. One potential alternative, the low frequency passive seismic method, relies on naturally produced sounds and does not introduce any sound into the environment. Table 2.3 summarizes some of the alternative technologies in consideration by the oil and gas industry. However, these alternative acoustic sources are in various stages of development and none of the systems with the potential to augment or replace airguns as a seismic source are currently commercially available. It is uncertain at this time exactly when these technologies could become available for commercial use; however, it is possible that some of them could be used during the timeframe of this EIS. Therefore, they are analyzed in this EIS based on the limited data currently available.

Technologies supplemental to seismic operations such as gravity/gradiometry and controlled source electromagnetics are commercially available and discussed in Section 2.3.2.

## Table 2.3 Alternative Technologies Summary

| Technology | Potential Availability Date | Activity the Technology Could Potentially Replace or Mitigate |
|---|---|---|
| **Marine Vibrators – Hydraulic** | System has been built and tested but requires renovation prior to deployment. Estimated time is 3 months to 1 year. | This tool cannot replace all airgun surveys but has the potential to replace airguns for certain geologic prospects in certain environments. |
| **Marine Vibrators – Electric** | If funds were available, it would take 2 to 4 years to fully develop and test a system for commercial use. | This tool cannot replace all airgun surveys but has the potential to replace airguns for certain geologic prospects in certain environments. |
| **Low-frequency Acoustic Source (patented) (LACS)** | Two LACS systems are under development. However, the first is not fully proven, and the second has not been built.<br>Additional tests of the LACS 4A system must be performed prior to deployment.<br>The LACS 8A system currently does not exist, and the project is presently on hold. It would take at least 18 months to build and field test one of these systems. | The LACS 4A system has been reported to be currently suitable for shallow penetration towed-streamer seismic surveys or vertical seismic profiling in certain environments.<br>Theoretically, the LACS 8A system has the potential to compete with a conventional deep penetration airgun seismic array. However, it is impossible to compare this system with an airgun array or project its capabilities until such a system has been built and tested. |
| **Deep-Towed Acoustics/Geophysics System (DTAGS)** | While there is one DTAGS currently in existence, it is not designed to conduct deep penetration oil and gas exploration. There is no projected timeframe to produce a low-frequency DTAGS. | It is impossible to compare this system with an airgun array or project its capabilities until such a system has been built and tested. |
| **Low Frequency Passive Seismic Methods for Exploration** | This is being offered commercially. | This technology is not yet proven in all environments. Passive acoustic data have the potential to enhance oil recovery at a better resolution than magnetic or gravimetric methods especially in areas that are environmentally sensitive (Bussat and Kugler 2009). |

### 2.3.5.1 Marine Vibrators

**Hydraulic**

In 1983, Industrial Vehicle International, Inc. (IVI) began developing a new marine vibrator seismic source system with the goal of producing a marine source able to emit a broad band, high amplitude, modulating frequency output. In 1985, the first commercial system was offered (IVI 2003). The developed system consists of a marine vibrator, vibrator controller, and a power unit. The source is capable of generating modulated frequencies between 10 and 250 Hz and can be used in water depths as shallow as one meter.

The system has been tested in various environments from transition zones to deepwater. A comparison of marine vibrator, dynamite, and airgun sources in southern Louisiana concluded that the marine vibrator was a viable source for environmentally sensitive areas (Potter et al. 1997, Smith and Jenkerson 1998). The best performance is on a seafloor which distributes the vibrator's forces.

Initial deep water tests were conducted in the Gulf of Mexico using a vibrator with an energy output approximately equivalent to a 1,000 $in^3$ (16.4 liter) airgun. Despite limitations of low frequency energy, good definition of reflectors down to three seconds indicated that the system was viable (Haldorsen et al. 1985). In 1996, a comparison between the marine vibrator and the airgun data indicated that the marine vibrator data contained more frequency content above 30 Hz and less frequency content below 10 Hz than the airgun data, but overall the data were comparable. Marine vibrator production rates were slightly lower than those of the airgun, but by the end of the survey, the technical downtime of the marine vibrator was similar to the airgun (Johnson et al. 1997). However, this technology has not been tested in the Arctic environment.

IVI continued to further develop the system into the early 2000s, but they are no longer actively marketing the product because there is no client base for the system. The significant expense to retrofit the marine exploration companies' ships to support marine vibrators is not offset by reduced operation costs or better data quality. IVI presently has marine vibrator systems that could be used for seismic data collection, but they would require renovation prior to deployment, which could take three months to a year (Elmo Christensen, Vice President IVI personal communications with Jana Lage 11/09/10, 12/17/10). This tool cannot replace all airgun surveys but has the potential to replace airguns for certain geologic prospects in certain environments.

**Electric**

Petroleum Geo-Services (PGS) began developing an electro-mechanical marine vibrator in the late 1990s. The original system consists of two transducers: the lower frequency (6 to 20 Hz) "Subtone" source and the higher frequency (20 to 100 Hz) "Triton" source (Tenghamn 2005, 2006). Each vibrator is composed of a flextensional shell that surrounds an electrical coil, a magnetic circuit and a spring element. The sound in the water column is generated by a current in the coil, which causes the spring elements and shell to vibrate. Mechanical resonances from the shell and spring elements allow very efficient, high power generation (Spence et al. 2007; Tenghamn 2005, 2006). The source tow-depth, generally between 5 and 25 m (16 to 82 ft) below the sea surface, is selected depending on the frequency and enhancement from the surface reflection which, to a certain degree, directs the acoustic signal downwards.

The reduction of the overall sound level and specifically the frequencies above 100 Hz, which are beyond the useful seismic range, is a major advantage of the system. Another advantage is the reduction of acoustic power in comparison with conventional seismic sources, which occurs because the net source energy is spread over a long period of time (Tenghamn 2005, 2006).

During the early period of development, the system proved the concept that it worked as a source for seismic data. However, unreliability prevented it from becoming a commercial system. PGS spent 2006 and 2007 conducting a feasibility study to improve reliability and testing a newly developed prototype.

After that work, PGS developed three additional systems that are currently being tested. This tool cannot replace all airgun surveys but has the potential to replace airguns for certain geologic prospects in certain environments. PGS does not have a commercial system available for data collection at this time. They project that, if funds were available, it would take two to four years to fully develop and test a system for commercial use (Rune Tenghamn, VP Innovation and Business Development PGS, personal communication to Jana Lage 11/09/10).

#### 2.3.5.2 Low-frequency Acoustic Source (patented)

Originally designed as a ship sound simulator for the Norwegian Navy, the low level acoustic combustion source (LACS) is being promoted as an alternative source for seismic acquisition (Weilgart 2010). The LACS system is a combustion engine with a cylinder, spark plug, two pistons, two lids, and a shock absorber. It creates an acoustic pulse when two pistons push lids vertically in opposite directions; one wave reflects from the sea surface and combines with the downward moving wave. There is no bubble noise from this system as all air is vented and released at the surface, not into the underwater environment. The absence of bubble noise allows the system to produce long sequences of acoustic pulses at a rate of 11 shots per second; this allows the signal energy to be built up in time with a lower amount of energy put into the water (Askeland et al. 2007, 2009).

There are two LACS systems advertised as under development. The first system is not fully proven, and the second has not been built. The LACS 4A has a diameter of 400 mm (16 in), a height of 600 mm (24 in), and a weight of approximately 100 kg (220 pounds) in air. Field test results of the LACS 4A system demonstrate that the system is capable of accurately imaging shallow sediments (~230 m [755 ft]) within a fjord environment (Askeland et al. 2008, 2009). It is reported that this system is suitable for shallow penetration towed-streamer seismic surveys or vertical seismic profiling (Askeland et al. 2008). Since there have been only a few tests conducted in a fjord environment, this system requires additional testing in various environments to determine if it is ready to replace currently used subbottom profiling systems.

The second system, the LACS 8A, theoretically has the potential to compete with a conventional deep penetration airgun seismic array. The weight is 400 kg (882 pounds), and the diameter is 800 mm (31.5 in). Several LACS units may be operated together to provide an increased pulse pressure (Bjørge Naxys AS 2010). This system currently does not exist, and the project is presently on hold. It would take at least 18 months to build and field test one of these systems if money became available to do so (Jens Abrahamsen, Managing Director Bjørge Naxys personal communication to Jana Lage 12/2/10). At this time, it is difficult to compare this system with an airgun array or project its capabilities since it has not been built and tested.

#### 2.3.5.3 Deep-Towed Acoustics/Geophysics System

The U.S. Navy developed a deep-towed acoustics/geophysics system (DTAGS) to better characterize the geoacoustic properties of abyssal plain and other deep-water sediments. The system was tested and modified in the early 1990s and used in various locations around the world until it was lost at sea in 1997 (Gettrust et al. 1991, Wood et al. 2003).

The second generation DTAGS is based on the original design but with more modern electronics. The source is extremely flexible, allowing for changes in waveform and decrease in sound level to produce a source amplitude, waveform, and frequency to suit specific requirements (Wood et al. 2003, Wood 2010).

The DTAGS is towed behind a survey vessel usually at a level of 100 m above the seafloor and a vessel speed of two knots; it can operate at full ocean depths (6,000 m). A 450 meter, 48 channel streamer array is towed behind the source to record the reflected signals. DTAGS can also be configured with an aluminum landing plate, which transmits the acoustic energy directly into the seafloor. With this configuration, vertical bottom founded hydrophone arrays are used to receive reflections (Breland 2010).

Proximity of the acoustic source to the seafloor is an advantage of the DTAGS system. The system has a limit of 1 km penetration in most marine sediments (Wood et al. 2003). It has been used very successfully to map out gas hydrates in the Gulf of Mexico (Wood et al. 2008), Canadian Pacific (Wood et al. 2002, Wood and Gettrust 2000) and Blake Ridge (Wood and Gettrust 2000).

There is only one DTAGS in existence at this time. While it has imaged shallow sediments and gas hydrate environments extremely well, the current tool design could not replace a deep penetration airgun array for oil and gas exploration at this time - DTAGS was not designed for this purpose. There is no physical limitation to designing a resonant cavity source to simulate the frequency band of airguns. At this time, it is difficult to compare this system with an airgun array or project its capabilities since it has not been built and tested.

The strength of the high frequency system is the ability to tow the source near the seafloor. While it may be technically feasible to create a system with frequencies comparable to that of an airgun, they system is a cabled, deep-tow, which is not a realistic replacement for airguns. The deep tow configuration is not conducive to multi-streamer exploration seismic surveys.

#### 2.3.5.4 Low Frequency Passive Seismic Methods for Exploration

Low frequency passive seismic methods utilize microseisms, which are faint Earth tremors caused by the natural sounds of the earth, to image the subsurface. A typical survey consists of highly sensitive receivers (usually broadband seismometers) placed in the area of interest to collect data over a period of time. Upon completion of the survey, the data are analyzed and filtered to remove all non-natural sounds, which is most efficiently completed using an automated process (Hanssen and Bussat 2008).

All of the current methods use one of following three sources of natural sounds: natural seismicity, ocean waves, or microseism surface waves.

Natural seismicity uses the Earth's own movements as a source of energy. Two techniques have been developed to utilize this energy source:

Daylight Imaging (DLI) uses the local seismicity of an area to produce reflection seismic profiles, similar to those recorded in active seismic surveys (Claerbout 1968). As in active reflection seismic operations, geophones are deployed; the target can be imaged using regularly-spaced 2D line geometry (Hohl and Mateeva 2006, Draganov et al. 2009).

Local Earthquake Tomography (LET) also uses local seismicity of a region to map on the reservoir scale (Kapotas et al. 2003). However, it is used to calculate the velocity structure of the subsurface in 3D by analyzing each earthquake on multiple receivers and generating ray paths instead of cross-correlating the recorded signals.

Ocean waves are used as a sound source for the Sea Floor Compliance technique. The method requires that Ocean Bottom Seismometer stations with highly-sensitive, broadband seismometers and differential or absolute pressure gauges be installed in water several hundred meters deep.

Ambient-Noise (Surface-Wave) Tomography [AN(SW)T] uses low frequency (between 0.1 and 1 Hz) ambient noise records to estimate shear wave velocities and structural information about the Earth. This technique requires the use of broadband seismometers to record the low frequency surface waves, which can penetrate to depths of several kilometers (Bensen et al. 2007, 2008). AN(SW)T can be used in areas where seismic data are difficult to collect or in environmentally sensitive areas. While this technology is new and still in need of further testing, the lateral resolution at several kilometer depths may reach a few hundred meters and the resolution may be better than gravimetric or magnetic data, which is promising for oil and gas exploration (Bussat and Kugler 2009).

Surface-wave amplitudes is a one-dimensional (1D) method that images the geological structure of the sub-surface by analyzing passive acoustic data that have not been geophysically processed. The

transformation of incoming micro-seismic surface-waves, scattered at vertical discontinuities, into body waves may produce these data, but the process is not well understood (Gorbatikov et al. 2008).

Low-Frequency Spectroscopy (LFS) is also known as Low Frequency Passive Seismic (LFPS) or Hydrocarbon Microtremor Analysis (HyMAS) tests for an indication of subsurface hydrocarbon accumulation using spectral signatures gathered from the ambient seismic wave field recorded by broadband seismometers. However, this methodology is highly dependent on the ability to process out all anthropogenic noise and topography (Hanssen and Bussat 2008). This method is still in the early stage of development and has not been confirmed in the field during any studies (Ali et al. 2007, Al-Faraj 2007).

The most successful use of low frequency passive micro-seismic data has been on land where it is easier to isolate the extraneous noise from the natural signal. The technique is also promising in the marine environment. To ensure success of a marine survey: (1) it is imperative that the recording instruments are in proper contact with the substrate (the natural signal may not be accurately recorded in unconsolidated material) and (2) the increase in both anthropogenic and naturally produced noise in the marine environment is correctly filtered so that it does not mask the signal of interest.

Like the CSEM technique that is discussed in Section 2.3.2, passive seismic surveys cannot replace active seismic acquisition. However, passive acoustic data have the potential to enhance oil recovery at a better resolution than magnetic or gravimetric methods (Bussat and Kugler 2009), especially in areas that are environmentally sensitive or where active seismic operations are difficult.

#### 2.3.5.5 Quieting Mitigation Technologies in Development

Industry and the public sector have actively investigated the use of technology-based mitigation measures to reduce anthropogenic noise and thus potentially reduce the impacts of current methods of hydrocarbon data collection. Some of these technologies are not yet available and may not work in all circumstances.

**Airgun Silencer**

One such measure, an airgun silencer, which has acoustically absorptive foam rubber on metal plates mounted radially around the airgun, has demonstrated 0 to 6 dB reductions at frequencies above and 0 to 3 dB reductions at frequencies below 700 Hz. This system has been tested only on low pressure airguns and is not a viable mitigation tool because it needs to be replaced after 100 shots (Spence et al. 2007). Other tests are being conducted to attenuate unwanted high frequency energy without affecting the frequencies of interest.

**Airgun Design**

Another mitigation measure in development is optimizing the design of the airgun to reduce unwanted energy through array, source, and receiver design optimization in both the inline and horizontal plane of interest (Weilgart 2009). There are other tests to lower source levels through better pairing of source and receiver characteristics or better system gains.

**Bubble Curtain**

Bubble curtains generally consist of a rubber hose or metal pipe with holes to allow air passage and a connector hose attached to an air compressor. They have successfully been tested and used in conjunction with pile driving and at construction sites to frighten away fish and decrease the noise level emitted into the surrounding water (Würsig et al. 2000, Sexton 2007, Reyff 2009). They have also been used as standalone units or with light and sound to deflect fish away from dams or keep them out of specific areas (Weiser 2010, Pegg, M. 2005).

The use of bubbles as a mitigation for seismic noise has also been pursued. During an initial test of the concept, the sound source was flanked by two bubble screens; it demonstrated that bubble curtains were capable of attenuating seismic energy up to 28 dB at 80 Hz while stationary in a lake. This two-bubble

curtain configuration was field tested from a moving vessel in Venezuela and Aruba where a 12 dB suppression of low frequency sound and a decrease in the sound level of laterally projecting sound was documented (Sixma 1996, Sixma and Stubbs 1998). A different study in the Gulf of Mexico tested an "acoustic blanket" of bubbles as a method to suppress multiple reflections in the seismic data. The results of the acoustic blanket study determined that suppression of multiples was not practical using the current technology. However, the acoustic blanket measurably suppressed tube waves in boreholes and has the capability of blocking out thruster noises from a laying vessel during an OBC survey, which would allow closer proximity of the shooting vessel and increase productivity (Ross et al. 2004, 2005).

A recent study "Methods to Reduce Lateral Noise Propagation from Seismic Exploration Vessels" was conducted by Stress Engineering Services Inc. under the BSEE Technology Assessment & Research Program. The first phase of the project was spent researching, developing concepts for noise reduction, and evaluating the following three concepts: (1) an air bubble curtain; (2) focusing arrays to create a narrower footprint; and (3) decreasing noise by redesigning airguns. The air bubble curtain was selected as the most promising alternative, which led to more refined studies the second year (Ayers et al. 2009). A rigorous 3D acoustic analysis of the preferred bubble curtain design, including shallow-water seafloor effects and sound attenuation within the bubble curtain, was conducted during the second phase of the study. Results of the model indicated that the bubble curtains performed poorly at reducing sound levels and are not viable for mitigation of lateral noise propagation during seismic operations from a moving vessel (Ayers et al. 2010).

#### 2.3.5.6 Fiber Optic Receivers

Fiber optic receivers incorporate optical fibers to transmit the received acoustic signal as light. They are most frequently used in the petroleum industry for seismic Permanent Reservoir Monitoring, a four-dimensional (4D) reservoir evaluation application. The optical receivers are permanently placed on the seafloor, ensuring consistency and repeatability of the 4D surveys, better signal to noise ratios, and quality of subsequently collected data. Fiber optic systems are not new and have proven to be highly reliable.

Fiber optic receivers are more sensitive than standard receivers, which allows for smaller airgun arrays to be used. While these receivers offer a benefit to the environment through a decrease in airgun noise, this technology is not presently available for towed-streamer surveys.

Fiber optic receivers have not been used in the Alaska OCS due to the lack of large scale offshore production requiring 4D monitoring. This technology is associated with production and therefore is not analyzed further in this document.

## 2.4 Alternatives Considered in the EIS

The federal actions considered in this EIS are the issuance of G&G permits and ancillary activity notice approvals by BOEM for the Beaufort and Chukchi seas and the issuance of ITAs under the MMPA for G&G surveys, ancillary activities, and exploratory drilling activities in the Beaufort and Chukchi seas by NMFS. ITAs could be issued for these activities in either federal or State of Alaska waters. Given the widespread presence of several species of marine mammals in the Beaufort and Chukchi seas and the nature of oil and gas exploration activities, it is likely that some amount of seismic and exploratory drilling activities may result in the disturbance of marine mammals through sound, discharge of pollutants, and/or the physical presence of vessels. Because of the potential for these activities to "take" marine mammals, oil and gas operators may choose to apply for an ITA.

Sections 101(a)(5)(A) and (D) of the MMPA direct NMFS to allow, upon request, the incidental, but not intentional, taking of small numbers of marine mammals of a species or population stock by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region if certain findings are made and either regulations are issued or, if the taking is limited to harassment, a

notice of proposed authorization is provided to the public for review. Authorization for incidental taking shall be granted if NMFS finds that the taking will have a negligible impact on the affected species or stock(s) and will not have an unmitigable adverse impact on the availability of the species or stock(s) for taking for subsistence uses. NMFS must also prescribe: the permissible methods of taking pursuant to the activity; other means of effecting the "least practicable adverse impact" on the affected species or stock and its habitat and on the availability of such species or stock for subsistence uses; and requirements pertaining to the monitoring and reporting of such taking.

The approach taken in identifying alternatives considered by NMFS and BOEM in this EIS involved four major components:

1) Evaluating alternative concepts suggested during the scoping period (such as using alternative technologies to airguns for seismic surveys);
2) Reviewing potential alternatives in the context of NMFS and BOEM's regulatory requirements;
3) Assessing potential levels of seismic exploration and exploratory drilling activities, and a suite of Standard Mitigation Measures; and
4) Identifying a range of potential Additional Mitigation Measures that need further analysis and may be applied to alternatives pursuant to the MMPA ITA process and the BOEM OCS Lands Act permitting processes.

### 2.4.1 Review of Multiple Exploration Activities

Past ITAs have been issued for individual G&G surveys, ancillary activities, and exploratory drilling projects in the Arctic Seas. These authorizations have been in the form of Incidental Harassment Authorizations (IHA) issued for periods of no more than one year at a time. One purpose of this EIS is to analyze effects from multiple oil and gas industry exploration activities with regard to marine mammals and subsistence hunting, assess the potential effects of authorizing takes from concurrent activities, and analyze whether the standard mitigation and monitoring measures stipulated in the past are appropriate for current and reasonably foreseeable oil and gas activities. Additional mitigation measures to address potential marine mammal or subsistence impacts from the activities have been suggested by the public or other agencies and the potential effectiveness of these measures will also be analyzed.

For planning purposes, NMFS and BOEM can project a reasonable level of activities in the near term (i.e. in the next one to two years) based upon upcoming lease sales and industry's stated needs for developing those leases. Although the levels of activities can be estimated, the particular strategy used by a company regarding where and when to explore for resources may change depending on what a company found during previous exploration activities, as well as changes in technology. Furthermore, outside forces (i.e. the price of oil) and politics may affect the oil and gas market and play a role in how much effort is applied to exploration in the Arctic. Therefore, predicting and planning for levels of activity over a longer period of time (i.e. three or more years in the future) can be difficult. In order to help predict the level of exploration activities for a given year, communications for upcoming G&G and exploratory drilling activities are ongoing between NMFS, BOEM, and industry throughout the year; but NMFS and BOEM are officially notified of the specific planned activities upon receipt of an application for an ITA, G&G permit, or ancillary notice, which may be submitted just several months prior to the activity taking place. Therefore, while NMFS and BOEM can estimate the level of proposed activity on an annual basis, there is some uncertainty.

### 2.4.2 Review of Mitigation Measures

The evaluation of measures intended to reduce adverse impacts to marine mammals and other protected resources and to ensure that there will be no unmitigable adverse impact on the availability of marine

mammals for subsistence uses are the main foci of this document and are key components of the development of alternatives. Mitigation measures directed at protecting subsistence uses include measures incorporated into previous ITAs, many of which were developed over a number of years through the annual negotiation of a CAA between offshore oil and gas operators and the AEWC. Mitigation is addressed in the action alternatives in three different ways:

1) **Required Standard Mitigation Measures** – These measures, which are required in all four of the action alternatives, are those that NMFS and BOEM have agreed are appropriate to *require* in G&G permits, ancillary activity notices, and MMPA authorizations. Typically, these measures (e.g. shutdown zones, certain time/area closures to protect known subsistence uses) have been used consistently in past permits and authorizations.

2) **Additional Mitigation Measures** – These measures, which are evaluated *but not required* in all four action alternatives, may or may not be implemented in current and future activities depending on the outcome of the MMPA authorization processes (or other environmental compliance processes) associated with current and future actions. These measures are intended to include other reasonable potential mitigation measures, such as those that have been required or considered in the past or recommended by the public, which may or may not have been required or considered in the past.

3) **Alternatives 4 and 5** – These two alternatives are characterized by additional specific mitigation measures associated with time/area closures or alternative technologies that are intended to minimize impacts to marine mammals and subsistence uses.

All of the mitigation measure categories described above are comprehensively evaluated in the context of the manner and degree in which the measure is likely to reduce adverse impacts to marine mammals, likely effectiveness, and practicability of implementation of the measures. This analysis, which also includes consideration of public comments received on previous proposed ITAs and from the scoping period of this EIS, is needed in order to better assess the appropriateness of each measure given certain activity levels and locations (and other considerations). From NMFS' perspective, the full analysis of any additional mitigation measures will inform future decisions of whether: a) the measure should be considered a standard measure (i.e. implemented in every ITA); b) the measure should never be implemented; or c) the measure should be implemented based on attributes of the specific project in combination with the other known activities for that year. This analysis can be found in Chapter 4 of this document.

In this EIS, NMFS and BOEM present and assess a reasonable range of G&G, ancillary, and exploratory drilling activities expected to occur, as well as a reasonable range of measures intended to reduce adverse impacts on the human environment, in order to accurately assess the potential consequences of issuing ITAs under the MMPA and permits under the OCS Lands Act. Based upon past lease sales, G&G permits, ancillary activity notices, exploration drilling activities, and requests for ITAs, NMFS and BOEM have determined a reasonable range and level of activities for which permits and authorizations may be requested in the foreseeable future (i.e. five years). While the level of activity proposed may vary from one year to the next, the structure of the action alternatives represents a reasonable range of exploration activities for which permits and authorizations may be requested.

### 2.4.3 Activity Definitions

The following discussion and table provide explanation and definitions for what is meant by the different types of activities considered in each of the action alternatives in this EIS. The potential level of activity described by each alternative is based on recent federal and state lease planning and recent industry plans for both seismic surveys and exploratory drilling programs in the Beaufort and Chukchi seas.

Table 2.4 outlines what each type of survey or drilling program entails. The definitions for the various programs include number of source and support vessels, types of sound sources used, time periods when the activity could occur (i.e. open-water season only, ice-covered season only, etc.), number of days of active operations, and size of the program activity area. Surveys or drilling programs could be conducted by a single company or companies working together using the same vessels and equipment.

For analysis in this EIS, one "program" entails however many surveys or exploration wells a particular company is planning for that season. Each "program" would use only one source vessel (or two source vessels working in tandem, e.g. OBC surveys) or drilling unit (i.e. drillship, jackup rig, SDC, etc.) to conduct the program and would not survey multiple sites or drill multiple wells concurrently. Survey vessels and drilling units are generally self-contained, with the crew living aboard the vessel. For surveys in the Beaufort Sea, support operations would likely occur out of West Dock or Oliktok Dock near Prudhoe Bay. Chukchi Sea surveys could be supported either from Wainwright or Nome. Helicopters stationed at either Barrow (for operations in either the Beaufort Sea or Chukchi Sea) or Deadhorse (for operations in the Beaufort Sea) would provide emergency or search-and-rescue support, as needed.

Site clearance and shallow hazards survey programs are contemplated in each action alternative and typically also include ice gouge and strudel scour surveys and are often referred to as marine survey programs by oil and gas industry operators. The ice gouge and strudel scour surveys do not involve the use of airguns but do involve the use of smaller, higher-frequency sound sources, such as multibeam echosounders and sub-bottom profilers. The area of a site clearance and shallow hazards survey, which is tied to a lease plan, is typically determined by the number of potential, future drill sites in the area. Table 2.4 outlines the typical types of sound sources used in these programs.

## Table 2.4 Activity Definitions

| Activity/Program | # of source vessels | # of support vessels | Type of Energy/Sound Sources Used | # of Days Activities Could Occur in a Season | Months During Which the Activity Could Occur | Extent of the Activity Area and/or # of Wells to be Drilled |
|---|---|---|---|---|---|---|
| **2D/3D Open Water Towed Streamer Seismic Survey** | 1 | • 1 support vessel<br>• 1 receiver vessel<br>• 1 vessel for monitoring | • Source array typically consists of one or more sub-arrays of 6-8 airgun sources each<br>• Individual airgun size: 5-1,500 $in^3$ (0.081-24.58 liter)<br>• Airgun array range from 1,800-5,000 $in^3$ (29.50-81.94 liter) | 30-90 | July – November | 85-110 line miles per day |
| **Ocean-bottom cable or node survey (Beaufort Sea only)** | 2 (working in tandem) | • 2 vessels for layout/pickup<br>• 1 recording vessel<br>• 2 small support vessels | • Source array on each vessel typically consists of two sub-arrays of 4 airgun sources each<br>• Individual airgun size: 70-150 $in^3$<br>• Airgun array range from 440-880 $in^3$ | 30-90 | July – October | 10 by 20 mile area |
| **In-ice seismic survey** | 1 Source/ Receiver vessel | • 1 icebreaker | Same as 2D/3D seismic survey | 60-90 | Late September – December | Approximately 75 line miles (120 km) per day |
| **CSEM Survey** | 1 | • 1 source and layout vessel | 0.5-10 Hertz electromagnetic signal | 60 | July – November | unknown |
| **Site Clearance and High-Resolution Shallow Hazard Surveys** | 1 Source/ Receiver vessel | • 1 vessel for monitoring, as needed | • Four, 10 $in^3$ (0.16 liter) airguns<br>• Multi-beam echosounders<br>• Sub-bottom profilers<br>• Side-scan sonars | 45-90 days | July – November | 46 line miles per day |
| **On-ice Vibroseis Seismic Survey (Beaufort Sea only)** | 4 wheeled vibrators | • 2 marking vehicles<br>• Bulldozer | Continuously driven piston (wheeled vibrators) | 30-90 days | January – May | 15-40 linear miles per day |

| Activity/Program | # of source vessels | # of support vessels | Type of Energy/Sound Sources Used | # of Days Activities Could Occur in a Season | Months During Which the Activity Could Occur | Extent of the Activity Area and/or # of Wells to be Drilled |
|---|---|---|---|---|---|---|
| **Exploratory Drilling Program (from a drillship)** | 1 drillship | • 2 icebreakers<br>• 1 anchor handler<br>• 1 oil spill response barge<br>• 1 oil spill response tug<br>• 1 tank vessel for spill storage<br>• 3 support vessels<br>• Aircraft for crew changes | Drill | 40 days per well | July – October | 25 mile (40 km) radius around the well;<br>2-4 wells per season |
| **Exploratory Drilling Program (from a jackup rig)** | 1 jackup rig | • 2 icebreakers<br>• 2 oil spill response vessels (each with two workboats)<br>• 1 oil spill response tug<br>• 1 tank vessel for spill storage<br>• 3 support vessels<br>• Aircraft for crew changes | Drill | 40 days per well | July – October | 25 mile (40 km) radius around the well<br>2-4 wells per season |

The following alternatives are summarized in Table 2.5.

## 2.4.4 Alternative 1 – No Action

NEPA's implementing regulations require that the No Action Alternative be evaluated. Under the No Action Alternative, NMFS would not issue any ITAs under the MMPA for seismic surveys or exploratory drilling in the Beaufort and Chukchi seas, and BOEM would not issue G&G permits or authorize ancillary activities in the Beaufort and Chukchi seas. If companies proceeded to operate in this area without MMPA authorizations, any takes of marine mammals would occur in violation of the MMPA.

## 2.4.5 Alternative 2 – Authorization for Level 1 Exploration Activity

Alternative 2 is defined for analytical purposes as the following:

### 2.4.5.1 Level of Activity

- Up to **four** 2D/3D seismic or CSEM surveys in the Beaufort Sea and up to **three** 2D/3D seismic or CSEM surveys in the Chukchi Sea per year, with up to **one** of that total number of surveys in each sea done in-ice with ice breaking if necessary.
- Up to **three** site clearance and high resolution shallow hazards survey programs in the Beaufort Sea and up to **three** site clearance and high resolution shallow hazards survey programs in the Chukchi Sea per year.
- **One** on-ice seismic survey in the Beaufort Sea per year.
- **One** exploratory drilling program in the Beaufort Sea and **one** exploratory drilling program in the Chukchi Sea per year.

### 2.4.5.2 Mitigation

- Including *required* Standard Mitigation Measures (described in Section 2.4.9) that are part of every action alternative.
- Including a full analysis of a wide range of Additional Mitigation Measures (described in Section 2.4.10) that *could potentially* be required through the MMPA process and could vary by alternative (i.e. some might be different based on level and/or type of activity in a given year)

### 2.4.5.3 Assumptions

Seismic work in the Arctic has traditionally been conducted in open water (ice-free) months (July through November), although this analysis addresses the possibility of one survey utilizing an icebreaker and potentially continuing through mid-December. Seismic surveys are also conducted on-ice in areas where there is bottom fast ice in the winter. These surveys generally occur from January through May. Each survey takes between 30 and 90 days, depending on ice conditions, weather, equipment operations, size of area to be surveyed, timing of subsistence hunts, etc. Because of the limited time period of open water, it is likely that concurrent surveys would be conducted in the same general time frame and may overlap in time, but will not overlap in space (i.e. within a minimum of approximately 24 km [15 mi] of each independent survey operation) for reasons regarding data integrity. It is assumed for analytical purposes that at least one of the authorized 2D/3D seismic surveys in the Beaufort Sea and one in the Chukchi Sea would utilize an ice breaker.

Exploratory activities (including deep penetration seismic, site clearance and high resolution shallow hazards, and exploratory drilling) in the next five years are expected to be concentrated in areas of recently purchased leases. This does not mean that there will not be exploratory activities in other areas

of the U.S. Arctic Ocean, especially if BOEM's next Five-Year OCS Leasing Plan includes sales in the Arctic OCS. In the U.S. Beaufort Sea, the two primary areas of interest for exploration are nearshore in Camden Bay and Harrison Bay. In the U.S. Chukchi Sea, the areas of interest are all well offshore in the lease areas, particularly around drill sites from the late 1980s, including Shell's Burger, Crackerjack, and Shoebill prospects; ConocoPhillips' Klondike prospect; and Statoil's leases in the northeast part of the Lease Sale 193 area (see Figure 1.3).

## 2.4.6 Alternative 3 – Authorization for Level 2 Exploration Activity

Alternative 3 is defined for analytical purposes as the following:

### 2.4.6.1 Level of Activity

- Up to **six** 2D/3D seismic or CSEM surveys in the Beaufort Sea and up to **five** 2D/3D seismic or CSEM surveys in the Chukchi Sea per year, with up to **one** of that total number of surveys in each sea done in-ice with ice breaking if necessary.
- Up to **five** site clearance and high resolution shallow hazards survey programs in the Beaufort Sea and up to **five** site clearance and high resolution shallow hazards survey programs in the Chukchi Sea per year.
- **One** on-ice seismic survey in the Beaufort Sea per year.
- Up to **two** exploratory drilling programs in the Beaufort Sea and up to **two** exploratory drilling programs in the Chukchi Sea per year.

### 2.4.6.2 Mitigation

- Including *required* Standard Mitigation Measures (described in Section 2.4.9) that are part of every action alternative.
- Including a full analysis of a wide range of Additional Mitigation Measures (described in Section 2.4.10) that *could potentially* be required through the MMPA process and could vary by alternative (i.e. some might be different based on level and/or type of activity in a given year).

Assumptions for the analysis of Alternative 3 would be the same as those listed for Alternative 2.

## 2.4.7 Alternative 4 – Authorization for Level 2 Exploration Activity <u>With Additional Required Time/Area Closures</u>

Alternative 4 is defined for analytical purposes as the following:

### 2.4.7.1 Level of Activity

- Up to **six** 2D/3D seismic or CSEM surveys in the Beaufort Sea and up to **five** 2D/3D seismic or CSEM surveys in the Chukchi Sea per year, with up to **one** of that total number of surveys in each sea done in-ice with ice breaking if necessary.
- Up to **five** site clearance and high resolution shallow hazards survey programs in the Beaufort Sea and up to **five** site clearance and high resolution shallow hazards survey programs in the Chukchi Sea per year.
- **One** on-ice seismic survey in the Beaufort Sea per year.
- Up to **two** exploratory drilling programs in the Beaufort Sea and up to **two** exploratory drilling programs in the Chukchi Sea per year.

#### 2.4.7.2 Mitigation

- Including *required* Standard Mitigation Measures (described in Section 2.4.9) that are part of every action alternative.
- Including *required* time/area closures for specific areas important to biological productivity, life history functions for specific species of concern, and subsistence activities. Activities would not be permitted to occur in any of the areas listed here during the specific time/area closure periods identified. Additionally, buffer zones around these time/area closures could potentially be included. Buffer zones would require that activities emitting pulsed sounds would need to operate far enough away from these closure areas so that sounds at 160 dB re 1 µPa rms do not propagate into the area or that activities emitting continuous sounds would need to operate far enough away from these closure areas so that sounds at 120 dB re 1 µPa rms do not propagate into the area. In the event that a buffer zone of this size was impracticable, a buffer zone avoiding the ensonification of the important habitat above 180 dB could be used. These areas are shown on Figures 3.2-25 and 3.2-26, and are described in detail in Chapter 3, Sections 3.2.3 and 3.2.4, and under additional mitigation measures described in Appendix A:
    - Camden Bay – An area of high biological productivity, including kelp communities; a feeding and resting area for bowhead whales (including subadults and females with calves); fall subsistence bowhead whale hunting area.
        - Bowhead whales: September 1 – October 15 for primary migration and feeding (Huntington and Quakenbush 2009, Koski and Miller 2009, Quakenbush et al. 2010a)
        - Subsistence (bowhead whale hunting): late August – early October (Huntington and Quakenbush 2009)
        - Except for emergencies or human/navigation safety, oil and gas exploration operations shall not occur within Camden Bay or the designated buffer zones during the dates noted here.
    - Barrow Canyon and the Western Beaufort Sea – An area of high biological productivity; a feeding area for bowhead and beluga whales; fall subsistence bowhead whale hunting area.
        - Bowhead whales: late August – early October
        - Beluga whales: mid-July – late August
        - Except for emergencies or human/navigation safety, oil and gas exploration operations shall not occur within the Barrow Canyon area or the designated buffer zones from August 1 to the close of the fall bowhead whale hunt in Barrow.
    - Shelf Break of the Beaufort Sea – A feeding area for beluga whales.
        - Beluga whales: mid-July – late-September
    - Hanna Shoal – An area of high biological productivity (benthic organisms); a feeding area for various marine mammals (walrus, gray whales, and bearded seals).
        - Walrus: July – August (USGS 2011)
        - Gray whales: late August – early October

        - Except for emergencies or human/navigation safety, oil and gas exploration operations shall not occur within the Hanna Shoal area or the designated buffer zones from September 1 through October 15.
    - Kasegaluk Lagoon/Ledyard Bay Critical Habitat Unit – An important habitat for beluga whales, spotted seals, and spectacled eiders; subsistence beluga whale hunting area.
        - Subsistence (Kasegaluk Lagoon beluga whale hunting): mid-June – mid-July
        - Except for emergencies or human/navigation safety, oil and gas exploration operations shall not occur within the Ledyard Bay Critical Habitat Unit or the designated buffer zones between July 1 and November 15.
        - To the maximum extent practicable, aircraft supporting seismic operations shall avoid operating below 1,500 ft (457 m) over the Unit between July 1 and November 15.

- Including a full analysis of a wide range of Additional Mitigation Measures (described in Section 2.4.10) that *could potentially* be required through the MMPA process and could vary by alternative (i.e. some might be different based on level and/or type of activity in a given year). The time/area closures that are described in this section that are optional for Alternatives 2, 3, and 5 would not be optional but rather required under Alternative 4.

Assumptions for the analysis of Alternative 4 would be the same as those listed for Alternative 2.

## 2.4.8 Alternative 5 – Authorization for Level 2 Exploration Activity <u>With Use of Alternative Technologies</u>

Alternative 5 is defined for analytical purposes as the following:

### 2.4.8.1 Level of Activity

- Up to **six** surveys (utilizing either airguns or an alternative technology, as described below) in the Beaufort Sea and up to **five** surveys (utilizing either airguns or an alternative technology, as described below) in the Chukchi Sea per year, with up to **one** of that total number of surveys in each sea done in-ice with ice breaking if necessary.
- Up to **five** site clearance and high resolution shallow hazards survey programs in the Beaufort Sea and up to **five** site clearance and high resolution shallow hazards survey programs in the Chukchi Sea per year.
- **One** on-ice seismic survey in the Beaufort Sea per year.
- Up to **two** exploratory drilling programs in the Beaufort Sea and up to **two** exploratory drilling programs in the Chukchi Sea per year.

### 2.4.8.2 Mitigation

- Including *required* Standard Mitigation Measures (described in Section 2.4.9) that are part of every action alternative.
- Including a full analysis of a wide range of Additional Mitigation Measures (described in Section 2.4.10) that *could potentially* be required through the MMPA process and could vary by alternative (i.e. some might be different based on level and/or type of activity in a given year), potentially including new mitigations developed to apply to new technologies.

- Including specific additional measures that focus on the use of alternative technologies that have the potential to augment or replace traditional airgun-based seismic exploration activities.

Assumptions for the analysis of Alternative 5 would be the same as those listed for Alternative 2.

### 2.4.9 Standard Mitigation Measures

The mitigation measures (and the identified mitigation monitoring needed to support them) listed below are planned for inclusion as a requirement under every ITA issued for the type of activity identified. In addition, some or all of these measures may also be included in G&G permit or ancillary activity approvals by BOEM. Full descriptions of these measures are contained in Appendix A.

**a) Detection-based measures intended to reduce near-source acoustic exposures and impacts on marine mammals within a given distance of the source**

*2D/3D Seismic Surveys, Including In-ice Seismic; Site Clearance and High Resolution Shallow Hazards Surveys*

- Establishment of 180 dB shutdown/power down radius for cetaceans and 190 dB shutdown/power down radius for pinnipeds.
- Specified ramp-up procedures for airgun arrays.
- Protected Species Observers (PSOs; formerly referred to as Marine Mammal Observers [MMOs]) required on all seismic source vessels and ice breakers, as well as on support (chase) vessels.

*On-ice Seismic Surveys*

- All activities must be conducted at least 150 m (490 ft) from any observed ringed seal lair.
- No energy source may be placed over a ringed seal lair.

*Exploratory Drilling Activities*

- PSOs required on all drill ships and ice management vessels.

**b) Non-detection-based measures intended to more broadly lessen the severity of acoustic impacts on marine mammals or reduce overall numbers taken by acoustic source**

*This measure would be required for all activities that occur during the open-water season and in-ice (i.e. 2D/3D seismic, including in-ice surveys, site clearance and high resolution shallow hazards surveys, and exploratory drilling activities).*

- Specified flight altitudes for all support aircraft except for take-off, landing, and emergency situations.

**c) Measures intended to reduce/lessen non-acoustic impacts on marine mammals**

*These measures would be required for all activities that occur during the open-water season and in-ice (i.e. 2D/3D seismic, including in-ice surveys, CSEM surveys, site clearance and high resolution shallow hazards surveys, and exploratory drilling activities).*

- Specified procedures for changing vessel speed and/or direction to avoid collisions with marine mammals.
- Notification of lost equipment that could pose a danger to marine mammals.

*On-ice Seismic Surveys*

- When traveling on ice-roads, the area shall be monitored for marine mammals.

*Exploratory Drilling Activities ONLY*

- Operators are required to have a plan(s) in place that a) minimize the likelihood of a spill; b) outline the response protocol in the event of the spill; and c) identify the means of minimizing impacts to marine mammals following a spill.

**d) Measures intended to ensure no unmitigable adverse impact to subsistence uses**

*These measures would be required for all activities that occur during the open-water season and in-ice (i.e. 2D/3D seismic, including in-ice surveys, CSEM surveys, site clearance and high resolution shallow hazards surveys, and exploratory drilling activities).*

- Shutdown of activities occurring in specific areas of the Beaufort Sea corresponding to the start and conclusion of the fall bowhead whale hunts in Nuiqsut (Cross Island) and Kaktovik beginning on or around August 25.
- Establishment and utilization of Communication Centers in subsistence communities to address potential interference with marine mammal hunts on a real-time basis throughout the season.
- Required flight altitudes and paths for all support aircraft in areas where subsistence occurs, except during take-off, landing, and emergency situations.

## 2.4.10 Additional Mitigation Measures

The mitigation measures (and mitigation monitoring needed to support them) listed below will be evaluated in Chapter 4, which could lead to some of these measures becoming Standard Mitigation Measures in the Final EIS. In the future, these Additional Mitigation Measures will be evaluated in the context of each specifically described activity to determine whether they should be required by NMFS in a specific ITA or by BOEM in a specific G&G permit or ancillary activity notice approval to make the necessary findings under the MMPA or the OCS Lands Act. In short, these measures may, or may not, be incorporated in future permits and authorizations, depending on the specific activity and the analysis conducted pursuant to the MMPA and the OCS Lands Act. Full descriptions of these measures are contained in Appendix A.

**a) Detection-based measures intended to reduce near-array acoustic exposures and impacts on marine mammals within a given distance of the source**

*2D/3D Seismic and In-ice Surveys; Site Clearance and High Resolution Shallow Hazards Surveys; Exploratory Drilling Activities*

- Sound source verification tests for sound sources and vessels at the start of the season.
- Measures to assess efficacy and improve detection capabilities in low visibility situations (e.g. Forward Looking Infrared [FLIR] imaging devices, 360° thermal imaging devices).
- Limiting activities in situations of low visibility.
- Measures to increase detection probability for real-time mitigation (e.g. to maintain 180 dB shutdown zones), such as passive and active acoustic monitoring.
- Enhancement of monitoring protocols and mitigation shutdown zones to minimize impacts in specific biologic situations (e.g. cow/calf groups and feeding or resting aggregations).

**b) Non-detection-based measures intended to more broadly lessen the severity of acoustic impacts on marine mammals or reduce overall numbers taken by acoustic source**

*These measures would be required for all activities that occur during the open-water season and in-ice (i.e. 2D/3D seismic, including in-ice surveys, site clearance and high resolution shallow hazards surveys, and exploratory drilling activities).*

- Temporal/spatial limitations to minimize impacts in particular important habitats, including Camden Bay, Barrow Canyon/Western Beaufort Sea, Hanna Shoal, the shelf break of the Beaufort Sea, and Kasegaluk Lagoon/Ledyard Bay Critical Habitat Unit.
- NMFS restricting number of surveys (of same level of detail) that can be conducted in the same area in a given amount of time (i.e. to avoid needless collection of identical data).

*2D/3D Seismic, including in-ice surveys ONLY*

- Separate seismic surveys are prohibited from operating within 145 km (90 mi) of one another.

**c) Measures intended to reduce/lessen non-acoustic impacts on marine mammals**

*These measures would be required for all activities that occur during the open-water season and in-ice (i.e. 2D/3D seismic, including in-ice seismic, CSEM surveys, site clearance and high resolution shallow hazards surveys, and exploratory drilling activities).*

- Vessel and aircraft avoidance of concentrations of groups of ice seals, walrus, and polar bears.
- Specified shipping or transit routes to avoid important habitat in areas where marine mammals may occur in high densities.

*Exploratory Drilling Activities ONLY*

- Requirements to ensure reduced, limited, or zero discharge of any or all of the specific discharge streams identified with potential impacts to marine mammals or marine mammal habitat.
- Operators are required to recycle drilling muds.

*On-ice Seismic Surveys*

- Use trained seal-lair sniffing dogs for areas with water deeper than 3 m (9.8 ft) depth contour to locate seal structures under snow in the work area and camp site before initiation of activities.
- Use trained seal-lair sniffing dogs to survey the ice road and establish a route where no seal structures are present.

**d) Measures intended to ensure no unmitigable adverse impact to subsistence uses**

*These measures would be required for all activities that occur during the open-water season and in-ice (i.e. 2D/3D seismic, including in-ice surveys, CSEM surveys, site clearance and high resolution shallow hazards surveys, and exploratory drilling activities).*

- No transit of exploration vessels into the Chukchi Sea prior to July 15 or until the beluga hunt is completed at Point Lay.
- Vessels transiting east of Bullen Point to the Canadian border should remain at least 8 km (5 mi) offshore during transit along the coast, provided ice and sea conditions allow.
- Shutdown of exploration activities in the Beaufort Sea for the Nuiqsut (Cross Island) and Kaktovik bowhead whale hunts based on real-time reporting of whale presence and hunting activity rather than a fixed date.
- Shutdown of exploration activities in the Beaufort Sea for the Barrow bowhead whale hunts from Pitt Point on the east side of Smith Bay to a location about half way between Barrow and Peard Bay from September 15 to the close of the fall bowhead whale hunt in Barrow.
- Shutdown of exploration activities in the Chukchi Sea for the Barrow (the area circumscribed from the mouth of Tuapaktushak Creek due north to the coastal zone boundary, to Cape Halkett due east to the coastal zone boundary) and Wainwright (the area circumscribed from

Point Franklin due south to the coastal zone boundary, to the Kuk River mouth due west to the coastal zone boundary) bowhead whale hunts based on real-time reporting of whale presence and hunting activity rather than a fixed date.

- Shutdown of exploration activities in the Chukchi Sea for the Point Hope and Point Lay bowhead whale hunts based on real-time reporting of whale presence and hunting activity rather than a fixed date.
- Transit restrictions into the Chukchi Sea modified to allow offshore travel under certain conditions (e.g. 32 km [20 mi] from the coast) if beluga whale, fall bowhead whale (Barrow and Wainwright), and other marine mammal hunts would not be affected.

*Exploratory Drilling Activities ONLY*

- For exploratory drilling operations in the Beaufort Sea west of Cross Island, no drilling equipment or related vessels used for at-sea oil and gas operations shall be moved onsite at any location outside the barrier islands west of Cross Island until the close of the bowhead whale hunt in Barrow.

## 2.4.11 Marine Mammal Monitoring Programs and Reporting Requirements

### 2.4.11.1 Monitoring Requirements

In addition to the measures outlined above, the MMPA and NMFS' implementing regulations require that an applicant conduct monitoring of marine mammals in the designated activity area. According to 50 CFR Part 216.108(c), the monitoring program must, if appropriate, document the effects (including acoustic effects) on marine mammals and document or estimate the actual level of take as a result of the activity. Additionally, the program should increase the knowledge of the affected species and/or increase knowledge of the anticipated impacts on marine mammal populations.

Monitoring plans are submitted as part of the MMPA ITA application. NMFS reviews the monitoring plans prior to issuing ITAs to ensure they meet the goals stated above. If an activity may affect the availability of a marine mammal species or stock for taking for subsistence uses, the proposed monitoring plan must be independently peer-reviewed prior to issuance of the ITA (16 U.S.C. 1371(a)(5)(D) and 50 CFR Part 216.108(d)).

There are two different types of monitoring that are most often included in monitoring plans submitted as part of MMPA ITA applications. The first type is what NMFS often refers to as mitigation monitoring. Mitigation monitoring is used to detect and localize marine mammals so that mitigation measures, which ensure that the activity is being conducted in a way to effect the least practicable adverse impact on marine mammals, their habitat, and on their availability for subsistence uses, may be implemented (e.g. monitoring the area immediately adjacent to an activity to ensure there are no marine mammals about to enter the 180- or 190-dB exclusion zones). The second type of monitoring relates to the applicant's specific statutory responsibility to monitor marine mammals in order to document the potential effects and level of take resulting from the applicant's action and to increase knowledge of the species (e.g. use of regional aerial surveys to assess changes in distribution).

Mitigation monitoring will be assessed along with the associated mitigation it accompanies, as described above and in Appendix A and analyzed in Chapter 4. The second type of monitoring described above will be further discussed in Chapter 5 through the following:

- A more detailed description of the goals of the required monitoring.
- A description/summary of the types of monitoring that have been required in the past and the nature of the data that has been collected.

- A discussion of the different methods/structure for peer-review used to date, including their comparative success, and discussion of any recommended means of improving the peer-review process.
- A discussion of different methods/frameworks that NMFS could potentially use for:
    - Identifying specific existing data gaps that can potentially be addressed through monitoring; and
    - Prioritizing monitoring needs in advance to inform would-be applicants and management decisions/recommendations.

### 2.4.11.2 Reporting Requirements

The following reports are planned to be included as requirements under every ITA; additional reporting requirements that may be considered and required are discussed in Chapter 5.

- 90-day Report: A draft report will be submitted to the Director, Office of Protected Resources, NMFS, within 90 days after the end of any activity authorized under an ITA in the Arctic Seas. The report will describe in detail (at a minimum): (i) the operations that were conducted; (ii) the results of the acoustical measurements to verify the safety radii (if required); (iii) the methods, results, and interpretation pertaining to all monitoring tasks; (iv) the results of that year's shipboard marine mammal monitoring; (v) a summary of the dates and locations of operations, including summaries of mitigation measures that were implemented (e.g. power-downs, shutdowns, and ramp-up delays); (vi) marine mammal sightings (species, numbers, dates, times and locations; age/size/gender, environmental correlates, activities, associated seismic survey activities); (vii) estimates of the amount and nature of potential take (exposure) of marine mammals (by species) by harassment or in other ways to industry sounds; (viii) an analysis of the effects of operations (e.g. on sighting rates, sighting distances, behaviors, movement patterns of marine mammals); (ix) an analysis of factors influencing detectability of marine mammals; and (x) summaries of communications with hunters and potential effects on subsistence uses.
- The draft 90-day report will be subject to review and comment by NMFS. Any recommendations made by NMFS must be addressed in the final report prior to acceptance by NMFS. The draft report will be considered the final report for this activity under the Authorization if NMFS has not provided comments and recommendations within 90 days of receipt of the draft report.
- A draft comprehensive report describing the acoustic and vessel-based monitoring programs will be prepared and submitted within 240 days of the date of the ITA. The comprehensive report will describe the methods, results, conclusions and limitations of each of the individual data sets in detail. The report will also integrate (to the extent possible) the studies into a broad based assessment of all industry activities and their impacts on marine mammals in the Arctic Seas during the year.
- The draft comprehensive report will be subject to review and comment by NMFS, the AEWC, and the North Slope Borough Department of Wildlife Management. The draft comprehensive report will be accepted by NMFS as the final comprehensive report upon incorporation of comments and recommendations.
- When Field Source Verification is required, the distances to the various isopleths are to be reported to NMFS within five days of completing the measurements. In addition to reporting the radii of specific regulatory concern, distances to other sound isopleths down to 120 dB rms (if measurable) will be reported in increments of 10 dB.

## 2.5 Alternatives Considered but Dismissed From Further Evaluation

Comments received during the scoping process have suggested features that should be incorporated into project alternatives (Table 2.1). Many of these have been incorporated into the alternatives considered for analysis in this EIS (Section 2.4). However, others have been dismissed from further consideration after careful review. These are described in the following sections:

### 2.5.1 Permanent Closures of Areas

Through the scoping process, a suggestion was put forward that certain areas of the Beaufort and Chukchi seas should be permanently closed to oil and gas leasing due to environmental sensitivity. The appropriate mechanism for considering exclusion of areas from leasing is when BOEM requests public comments on its Five Year OCS Leasing Plan and later when considering lease sales as described as the leasing stage of the OCS Lands Act. During the Five-Year Program stage, the public is afforded the opportunity to make recommendations regarding the size, timing, and location of proposed lease sales for the next five years. At the lease sale stage, BOEM invites the public to make comments regarding a specific sale and potential exclusions.

The President of the United States can place a moratorium on an area or the U.S. Congress can permanently close an area. The current alternatives in this EIS consider a wide array of geographic restrictions that could be used, alone or in combination, to mitigate impacts to different resources in the context of the specific activity that is being permitted. BOEM and BSEE retain jurisdiction of prelease and post-lease operations and can stop operations when activities pose a threat of serious, irreparable, or immediate harm or damage (30 CFR Part 551.9 and 30 CFR Part 250.172).

Applicants come to NMFS requesting take authorization for specified activities. The MMPA states that if NMFS finds that the specified activity itself, or with the implementation of mitigation and monitoring measures, will have a negligible impact on affected marine mammal species or stocks and will not have an unmitigable adverse impact on the availability of affected marine mammal species or stocks for taking for subsistence uses, NMFS *shall issue* the requested ITA. NMFS is required to make these decisions on an application-specific basis, and there is no mechanism in Section 101(a)(5) to preemptively permanently close an area to all oil and gas activity.

NEPA does not preclude the consideration of alternatives that the lead agency(s) cannot implement or enforce, however, nor does it require the consideration of alternatives that do not meet the purpose and need of the EIS. In this case, NMFS is using this EIS to inform decisions of whether to issue ITAs pursuant to Section 101(a)(5) of the MMPA, and the analysis of a permanent closure alternative does not add value, especially considering the broad array of geographic restrictions that are considered within the action alternatives carried forward for analysis. In this case, BOEM is using this EIS to inform decisions on issuing G&G permits and authorizing ancillary activities. The analysis of a permanent closure alternative does not add value, especially considering the broad array of geographic restrictions that are considered within the action alternatives and both BOEM and BSEE have statutory and regulatory authority to stop operations.

As noted above, NMFS and BOEM may, and do in the alternatives carried forward, consider temporary restrictions, such as time/area closures (see Alternative 4) and other mitigation measures to avoid or minimize adverse effects on marine mammals, other marine resources, and subsistence harvest activities through their respective authorities.

### 2.5.2 Caps on Levels of Activities and /or Noise

During the scoping period, commenters suggested that there should be a cap established to limit the total number of oil and gas seismic and exploratory drilling activities that may occur in the EIS project area on a per season basis. The alternatives carried forward for analysis in this EIS include a range of exploration

activities at different activity levels. While these separate activity level alternatives do not function as "caps," they do serve as the maximum annual level of activities for which NEPA coverage exists for NMFS' and BOEM's issuance of ITAs and permits, respectively, in a given year.

There is little, if any, quantitative data upon which BOEM or NMFS could justify designating a particular activity-level cap. The impacts of sound exposure on marine mammals can vary greatly depending upon context (i.e. where, when, and how the activities and marine mammals overlap) and the likely impacts from a particular combination of multiple activities can vary even more depending on the context of each activity, which is not known prior to the submittal of applications. This EIS will specifically analyze the likely effects of individual oil and gas activities in different particular contexts (e.g. in marine mammal feeding areas, during subsistence hunts), further generally analyze the likely impacts of multiple activities, including a qualitative assessment of how specific contextual factors would affect the multiple activity analysis, and analyze the implementation of mitigation measures intended to minimize environmental impacts from both individual activities and multiple activities occurring at once (e.g. minimum distances between seismic vessels), all of which will be used in the context of specific industry requests to support NMFS' and BOEM's decisions in a given season. NMFS will also continue to require monitoring that contributes to the understanding of marine mammal responses to both individual and multiple activities, which is then used to better inform future decisions.

An OCS lease authorizes a lessee to engage only in "*ancillary activities*" that receive further environmental review to determine if they will cause any harm to the environment and are only approved if the activity does not cause "*undue or serious harm or damage to the human, marine, or coastal environment*" (30 CFR Parts 550.105, 550.202, and 550.209; see also 43 U.S.C. 1340[c} approval required prior to exploration]. The U.S. Supreme Court has recognized that *"[u]nder OCSLA's plain language, the purchase of a lease entails no right to proceed with full exploration, development, or production. . .; the lessee acquires only a priority in submitting plans to conduct these activities*" (*Secretary of the Interior v. California*, 464 U.S. 312, 339 [1984]).

BOEM has the statutory authority to make a decision on exploratory drilling activities. NMFS does not authorize the exploration activities, but rather authorizes the take of marine mammals incidental to specified activities. And, as discussed above, NMFS must consider every application and shall issue the ITA if the requisite findings are made. For the reasons above, NMFS and BOEM do not believe that adding an alternative of this nature meets the purpose and need of this EIS.

Similarly, a commenter recommended that this EIS include an alternative wherein BOEM and NMFS only issued permits and authorizations in alternate years. The information in the paragraphs immediately above supports our decision not to carry this alternative forward for consideration. Additionally, there are little to no data to support an analysis of this alternative.

Separately, a commenter suggested that a sound cap or sound budget that limits the total amount of noise (from oil and gas exploration sounds, as well as other sounds that are not part of the proposed action) allowed per season should be considered as an alternative. The factors discussed in the paragraphs above (activity level caps) apply to this recommendation as well. Additionally, there are even fewer data to support a cumulative noise cap as the current understanding of the likely impacts from noise and ability to quantify those impacts are generally limited to observed responses to a single sound source. Also, even if justified, this recommendation would be very difficult (if not impossible) to effectively implement since the entities conducting non-oil and gas-related activities without MMPA authorization have no responsibility either to indicate their future plans or report their prior sound production, which would be necessary for the budget "accounting."

In Chapter 4, NMFS will consider the combined noise impacts from multiple surveys. Similarly, in the cumulative impact analysis, NMFS will consider the potential noise (and other types of) impacts from other known activities occurring in the EIS project area. This information will be analyzed on a qualitative basis and potentially in the development of mitigation or monitoring measures contained in

this EIS. Additionally, NMFS and BOEM are aware of several ongoing scientific efforts to better quantify different aspects of potential cumulative impacts in the Arctic (e.g. the Cumulative Effects of Anthropogenic Sound on Marine Mammals Workshop sponsored by British Petroleum [BP] and the NOAA Sound Mapping Working Group) and any applicable available preliminary or final products will be considered in the EIS, as appropriate. While NMFS will consider the potential impacts from exposure over time to multiple sound sources in this document, a "budget" implies a quantitative management of total sound that cannot currently be supported by the science.

### 2.5.3 Duplicative Surveys

A question was raised as to why restrictions could not be placed on companies that are repeating seismic surveys in the same geographic area. Based upon the OCS Lands Act and applicable regulations (30 CFR Parts 550 and 551), BOEM does not have the discretion to require companies to share proprietary data, combine seismic programs, change lease terms, or prevent companies from acquiring data in the same geographic area. The agency does not have the authority to deny seismic permits simply on the grounds that they are duplicative – meaning the acquisition of the exact same data using the exact same equipment and technology in the exact same location. Continuing improvements in seismic survey technology, operations, and data processing could provide better quality data, which would support better decisions and higher drilling success rates (i.e., fewer unsuccessful wells or "dry holes"). To improve data quality and imaging in the same area, surveys have been shot in different orientations, using different cable lengths, using new wide azimuth techniques, or using multi-component sensors, just to name a few. Some improvements resulted in deeper imaging, others in better imaging. Also, all seismic surveys are not the same, even when the exact equipment and technology is being used. Variances in the use of the exact same equipment and technology provide different data sets that have the potential to produce information to assist in subsequent exploration.

However, NMFS and BOEM are both committed to supporting the reduction of unnecessary sound in the water.

### 2.5.4 Zero Discharge

Through the scoping process, a suggestion was put forward that "zero discharge" practices should be implemented to eliminate discharges of waste into the marine environment. Part of the impetus for making this suggestion was the fact that there have been zero discharge standards in place previously in Norway. An additional basis for this particular recommendation was a specific voluntary "zero discharge" proposal by one oil and gas operator (i.e. Shell Oil) to manage five specific waste streams within its lease blocks in Camden Bay in the Beaufort Sea by:

1) collecting sanitary waste, bilge water, ballast water, and domestic waste (i.e. gray water) on drillships, and subsequently transporting those waste materials for disposal out of the activity area; and
2) off-site disposal of drill cuttings and drilling fluids collected after the well casing is set in the top hole.

However, oil and gas exploration activities generate a wide range of waste materials in addition to those associated with the current "zero discharge" proposal put forth by Shell Oil.

The NPDES Arctic General Permit issued by the EPA regulates discharges of drilling muds and cuttings; deck drainage; sanitary wastes; domestic wastes; uncontaminated ballast water; bilge water; desalination unit wastes; blowout preventer fluid; boiler blowdown; fire control system test water; non-contact cooling water; excess cement slurry; muds; cuttings; cement at seafloor; and test fluids. The NPDES Arctic General permit includes restrictions specific to the discharges of drilling muds and drill cuttings and effluent limitations and monitoring requirements for all authorized discharges.

The Arctic General Permit includes further prohibitions for muds and cutting by restricting discharges within certain water depths, sensitive areas, and ice conditions. The permit was issued in compliance with EPA's Ocean Discharge Criteria for preventing unreasonable degradation of ocean waters (40 CFR Part 125, Subpart M). These specific criteria are designed to prevent significant adverse changes in ecosystem diversity, productivity, and stability of the biological community within the area of discharge and surrounding biological communities; threats to human health through direct exposure to pollutants or through consumption of exposed aquatic organisms; and loss of aesthetic, recreational, scientific, or economic values, which are unreasonable in relation to the benefit derived from the discharge.

NMFS has the authority to require mitigation measures to effect the least practicable adverse impact to marine mammals and their habitat and to ensure an unmitigable adverse impact to subsistence uses of these species. NMFS will consider as additional mitigation measures, within the action alternatives carried forward for analysis, the reduction, limitation, or elimination of the discharge of specific wastes that may potentially impact marine mammals or marine mammal habitat. NMFS does not have the authority to require mitigation measures that limit discharge streams for which there is no science supporting the link to impacts to marine mammals or their habitat. Again, NEPA does not preclude the consideration of alternatives that the lead agency(s) cannot implement or enforce, however, nor does it require the consideration of alternatives that do not meet the purpose and need of this EIS. Therefore, NMFS does not intend to include an alternative that includes zero discharge of all waste streams, as it will not add value to this analysis. Rather, the EIS will analyze the limitation (zero discharge or reduced discharge) of the subset of discharge streams associated with impacts to marine mammals or their habitat in the Additional Mitigation section. The mitigation analysis will look at how the limitation will reduce adverse impacts to marine mammals and their habitat or to subsistence uses of marine mammals, how effective the measure is likely to be, and the practicability for applicant implementation. This analysis/approach will more effectively support NMFS' purpose and need without creating unnecessary administrative complexity.

## Table 2.5 Summary of Alternatives

| Element | Alternative 1 – No Action | Alternative 2 | Alternative 3 | Alternative 4 | Alternative 5 |
|---|---|---|---|---|---|
| **Level of Activity** | No ITAs issued; No G&G permits or ancillary activity notices issued | Up to four 2D/3D seismic or CSEM surveys in the Beaufort Sea (Beaufort) and up to three 2D/3D seismic or CSEM surveys in the Chukchi Sea (Chukchi) per year. Up to one of the total number of surveys in each sea done in-ice with ice breaking if necessary. | Up to six 2D/3D seismic or CSEM surveys in the Beaufort and up to five 2D/3D seismic or CSEM surveys in the Chukchi per year. Up to one of the total number of surveys in each sea done in-ice with ice breaking if necessary | Same as Alternative 3 | Same as Alternative 3 |
| | | Up to three site clearance and high resolution shallow hazards survey programs in the Beaufort and up to three site clearance and high resolution shallow hazards survey programs in the Chukchi per year. | Up to five site clearance and high resolution shallow hazards survey programs in the Beaufort and up to five site clearance and high resolution shallow hazards survey programs in the Chukchi per year | Same as Alternative 3 | Same as Alternative 3 |
| | | One on-ice seismic survey in the Beaufort per year. | Same as Alternative 2 | Same as Alternative 2 | Same as Alternative 2 |
| | | One exploratory drilling program in the Beaufort and one exploratory drilling program in the Chukchi per year. | Up to two exploratory drilling programs in the Beaufort and up to two exploratory drilling programs in the Chukchi per year. | Same as Alternative 3 | Same as Alternative 3 |
| | | | | | |
| **Required Standard Mitigation Measures** | None needed | Full range of those measures described in Section 2.4.9 for consideration as needed. | Same as Alternative 2 | Same as Alternative 2 | Same as Alternative 2 |
| | | | | | |
| **Additional Mitigation Measures** | None needed | Full range of those measures described in Section 2.4.10 for consideration as needed. | Same as Alternative 2 | Same as Alternative 2 | Same as Alternative 2 |
| | | | | Additional required time/area closures for:<br>• Camden Bay<br>• Barrow Canyon/ Western Beaufort Sea<br>• Shelf Break of the Beaufort Sea<br>• Hannah Shoal<br>• Kasegaluk Lagoon/ Ledyard Bay Critical Habitat Unit | Additional Mitigation Measures that focus on the use of alternative technologies that have the potential to augment or replace traditional airgun-based seismic exploration activities. |

## 2.6 Comparison of Impacts

Table 2.6 presents a summary of impacts to all resources from Alternative 1 through Alternative 5. Summary impact conclusions are identified in the table for each resource. The methodology for determining the level of impact is discussed in Chapter 4, Section 4.1.3. Table 2.6 also presents a summary of the potential impacts of a very large oil spill scenario in the Beaufort or Chukchi seas.

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## Table 2.6 Comparison of Impacts

| Impact Topic | Alternative 1- No Action Alternative | Alternative 2- Authorization for Level 1 Exploration Activity | Alternative 3- Authorization for Level 2 Exploration Activity | Alternative 4- Authorization for Level 2 Exploration Activity with Additional Required Time/Area Closures | Alternative 5- Authorization for Level 2 Exploration Activity with Use of Alternative Technologies | Very Large Oil Spill Scenario in Beaufort or Chukchi Sea |
|---|---|---|---|---|---|---|
| **PHYSICAL ENVIRONMENT** | | | | | | |
| **Physical Oceanography** | No effect | Minor impacts from deposition of materials during exploratory drilling, construction of artificial island, ice-breaking, and on-ice seismic surveys. | Same types of impacts as Alternative 2, intensity and extent of the impact would be doubled, level of impact still minor. | Same as Alternative 3 | Same as Alternative 3 | Moderate impact from the viscosity and stickiness of oil floating at the sea surface, temporary duration. |
| **Climate** | No effect | Minor impacts due to low contribution to GHG emissions. | Although the projected direct GHG emissions are higher than those projected for Alternative 2, impacts would be minor due to their low magnitude. | Same as Alternative 3 | Same as Alternative 3 | Minor to moderate impact from activities associated with a VLOS that would cause a temporary increase in GHG emissions |
| **Air Quality** | No effect | Minor impacts due to emissions from fuel combustion for oil and gas exploration activities. | Moderate impacts because the increase in detrimental effects on air quality is expected to be minimal. | Same as Alternative 3 | Same as Alternative 3 | Minor impact, as associated activities could cause temporary increase in emissions. |
| **Acoustics** | No effect | Moderate impacts from sound of exploration activities. | Moderate, although the number of exploration programs is increased from Alternative 2, the same types of noise-generating sources are to be used. | Same as Alternative 3 | Same as Alternative 3 | Effects of spill response and cleanup on the acoustic environment would be considered minor to moderate. |
| **Water Quality** | No effect | Impacts reduced to negligible by mitigation measures. | Impacts reduced to negligible by mitigation measures. | Same as Alternative 3 | Same as Alternative 3 | Major impact from sustained degradation of water quality by hydrocarbon contamination exceeding state and federal water and sediment quality criteria. |
| **Environmental Contaminants and Ecosystem Functions** | No effect | Negligible impacts, they could be medium intensity but would be local and temporary. | Minor impacts due to the greater level of activity increasing the potential volume of contaminants introduced to the project area. | Same as Alternative 3 | Same as Alternative 3 | Major impact from contamination caused degradation of ecosystems functions. |
| **BIOLOGICAL ENVIRONMENT** | | | | | | |
| **Lower Trophic Levels** | No effect | Minor impacts from disturbance of habitat and displacement of organisms from drilling, sediment sampling, ship anchoring, or platform installation; toxicity due to production discharge; increased productivity due to ice breaking. Introduction of invasive species from ship traffic could cause moderate impacts. | Minor impacts, the increased levels of activity would not generate different types or level of impacts.<br>Introduction of invasive species from ship traffic could cause moderate impacts. | Same as Alternative 2, the time/area closures would not affect lower trophic levels. | Same as Alternative 2, the use of alternative technologies would not affect lower trophic levels. | Moderate to major impact depending on if the spill persists or affects unique resources. |
| **Fish/Essential Fish Habitat** | No effect | Negligible impacts, small scale and temporary only. | Negligible impacts, increased activities would not change the impact level. | Negligible impacts. The time/area closures would reduce the impacts to lower than Alternative 2. | Negligible impacts. The use of alternative technologies may reduce any impact. | Moderate impact from toxic exposure and habitat contamination. |
| **Marine and Coastal Birds** | No effect | Negligible impacts from temporary and localized disturbance, injury/mortality, and changes in habitat. | Negligible impacts, increased activities would not change the impact level. | Same as Alternative 3 | Same as Alternative 3 | Major impact from toxic exposure to prey and individuals, mortality of individuals, and contamination of habitat. |

| Impact Topic | Alternative 1- No Action Alternative | Alternative 2- Authorization for Level 1 Exploration Activity | Alternative 3- Authorization for Level 2 Exploration Activity | Alternative 4- Authorization for Level 2 Exploration Activity with Additional Required Time/Area Closures | Alternative 5- Authorization for Level 2 Exploration Activity with Use of Alternative Technologies | Very Large Oil Spill Scenario in Beaufort or Chukchi Sea |
|---|---|---|---|---|---|---|
| **Marine Mammals: Bowhead Whales** | No effect | Minor to moderate impacts from noise disturbance, possible ship strikes, or habitat degradation. | Moderate impacts from noise disturbance, possible ship strikes, or habitat degradation. | Moderate impacts. Although the Time/Area closures could reduce adverse impacts in particular times and locations, the impact level would not change. | Moderate impacts. Despite possible localized mitigating capabilities of alternative technologies the impact level would not change. | Major impact from toxic exposure, loss of seasonal habitat, reduction and contamination of prey, and disturbance from increased human activity. |
| **Marine Mammals: Beluga Whales** | No effect | Minor to moderate impacts from noise disturbance, possible ship strikes, or habitat degradation. | Moderate impacts from noise disturbance, possible ship strikes, or habitat degradation. | Moderate impacts. The effects on beluga whales would be similar to Alternative 3 but may occur in different times and places. | Moderate impacts. Although the gradual introduction of these alternative technologies could eventually reduce the amount of seismic noise introduced into the marine environment, alternative technologies would not completely replace the existing technology, so moderate impacts would remain. | Major impact from toxic exposure, loss of seasonal habitat, reduction and contamination of prey, and disturbance from increased human activity. |
| **Marine Mammals: Other Cetaceans** | No effect | Minor impacts from temporary, local disturbance. | Minor impacts from temporary, local disturbance. Increased activities would not change the impact level. | Minor impacts. Although the time/area closures could reduce adverse impacts in particular times and locations, the overall exploration effort may not be reduced, but, rather, redistributed and possibly concentrated in other areas, so the impact would not change. | Minor impacts. Alternative technologies could reduce the extent to localized areas on a small scale; it is not currently possible to assess potential behavioral reactions and determine if intensity level would change as a result. | Major impact from toxic exposure, loss of seasonal habitat, reduction and contamination of prey, and disturbance from increased human activity. |
| **Marine Mammals: Pinnipeds** | No effect | Minor impacts from temporary localized disturbance. | Minor impacts from temporary localized disturbance. Increased activities would not change the impact level. | Minor impacts. Although the time/area closures would reduce potentially adverse effects on seals in those areas, the impact level would not change. | Minor impact. Alternative technologies would presumably reduce the amount of noise introduced but would still use marine vessels which are at least as important for disturbance to seals in the water. | Minor to moderate impact from toxic exposure, loss of seasonal habitat, reduction and contamination of prey, and disturbance from increased human activity. |
| **Marine Mammals: Pacific Walrus** | No effect | Minor impacts from disturbance, risk of injury or mortality, and changes in habitat in the Chukchi Sea.<br>No impact from activities in the Beaufort Sea as they are uncommon there. | Minor impacts from disturbance, risk of injury or mortality, and changes in habitat in the Chukchi Sea. Despite the increased activity, there would be no increase in the impact level.<br>No impact from activities in the Beaufort Sea as they are uncommon there. | Minor impacts, although time/area closures would reduce potentially adverse effects on walrus in those areas.<br>No impact from activities in the Beaufort Sea as they are uncommon there. | Minor impacts. Alternative seismic technologies for in-ice surveys would likely still require the use of ice and would therefore have similar disturbance effects on walrus as those technologies currently in use.<br>No impact from activities in the Beaufort Sea as they are uncommon there. | Minor to moderate impact from VLOS in Chukchi sea from toxic exposure, loss of seasonal habitat, reduction and contamination of prey, and disturbance from increased human activity.<br>Negligible effect from VLOS in the Beaufort as walrus are uncommon there. |
| **Marine Mammals: Polar Bears** | No effect | Minor impacts from temporary localized disturbance. | Minor impacts from temporary localized disturbance. Despite the increased activity, there would be no increase in the impact level. | Minor impacts. The time/area closures may protect ice seals, a primary food source for polar bears. | Minor impacts. Alternative technologies would presumably reduce the amount of noise introduced but would still use marine vessels which are at least as important for disturbance to polar bears in the water. | Moderate to major impacts from toxic exposure, habitat loss, contamination of prey, and increased human activity. |
| **Terrestrial Mammals** | No effect | Minor impacts from temporary localized disturbance, risk of vehicle strikes, and habitat alternations. | Minor impacts. Despite the increased activity, there would be no increase in the impact level. | Minor impacts. The time/area closures would not affect terrestrial mammals. | Minor impacts. The use of alternative technologies would not affect terrestrial mammals. | Minor to moderate impact from toxic exposure, habitat loss, and temporary disturbance. |
| **SOCIAL ENVIRONMENT** | | | | | | |
| **Socioeconomics** | Minor adverse impact from unrealized local employment and tax revenue. | Minor beneficial impact from temporary rise in regional personal income and employment rates. | Minor beneficial impact. Despite the increased activity, there would be no increase in the impact level because the increases in income and employment rates are not more than 5 percent. | Minor beneficial impact. The time/area closures could reduce total local employment rates and personal income so the positive impact would be less than Alternative 2. | Minor beneficial impact. The alternative technologies could result in additional costs from lost productivity so the positive impact would be less than Alternative 2. | Major impact from changes in employment, revenues, workforce, demographics, subsistence, and local and state agency spending. |
| **Subsistence** | No effect | Negligible to moderate impacts from disturbance. | Negligible to moderate impacts from disturbance. Even with the increased activities, the impacts to subsistence resources and harvest would be similar in type, intensity, and duration, but would occur in more locations. | Negligible to moderate impacts from disturbance. However time/area closures would reduce impacts from disturbance on subsistence harvest and use for certain communities. | Negligible to moderate impacts from disturbance. The effectiveness of these alternative technologies to reduce adverse impacts to subsistence uses is unknown. If alternative technologies reduce disturbance to marine mammals, that would reduce impacts to subsistence users. | Major impact from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices. |

| Impact Topic | Alternative 1- No Action Alternative | Alternative 2- Authorization for Level 1 Exploration Activity | Alternative 3- Authorization for Level 2 Exploration Activity | Alternative 4- Authorization for Level 2 Exploration Activity with Additional Required Time/Area Closures | Alternative 5- Authorization for Level 2 Exploration Activity with Use of Alternative Technologies | Very Large Oil Spill Scenario in Beaufort or Chukchi Sea |
|---|---|---|---|---|---|---|
| **Public Health** | No effect | Negligible impacts from changes to:<br>• Diet and nutrition<br>• Contamination<br>• Safety<br>• Acculturative stress<br>• Economic impacts<br>• Health care services | Negligible impacts from changes to:<br>• Diet and nutrition<br>• Contamination<br>• Safety<br>• Acculturative stress<br>• Economic impacts<br>• Health care services<br>Despite the increased activity, there would be no increase in the impact level. | Negligible impacts. If the time/area closures improve the likelihood of maintaining a strong subsistence harvest, there will also be resulting reduction in adverse impacts to public health. If the closures allow hunters to complete their hunts with less travel time, it will benefit safety. However, these benefits do not affect the overall impact criteria rating, as it is are already negligible. | Negligible impacts. The alternative technologies may reduce disturbance to marine mammals, which could reduce adverse impacts to subsistence users. However, the effectiveness of the alternative technologies in reducing adverse impacts to subsistence uses is unknown. Therefore, the impact rating remains the same. If the alternative technologies are demonstrated to be effective, they would benefit public health. | Moderate to major impacts from introduced diseases from outside workers, strain on local health care system, poor air quality, increased stress, potentially contaminated food, and change to subsistence harvest patterns. |
| **Cultural Resources** | No effect | Negligible impact. | Negligible impact. | Minor impact. The time/area closures would not affect cultural resources. | Minor impact. The alternative technologies would not affect cultural resources. | Minor to moderate impact from onshore clean-up activities. |
| **Land and Water Ownership, Use, and Management** | Major adverse impacts from loss of opportunity to explore for oil and gas. | Moderate impacts to land and water use from activity in new areas and potential long-term development.<br>Negligible impacts to land and water ownership and management as no changes in management or ownership would occur. | Moderate impacts to land and water use from possible conflict between subsistence use and seismic surveys, changes in industrial, transportation, and commercial land use and management. Slightly higher possibility of new facilities and infrastructure, higher levels of air and vessel traffic, and commercial activity associated with survey support.<br>Minor impacts to land and water management - as activities increase, the possibility for conflicts with borough offshore development policies goes up as well.<br>Negligible impacts to land and water ownership as no changes in ownership would occur. | Moderate impacts to land and water use.<br>As time/area closures are implemented, the likelihood of conflicts decreases because the closures would lessen the exposure of subsistence species to seismic activities and exploratory drilling at critical locations and during critical seasons of the year. Time/area closures would shorten the timeframe available for oil and gas exploration activities and potentially impede exploration activity. As a result, there may be a reduction in transportation and commercial uses during certain times of the year.<br>Minor impacts to land and water management. Constraining exploration to certain times and locations may result in more moderate state and federal resource development goals, while promoting management practices to protect the human, marine and coastal environments, and improve consistency with North Slope Borough and Northwest Arctic Borough comprehensive plans and Land Management Regulations. Therefore, because these techniques reflect balanced management and do not prohibit resource development, no inconsistencies or changes in federal or state land or water management are anticipated.<br>Negligible impacts to land and water ownership as no changes in ownership would occur. | Moderate impacts to land and water use from activity in new areas and potential long-term development.<br>Minor impacts to land and water management.<br>Negligible impacts to land and water ownership as no changes in ownership would occur. | Major impact to land and water use and management from changes in resource use/values, and high response activity level, and changes in management to accommodate response.<br>Negligible impact to land and water ownership. |
| **Transportation** | No effect | Negligible (aircraft and vehicle) to minor (vessel) impacts from increased traffic. | Minor to moderate impacts from increased traffic. | Minor to moderate impacts from increased traffic. The time/area closures would limit the amount of aircraft overflights in these areas. | Minor to moderate impacts from increased traffic. It is assumed that these new alternative technologies would require the same levels of aircraft and surface and vessel support as under Alternative 3, and, therefore, the impacts are expected to be similar. | Moderate to major impacts from increased levels of air, vessel, and surface traffic from spill response activities. |
| **Recreation and Tourism** | No effect | Minor impacts from temporary and local effects on recreational setting. | Minor impacts from temporary and local effects on recreational setting. The increased levels of activity would not generate different types or level of impacts. | Minor impacts from temporary and local effects on recreational setting. If the time/area closures benefit marine mammals, they would also benefit recreation and tourism based on wildlife viewing. | Minor impacts from temporary and local effects on recreational setting. The alternative technologies would not affect recreation or tourism. | Major impact from displacement of recreationists and reduction in tourism |
| **Visual Resources** | No effect | Moderate impacts from high contrast of drill sites and associated activities. | Moderate impacts from high contrast of drill sites and associated activities. | Same as Alternative 3. | Same as Alternative 3. | Major impact from acute disturbance in visual resources. |
| **Environmental** | No effect | Minor adverse impacts from disruption of | Minor adverse impacts from disruption of | Minor impacts. With the time/area closures, the | Minor impacts. With the alternative technologies, the | Moderate to major impacts from |

| Impact Topic | Alternative 1- No Action Alternative | Alternative 2- Authorization for Level 1 Exploration Activity | Alternative 3- Authorization for Level 2 Exploration Activity | Alternative 4- Authorization for Level 2 Exploration Activity with Additional Required Time/Area Closures | Alternative 5- Authorization for Level 2 Exploration Activity with Use of Alternative Technologies | Very Large Oil Spill Scenario in Beaufort or Chukchi Sea |
|---|---|---|---|---|---|---|
| **Justice** | | subsistence activities and potential contamination of subsistence food.<br>Minor beneficial impacts from local employment opportunities. | subsistence activities and contamination of subsistence food.<br>Minor beneficial impacts from local employment opportunities. | impacts to subsistence activities could be further minimized but would remain minor. | impacts to subsistence foods and human health could be further minimized but would remain minor. | disproportionate adverse effect on minority populations from impacts to subsistence foods and human health. |

# 3.0 AFFECTED ENVIRONMENT

This chapter describes the physical, biological, and social resources that are affected by the issuance of ITAs by NMFS or the authorization of G&G permits and authorization of ancillary activities in the U.S. Beaufort and Chukchi seas by BOEM. The objective of this section is to describe the past and present effects on relevant resources, thereby defining their baseline conditions, as a basis for the analysis of direct and indirect effects of the alternatives and the cumulative effects analysis presented in Chapter 4 of this document.

The following descriptions of the affected environment have been compiled from several other sources, including NMFS and BOEM documents. In many cases, the original documents are referenced and the pertinent information has been summarized. In other cases, pertinent sections of documents have been reproduced from the original. All source documents are cited in the text with full references in Chapter 7 of this document.

## 3.1 Physical Environment

### 3.1.1 Physical Oceanography

#### 3.1.1.1 Water Depth and General Circulation

The Beaufort and Chukchi seas are the northernmost seas bordering Alaska. The Beaufort and Chukchi seas are parts of the Arctic Ocean, but both are linked, atmospherically and oceanographically, to the Pacific Ocean. The atmospheric connection involves the Aleutian Low, which affects regional meteorological conditions. The oceanographic link is via the Bering Strait, which draws relatively warm nutrient-rich water into the Arctic Ocean from the Bering Sea (Weingartner and Danielson 2010).

The Beaufort Sea is a semi-enclosed basin with a narrow continental shelf extending 30 to 80 kilometers (km) (19 to 50 miles [mi]) from the coast (Figure 3.1-1) (Chu et al. 1999). The Alaskan coast of the Beaufort Sea is about 600 km (373 mi) in length, reaching from the Canadian border in the east, to the Chukchi Sea at Point Barrow in the west. The continental shelf of the Beaufort Sea is relatively shallow, with an average water depth of about 37 m (121 feet [ft]). Bottom depths on the shelf increase gradually to a depth of about 80 m (262 ft), then increase rapidly along the shelf break and continental slope to a maximum depth of around 3,800 m (12,467 ft) (Figure 3.1-2) (Weingartner 2008, Greenberg et al. 1981). Numerous narrow and low relief barrier islands within 1.6 to 32 km (1 to 20 mi) of the coast influence nearshore processes in the Beaufort Sea (Brown et al. 2010).

The shallow continental shelf waters of the Beaufort Sea are subjected to seasonally varying conditions, such as heating, cooling, wind stress, ice formation and melting, and terrestrial freshwater input. Seasonal variations in the temperature and salinity of the continental shelf waters are large (Chu et al. 1999). Such physical and chemical gradients influence the productivity and trophic structure of the Beaufort Sea shelf. Freshwater discharge from the Mackenzie River, along with numerous smaller rivers and streams distributed along the coast, create an environment that is estuarine in character, especially in late spring and summer. In addition, coastal erosion and river discharge are responsible for introducing high concentrations of suspended sediment and associated terrestrial organic carbon into the near shore zone. These terrestrial inputs of organic carbon, identifiable on the basis of isotopic composition, are important to the functioning of the Beaufort Sea shelf ecosystem (Dunton et al. 2006).

The Chukchi Sea is predominantly a shallow sea with a mean depth of 40 to 50 m (131 to 164 ft). Gentle mounds and shallow troughs characterize the seafloor morphology of the Chukchi Sea (Chu et al. 1999). The Chukchi Sea shelf is approximately 500 km (311 mi) wide and extends roughly 800 km (497 mi) northward from the Bering Strait to the continental shelf break (Weingartner 2008). Beyond the shelf break, water depths increase quickly beyond 1,000 m (3,281 ft). The western edge of the Chukchi Sea

shelf extends to Herald Canyon, and the eastern edge is defined by Barrow Canyon (Pickart and Stossmeiser 2008), which separates the Beaufort and Chukchi seas.

Mean northward flow of relatively warm nutrient-rich water through the Bering Strait occurs due to the Pacific-Arctic pressure gradient (Weingartner and Danielson 2010). This pressure gradient propels Bering Strait water through the Chukchi Sea along three principal pathways that are associated with distinct bathymetric features: Herald Valley; the Central Channel; and Barrow Canyon (Figure 3.1-3). This northward flow opposes the prevailing winds, which are from the northeast (Weingartner and Danielson 2010). The northward flows of relatively warm nutrient-rich water through the Bering Strait are largely responsible for the ecological characteristics of the Chukchi shelf, including its ability to support large and diverse marine mammal populations (Springer et al. 1996).

#### 3.1.1.2 Currents, Upwelling and Eddies

**Beaufort Sea**

Three oceanic geographic regions influence the movement of Beaufort Sea waters: 1) Pacific waters that flow from the Chukchi Sea shelf through the Barrow Canyon; 2) the offshore boundary of the Beaufort Sea shelf and slope; and 3) the Mackenzie shelf (Weingartner 2008).

Pacific Ocean waters that exit the Chukchi shelf through Barrow Canyon comprise the first regime (Mountain et al. 1976, Weingartner 2008). Some of this outflow continues eastward along the Beaufort shelf break and contributes to thermohaline stratification in the Canada Basin (Mountain et al. 1976, Weingartner 2008), while some of the water exiting the Barrow Canyon appears to spread offshore (Shimada et al. 2001).

The second oceanic regime includes the outer shelf and continental slope. Along the outer shelf and continental slope, the Beaufort undercurrent, or shelf break jet, carries Bering Sea water from the Chukchi Sea between late spring and early fall; from mid-fall to mid-spring, warmer, saltier Atlantic Water upwelled from greater depths is transported by the Beaufort undercurrent jet (Pickart 2004, Weingartner 2008). The jet configuration changes seasonally. From late spring to early fall, the subsurface jet carries Bering Sea water, and from mid-fall to mid-spring upwelled Atlantic water is transported by the Beaufort undercurrent jet (Pickart 2004). Wind-driven upwelling is occasionally strong enough to push the undercurrent onto the shelf (Weingartner 2008). This flow along the Beaufort Sea slope appears to be highly unstable, and it is therefore likely to be a source for the numerous eddies that extend into the Canada Basin (Shimada et al. 2001, Weingartner 2008).

The Mackenzie shelf forms the eastern boundary of the Alaska Beaufort Sea shelf and also characterizes the third oceanic regime that influences Beaufort Sea waters. Although there are few measurements in this area, it appears that discharge from the Mackenzie River influences the eastern Alaskan Beaufort Sea, and that northeast winds may occasionally force Mackenzie waters onto the Alaska Beaufort Sea shelf (Weingartner 2008).

Winds, river water, and sea ice influence circulation in the Beaufort Sea (Weingartner et al. 2009). During a brief period in the spring when the river stage increases rapidly as the snow pack melts, river water overfloods the ice and creates a freshwater lens (Dickens et al. 2011). Currents during the open water period (July to mid-October) correlate with local winds, whereas during the landfast ice period, underlying shelf waters are separated from surface stresses, such as wind (Weingartner et al. 2009). Nearshore currents are weak when landfast ice is present, and strengthen during the open water period (Weingartner 2008). Potter and Weingartner (2010) found that along-shore winds accounted for approximately 75 percent of the along-shore surface current variance and that winds accompanying strong storms lead to rapid turnover of Beaufort Sea shelf waters.

Prevailing northeasterly winds contribute to onshore and westward flow of sea ice onto the shelf, which promotes upwelling of sub-surface waters along the shelfbreak (Weingartner 2008, Weingartner et al.

2009). During the open-water season, mid-water currents may be greater than 20 cm/s (0.4 knots), but during the landfast ice period (mid-October through June) the mid-water currents are generally less than 10 cm/s (0.2 knots). Tidal currents in the Beaufort Sea shelf area are relatively weak, at less than 3 cm/s (0.06 knots) (Weingartner et al. 2009). Rates of cross-shore flows are also usually small, at less than 3 cm/s (0.06 knots), but freshwater inputs from numerous rivers in the area are responsible for greater rates of cross-shore flow during the spring (Weingartner et al. 2009).

**Chukchi Sea**

Circulation through the Chukchi Sea is primarily influenced by topography, while variability in flow is primarily wind driven (Weingartner et al. 2005). Mean flow through the Chukchi Sea is generally northward against the prevailing northeasterly winds (Weingartner 2008). Herald Canyon and Barrow Canyon influence the northward flow of Pacific waters (Pickart et al. 2011), and Hanna Shoal diverts central shelf water northeastward toward the continental slope and eastward along the southern edge of the shoal (Figure 3.1-3) (Weingartner et al. 2005, Weingartner et al. 2011).

Pacific water flowing through the Bering Strait crosses the Chukchi Sea by three main pathways: 1) a western branch flows northwestward through Herald Canyon; 2) a second branch flows across the Central Channel shelf; and 3) a third branch flows northeastward along the Alaska coast toward Barrow Canyon and the junction of the Chukchi and Beaufort shelves (Weingartner 2008). During summer, the third branch includes the northward extension of the Alaska Coastal Current, which merges with eastward flowing water from the central shelf within Barrow Canyon (Weingartner 2008, Woodgate et al. 2005). Pacific water flowing through Herald and Barrow Canyons contributes to a boundary current that flows east into the Beaufort Sea (Pickart and Stossmeister 2008) (Figure 3.1-3).

During the spring and fall, the Siberian Coastal Current carries water from the Siberian coast into the Chukchi Sea. The Siberian Coastal Current moves offshore near the Bering Strait, mixes with Bering Strait water, and then flows through Herald Canyon and across the central Chukchi shelf. This process is seasonal, occurring during the spring and fall, as the Siberian Coastal Current is absent or weak during winter (Weingartner 2008, Weingartner et al. 2011).

Mean current speeds are greatest within Herald Canyon and Barrow Canyon (~25 cm/s or 0.5 knots), moderate in the central channel (~10 cm/s or 0.2 knots), and generally much slower (less than 5 cm/s or 0.1 knots) elsewhere on the shelf (Weingartner et al. 2005, Weingartner 2008). Maximum current speeds of ~100 cm/s (about 2 knots) have been recorded in Barrow Canyon, while maximum flow rates of up to 50 cm/s (1 knot) have been recorded elsewhere (Weingartner et al. 2011).

Wind strongly influences current flow and flow variability. Wind magnitude and variability are highest in fall and winter and lowest in summer (Weingartner 2008). Flow through Long Strait and Barrow Canyon correlate well with local winds, whereas flow through Herald Canyon does not (Woodgate et al. 2005).

### 3.1.1.3 Temperature and Salinity

**Beaufort Sea**

Throughout the summer, temperature increases and salinity decreases due to surface warming and associated ice melting and freshwater input from rivers to the Beaufort Sea. The sea surface temperature increases to a maximum value near 8 °C, and the sea surface salinity decreases to a minimum value below 20 practical salinity units (psu) (Chu et al. 1999). During summer, profiles of temperature and salinity in the Beaufort Sea show a multilayer structure, with a shallow layer of warm low-salinity water overlying cooler saltier deep layers. A rapid (one to two weeks) collapse to the freezing point (~-1.7 °C) occurs in autumn (usually in early October), after which temperatures remain near-freezing until late June or early July. At that time, temperatures slowly increase and reach 0 °C by late July. During summer, salinity varies from 14 to 32 psu, with the lowest salinities observed immediately following the decay of the landfast ice. After the ice forms in October, salinities increase and attain values of 34 to 35 psu by

January due to the expulsion of salt from growing sea ice. Thereafter, salinities remain relatively constant through winter and spring before slowly starting to decrease in June. Following the removal of ice and the first significant wind-mixing event, salinities decrease rapidly in nearshore areas as a result of low-salinity ice meltwater and freshwater input from rivers (Weingartner et al. 2009). During winter, temperature decreases and salinity increases as freezing expels brine from sea ice (Weingartner et al. 2009).

**Chukchi Sea**

Temperature and salinity in the Chukchi Sea vary seasonally and are influenced by sea ice formation and melting. During winter (January to May), shelf waters cool to the freezing point, and salinity in the water increases during sea ice formation. Salinities decrease as ice melts and Bering Sea water moves onto the shelf during spring and summer (Weingartner 2008, Woodgate et al. 2005, Weingartner et al. 2011).

During the spring season (May to July) warm water (above 0 °C) appears in the southern Chukchi Sea due to the gradual increase of solar radiation and warm water advected through the eastern Bering Strait (Chu et al. 1999). During the summer season (July to August), the deep water can still be cold (0 to 3 °C), depending upon location on the shelf. However, surface water temperatures can be above 9 °C in the southern Chukchi Sea. During the fall season, the surface water temperatures of the southern Chukchi Sea cools but still remains relatively warm (2 to 6 °C).

During the winter season (November to April), radiative cooling makes the whole Chukchi Sea surface temperature fall below 0°C (Chu et al. 1999).

Water properties also vary regionally across the Chukchi Sea. The eastern Chukchi is influenced by the warmer, fresher waters of the Alaskan Coastal Current and eastern Bering Strait (Woodgate et al. 2005). The largest seasonal variability in temperature and salinity occurs in the eastern Chukchi, where variations in ice cover modify the shelf waters (Woodgate et al. 2005). The western Chukchi, influenced by Anadyr waters from south of the Bering Strait, is generally colder and saltier than the eastern Chukchi (Weingartner 2008). Waters in Herald Valley include flow from the Bering Strait and cold salty water formed in winter on the Chukchi shelf near Wrangel Island (Weingartner 2008). These water masses mix with one another as they flow out of the Herald Valley and create a new water mass (Figure 3.1-3) (Pickart et al. 2011, Weingartner 2008).

### 3.1.1.4 Tides and Water Levels

**Beaufort Sea**

Recent tide gauge observations at Barrow show coastal water levels are driven primarily by the wind stress and barometric pressure changes from the passage of storm centers and frontal passages (Gill et al. 2011). Storm surge on the coast and coastal water level withdrawal can be significant (about 1 m [3.3 ft] amplitude; Gill et al. 2011). Highest montly sea levels generally occur in August and lowest monthly mean sea levels generally occur in March. Winds from the west are associated with positive surges, and winds from the east are associated with negative surges.

In the Beaufort Sea, tides propagate from west to east along the coast. Tidal ranges in the Beaufort Sea are relatively small, ranging from 0.3 to 0.7 m (1 to 2 ft), depending on location (VanderZwaag and Lamson 1990). Although tides do not seem to exert an important influence on the oceanography of the Beaufort Sea shelf, they may play an important role in sea ice dynamics. Storm surges influence coastal erosion, and may influence the time at which landfast ice breaks away from the shore (MBC 2003).

Anecdotal observations suggest that wind speed and direction may drastically influence water levels along the Beaufort Sea coast. In a Northstar public meeting, Thomas Napageak described the interaction between wind and water levels as follows: *"…you don't get…high tides [storm surges] on a northeast wind…. But when we've got the southwesterly wind, that's when the tide [water level] comes up."*

(Napageak, in Dames and Moore, 1996). Frank Long, Jr., described how a rising tide or storm surge can force water over the top of sea ice and flood river drainages: *"If there's enough water that comes in, it'll bring the ice up, plus water will be flowing…up over the edge."* (Long, in Dames and Moore 1996). An example of a negative storm surge also was observed by Nuiqsut whaling captains who reported that in 1977, the water drained out of a bay near Oliktok Point and then came back in (Dames and Moore 1996).

**Chukchi Sea**

Tides are small in the Chukchi Sea, and the tidal range is generally less than 0.3 m (1 ft). Tidal currents are largest on the western side of the Chukchi and near Wrangel Island, ranging up to 5 cm/s (0.1 knots) (Woodgate et al. 2005). Storm surges are both positive and negative. Winds from the west are associated with positive surges, and winds from the east are associated with negative surges. In late fall, the lack of sea ice increases the open-water area, enhancing water transport and increasing wave height (Lynch and Brunner 2007).

#### 3.1.1.5 Stream and River Discharge

**Beaufort Sea**

Freshwater input from the Mackenzie River, the Colville River, and numerous other rivers affects a range of physical and chemical parameters in the Beaufort Sea (Weingartner et al. 2009).

With the exception of the Mackenzie River, these rivers usually do not flow year-round. Flow is minimal or absent throughout the winter. Stream flow begins in late May or early June as a rapid flood event that can inundate extremely large areas in a matter of days (MMS 2008). During the spring flood, river waters flow under landfast ice in narrow (1 to 2 m [3 to 7 ft]), highly stratified plumes. The plumes can spread 20 km (12 mi) or more offshore and transport large quantities of fresh water, sediments, and associated nutrients to offshore waters (Weingartner et al. 2009). Most streams continue to flow throughout the summer but at rates much lower than during the spring flood event (Weingartner et al. 2009, Weingartner 2008).

**Chukchi Sea**

The Kivalina, Kobuk, Kokolik, Kukpowruk, Kukpuk, Noatak, Utukok, Pitmegea, and Wulik Rivers flow into the Chukchi Sea. There are also numerous other small streams and inlets (several unnamed) that feed the Chukchi Sea on the U.S. side. These rivers, streams, and inlets have local effects on the salinity, temperature, and nutrient concentrations of the receiving waters. Discharges from the Red Dog Mine, a large zinc hardrock mine, flow into tributaries of the Wulik River, which discharges into the Chukchi Sea. These discharges are treated to remove dissolved metals. The treatment of the discharged water has improved the water quality downstream of the mine so that now the Red Dog Creek supports a population of spawning and rearing Arctic Grayling and Dolly Varden.

### 3.1.2 Sea Ice

#### 3.1.2.1 Ice Dynamics

Sea ice, formed by the freezing of sea water, is a dominant feature of the Arctic environment. Annual formation and decay of sea ice influence the oceanography and dynamics of the Beaufort and Chukchi seas, impacting the physical, biological, and cultural aspects of life in this region. Sea ice generally reaches its maximum extent in March and minimum extent in September.

Ice cover consists of drifting pack ice over the middle and outer shelf and landfast ice on the inner shelf (Weingartner 2008). Landfast ice usually starts to form in October and can extend 20 to 40 km (12 to 25 mi) offshore. Stamukhi, or grounded ice, forms along the seaward edge of the landfast ice. It may help protect the inner shelf from forces exerted by pack ice (Weingartner et al. 2009).

Sea ice covers the Beaufort shelf for about nine months of the year (MBC 2003). In recent years, the Alaska Beaufort Sea shelf has been ice-free from late-July through early October (Weingartner 2008). Sea ice formation in the Chukchi Sea begins in mid-October near Wrangel Island, while the central Chukchi may remain ice free through early November. By December, the entire region is generally ice-covered (Woodgate et al. 2005).

Iñupiat hunters in Barrow describe three basic sea-ice zones: 1) *Tuvag* is the innermost zone of landfast ice, which consists of first-year ice mixed with varying amounts of multi-year ice; 2) *Uiñiq* includes the open lead, or flaw lead, and the ice fragments moving within it, which is a very dynamic area where seal and whale hunting occur; and 3) S*arri* is the outer realm of pack ice comprised of fast and varying currents and shifting sea ice (George et al. 2004).

#### 3.1.2.2 Landfast Ice

Landfast ice is, by definition, stationary. It is contiguous with the land and strongly associated with the 20 m (66 ft) isobath, where it coincides with grounded ridges of ice (Eicken et al. 2006). Coastline and bathymetry are the primary determinants of landfast ice extent (Mahoney et al. 2007a). Most landfast ice is floating and held in place by non-floating landfast ice. Tide cracks commonly form in landfast ice along northern Alaska beaches in response to sea level fluctuations affecting the floating ice (Mahoney et al. 2007b).

A combination of processes lead to the formation patterns of landfast ice (Eicken et al. 2006). Wind and current patterns during fall and winter are critical to ice formation (George et al. 2004). Landfast ice generally starts forming in October, and, at its maximum extent in March and April, covers roughly 25 percent of the Beaufort shelf area (Weingartner 2008, Mahoney et al. 2007a). Formation of landfast ice is a complex process, and the landfast ice may form, break up, and reform several times before becoming stable (Eicken et al. 2006, Mahoney et al. 2007b).

The ice retreats with the onset of spring in May and June (Eicken et al. 2006). Timing of the ice retreat correlates with increasing temperature and atmospheric changes (Mahoney et al. 2007a). Areas of open water (e.g. polynyas and leads), act as heat sinks for solar radiation and allow for increased wind and wave action, which destabilizes landfast ice (Mahoney et al. 2007a).

The landfast ice is important to the biology, economy, and cultures of the Arctic. It is used by various seal species, polar bears, and Arctic fox, is critical to Iñupiat hunting, and has been used as a platform for transportation in nearshore areas (George et al. 2004, Eicken et al. 2006).

#### 3.1.2.3 Stamukhi

The stamukhi ice zone lies seaward of the landfast ice and is characterized by pressure ridges, leads, and polynyas (large areas of open water) resulting from interactions between relatively stable landfast-ice and mobile pack-ice. In the Chukchi Sea, the most intense ridging occurs in waters from 15 to 40 m (49 to 131 ft) deep, while moderate ridging extends seaward and shoreward of these regions (MMS 2007a). In the Beaufort Sea, ridges occur at depths ranging from 18 to 25 m (59 to 82 ft) (Mahoney et al. 2007a). Grounded ridges help to stabilize the seaward edge of the landfast-ice zone. Extensive sea-ice rafting may occur in areas adjacent to pressure ridges, and ice thicknesses of two to four times the sheet thickness may be found within a few hundred meters of the ridge. Shear ridges are straighter, usually have one vertical side, and are composed of ice pieces that range in size from a few centimeters to several meters. The outer edge of the stamukhi zone advances seaward during the ice season (MMS 2007a).

#### 3.1.2.4 Pack Ice and Ice Gouges

During winter, movement in the pack ice zone of the Beaufort Sea generally is small and tends to occur only during strong wind events of several days' duration. The long-term direction of ice movement tends

to be from east to west, however, there may be short-term perturbations from this general trend due to variable weather (MMS 2008).

The seabed of the Alaskan Beaufort Sea shows evidence of modification by ice keels, which gouge the seafloor. The keels of sea-ice pressure ridges cut through seafloor sediments to form 'V' shaped incisions called gouges, also referred to as scours. Most ice gouges are less than 0.5 m (2 ft) deep, but the deepest gouges exceed 2 m (7 ft) in depth (NRC 2011). Gouging is associated with ice keels driven by forces from the associated ice pack. A study of ice gouging in the Alaskan Beaufort Sea showed that the maximum number of gouges occur in the 20 to 30 m (66 to 99 ft) water-depth range (Machemehl and Jo 1989). Ice gouges are important to pipeline engineers involved in the design and burial of Arctic offshore pipelines (Machemehl and Jo 1989).

#### 3.1.2.5 Leads and Polynyas

Polynyas are semi-permanent areas of open water that can be up to thousands of square kilometers in size (ACIA 2005). There are generally two types of polynyas: persistent polynyas that form off of south and west facing coasts, and north coast polynyas that form along north facing coasts (Stringer and Groves 1991). The frequency with which polynyas change from ice-covered to open water and vice-versa is influenced by wind, currents, and solar warming (Stringer and Groves 1991).

Leads are open channels, or lanes of water that form between large pieces of ice as a result of forces generated by winds and /or currents. Flaw leads occur along landfast ice when winds separate drift ice from fast ice (ACIA 2005). Pack ice shifting north is the simplest way for a lead to form along the landfast ice edge. Leads formed this way are generally narrow and short lived. Leads most commonly open along the boundary between landfast ice and pack ice. Pack ice moving parallel to landfast ice may generate leads well inside of the pack ice boundary (Eicken et al. 2006).

Spatial patterns of lead occurrence and size are consistent between years in the eastern Chukchi and the central Beaufort seas. The number of leads and mean size of leads are greater in the eastern Chukchi and off the Mackenzie Delta than in the central Beaufort Sea. Prevailing easterly winds usually force ice offshore in these areas and create recurring leads and polynyas along the landfast ice. Linear leads are prevalent in winter, while patches of open water are more common in late May or early June (Eicken et al. 2006).

Ice conditions to the west of Point Barrow are more dynamic than to the east, with leads radiating out of Point Barrow (Eicken et al. 2006). Point Barrow juts out into the Beaufort and Chukchi Seas, forming an obstacle to westward drifting Beaufort Sea pack ice (Mahoney et al. 2007a). As a result, the area to the west of Point Barrow in the Chukchi Sea is dominated by a semi-permanent polyna or flaw zone (Norton and Gaylord 2004). Grounded ice on Hanna Shoal also creates a series of leads. Ice movement is more stagnant in the eastern Beaufort, and winter breakouts are more common in the western Beaufort and eastern Chukchi (Eicken et al. 2006).

Leads and polynyas are important habitat for several seal species, polar bears, and migrating bowhead and beluga whales. Iñupiat hunters rely on these leads and open water for spring whaling of bowheads from April to June (Norton and Gaylord 2004).

#### 3.1.2.6 Changes in Sea Ice

Arctic sea ice is changing in extent, thickness, distribution, age, and timing of melt. Analysis of long-term data sets show substantial decreases in both extent (area of ocean covered by ice) and thickness of sea ice cover during the past 30 years. Sea ice extent, the primary measure by which Arctic ice conditions are judged, has been monitored using satellite imagery since 1979. The annual maximum extent (March) and minimum extent (September) are the measures used for interannual comparisons (Perovich et al. 2010). The September 2011 minimum ice extent was the second lowest since 1979, surpassed only by the

record low in 2007 (NSIDC 2011b; see Figures 3.1-4a and 3.1-4b. The summers of 2007 to 2011 experienced the five lowest minimums in the satellite record; eight of the ten lowest minimums occurred during the last decade (NSIDC 2011b, Perovich et al. 2010). The March 2010 ice extent was four percent lower than the 1979 to 2000 average. A time series of anomalies in sea ice extent (1979 to 2009) reveals both interannual variability and general decreasing trends. March ice extent decreased at a rate of 2.7 percent per decade, while September extent decreased 12 percent per decade (Perovich et al. 2010, NSIDC 2011b).

Sea ice age is another indicator of ice cover and changes. Following the record summer melt of 2007, there was a record low amount of multiyear ice (ice that has survived at least one summer melt season) in March 2008. Multiyear ice increased modestly in 2009 and 2010. Despite this, 2010 had the third lowest March multiyear ice extent since 1980. Most of the 2-3 year old ice remained in the central Arctic due to atmospheric patterns in the winter of 2010. Although some older ice from north of the Canadian Archipelago moved into the Beaufort and Chukchi seas, it did not survive the summer melt period (Perovich et al. 2010).

Loss of multiyear ice is considered a key factor in ice thinning and retreat in the Beaufort and Chukchi shelves. Ice older than five years decreased by an estimated 56 percent from 1982 to 2007 (Stroeve et al. 2008). Analysis of a satellite-derived record of sea ice age for 1980 through March 2011 shows a particularly extensive loss of the oldest ice types. The fraction of multiyear sea ice in March decreased from about 75 percent in the mid 1980s to 45 percent in 2011, while the proportion of the oldest ice declined from 50 percent of the multiyear ice pack to 10 percent (Maslanik et al. 2011). Multiyear ice (as detected by satellite) was studied in the winters from 1979-2011. The extent and area are declining at rates of -15.1 percent and -17.2 percent per decade, respectively. A record low value occurred in 2008 followed by higher values in 2009, 2010, and 2011 (Comiso 2011). The Beaufort and Chukchi seas have experienced reductions of overall mean thickness of level ice due to the replacement of multi-year by first-year ice over large areas (Shirawasa et al. 2009).

The landfast ice season has shortened since the 1970s, with coastlines being ice-free over a month earlier for the Beaufort Sea and two weeks earlier for some areas of the Chukchi Sea (Mahoney et al. 2007a). Landfast ice has also been less stable in recent years, with break-offs at the beach occurring as late as January and February, or near to the beach in March. Lack of multiyear ice and decreased pressure ridges decrease stability and increase the likelihood of early break-offs and break-up events (George et al. 2004).

Iñupiat hunters have described these changes to the landfast ice, including thinning ice, changing pressure ridge patterns, and the loss of multiyear ice. These changes affect the ability to haul large whales onto the ice during spring whaling (Gearheard et al. 2006).

### 3.1.3 Geology

This section presents brief summaries of the regional geologic setting, stratigraphy and petroleum resources of northern Alaska, exploration history of the Alaska North Slope region, potential targets of undiscovered oil and gas resources in the Arctic Alaska offshore, and Arctic Alaska seafloor features. The Alaska Outer Continental Shelf lies north of the petroleum-resource rich Alaska North Slope where the large Prudhoe Bay oil-field was discovered in 1968 by Atlantic Richfield. The surface and subsurface geology of the Alaska North Slope is very complex and has been studied extensively by numerous workers within federal and state agencies, academia, and the oil and gas industry over the last 50 years. Limited exploration has occurred on federal lands within the Alaska Outer Continental Shelf (OCS) region that includes the Beaufort Sea and Chukchi Sea along the northwest coast of Alaska between Kotzebue and Barrow. The rocks under the Beaufort and Chukchi seas of the Arctic Ocean within the Alaska OCS are interpreted by examination of rocks exposed at surface, those encountered during exploration activities onshore north of the Brooks Range the south, from the 35 exploration wells drilled in Alaska OCS waters and from wells drilled near-shore within State of Alaska waters, within three miles

of the coastline. The onshore and near-shore surface and subsurface rocks have been grouped into the Arctic Alaska Petroleum Province by numerous previous workers. The Arctic Alaska Petroleum Province is also referred as the Northern Alaska Province. These workers speculate that a large portion of conventionally recoverable oil and gas in Alaska OCS federal off-shore waters (Beaufort and Chukchi seas of the Arctic Ocean) occur in rocks similar in age and composition to those found within the Arctic Alaska Petroleum Province (Houseknecht and Bird 2006, Bird 2001). In the early 1990s the Northstar (Seal Island) field was discovered and is recognized as the first petroleum producing field from Arctic Alaska federal offshore lands. The Northstar field lies within both State of Alaska and federal waters north of Prudhoe Bay.

For planning purposes the following terms, as defined in *Undiscovered Oil and Gas Resources, Alaska Federal Offshore-As of 2006* (Minerals Management Service 2006b), are utilized by stakeholders when describing physiographic and geologic features and economic assessments of petroleum resources. MMS 2006a *Common Assessment Terms* is quoted below for brevity:

- ***Prospect*** - an untested geologic feature having the potential for trapping and accumulating hydrocarbons.
- ***Pool*** – a subsurface accumulation of liquid or gaseous hydrocarbons, typically within a single stratigraphic interval, that is hydraulically separated from any other hydrocarbon accumulation.
- ***Field*** - a pool or grouping of related pools, sufficiently large to be economically producible.
- ***Play*** – a family of geologically related prospects, having similar hydrocarbon source, reservoir, and trapping mechanism.
- ***Basin*** – a large downwarped region serving as a center of sediment deposition. It can contain numerous geologic plays.
- ***Province*** – a large area or region unified geologically by a single dominant structural element or a number of contiguous elements. A province can be defined to contain a single basin or may contain several related or similar basins.
- ***Planning Area*** – an administrative subdivision of an offshore area used as the initial basis for considering blocks to be offered for lease in the Department of Interior offshore oil and gas leasing program.
- ***Undiscovered, technically recoverable resources (UTRR)*** – focus on geologic attributes. The resource potential is estimated without being constrained by economic considerations, such as the existence of transportation infrastructure to take the resources to market. The only constraint is that conventional recovery techniques are assumed. The reported resources are those that would be produced at the surface, but estimates of recovery efficiency are based on current, known techniques. Ranges of values imply that some improvement in efficiency is considered, but dramatic improvements from unknown future techniques are not included.

#### 3.1.3.1 Regional Physiography

The Arctic Alaska offshore region is divided into five distinct physiographic provinces (Figure 3.1-14). The boundaries of the provinces are delineated by geology, geography, water depth, and bathymetric surface relief of seafloor morphology. From east to west they include the Beaufort Shelf, the Canada Basin-Beaufort Shelf, the Chukchi Borderland, the Chukchi Shelf, and the Hope Basin. The Canada Basin-Beaufort Slope lies north of the Beaufort Shelf where its border with the Beaufort Shelf is recognized by sharp break in bathymetric slope that extends north and is expressed as a deep-water abyssal plain. This abyssal plain increases in depth northward and is ice-covered throughout much of the year. North of the Chukchi Shelf and west of the Canada Basin-Beaufort Slope is the Chukchi

Borderland. The Chukchi Borderland is composed of submarine ridges and basins that trend north-south with water depths greater than 1,000 m (3,281 ft). Along the sub-sea boundaries of the provinces marked by sharp breaks in slope morphology, gravity-driven slope failures indicate that the most historically active seafloor features are gravity-driven slope failures (Grantz et al. 1994).

The Beaufort Sea area of the Alaska continental shelf is approximately 100 km (60 mi) wide, with water depths ranging from 10 to 200 m (30 to 660 ft). The Beaufort Shelf contains many barrier islands and shoals that are generated from sediment deposition at river mouths. The barrier islands and shoals origins are considered erosional remnants of coastal plain sediments, and constructional islands. The constructional islands are eventually overridden by storm surges, and migrate landward and to the west due to longshore marine currents.

The Chukchi Sea area is an approximately 600-km (400-mi) wide shallow embayment of the Arctic Ocean. The floor of the Chukchi Sea is a broad, northerly inclined, continental shelf in water depths generally less than 61 m (200 ft). Two shoals, the Hanna and Herald, lie within the Chukchi Sea (MMS 2006a). These shoals rise above the surrounding seafloor to approximately 20 m (66 ft) below sea level. In the Barrow and Hanna submarine canyons, water depths range from 50 to 200 m (160 to 660 ft) (MMS 2008).

The Hope Basin is bounded on the west by the U.S.-Russia maritime boundary and to the east by the northwest coastline of Alaska south of Point Hope into Kotzebue Sound, continuing southward along the northwestern coast of the Seward Peninsula near the Bering Strait. The Hope Basin province includes the easternmost part of the larger South Chukchi-Hope basin that extends 483 km (290 mi) west into Russian waters (MMS 2006a, Gautier and Klett 2010, Gautier et al. 2009). The Chukchi Borderlands is bounded on the south by the Chukchi Shelf, on the west by the Arlis Plateau, and on the east by the Northwind Ridge that separates the borderlands from the abyssal plain of the Canada Basin (Figure 3.1-14).

### 3.1.3.2 Regional Geologic Setting

The following summary of the geologic setting of north and northwest Alaska is based on previous work conducted by Alaska Department of Natural Resources (ADNR) (2009), Bird (2001), Gautier et al. (2009), Gautier and Klett (2010), Grantz et al. (1994), Houseknecht and Bird (2006), MMS (2006a, 2006b, 2008), Sherwood (1998, 2006), and Sherwood et al. (1996, 2001). Rocks within the continental shelves beneath the Beaufort and Chukchi Seas are recognized as direct geological extensions of rocks found onshore and near-shore in northern Alaska. Northern Alaska is a geologically complex region that over the last 400 million years (my) has undergone periods of tectonic plate collisions, continental rifting, regional uplift, and episodes of major erosion and sedimentary deposition. The principle geologic features of northern Alaska are presented in Figure 3.1-14. The Devonian age Chukchi and Arctic platforms are the oldest geologic features of the Arctic Alaska Petroleum Province and are recognized as remnants of a stable continental margin that existed in Northern Alaska some 345 to 395 million years before present [myBP].

The stable continental margin continued to exist through early Mesozoic time (about 200 myBP). The Chukchi and Arctic platforms are separated by the Hanna Trough that straddles the U.S.-Russia maritime boundary and extends from Point Lay northward to the North Chukchi Basin and straddles the U.S.–Russia maritime boundary. The Hanna Trough is a structural depression characterized by extensional normal faulting that received thick accumulation of sediments during Mississippian time (310 to 345 myBP) and into the early Mesozoic (Houseknecht and Bird 2006). The Barrow Arch is recognized as the expression of the onset of continental rifting (spreading apart) during the Late Jurassic through Early Cretaceous time (100 myBP). The trace of the Barrow Arch roughly parallels the northern Alaska coastline from Prudhoe Bay west past Point Barrow and continues to the northwest extending to the North Chukchi Basin (Figure 3.1-14). During this period of continental rifting, tectonic uplift dominated to the north of the Barrow Arch, whereas south of the arch, deposition of sediments continued into Cretaceous

time. The oceanic Canada Basin and associated passive margin resulted from the development of the Barrow Arch (Houseknecht and Bird 2006). Also during this time of rifting along the southern margin of the Arctic and Chukchi platforms, a volcanic arc-continent collision perpetrated the creation of the Brooks Range, the adjacent Colville foreland basin, and the Herald Arch. The Herald Arch begins at the west end of the Brooks Range just south of Point Hope and extends northward to Cape Lisburne and continues west toward the North Chukchi Basin. The Herald Arch separates the Hope Basin to the south from the Chukchi Shelf on the north (Figure 3.1-14).

With continued uplift of the Brooks Range came deposition of sediments to the north onto the coastal plain during Early Cretaceous through Tertiary time (145 to 2 myBP). During Tertiary time convergent deformation events created the fold-and thrust belt of rocks that extends northward from the Brooks Range and is referred as the Foothills Belt (Houseknecht and Bird 2006, ADNR 2009, Bird 2001, Grantz et al. 1994).

### 3.1.3.3 Stratigraphy and Petroleum Resources

Geoscientists believe that a large portion of the undiscovered, technically recoverable oil and gas in Alaska OCS federal offshore waters will be found in the Beaufort and Chukchi seas of the Arctic Ocean. The Beaufort and Chukchi seas are predicted to contain 89 percent of the oil and 79 percent of the gas resources of the Alaska OCS. The Beaufort and Chukchi seas are estimated in the mean case to contain more than 23 billion barrels of oil and over 104 trillion cubic feet of gas (MMS 2006b).

#### Northern and Arctic Alaska

Evidence from surface outcrops, exploration drilling, and geophysical assessments have identified four major geologic sequences of rocks north of the Brooks Range, each having a unique structural setting, sediment source area, and depositional environment. These rock sequences extend north and northwest beneath the Beaufort and Chukchi shelves and are geologically important in the Arctic Alaska Petroleum Province. The four major rock sequences from oldest to youngest are the Franklinian, Ellesmerian, Beaufortian, and Brookian. The stratigraphic record of rocks within the Arctic Alaska Petroleum Province includes Precambrian age rocks (more than 600 myBP). The Precambrian age rocks have undergone intense periods of temperature and pressure changes that erase the potential of hosting economic quantities of petroleum hydrocarbons. Rocks within Northern Alaska with a potential for petroleum accumulation have ages of 310 to 345 myBP (Mississippian) and younger (Bird 2001, Houseknecht and Bird 2006).

The pre-Mississippian age Franklinian sequence consists of fractured carbonate, argillite, quartzite, volcanic, and granitic rocks that represents the stable continental platform before Devonian time (345 to 395 myBP). The Franklinian sequence was deformed, uplifted, and eroded during Cambrian (500 to 600 myBP) through Devonian time. Following the uplifting event, the Franklinian high was eroded and was the northerly source of sediments for the Ellesmerian sequence. The Franklinian rocks have undergone burial and metamorphism. This characteristic has given the Franklinian sequence rocks limited petroleum potential and they are considered to be the economic basement rocks of the Arctic Alaska Petroleum Province (ADNR 2009, Houseknecht and Bird 2006).

The Ellesmerian sequence consists of marine carbonates and quartz- and chert-rich clastic rocks and is the most important sequence geologically in terms of petroleum production. The Ellesmerian sequence rocks were deposited over a 150 my period during the Mississippian through Early Jurassic time (approximately 195 myBP). The Ivishak Formation is an alluvial fan-delta complex that was deposited within the Ellesmerian sequence in Permo-Triassic time (200 to 300 myBP) and forms the reservoir for the giant Prudhoe Bay Oil Field that has produced over 12 billion barrels of oil (ADNR 2009). Continental shelf deposits of the Ellesmerian accumulated on a south-facing passive margin of the Arctic Platform (Houseknecht and Bird 2006). To the west, thick accumulations of Ellesmerian strata were deposited into the Hanna Trough. On the Chukchi Platform beyond the trough, Ellesmerian sediments are rare and when

present have very limited thickness. Although the Ellesmerian sequence contains both petroleum source and reservoir rocks, petroleum was not generated in the source rocks, which lie near the top of the sequence, until they were buried by Beaufortian and Brookian deposits (Houseknecht and Bird 2006).

The Jurassic and Lower Cretaceous age (approximately 150 to 100 myBP) Beaufortian sequence is associated with uplift and faulting within the Barrow Arch. This sequence is also referred as the Beaufortian Rift sequence. Uplift and faulting of the Franklinian and Ellesmerian sequences resulted in normal fault blocks consisting of horst (highlands) and graben (basin) structures. The grabens were filled with sediments from nearby locally uplifted or block-faulted Ellesmerian and Franklinian sequences forming the Beaufortian Rift sequence. During this period of geologic time the Barrow Arch formed along the northern reaches of the Beaufort Coast. The Beaufortian sequence consists of fine-grained sediments (mudstones and siltstones) that contain petroleum source and reservoir rocks. Uplift and erosion along the Barrow Arch created a regional erosion boundary referred to as the Lower Cretaceous Unconformity or LCU. The LCU helped create secondary porosity in potential reservoir rocks and an associated migration conduit to transport oil and gas from source rocks. Some of the largest oil accumulations in Northern Alaska are attributed to the LCU. The large spatial erosional activity attributed to the LCU is geologically significant by helping to create secondary porosity in potential reservoir rocks and creating a conduit for the migration of oil and gas into these enhanced porosity reservoirs (ADNR 2009). Evidence of this geologically significant erosion event is provided by three prolific oil producing formations within the Ellesmerian sequence, the Kuparuk A Sandstones, and the Ivishak and Kekiktuk formations, all three of which lie directly below the LCU (ADNR 2009). Cretaceous age fine-grained sediments that overlie the unconformity act as a seal, thereby creating structural and stratigraphic traps (Houseknecht and Bird 2006).

Cretaceous and Tertiary age deposits that originated from erosion of the Brooks Range high are assigned to the Brookian sequence. These sediments were shed from the Brooks Range during latest Cretaceous and Paleocene time (60 to 70 myBP), filling the Colville foreland basin and trough, and continued seaward eventually topping the Barrow Arch and extending beyond the coastline onto Alaska's continental margin. Throughout the North Slope basin the Brookian sequence rocks host large petroleum accumulations. The Brookian sequence consists of marine mudstone (Hue Shale); deep marine sequences of mudstone and sandstone (Torok, Seabee, and Canning Formations); and shallow-marine to nonmarine sandstone, mudstone, and conglomerate (Nanushuk, Tuluvak, Prince Creek, Schrader Bluff, and Sagavanirktok Formations). The non-marine sediments all contain amounts of coal-bearing strata intertwined within the host rocks (Houseknecht and Bird 2006). The Hue Shale contains organic-rich beds that are important oil source rocks. The Brookian sequence mudstones may contain gas source rocks. The marine and nonmarine sandstone reservoir rocks with documented oil and gas accumulations occur within both structural and stratigraphic traps within the Brookian sequence (Houseknecht and Bird 2006). Documented oil and gas accumulations and fields within the Brookian sequence include West Sak, Schrader Bluff, Ugnu, Flaxman Island, and Badami. One known field of the Brookian sequence is recognized in the OCS, the Hammerhead accumulation (ADNR 2009).

The Quaternary age unconsolidated sediments of the Gubik Formation exposed onshore on the Alaska North Slope unconformably overlie low indurated sediments of the upper Brookian sequence. The Gubik formation sediments consist of sand and gravel deposits derived by erosional activity within the last million years from both the Brookian sequence and the present day Brooks Range (ADNR 2009).

## Hope Basin

The Hope Basin is disconnected from rocks found within onshore Alaska north of the Brooks Range and the Arctic offshore north of the Herald Arch. The Hope Basin lacks most of the key geological attributes that are found in northern Alaska which are favorable to creation of petroleum deposits. In U.S. waters, the Hope Basin is filled with Cenozoic age (up to 65 myBP) rocks with characteristics that suggest gas is the dominant resource (Sherwood 1998). Cretaceous age (65 to 145 myBP) rocks with potential oil

attributes may lie within the Hope Basin in Russian waters (Sherwood 1998, Gautier and Klett 2010). Outcrops surrounding Hope Basin indicate that basin fill consists of Eocene age (34 to 56 myBP) volcanics, volcaniclastics, conglomerates and sandstones, which are overlain by Oligocene age (24 to 34 myBP) shallow-marine to nonmarine sandstones, siltstones, and conglomerates (MMS 2006a). The Hope Basin also includes the smaller local Kotzebue basin. The two basins are separated within the planning area by the Kotzebue Arch. The Tertiary aged (65 to 2 myBP) divergent Hope and Kotzebue basins are recognized to be related to right-lateral movement along the Kobuk fault zone recognized onshore in northwest Alaska. Basin development likely began in the early Tertiary (MMS 2006a).

### 3.1.3.4 Exploration and Production

#### Petroleum Plays

A total of 14 individual petroleum plays are identified for the Beaufort Sea offshore region. Plays in the Beaufort Sea target specific stratigraphic units. Of the 14 individual plays, nine are targeting strata within the Brookian sequence of rocks. Of the remaining five plays, one is targeting Beaufortian Rift sequence rocks, and another is targeting Upper Ellesmerian sequence rocks. The remaining three plays are targeting undeformed pre-Mississippian basement rocks, Endicott Formation rocks, and Lisburne Formation rocks (MMS 2006a).

The Chukchi Sea region is underlain by five distinct basins that are varyingly deformed by complex faulting and folding. The structural complexity of the faulting and folding has formed a large number of petroleum prospects that are mappable using only conventional 2D seismic data. Rocks equivalent to oil source sequences recognized in northern Alaska have been encountered during exploratory drilling (MMS 2006a). A total of 29 individual plays are identified for the Chukchi Sea offshore region. Plays in the Chukchi Sea target both specific stratigraphic units and structural features. Of the 29 individual plays, 14 are targeting strata within Brookian sequence rocks, three are targeting strata within Beaufortian Rift sequence rocks, and one is targeting the Herald Arch thrust structure. Of the remaining 11 plays, one is targeting strata within Franklinian sequence rocks, two are targeting Endicott Formation rocks, two are targeting Sadlerochit Group rocks, and one is targeting Lisburne Formation rocks. The five remaining plays are targeting Tertiary age strata within an area where the Chukchi Shelf and Hope Basin converge (MMS 2006a).

Hope and Kotzebue basins contain faulted structures and stratigraphic traps as potential targets. A total of 4 individual plays are identified for the Hope Basin. These plays are predominantly gas pools with a minor fraction containing mixtures of oil and gas (MMS 2006a).

#### Exploration History

##### *Arctic Alaska*

Oil seeps were first discovered in the Cape Simpson area near the northernmost tip of Alaska by the U.S. Geological Survey in 1917. Based on the presence of these seeps, President Warren Harding established the Naval Petroleum Reserve No. 4 in 1923. The Naval Petroleum Reserve No. 4 was later renamed the National Petroleum Reserve-Alaska (NPR-A). NPR-A consists of approximately 23 million acres situated within the west central portion of northern Alaska. The onset of World War II prompted the first publicly funded exploration program in the NPR-A from 1944 to 1953 (Sherwood et al. 1996). As a result of the drilling from 1944 to 1953, small oil fields were discovered at Umiat, Simpson, and Fish Creek and gas fields were discovered at Gubik, South Barrow, Meade, Square Lake, Oumalik, and Wolf Creek. Following passage of Alaska statehood in 1959, exploration was focused on State of Alaska lands situated between the NPR-A and the Arctic National Wildlife Refuge (ANWR) to the east. Following the initial lease sale of State of Alaska lands in 1964 and 1965, came the 1968 discovery of the Prudhoe Bay field, the largest oil field ever found in North America at that time (Sherwood et al 1996). The Prudhoe Bay discovery lead to other oil fields being discovered including Kuparuk (1969), West Sak (1969),

Milne Point (1970), Flaxman Island (1975), Point Thomson (1977), and Sag Delta-Duck Island (1978), later called the Endicott field (MMS 2006a).

The 1973 embargo of the United States by the Organization of Petroleum-Exporting Countries (OPEC) drove federally funded exploration of NPR-A in 1975. Exploration in NPR-A continued for seven years and led to discoveries of small oil and gas fields at East Barrow and Walakpa. South Barrow, East Barrow, and Walakpa gas fields near the community of Barrow are being utilized for local consumption. Since the 1990s, petroleum accumulations discovered in stratigraphic traps have been developed including the Alpine pool in the Colville River unit and Lookout and Sparks discoveries in NPR-A that tap sandstones of the Beaufortian sequence. The Badami unit, the Tarn and Meltwater pools in the Kuparuk River Unit, and Nanukq pool in the Colville River unit tap sandstones in the Brookian sequence. The Tabasco pool in the Kuparuk River unit taps channel sandstones in the Brookian sequence (Houseknecht and Bird 2006). In 2003 and 2004, two new field units were formed, the Oooguruk and Nikaitchuq, with wells testing positive for oil.

### *Beaufort Shelf*

A total of 30 exploratory OCS wells have been drilled on the Beaufort Shelf since the first Federal OCS leases were offered in 1979. Many more wells have been drilled in the nearshore Beaufort Sea under the jurisdiction of the State of Alaska. Locations of the OCS exploration wells drilled in the Beaufort Shelf region are presented in Figure 3.1-13. The wells were drilled in the Beaufort Sea between 1981 and 2003, resulting in the discovery of several commercial and subcommercial pools of oil. The Mississippian age Kekiktuk formation of the Endicott Group hosts oil at Tern Island (Liberty field). The Permo-Triassic age Ivishak Formation hosts oil at Seal Island (Northstar field). Cenozoic age Brookian sequence rocks host oil at the Hammerhead and Kuvlum wells. Two wells drilled into Salerochit sands at the Sandpiper prospect encountered significant quantities of gas and condensate (MMS 2006a). The Sagavanirktok River formation penetrated in the Phoenix and Antares wells hosted minor amounts of oil. The Salerochit Group of rocks penetrated in the Mukluk and Mars wells also hosted minor amounts of oil. Cenozoic age sands penetrated by the Galahad well hosted minor amounts of gas and an oil show. Brookian sandstone sequence penetrated by the McCovey well showed oil in core samples (MMS 2006a).

### *Chukchi Shelf*

A total of five exploratory wells have been drilled on the Chukchi Shelf since the first OCS leases were offered in 1988. The locations of the exploration wells drilled in the Chukchi Shelf region are presented in Figure 3.1-13. The wells were drilled between 1989 and 1991, resulting in the discovery of hydrocarbons in four of the wells (Burger, Klondike, Crackerjack, and Popcorn).

The Klondike well was drilled to investigate Sadlerochit-equivalent rocks beneath a Jurassic age erosional surface on the east flank of the Chukchi platform. Unfortunately, the Sadlerochit equivalent rocks are within a shale facies, and no reservoir rock was discovered. However, oil hosted in Brookian sequence rocks near the base of the Torok Formation was encountered in the Klondike well (MMS 2006a). The Burger well was drilled to investigate Beaufortian Rift sequence rocks equivalent to the Kuparuk Formation in the Wainwright Dome on the east flank of the Hanna Trough. The Burger well discovered a pool of gas within a 32.5 m (107 ft) thick Kuparuk-equivalent Beaufortian Rift sequence sandstone. The Popcorn well drilled into Sadlerochit-equivalent and older rocks on a faulted uplift block along an extension of the Barrow Arch that separates North Chukchi and Colville basins. The Popcorn test well failed because no reservoir rock was encountered. However, oil shows were found in sandstones of the Torok Formation and within the Permian and Pennsylvanian age carbonate rocks of the Lisburne Group. The Crackerjack well investigated Sadlerochit-equivalent rocks in a stratigraphic trap on the flank of a horst. The test well was deemed unsuccessful because no porous reservoir was encountered. However, sandstones at the base of the Early Cretaceous age Torok Formation appeared in geophysical electric logs to contain an oil pay zone. Sandstones of the Nanushuk Group also hosted minor oil shows in the Crackerjack test well (MMS 2006a).

### *Hope Basin*

A total of two onshore exploration wells were drilled in the Hope and Kotzebue basins in 1975. The Cape Espenberg well and Nimiuk Point well were drilled on State of Alaska lands on the south and north flanks, respectively, of Kotzebue basin. No oil or gas shows were discovered in Tertiary age sediments penetrated by these two wells. Eocene and Miocene age stages of faulting caused structural deformation in Hope basin. Deformed Mesozoic and Paleozoic age rocks of the Brookian-Chukotkan mountain belt exposed on Wrangel Island (Russia) and on Cape Lisburne (Alaska) make up the basement for sediments in the northern parts of Hope basin. Cretaceous age igneous and sedimentary rocks like those exposed in the northern Yukon-Koyukuk province of Alaska form the basement for sediments in the eastern portion of the Kotzebue basin. The estimated maximum thickness of sediment fill in both Hope and Kotzebue basins is approximately 5,500 m (18,000 ft) (MMS 2006a).

### Petroleum Production

Houseknecht and Bird (2006) succinctly summarize the petroleum production history of the Alaska North Slope:

> *Approximately 15 billion barrels of oil has been produced from the Arctic Alaska Petroleum Province and proven reserves are estimated at more than 7 billion barrels of oil and 35 trillion cubic feet of gas. Most oil production is from Ellesmerian reservoirs, consisting of Mississippian through Triassic marine carbonate and marine to nonmarine siliciclastic deposits that accumulated on the shelf of a passive continental margin. Lesser production has been from Beaufortian reservoirs, consisting of Jurassic through Early Cretaceous marine siliciclastic deposits associated with the rift opening of the Canada Basin, and from Brookian reservoirs, consisting of Cretaceous through Tertiary marine to nonmarine siliciclastic strata deposited as wedges of sediment shed from the Brooks Range orogenic belt. Most production is from structural and combination structural-stratigraphic traps, although several recent oil discoveries are in purely stratigraphic traps.*

## 3.1.3.5 Seafloor Features

Within the Beaufort Sea and Chukchi Sea regions, active dynamic surficial processes occur along the surface of the seafloor. Most of the available information regarding these processes reflects the voluminous amount of studies that have been conducted within the Beaufort Sea region making it one of the most studied shelves in the world. The most recent studies for the Beaufort and Chukchi seas have been for the oil and gas industry.

### Permafrost

The occurrence and extent of permafrost onshore Alaska is well documented and understood, however, the occurrence and extent of permafrost offshore is not well known. Permafrost is defined as rock or soil that has exhibited temperatures below 0°Centigrade continuously for 2 or more years. Onshore Northern Alaska permafrost extends to depths of 660 m (2,165 ft). Permafrost in sediments off-shore was first recognized in 1972 beneath the Beaufort Sea off the McKenzie River Delta. Off-shore permafrost depths are variable due to interaction with warm marine currents and saline rich groundwater. Seafloor sediments are usually unbonded due to the salinity of the seawater. Buried sediments normally do not contain ice due to the presence of dissolved salts, confining pressure, and capillary forces. These characteristics lower the freezing point of pore water below the ambient temperature. Numerous geophysical surveys and geotechnical investigation boreholes indicate that permafrost is widespread beneath the Beaufort inner shelf, however highly irregular. Fine-grained, semi-lithified deposits of the Gubik Formation are recognized to having a direct relationship with bonding of seafloor sediments found within the Beaufort Shelf. Low permeable silts and clays of the Flaxman Member of the Gubik Formation form a barrier to the infusion of saltwater that would lower the thaw point and cause ice to

melt. The depth to the surface of subsea permafrost and boundary between bonded and unbounded permafrost is highly variable. Depths to bonded permafrost have been shown to be as shallow as 10 m (33 ft) in 2 m (6.6 ft) of water. Studies have identified that the depth to subsea permafrost is variable due to different degrees of ice bonding before the region was inundated with warm water of the Holocene age (10,000 years BP) marine transgression. Other studies have speculated that the amount and distribution of subsequent thawing is probably due to the introduction of saline groundwater originating from deeper depths. These observations suggest that subsea permafrost melting is occurring from above and below (MMS 2003).

In Pleistocene times (2 myBP) the Beaufort Shelf was exposed to the Arctic atmosphere during several lowstands of sea level. Throughout this period, bonded permafrost is thought to have formed to depths of several hundred meters beneath the exposed shelf. Pleistocene age highstands of sea level generated warm seawater and saline advection from the seawater into the underlying sediments causing the bonded permafrost to melt partially both from above by thermal heating and from below by geothermal heating. Geotechnical investigations in the Prudhoe Bay area reported that seafloor sediments are at or below the freezing point, although it is not bonded permafrost (MMS 2003).

In the Chukchi Sea, the distribution and extent of subsea permafrost is sparse or non-existent, and where present, becomes thin or absent at approximately 1 km (0.6 mi) offshore. Many workers believe that the absence of relict permafrost beneath the Chukchi Shelf may be due to the lack of significant deposits of unconsolidated sediments near surface when lowstands of sea level occurred, or to relatively warm currents moving north from the Bering Sea (MMS 2007a).

## Ice Dynamics

Ice gouging and ice push are two common seafloor features. In the Beaufort Shelf region in water depths ranging between 18 and 50 m (50 to 160 ft) ice gouging is a common characteristic. Ice gouging is a significant process for sediment transport on Arctic continental shelves, especially at midshelf and innershelf water depths. In the midshelf regions of the Arctic continental shelves, ice ridges with deep keels have been observed to produce scour along the seafloor to depths of several meters. Ice gouging is mostly concentrated in water depths of 18 to 30 m (59 to 98 ft) and increase in intensity on the seaward slopes of shoals. In the area of Prudhoe and Foggy Island bays, the intensity of ice gouging is dictated by the barrier or constructed island chains that occur roughly 15 to 20 km (9 to 12 mi) from the shoreline (MMS 2003).

In the Harrison Bay region that is free of barrier islands, ice gouging is concentrated in two zones of water depths, between water depths of 10 and 20 m (33 to 66 ft). In parts of Foggy Island Bay beneath shorefast floating ice, ice gouging is very limited in extent. In other areas of shorefast floating ice, ice gouging is generally found associated with discontinuous, sparse, narrow, and shallow features (MMS 2003).

The abundance of ice-gouge in the Chukchi Sea is dependent on geographical latitude and the angle or slope of the seafloor, and decreased in abundance with increasing water depth. In deep water up to 35 m (110 ft), ice gouging in the Chukchi Sea is less concentrated and generally is wider, deeper, larger, and more linear than ice gouges in shallower water. Within the Barrow Sea Valley and Hanna Shoal regions of the Chukchi Sea, ice gouges are the dominant seafloor feature (MMS 2007a).

Throughout the Beaufort and Chukchi seas, ice-push and ice-override processes are significant methods of sediment transport and erosion. Strong winds and/or currents push blocks of ice onshore that displaces sediment into ridges farther inland. Ice-push ridges up to 2.5 m (8 ft) high and extending 100 m (330 ft) inshore have been found on some of the outer barrier islands (MMS 2003). Ridges up to 5 m (16 ft) high have been documented along the Chukchi Sea coast between Barrow and Wainwright (Mahoney et al. 2004). Throughout the Arctic coast, ice-push rubble has been identified 20 m (66 ft) inland (MMS 2003).

Strudel scour is another important process that occurs near sheltered coastal areas and river mouths. The Colville, Sagavanirktok, and Canning rivers are common locations where strudel scouring has been identified (MMS 2003). Strudel scours as deep as 6 m (20 ft) and as wide as 20 m (66 ft) have been observed near major river mouths. MMS (2003) presents a description of strudel scour developed from Reimnitz, Rodeick, and Wolf (1974) where the process *strudel scour* and feature *strudel scours/scouring* are differentiated:

> *During spring runoff, landfast sea ice is inundated by river floodwaters. Extensive areas of the fast ice near major river mouths are covered as far as 6.5 km (4 mi) from shore to depths of up to 1.5 m (4.9 ft). When the floodwater reaches holes or small cracks in the ice called strudel, it rushes through with enough force to scour the bottom to depths of several meters* (MMS 2003; Reimnitz, Rodeick, and Wolf 1974).

## Sediment Transport Dynamics

In the Beaufort Sea, coast-parallel marine currents that are wind driven and strongly influenced by presence or absence of ice, are the primary sediment transport mechanisms. This sediment gets deposited along coast promontories and along barrier islands (MMS 2003). Due to the short open-water season, the annual rate of longshore sediment transport is relatively low. There are three types of shelf currents that occur in response to prevailing wind directions: inner-shelf, open-shelf, and outer shelf. Inner shelf currents generally flow to the west (MMS 2003). Open shelf currents average between 7 and 10 cm/s over the broad Bering Shelf. Outer shelf currents or Geostropic currents flow parallel to the break in shelf-slope in both easterly and westerly directions (MMS 2003). These currents transport fine-grained sediment and deposit them on the continental shelf and outer slope regions.

In the Chukchi Sea, fine-grained sediments that cover much of the continental shelf originated from the Yukon and other rivers of western Alaska were transported north by the Alaska Coastal Current. Sand and gravel concentrations tend to be higher over some of the shoals, and may be from relict submerged shoreline or residual cliff-eroded deposits. Migrating asymmetric bedform features or sand waves occur in the Chukchi in water depths ranging from 6 to 90 m (20 to 300 ft). Sand waves up to 3 m (10 ft) high generally occur in shallower water off Icy Cape and Cape Lisburne and migrate northward in response to the Alaska Coastal Current. Bedforms in deeper waters reach more than 6 m (20 ft) high and appear to migrate under the influence of westward or southward countercurrents and eddies (MMS 2007a).

## Buried Channels

In the middle and inner portions of the Beaufort shelf, relicts of stream channels are buried offshore of modern river deltas. These buried stream channels generally trend north and are cut into Pleistocene age deposits and produce infill and overbank stratification features. These relict stream channels are thought to be extensions of the modern-day Canning or Sagavanirktok rivers onto the paleo-Arctic coastal plain (MMS 2003).

Buried channels are abundant in the northern and central Chukchi Sea, forming cross-cutting, generally north-trending drainage complexes. These represent successive layers of Pleistocene and Holocene sediments filling channels cut into Cretaceous bedrock, with the different channel bottom depths representing erosional baselines for different lower sea-level stands (MMS 2007a).

## Shallow Gas

Shallow gas, when concentrated and under pressure by being trapped at shallow subsurface depths, typically between 100 and 1,000 m (300 and 3,000 ft), poses a drilling hazard. Numerous anomalies associated with shallow gas have been indicated on seismic profiles throughout the Beaufort Sea as isolated pockets beneath permafrost, associated with faulted strata, and as concentrations in submerged coastal plain sediments and peat deposits. Because these anomalies are avoided after being identified in shallow hazard surveys and because the gas is not an exploration target, shallow gas has not been detected

in most offshore Beaufort Sea exploration wells. Free-flowing gas was encountered in one U.S. Geological Survey well in Stefansson Sound, and shallow gas has been inferred from seismic data in Harrison Bay and extensive areas of the outer shelf (MMS 2003). Shallow gas was also encountered at about 1,700 feet in the Hammerhead structure drilled in the 1980s (e.g. Unocal 1986).

Shallow gas has been mapped in the Chukchi Sea from both seismic data and water column anomalies, which probably represent gas rising from the seafloor. In the northern part of the Chukchi Sea and east-central shelf area, acoustic "wipe-out" zones representing either biogenic or thermogenic gas are found in Pleistocene sediment in buried channels, as well as in Tertiary and Cretaceous age strata. Depending on depth, trapping mechanisms, and the presence or absence of an effective seal, some gas accumulations could be overpressured (MMS 2007a). In particular, there is the potential for shallow gas along the Burger structure due to faults which extend from the deeper target zone upwards close to the seafloor (e.g. Craig and Sherwood 2004) that could act as conduits for gas migration.

## 3.1.4 Climate and Meteorology

### 3.1.4.1 Introduction

This section describes existing climate and meteorology in the project area. This information is intended, in part to establish baseline information that will provide a context for assessing climate change effects that may result from implementation of the proposed action and alternatives and, conversely, the potential effects of climate change on the proposed action and alternatives in Chapter 4 of this EIS.

### 3.1.4.2 Regulatory Overview

**Council on Environmental Quality Draft NEPA Guidance**

Currently there is no well-established guidance for considering climate change as a part of the NEPA process. NOAA and other federal agencies have begun to examine how to address climate change within their realm of responsibility, but these efforts are still in progress. The Council on Environmental Quality (CEQ) has provided draft guidance for consideration of the effects of climate change and greenhouse gas (GHG) emissions, and this approach is being followed for this analysis (CEQ 2010a). Per this draft guidance, climate change issues arise in relation to:

1) The GHG emissions effects of a proposed action and alternative actions; and
2) The relationship of climate change effects to a proposed action or alternatives, including the relationship to proposal design, environmental impacts, mitigation, and adaptation measures.

The CEQ recommends climate change and impacts of greenhouse gases from proposed projects be evaluated in NEPA documents if the proposed action is reasonably anticipated to cause direct emissions of 25,000 metric tons or more on an annual basis (CEQ 2010a).

**Final Mandatory Reporting of Greenhouse Gases Rule**

The Environmental Protection Agency (EPA) has issued the Final Mandatory Reporting of Greenhouse Gases Rule (EPA 2011b), which requires reporting of GHG emissions from large sources and suppliers in the United States. Section 3.1.5.2, Air Quality, provides further background on this rule.

### 3.1.4.3 Meteorology

The majority of the project area is located within the polar maritime subtype of the Arctic climate region, meaning that it is influenced by the Arctic Ocean (Alaska Climate Research Center 2002). The Arctic climate is characterized by high spatial variability and affected by the extreme solar radiation conditions of high latitudes. The low sun angle present in the Arctic due to its high latitude (elevation of the sun above the horizon) means that shading caused by the most minor topographic features can cause relatively

major differences in local climate; heat gain during long summer days in the Arctic is still relatively small.

Weather patterns in summer are dominated by the movement of low pressure systems (cyclones) across Siberia and into the Arctic Basin (NSIDC 2011a). In the winter, solar radiation is weak or absent, and weather is dominated by the frequent occurrence of inversions (when warm air lies above a colder air layer near the surface), resulting in relatively low surface wind speeds (NSIDC 2011a).

The southwestern portion of the EIS project area, from approximately Point Hope to the southwest project terminus, is within the West Coast Climate Region (Alaska Climate Research Center 2002). This climate region is considered a transitional zone, and is influenced by the high winds, strong storms, and interannual sea ice of the Bering Sea, as well as the air masses of the Interior Climate Region to the east.

Due to the influence that proximate water bodies have on the meteorological conditions within the project area, the following meteorology discussion is separated into areas in and adjacent to the Beaufort and Chukchi seas. Specific weather stations were selected to represent existing conditions in each sub-area, including data on air temperature, precipitation, and wind. These weather stations were selected based on availability of substantial data records and their proximity to the onshore communities within the project area. Table 3.1-1 lists the weather stations analyzed for describing existing conditions in the Beaufort Sea and Chukchi Sea sub-areas. Table 3.1-2 at the end of this section provides a summary of air temperature, precipitation, and winds for the weather stations listed in Table 3.1-1.

**Table 3.1-1 Weather Stations by Sea**

| Beaufort Sea | Chukchi Sea |
|---|---|
| Barter Island[1] | Wainwright |
| Deadhorse/Prudhoe Bay[2] | Cape Lisburne |
| Barrow[3] | Kotzebue |

**Notes:**

1) The Barter Island station was selected due to its proximity to Kaktovik, since complete meteorological data for Kaktovik was not found to be available.
2) Deadhorse and Prudhoe Bay data are considered be to represent the same geographic location, due to their immediate proximity to one another.
3) Although Barrow is included in the Beaufort Sea category, it is also influenced by the Chukchi Sea since it is located at the boundary between the two seas.

## Air Temperature

Temperatures in the region are considered relatively mild for Alaska due to the proximity of the ocean; with relatively small seasonal temperature fluctuations compared to areas further inland (Table 3.1-2).

### *Beaufort Sea*

For the majority of the year, temperatures are below freezing. During summer months (June through September) average maximum daily temperatures are above freezing for all three stations reviewed: Barter Island, Prudhoe Bay, and Barrow. Average maximum temperatures are highest in July, ranging from approximately 45 degrees-Fahrenheit (°F) to 55 °F, while average minimum temperatures are lowest in February at around -25 °F (WRCC 2011a). Historically, extreme temperatures have been recorded as high as 82 °F in Deadhorse (August 1999) and as low as -59 °F in Barter Island (February 1950) (WRCC 2011b).

### *Chukchi Sea*

Sub-freezing temperatures dominate for the majority of the year, and the Chukchi Sea is almost totally ice covered from early December to mid-May. A brief warm and snow-free season follows in June, July, and August. Summer high air temperatures average from 40 to 60 °F. Summer ice breakup is initiated in the eastern portion of the Chukchi and progresses westward, due to the inflow of warmer water from the Bering Sea (MMS 2007a).

Annual average temperatures typically fall between 10 °F and 22 °F. Historical extreme temperatures have been recorded as high as 85 °F in Kotzebue (July 1958) and as low as -56 °F in Wainwright (February 1964) (WRCC 2011b).

## Precipitation

### *Beaufort Sea*

During the winter, the Beaufort-Chukchi Sea region is dominated by a ridge of high pressure linking the Siberian High and high pressure over the Yukon of Canada. Rainfall usually is light during the short summers; however, heavier rainstorms occasionally occur, with the greatest amount of precipitation falling in July and August. Snow cover in the region begins between late September and early October and disappears from late May through the mid-June (MMS 2003).

Total annual precipitation recorded at the weather stations indicates that the Beaufort Coast receives an annual precipitation ranging from approximately four to six inches, while average snowfall ranges from approximately 30 to 42 inches. The amount of annual precipitation includes the melted amount of any frozen precipitation (e.g. snow, sleet) that may have fallen, in addition to any rain.

### *Chukchi Sea*

Western-Pacific low-pressure systems, which are associated with cloudy skies, frequent precipitation, and southwesterly winds, move northeasterly through the Bering Sea into the Chukchi Sea, where they follow the northwestern Alaska coast. During the winter, the Chukchi Sea region is dominated by a ridge of high pressure linking the Siberian High and high pressure over the Yukon of Canada (MMS 2007a).

From June through August, the occurrence of low visibility in the open sea ranges from 25 to 30 percent. This value decreases toward the mainland coast (10 percent). During the central winter months, the occurrence of low visibility does not increase more than 10 to 15 percent, because snowstorms causing visibility of <1 km (0.6 mi) are infrequent (MMS 2007a).

Total annual precipitation recorded at the weather stations indicates that the Chukchi Sea coast receives an annual precipitation ranging from approximately four inches to 11 inches, while average snowfall ranges from approximately 40 to 53 inches per year. The amount of annual precipitation includes the melted amount of any frozen precipitation (e.g. snow, sleet) that may have fallen, in addition to any rain.

## Wind

The communities within the project area as a whole tend to have moderate winds throughout the year, with averages ranging from approximately 11 to 13 miles per hour (mph) (Table 3.1-2). Wind speeds tend to remain relatively constant throughout the year. Of the weather stations analyzed, Cape Lisburne near the western edge of the project area experiences the highest winds, with average winds in October exceeding 16 mph (WRCC 2011a). Winds blow from the east the majority of the year at each weather station analyzed; however, seasonal variations do exist.

### *Beaufort Sea*

For weather stations along the Beaufort Sea, onshore winds are predominantly from the east, east-northeast, and northeast, while offshore winds are chiefly from the west, west-southwest, and southwest (WRCC 2011c). The dominance of onshore winds, also known as the sea breeze effect, is more prevalent

in the summer months and reaches a peak in June when snow cover over land has diminished, and the land-sea thermal gradient is the most pronounced (MMS 2007b).

The weather stations at Barter Island, Prudhoe Bay, and Barrow generally experience easterly winds, although seasonal variations do exist. These alterations include prevailing winds from the west in January, March, and December at Barter Island; from the west-southwest in January and February and the east-northeast in February, March, and July at Deadhorse; and from the east-northeast in January and December in Barrow (WRCC 2011c).

### *Chukchi Sea*

During the winter, northerly winds prevail in the Chukchi Sea; however, wind directions vary from northwest in the western part of the sea to northeast in the eastern part of the sea. Prolonged winds can lead to extreme ice pressures and dangerous wind chills. During the summer, the Chukchi Sea experiences alternating north and south winds (MMS 2007a).

The communities of Wainwright, Point Lay, Point Hope, Kivalina, and Kotzebue generally experience winds from the east, although seasonal variations do exist, including prevailing winds from the west in July and from the south-southwest in July and August in Wainwright; from the east-northeast in October at Point Hope; and from the west in May through August at Kotzebue (WRCC 2011c).

## Storms

### *Beaufort Sea*

Weather can change abruptly in the Beaufort Sea area and has been described as unpredictable by whaling captains and residents in nearby villages (MMS 2003). In the Beaufort Sea, storms can come in from all directions but have been observed to typically come in from the north (MMS 2003). Storms and high-wind events are typically most frequent in winter and fall.

### *Chukchi Sea*

Storms are observed more often in winter than in summer in the Chukchi Sea, with approximately six to ten storm days occurring per month. Typical storm durations range from six to 24 hours, although stormy weather has been known to last for up to 14 days. The region can experience intense storms involving high winds (gusts recorded up to 100 mph), storm surges, and intense waves causing extensive damage and coastal flooding (MMS 2007a).

**Table 3.1-2 Meteorological Data Summary by Community**

| Parameter | Beaufort Sea | | | Chukchi Sea | | |
|---|---|---|---|---|---|---|
| | Barter Island | Prudhoe Bay | Barrow | Wainwright | Cape Lisburne | Kotzebue Airport |
| **Average Wind Speed (mph)** | 10.9[3] | 11.9[3] | 12.7[3] | 11.6[3] | 12.8[3] | 11.5[3] |
| **Average Daily Peak Wind Gust (mph)** | N/A | 22.3[6] | 22.2[7] | 22.2[8] | N/A | 22.6[10] |
| **Prevailing Wind Direction[1]** | E[4] | E[4] | E[4] | E[4] | E[4] | E[4] |
| **Average Air Temperature (degrees-F)** | 9.8[5] | 11.7[6] | 10.2[7] | 13.6[8] | 17.5[9] | 21.9[10] |
| **Average Total Precipitation (in)** | 6.19[5] | 4.26[6] | 4.63[7] | 4.11[8] | 11.34[9] | 9.72[10] |
| **Average Total Snowfall (in)** | 41.8[5] | 33.1[6] | 29.5[7] | N/A[8] | 41.4[9] | 53.0[10] |
| **Average Days of Precipitation per Year[11]** | N/A | 9.9[6] | 12.6[7] | 12.8[8] | N/A | 32.5[10] |

**Notes:**

N/A = Data not available.

1) Indicates direction wind blows *from*.

2) Days receiving at least 0.1 inch of precipitation

3) Period of Record: 1999 – 2006

4) Period of Record: 1992 – 2002

5) Period of Record: 1949 – 1988

6) Period of Record: 1999 – 2008

7) Period of Record: 1996 – 2008

8) Period of Record: 1949 – 1969

9) Period of Record: 1954 – 1984

10) Period of Record: 1996 – 2008

11) Days receiving at least 0.1 inches of precipitation

**Sources:**

WRCC 2011a; WRCC 2011b; WRCC 2011c; WRCC 2011d

### 3.1.4.4 Climate Change in the Arctic

## Climate Change

As with many fields of science, the field of climate change has many uncertainties and numerous theories. Outstanding questions such as how much and at what rate warming will occur, and how such effects will globally influence precipitation, storms, and wildlife habitat, etc. still remain relatively uncertain. However, in recent years, most scientists have come to acknowledge that: 1) increasing levels of carbon dioxide ($CO_2$) are changing the compositions of the earth's atmosphere; 2) the major GHGs emitted by human activities remain in the atmosphere for up to centuries; and 3) increasing GHGs concentrations tend to warm the planet (EPA 2011c).

Climate in the Arctic is showing signs of rapid change; nevertheless further study is needed to better understand the changes that have been observed and their significance to the Arctic Climate Region as well as global climate change. Since climate is inherently variable, and several climate cycle systems are known to influence climate patterns in the project area, climate patterns and trends within the project area are complex with several contributing factors.

## Climate Cycle Systems

The Pacific Decadal Oscillation (PDO), the Arctic Oscillation(AO), and the North Atlantic Oscillation (NAO) all represent patterns of climate variability that are believed to influence the climate patterns and trends of the project area.

The PDO is used to describe the fluctuation in northern Pacific sea surface temperatures that alternate between above normal (negative phase) and below normal (positive phase) Pacific Ocean sea surface temperatures. These cycles operate on a 20- to 30-year time scale (NOAA 2011a), and have been shown to be associated with dramatic shifts in the climate of the North Pacific around 1948 and 1976 (Bond 2011). The last major shift in the PDO occurred in 1976-77 and marked a change from cold to warm conditions in Alaskan waters (Bond 2011).

The AO is a climate cycle system that influences climate patterns in the Arctic. The AO exhibits both a negative and positive phase. The negative phase is characterized with relatively high pressure over the polar region and low pressure at mid-latitudes (about 45 degrees North); the pattern is reversed in the positive phase. In the positive phase, higher pressure at mid-latitudes drives ocean storms farther north, and changes in the circulation pattern bring wetter weather to Alaska. Frigid winter air does not extend as far into the middle of North America as it would during the negative phase of the oscillation. Weather patterns in the negative phase are in general opposite to those of the positive phase (NSIDC 2011a). Over most of the past century, the AO alternated between its positive and negative phases. Starting in the 1970s, however, the oscillation has tended to stay in the positive phase, causing lower than normal Arctic air pressure and higher than normal temperatures in much of the United States.

The NAO is a climate system that is considered the dominant mode of winter climate variability for a wide geographic area, extending from the North Atlantic region, to central North America, Europe, and Northern Asia. The NAO is a large-scale alteration of atmospheric mass that controls the strength and direction of the westerly winds and storm tracks across the North Atlantic. A positive NAO index is associated with stronger and more frequent winter storms crossing the Atlantic Ocean. The NAO has trended toward the positive phase over the past 30 years (Bell 2011), which is associated with stronger and more frequent winter storms crossing the Atlantic Ocean. The NAO is very similar to the AO with respect to timing and effects on local temperatures and precipitation (Dickson et al. 2000).

## Changes in the Arctic

Climate is naturally variable, and the Arctic is no exception having experienced climatic conditions that have ranged from one extreme to the other during a period of millions of years. Fossil records indicate that during the mid-Cretacous Period (approximately 120 to 90 my ago), the Arctic region was significantly warmer than present-day conditions, and the geography, atmospheric composition, ocean currents were considerably different than current conditions (ACIA 2005).

Evidence of climate change in the past few decades, commonly referred to as global warming, has accumulated from a variety of geophysical, biological, oceanographic, atmospheric, and anthropogenic sources. Such evidence includes scientific data, as well as traditional knowledge from Alaska Native communities along the Beaufort and Chukchi seas (further described below in Section 3.3.2.6). Since much of this evidence has been derived from relatively short time periods, and climate itself is inherently variable, the recent occurrence of unusually high temperatures may not necessarily be abnormal since it could fall within the natural variability of climate patterns and fluctuations. However, with that possibility, it should be noted that evidence of climate changes in the Arctic have been identified and appear to generally agree with climate modeling scenarios of GHG warming. Such evidence suggests (NSIDC 2011a):

- Air temperatures in the Arctic are increasing at an accelerated rate;
- Year-round sea ice extent and thickness has continually decreased over the past three decades;

- Water temperatures in the Arctic Ocean have increased;
- Changes have occurred to the salinity in the Arctic Ocean;
- Rising sea levels;
- Retreating glaciers;
- Increases in terrestrial precipitation;
- Warming permafrost in Alaska; and
- Northward migration of the treeline.

Although establishing such trends in the Arctic is challenging due to the small number of monitoring stations and relatively short records of data, the following statistics for the Arctic published as part of the Arctic Climate Impact Assessment (ACIA 2010, ACIA 2005) support these trends:

- A warming trend in the Arctic of 0.16 ºF per decade compared to 0.11 ºF per decade for the globe;
- A warming trend of 0.7 ºF per decade over last four decades;
- Precipitation has increased approximately one percent per decade over the past century;
- Snow extent has declined approximately 10 percent and permafrost has warmed by almost 3.6 ºF over the past three decades;
- Arctic Sea level has risen 10 to 20 centimeters (cm) in the past 100 years;
- Annual average sea ice extent has decreased by about eight percent, and the summer sea ice extent has decreased by 15 to 20 percent over the past three decades;
- Mean annual temperatures have increased by about 3.5 to 5.5 ºF over the last five decades;
- Sea ice thickness has decreased by 42 percent since the mid-1970s; and
- Winter temperatures have decreased by about 5.5 to 7 ºF over the last five decades.

Climate change in the Arctic has global implications. One reason is due to the albedo feedback. Warming (or cooling) in the Arctic affecting ice and snow cover directly affects the amount of sunlight reflected or absorbed by the earth's surface, which can produce a warmer Arctic and an accelerating decrease in ice cover over time. Such an effect has the potential to increase sea levels, alter the salinity in the Arctic Ocean, cause an increased release of methane ($CH_4$) into the atmosphere due to melting of permafrost, impact storm tracks, patterns of precipitation and the frequency and severity of cold-air outbreaks in middle latitudes (ACIA 2005, Serreze 2008).

Concurrent with climate change is a change in ocean chemistry known as ocean acidification. This phenomenon is described in the IPCC Fourth Assessment Report (IPCC 2007a), a 2005 synthesis report by members of the Royal Society of London (Raven et al. 2005), and an ongoing BOEM-funded study (Mathis 2011). The greatest degree of ocean acidification worldwide is predicted to occur in the Arctic Ocean. This amplified scenario in the Arctic is due to the effects of increased freshwater input from melting snow and ice and from increased $CO^2$ uptake by the sea as a result of ice retreat (Fabry et al. 2009). Measurements in the Canada Basin of the Arctic Ocean demonstrate that over 11 years, melting sea ice forced changes in pH and the inorganic carbon equilibrium, resulting in decreased saturation of calcium carbonate in the seawater (Yamamoto-Kawai 2009). Bates et al. (2009) showed the effects of decreasing pH on the saturation states of inorganic carbonate in the Chukchi and Beaufort seas, and the interaction of carbonate states with primary productivity.

### 3.1.4.5 Greenhouse Gas Emissions

Gases that trap heat in the atmosphere are often called greenhouse gases (EPA 2011c). Due to this ability, GHGs are widely considered an important contributing factor in climate change. Some GHGs such as carbon dioxide ($CO_2$) occur naturally and are emitted to the atmosphere through natural processes and human activities. Other GHGs (e.g. fluorinated gases) are created and emitted solely through human activities. The principal GHGs that enter the atmosphere because of human activities are:

*Carbon Dioxide ($CO_2$)* – $CO_2$ enters the atmosphere through the burning of fossil fuels (oil, natural gas, and coal), solid waste, trees and wood products, and also as a result of other chemical reactions (e.g. manufacture of cement). $CO_2$ is also removed from the atmosphere when it is absorbed by plants as part of the biological carbon cycle (EPA 2011d).

*Methane ($CH_4$)* – $CH_4$ is emitted during the production and transport of coal, natural gas, and oil. $CH_4$ emissions also result from livestock and other agricultural practices and by the decay of organic waste in municipal solid waste landfills (EPA 2011c).

*Nitrous Oxide ($N_2O$)* – $N_2O$ is emitted during agricultural and industrial activities, as well as during combustion of fossil fuels and solid waste (EPA 2011d).

*Fluorinated gases* – Hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride are synthetic, powerful GHGs that are emitted from a variety of industrial processes. Fluorinated gases are sometimes used as substitutes for ozone-depleting substances. These gases are typically emitted in smaller quantities, but because they are potent GHGs, they are sometimes referred to as "High Global Warming Potential" gases (EPA 2011d).

These particular gases are covered under the United Nations Framework Convention on Climate Change, an international agreement that requires participating countries to develop and periodically submit an inventory of greenhouse gas emissions (EPA 2011e).

In 2005, activities in Alaska were estimated to contribute 52.1 million metric tons (MMt) of gross[1] $CO_2e$, accounting for approximately 0.7 percent of the total US gross GHG emissions. From 1990 to 2000, GHG emissions from activities in Alaska were estimated to increase by approximately 13 percent which is on par with the national total, which rose by approximately 14 percent over the same period. The main source of Alaska's GHG emissions is residential, commercial, and industrial fuel use followed by the transportation sector. In 2010, the fossil fuel industry was estimated to produce approximately 2.9 MMt of $CO_2e$, representing approximately 5.2 percent of the state's $CO_2e$ emissions. Approximately 2.4 MMt of those emissions are attributed to the oil industry, equaling approximately 4.3 percent of the state's total. Table 3.1-3 provides historical and estimated current GHG emissions in Alaska by sector. Current conditions are estimated as values for the year 2010 as projected as part of a study conducted in 2007 by Center for Climate Strategies (CCS 2007).

**Table 3.1-3 Alaska Historical and Estimated Existing GHG Emissions, by Sector**

| Million Metric Tons $CO_2e$ | 1990 | 2000 | 2005 | 2010 Estimation | Source of 2010 Estimates |
|---|---|---|---|---|---|
| **Electricity Production** | **2.6** | **3.1** | **3.2** | **3.6** | |
| - Coal | 0.4 | 0.8 | 0.6 | 0.6 | |
| - Natural Gas | 1.9 | 1.9 | 2.1 | 2.1 | |
| - Oil | 0.3 | 0.5 | 0.6 | 0.9 | |

[1] Excludes emissions removed due to carbon sequestering.

| Million Metric Tons $CO_2e$ | 1990 | 2000 | 2005 | 2010 Estimation | Source of 2010 Estimates |
|---|---|---|---|---|---|
| **Residential/Commercial** | **3.8** | **4.3** | **3.9** | **3.9** | Based on USDOE regional projections |
| - Coal | 0.8 | 0.8 | 0.7 | 0.7 | |
| - Natural Gas | 1.8 | 2.2 | 1.9 | 1.9 | |
| - Oil | 2.4 | 2.4 | 3.1 | 3.6 | |
| - Wood ($CH_4$ and $N_2O$) | 0.01 | 0.00 | 0.00 | 0.00 | |
| **Industrial (Non-Fossil Fuel Production)** | **15.7** | **19.6** | **21.6** | **23.5** | Based on USDOE regional projections |
| - Coal | 0.00 | 0.001 | 0.001 | 0.001 | |
| - Natural Gas | 13.2 | 17.3 | 18.5 | 19.9 | |
| - Oil | 2.4 | 2.4 | 3.1 | 3.6 | |
| - Wood ($CH_4$ and $N_2O$) | 0.01 | 0.00 | 0.00 | 0.00 | |
| **Transportation** | **15.1** | **16.8** | **19.0** | **19.6** | |
| - Aviation | 7.2 | 10.6 | 12.9 | 13.0 | FAA aircraft operations forecasts |
| - Marine Vessels | 4.4 | 2.4 | 2.4 | 2.6 | DEC commercial marine inventory growth factors |
| - Onroad Vehicles | 3.4 | 3.7 | 3.6 | 3.9 | WRAP inventory VMT projections |
| - Rail and Other | 0.08 | 0.08 | 0.12 | 0.13 | Historical trends and USDOE regional projections |
| **Fossil Fuel Industry** | **4.9** | **3.2** | **3.0** | **2.9** | |
| - Natural Gas Industry | 0.2 | 0.4 | 0.5 | 0.4 | Historical trends and DNR natural gas production forecasts |
| - Oil Industry | 4.7 | 2.8 | 2.5 | 2.4 | Historical trends and DNR oil production forecasts |
| - Coal Mining (Methane) | 0.01 | 0.01 | 0.01 | 0.01 | Historical trend |
| **Industrial Processes** | **0.05** | **0.2** | **0.3** | **0.5** | |
| - Limestone and Dolomite Use | 0.00 | 0.00 | 0.01 | 0.01 | Alaska manufacturing employment growth |
| - Soda Ash | 0.01 | 0.01 | 0.01 | 0.01 | National projections for 2004-2009 (USGS) |
| - ODS Substitutes | 0.001 | 0.2 | 0.3 | 0.4 | EPA 2004 ODS cost study report |
| - $SF_6$ from Electric Utilities | 0.04 | 0.02 | 0.02 | 0.02 | Based on national projections (EPA) |
| **Waste Management** | **0.6** | **0.9** | **1.0** | **1.2** | |
| - Solid Waste Management | 0.6 | 0.8 | 1.0 | 1.1 | Projected based on 1995-2005 trend |
| - Wastewater Management | 0.1 | 0.1 | 0.1 | 0.1 | Projected based on population |

| Million Metric Tons $CO_2e$ | 1990 | 2000 | 2005 | 2010 Estimation | Source of 2010 Estimates |
|---|---|---|---|---|---|
| **Agriculture** | **0.05** | **0.05** | **0.05** | **0.06** | |
| - Manure Management | 0.001 | 0.002 | 0.004 | 0.005 | USDA livestock projections |
| - Enteric Fermentation | 0.01 | 0.02 | 0.02 | 0.02 | USDA livestock projections |
| - Agricultural Soils | 0.04 | 0.04 | 0.03 | 0.03 | Projected based on historical trend |
| **Total Gross Emissions** | **42.8** | **48.3** | **52.1** | **55.2** | |
| Forestry and Land Use[1] | -0.3 | -1.4 | -1.4 | -1.4 | Projections held constant at 2000 level. |
| **Net Emissions[2]** | **42.5** | **46.9** | **50.7** | **53.8** | |

**Notes:**
Forestry activities are negative because they represent an increase in carbon sequestering.
Net Emissions take into account carbon sequestering.
**Source:** CCS 2007

## 3.1.5 Air Quality

Air quality is a function of the air pollutant emission sources within an area, atmospheric conditions (such as wind direction and speed), and characteristics of the area itself (topography and air shed size). Pollutants transported from outside an area can also affect its air quality. Air pollutants are emitted from both man-made (anthropogenic) and natural sources. Industrial, residential, transportation-related, and construction-related emissions are anthropogenic sources; these sources can be either ongoing or temporary. Natural sources include windblown dust, forest fires, and volcanic eruptions; these typically contribute only to temporary increases in air pollution.

Air quality in the majority of Alaska's Arctic region, including the Beaufort and Chukchi seas, is generally considered very good due to minimal human habitation and industrial development, along with the distance from population centers such as Anchorage or Fairbanks (MMS 2007c). Widely scattered air pollutant emission sources exist in the onshore coastal regions of the EIS project area, with the only major industrial complex of more concentrated emission sources being Prudhoe Bay, Kuparuk, and Endicott oil-production facilities in the North Slope Areawide Oil and Gas Lease Sale Area (North Slope area). Dust and other pollutants from combustion sources in Europe and Asia also have the potential to be transported to the Arctic, having temporary and usually seasonal effects on visibility.

### 3.1.5.1 EIS Project Area

For purposes of defining existing air quality in the EIS project area, it is convenient to divide the project area into three zones: the state's seaward boundary (0 to 3 miles); within 25 miles of a state's seaward boundary (i.e., 3 to 28 miles from the coast); and beyond 25 miles of the state's seaward boundary (i.e., 28 to 200 miles from the coast). These three zones are subject to different air quality regulatory requirements and different ambient air quality backgrounds. Air pollutant sources located offshore are regulated under the OCS Air Regulations (discussed below). Certain ADEC rules are also applicable to offshore areas within 40 km (25 mi) of Alaska's seaward boundary (inner OCS); the EPA applies the corresponding onshore area (COA) rules to these areas, so they are basically treated the same as onshore sources for permitting purposes. Outer OCS offshore areas (beyond 40 km [25 mi] of the State's seaward boundary) are expected to have minimal anthropogenic sources of air pollution. The onshore areas are regulated by EPA and ADEC, and do not fall under the OCS regulations.

Except for the areas around Prudhoe Bay, Barrow and Kotzebue are the largest communities in terms of population within the onshore areas, and would thus be expected to have the highest air current pollutant levels. In addition, Kivalina is reported to have elevated dust levels, and Nuiqsut is located adjacent to the North Slope Area which has industrial activity. The other communities in the study area (Point Hope, Point Lay, Wainwright, and Kaktovik (located within the Arctic National Wildlife Refuge [ANWR]) are assumed to have lower background levels than the industrial areas and larger communities. However, in the absence of background air quality data in these remote regions, they are conservatively included in the onshore group for air quality purposes in this EIS.

### 3.1.5.2 Regulatory Framework and Pollutants of Concern

**Air Quality Standards**

Air quality in Alaska is regulated by the EPA and ADEC. The EPA has established the NAAQS, which specify maximum allowable concentrations for six principal criteria pollutants (EPA 2011f). Nonattainment areas are geographic regions where air pollutant concentrations exceed the NAAQS for a pollutant. An area is designated as unclassified when there is insufficient information to determine attainment status; these are typically areas where air pollution is not considered a problem (often rural areas), and no monitoring is conducted. The areas in and around the Beaufort and Chukchi seas are uniformly classified as attainment, that is, the air quality in these areas meet the NAAQS for all criteria pollutants (MMS 2007c). There are no designated nonattainment areas within or near the EIS project area (ADEC 2011a).

The two main criteria air pollutants affecting Alaska are carbon monoxide (CO) and particulate matter less than 10 microns in diameter ($PM_{10}$). Outdoor carbon monoxide emissions come from combustion sources, such as automobiles, airplanes, and industrial engines (ADEC 2011b). Fuel combustion is also a source of particulate matter emissions. In rural communities, airborne dust ($PM_{10}$) can be caused by windflow over glaciers, gravel pits, vehicles on dirt roads, dry river beds, and human activity on non-vegetated land (ADEC 2011c). Air quality standards for these two pollutants, along with the other criteria pollutants, are listed below in Table 3.1-4.

**Table 3.1-4 Federal and State Ambient Air Quality Standards**

| Pollutant | Averaging Period | National Standards | | Alaska State Standards |
|---|---|---|---|---|
| | | Primary | Secondary | |
| Ozone ($O_3$) | 8-hour (2008 Std)<br>8-hour (1997 Std) | 0.075 ppm<br>0.080 ppm | 0.075 ppm<br>0.080 ppm | 0.075 ppm |
| Particulate Matter equal to or less than 2.5 micrometers in diameter ($PM_{2.5}$) | Annual | 15.0 μg/m$^3$ | 15.0 μg/m$^3$ | 15 μg/m$^3$ |
| | 24-hour | 35 μg/m$^3$ | 35 μg/m$^3$ | 35 μg/m$^3$ |
| Particulate Matter equal to or less than 10 micrometers in diameter ($PM_{10}$) | | | | |
| | 24-hour | 150 μg/m$^3$ | 150 μg/m$^3$ | 150 μg/m$^3$ |
| Carbon Monoxide (CO) | 8-hour | 9 ppm<br>(10 mg/m$^3$) | | 10 mg/m$^3$ |
| | 1-hour | 35 ppm<br>(40 mg/m$^3$) | | 40 mg/m$^3$ |
| Nitrogen Dioxide ($NO_2$) | Annual | 0.053 ppm (100 μg/m$^3$) | 0.053 ppm (100 μg/m$^3$) | 100 μg/m$^3$ |
| | 1-hour | 0.100 ppm | | 0.100 ppm |

| | | | | |
|---|---|---|---|---|
| Sulfur Dioxide ($SO_2$) | Annual | 0.03 ppm (80 μg/m$^3$) | | 80 μg/m$^3$ |
| | 24-hour | 0.14 ppm (365 μg/m$^3$) | | 365 μg/m$^3$ |
| | 3-hour | | 0.5 ppm (1300 μg/m$^3$) | 1300 μg/m$^3$ |
| | 1-hour | 0.075 ppm | | 0.075 ppm |
| Reduced Sulfur Compounds (as $SO_2$) | 30-minute | | | 50 μg/m$^3$ |
| Ammonia ($NH_3$) | 8-hour | | | 2.1 mg/m$^3$ |
| Lead (Pb) | Rolling 3-Month Average | 0.15 μg/m$^3$ | 0.15 μg/m$^3$ | 0.15 μg/m$^3$ |
| | Quarterly Average | 1.5 μg/m$^3$ | 1.5 μg/m$^3$ | |

**Notes:**
μm = micrometers (for particulate diameter)
μg/m$^3$ = micrograms of pollutant per cubic meter of air
mg/m$^3$ = milligrams of pollutant per cubic meter of air
ppm = parts per million

**Source:** EPA Office of Air Quality Planning (EPA 2011f) and Alaska Administrative Code (AAC) 18-50.010 (AAC 2011).

## Permit Requirements

Air pollutant sources located offshore are regulated under Section 55.2 of the OCS Air Regulations as specified in the Code of Federal Regulations (40 CFR Part 55) (BOEMRE 2011a, EPA 2011f). Source being located (or modified) in either the outer OCS or inner OCS require permitting under these regulations. For operations outside the 40 km (25 mi) state seaward boundary (outer OCS), the federal 40 CFR Part 71 Operating Permit rules apply. For operations within the seaward boundary (inner OCS), EPA applies the COA rules, in this case the Alaska permitting rules in 18 AAC 50, which also cover potential onshore facilities. Depending on the magnitude of the potential emissions from a proposed activity, it may qualify as a Major Source subject to the federal PSD permitting requirements, which include implementation of Best Available Control Technology, air quality impact analysis (dispersion modeling) and evaluation of impacts to air quality-related values such as visibility, acid deposition and effects on soils and vegetation. In addition, an associated Title V operating permit under Alaska rules may also be required for a new emission source, depending on the specific source/facility. In each case, the permit must contain limits in order to ensure that the project will not result in NAAQS violations.

## Other Air Quality Evaluation Criteria

### *Air Toxics*

The EPA defines air toxics, also known as hazardous air pollutants (HAPs), as pollutants that cause or may cause cancer or other serious health effects (EPA 2011g). Although there are no NAAQS for air toxics, there are regulatory thresholds for HAPs emission limits and control requirements. The Kotzebue Air Toxics Monitoring Study was conducted between December 2004 and April 2006. No data are available from this study at this time (ADEC 2011d). In addition to the Kotzebue study, a lead (Pb) monitoring site was established in January 2010 in Noatak, a community located approximately midway between Kotzebue and Kivalina, inland on the Noatak River. This site was selected due to its location as the nearest population center to the Red Dog Mine. Data from this monitoring station will eventually be used by the State of Alaska to determine compliance with the NAAQS for Pb (attainment status) in this area (ADEC 2011d). No data are available from this site at this time.

### *Climate Change and Greenhouse Gases*

Climate change is believed to be occurring as a direct consequence of emissions of GHGs from many types of sources in every nation of the world. The EPA has issued the Final Mandatory Reporting of

Greenhouse Gases Rule (EPA 2009a), which requires reporting of greenhouse gas emissions from large sources and suppliers in the United States. The reporting is intended to collect accurate and timely emissions data to inform future policy decisions. Under the rule, suppliers of fossil fuels or industrial greenhouse gases, manufacturers of vehicles and engines, and facilities that emit 25,000 metric tons or more per year of greenhouse gas emissions are required to submit annual reports to the EPA. New rules specific to Petroleum and Natural Gas Systems have recently been promulgated (EPA 2011h). Section 3.1.4, Climate and Meteorology, provides baseline information regarding climate change and GHGs in the project area.

### *Regional Haze*

Regional haze refers to haze that impairs visibility in all directions over a large area. In general, visibility is measured by the farthest distance a viewer can see a landscape or feature, which may be limited by tiny particles in the air absorbing and scattering sunlight, which in turn degrades color, contrast, and clarity of the view. Many sources produce the particulate matter that causes haze. In addition to the primary sources of particulate matter discussed above, secondary particulate matter is also formed when gaseous pollutants undergo chemical reactions with sunlight in the atmosphere. Factors such as weather and humidity further influence the formation of haze. The EPA Regional Haze Rule is designed to protect and improve visibility in National Parks and Wilderness Areas throughout the country (EPA 1999a). Class I airsheds are federally designated areas under the Clean Air Act where no degradation of visibility is allowed. Alaska has four Class I areas subject to the rule (ADEC 2011e). Denali National Park is the closest Class I area to any of the EIS project area, ranging from approximately 650 km (404 mi) southeast of Kotzebue and approximately 750 km (466 mi) south of the more industrialized Prudhoe Bay area, to well over 1,000 km (621 mi) south of some of the outer OCS region (Wilderness Net 2011). The National Park Service (NPS) and USFWS monitor regional haze at Denali. Potential new sources of air pollution as part of this EIS are expected to have no appreciable effect at this distant Class I area, so no further description of the area is provided. In addition, monitoring data from this site are not representative of the EIS project area, although they could be used to identify specific events (such as Asian dust storms, see below) for verification purposes.

The focus of the regional haze issue in Alaska is primarily on visibility degradation within the Arctic region. Arctic Haze and Asian dust events are the primary areas of concern, both identified as being the result of international transport of pollutants into Alaska (ADEC 2002). Arctic Haze is defined as “diffuse bands of tropospheric aerosol occurring northward of about 70° latitude and at altitudes of up to 9,000 meters. These layers are hundreds to thousands of kilometers wide and 1-3 km (0.6-1.9 mi) thick” (ADEC 2002). Coal burning and metal smelting from sources in the industrial regions of Europe and Russia appear to be the primary contributors to Arctic Haze. Sources in North America and the Orient only contribute a minor amount of pollution to the Arctic due to their position relative to oceans and prevailing meteorology which provide pollutant scavenging mechanisms before reaching the Arctic (ADEC 2002).

Dust storms in Mongolia and northern China also have the potential to create large dust incidents within the Arctic region. These Asian dust events typically occur in the springtime, usually April and May, and appear to have high enough loft to avoid the ocean scavenging mechanisms. Anthropogenic sources of pollution, likely associated with China’s largely coal-fired economy, have also been shown to be transported concurrently with the dust events (ADEC 2002).

## 3.1.5.3 Existing Air Quality

Based on the physical environment, land uses, and low population density of the EIS project area, existing air quality is assumed to be generally good in all of the offshore and onshore locations, although as mentioned previously, dust emissions in even remote areas can cause localized increased particulate concentrations. The levels of some pollutants are expected to be slightly higher in the onshore areas due to increased numbers of fuel combustion sources; however these areas are still in attainment of air quality

standards. For the nonindustrial onshore areas, residential emission sources (diesel generators, fuel oil stoves, propane heating and/or woodstove) and mobile sources (vehicles) are expected to cause relatively low levels of combustion pollutants due to the limited population in the communities, as compared to the industrial North Slope area or the larger communities of Barrow and Kotzebue. In addition, fairly consistent winds in these areas provide adequate transport and dispersion of these localized emissions. External (international) sources of air pollution may also have an influence on air quality in the EIS project area, including temporary increases in levels of dust and combustion pollutants, which may affect visibility (Arctic haze).

Federal regulations requiring ultra-low sulfur diesel were promulgated by the EPA (EPA 2006a). These regulations are expected to benefit air quality in the EIS project area where diesel combustion is an important anthropogenic category of air pollution emissions. By June 1, 2010, all rural areas in Alaska were to have transitioned to 15 parts per million (ppm) diesel fuel for all highway, non-road, locomotive, and marine engines. By October 1, 2010, retail and wholesale purchaser-consumer transitions were to be complete; and by December 1, 2010, 15 ppm sulfur content diesel fuel was to be in retail facilities in all rural areas (ADEC 2010f). The switch to ultra-low sulfur diesel is expected to result in improved air quality, as it will reduce emissions of smoke, particulate matter, sulfur dioxide, and toxics from diesel combustion sources.

## Background Data

The EIS project areas included in this discussion are in attainment (or unclassifiable) for all criteria pollutants. ADEC maintains air quality monitoring sites in some rural communities where there is concern for dust problems (ADEC 2011c, ADEC 2011d). The majority of background air quality data in northern Alaska have been collected in the North Slope area; criteria air pollutant monitoring data have been used for source permitting in the North Slope area, and for several OCS facilities (Air Sciences, Inc 2009, Environ 2010, and AECOM 2010). The dataset shown in Table 3.1-5 was compiled using maximum monitored values and should be conservatively representative of the OCS areas, including the COA areas. Therefore, it is expected that this compiled dataset is reasonably representative for the three air quality area zones covered in this EIS (outer OCS, inner OCS, and onshore).

**Table 3.1-5 Background Concentrations**

| Pollutant | Averaging Period | Measured Concentration ($\mu g/m^3$) | Percent of Air Quality Standard |
|---|---|---|---|
| $PM_{10}$ | Annual | 7.5 | 15.0 |
| | 24-hour | 55.1 | 36.7 |
| CO | 8-hour | 1097 | 11.0 |
| | 1-hour | 1749 | 4.4 |
| $NO_2$ | Annual | 11.3 | 11.3 |
| $SO_2$ | Annual | 2.6 | 3.3 |
| | 24-hour | 13.0 | 3.6 |
| | 3-hour | 41.6 | 3.2 |

**Source**: Compiled from monitoring data for BPX Liberty and BPX Prudhoe Bay monitoring sites (Environ 2010).

**Note:**
$\mu g/m^3$ = micrograms of pollutant per cubic meter of air

There are limited background concentration data for offshore regions of Alaska, therefore, to be conservative, the data shown in Table 3.1-5 are assumed to represent worst-case pollutant levels for these areas, as far as permitting needs. Data from an old NPS Interagency Monitoring of Protected Visual Environments (IMPROVE) station on Simeonoff Island in the upper Aleutian chain provide a comparison to these conservative values (Environ 2010). The maximum 24-hour $PM_{10}$ concentration at this site during the 2001-2004 time period was 26.50 micrograms of pollutant per cubic meter of air ($\mu g/m^{3)}$, which is less than half the value shown in Table 3.1-5. Although this is considered a pristine monitoring site, the area is also subject to dust events, so it too may be showing particulate levels that are higher than those that would be seen in true offshore locations. In another effort to determine offshore background levels, particulate data have more recently been collected as part of the Wainwright Monitoring Program, and the data have been processed to account for the effects of community fugitive dust and combustion sources and sea salt particulates to determine regional background particulate levels for offshore sources (AECOM 2010). The maximum representative 24-hour $PM_{10}$ concentration at this site was 49 $\mu g/m^3$, which is just slightly lower than the value presented in Table 3.1-5. By the same processing method, the Wainwright data shows maximum regional $PM_{2.5}$ levels of 3 and 10 $\mu g/m^3$, for the annual and 24-hour periods, respectively (AECOM 2010). This corresponds well with the 98$^{th}$ percentile 24-hour $PM_{2.5}$ concentration (NAAQS reporting standard) at the Simeonoff IMPROVE site, which was 9.3 $\mu g/m^3$ (Environ 2010).

As shown in Table 3.1-5, the maximum measured concentrations are all well below the NAAQS and Alaska State Standards. These values are indicative of the relatively good air quality in the area, and show that there is still room for future development that would not necessarily jeopardize the regions ability to meet the federal and State of Alaska air quality standards.

## 3.1.6 Acoustics

### 3.1.6.1 Introduction to Acoustics

**<u>Sound Characteristics</u>**

Sound is a physical phenomenon consisting of minute vibrations that travel through a medium, such as air or water. When a source vibrates, it compresses the molecules in the adjacent medium (water or air) and creates a region of high pressure. As the surface of the vibrating object moves back toward its original position, the molecules of the surrounding medium are pulled back and a region of low pressure results. These are called *compressions* and *rarefactions*, respectively. The speed at which these compressions and rarefactions travel away from the source depends on the compressibility and density of the media and is called the *speed of sound*. The layers of compressions and rarefactions result in a *sound wave*. Sound waves travel much faster in water than in air.

Sound is generally described in terms of frequency (or pitch), intensity, and temporal properties (short or long in duration). The following text provides a general description of these terms. For more details, there are several publications and books that provide detailed overviews of acoustics, such as Richardson et al. (1995) and Au and Hastings (2008) for underwater sound, and Harris (1998) for airborne sound.

Frequency, measured in *Hertz* (Hz), is a measure of how many times each crest of a sound pressure wave passes a fixed point within a second. For example, when a drummer beats a drum, the skin of the drum vibrates a number of times per second. A particular tone that makes the drum skin vibrate 100 times per second generates a sound pressure wave at 100 Hz, and this vibration is perceived as a tonal pitch of 100 Hz. Sound frequencies between 20 Hz and 20,000 Hz are within the range of sensitivity of the best human ear. Some mysticetes (baleen whales) produce and likely hear sounds below 20 Hz, while odontocetes (toothed whales) produce and hear sounds at frequencies much higher than 20,000 Hz (also reported as 20 kiloHertz [kHz]).

Acoustic *intensity* is defined as the acoustical power per unit area. The intensity, power, and energy of a sound wave are proportional to the average of the squared pressure. Measurement instruments and most receivers (humans, animals) sense changes in pressure which is measured in Pascals (Pa). Pressure changes due to sound waves can be measured in Pa but they are more commonly expressed in *decibels* (dB). The decibel is a logarithmic scale that is based on the ratio of the sound pressure relative to a standard reference pressure $p_{ref}$. Different standard reference pressures are used for airborne sounds and underwater sounds. The airborne standard pressure reference is $p_{ref}$(air) = 20 microPascals (µPa), where 1 µPa = 0.000001 Pa. The underwater standard reference pressure is $p_{ref}$(water) = 1 µPa. The formula used to convert a pressure $p$ measured in µPa to sound pressure level $P$ measured in dB is $P = 20 \log_{10}[p/p_{ref}]$. Because of the logarithmic nature of the decibel, sound levels cannot be added or subtracted directly. If a sound's pressure is doubled, its sound level increases by approximately 6 dB, regardless of the initial sound level. This can be illustrated by considering a sound having pressure $p_1$; it has decibel level $P_1 = 20 \log[p_1/p_{ref}]$. Now consider a sound with twice the pressure: $p_2=2p_1$. It has decibel level $P_2 = 20 \log[p_2/p_{ref}] = 20 \log[2p_1/p_{ref}] \approx P_1 + 6$ dB.

## Sound Metrics

Three metrics are commonly used for the evaluation of underwater sound impacts: peak pressure (0-peak) or peak-to-peak, root-mean-square (RMS), and sound exposure level (SEL). Figure 3.1-5 shows a representation of a sinusoidal (single-frequency) pressure wave to help illustrate the various metrics. The amplitude of the pressure is shown on the vertical axis, and time is shown on the horizontal axis. The pressure of the wave is shown to fluctuate around the neutral point. The *peak sound pressure* is the absolute value of the maximum variation from the neutral position; therefore, it can result from either compression or a rarefaction. The *peak-to-peak sound pressure* is the difference between the maximum and minimum pressures. The average amplitude is the average of absolute value of pressure over the period of interest. The *RMS amplitude* is a type of average that is determined by squaring all of the amplitudes over the period of interest, determining the mean of the squared values, and then taking the square root of this mean. The RMS amplitude of an impulsive signal could vary significantly depending on the length of the period of interest (DOSITS 2011). SEL is a metric that is related to the sound energy per area received over time, though it does not have energy units. It is proportional to the square of the sound pressure and the time over which a sound is received.

An *audiogram* shows the lowest level of sounds that an animal or human can hear (hearing threshold) at different frequencies (pitch). The y-axis of the audiogram is sound levels expressed in dB (either in-air or in-water) and the x-axis is the frequency of the sound expressed in Hz. A typical audiogram for human hearing is shown on Figure 3.1-6a. In evaluating airborne noise impacts, the method commonly used to quantify environmental sound consists of evaluating all frequencies of a sound according to a weighting system that reflects that human hearing sensitivity varies with sound frequency. The most common frequency weighting to assess human hearing sensitivity and noise impacts is referred to as A-weighting and the decibel level measured is called the A-weighted sound level (dBA). Figure 3.1-6b shows the A-weighting function, with sound levels expressed in dB on the y-axis and frequency on the x-axis. Another human hearing weighting function commonly used includes C-weighting, which is used to address human hearing sensitivity when exposed to loud sound. Common metrics used to for airborne noise include the $L_{eq}$ (equivalent sound level) – the energy-mean A-weighted sound level during a measured time interval and the $L_{min}$ and $L_{max}$ – the RMS minimum and maximum noise levels during the monitoring period.

When evaluating potential noise impacts on wildlife, the A-weighting curve is usually not applied, as it is based on human hearing. Figure 3.1-7 shows hearing thresholds for some terrestrial and marine mammals as compared to the hearing threshold for humans. Figure 3.1-8 illustrates the proposed M-weighting functions for marine mammals by Southall et al. (2007).

Comparisons of underwater and airborne sound levels are difficult for several reasons, primarily due to the differences in the media (especially the characteristic impedance of the media), and it is important to

take into account the reference pressure level noted previously (1 µPa for underwater, 20 µPa for airborne). Sound pressure level is derived from the equation SPL = 20 log $(p/p_{ref})$, where $p$ is the acoustic pressure being measured and $p_{ref}$ is the reference pressure. Thus, 26 dB must be added to the dB level measured in air in order to have the same reference level in water (20 log 20) = 26. Table 3.1-6 shows underwater and airborne sound pressure levels and the relationship with the pressure. While it may be useful to compare the difference in a source sound level or hearing sensitivity of a marine mammal to a terrestrial mammal, this is for comparison purposes only.

O'Neill et al. (2010a and 2010b) explain underwater noise levels intensity, or loudness, of impulsive noise used for the purpose of estimating biological impact is characterized most commonly by three acoustic metrics: the peak SPL, the root-mean-square (rms) SPL, and the SEL. The peak SPL is expressed either as a per-pulse metric or as a cumulative metric over multiple pulses to describe the maximum instantaneous sound pressure level attained from a pressure pulse (O'Neill et al. 2010). The rms SPL is the mean square pressure level integrated over a specified time window containing the pressure pulse; the time window computed for each airgun seismic shot is the interval containing 90 percent of the pulse energy, and the resulting metric is commonly referred to as the 90 percent rms SPL (O'Neill et al. 2010). The SEL is a measure of the sound energy or exposure rather than sound pressure, and may be expressed as a per-pulse metric or a cumulative metric over multiple pulses, depending upon the application and context SEL for airgun signals (O'Neill et al. 2010).

**Table 3.1-6 Sound Levels of Typical Sources**

| Pascals | Underwater sound level (dB re 1 µPa) | Airborne sound level (dB re 20 µPa) | Typical underwater sounds | Typical airborne sounds |
|---|---|---|---|---|
| 1,000,000 | 240 | 214 | 1 m from hypothetical airgun array | |
| 100,000 | 220 | 194 | 2 kg high explosive at 100 m | |
| 10,000 | 200 | 174 | | Some military guns at 1 m |
| 1,000 | 180 | 154 | | Sonic booms |
| 100 | 160 | 134 | Large ship, 100 m | |
| 10 | 140 | 114 | Fin whale call, 100 m | Discomfort threshold for humans, 500 m from jet takeoff |
| 1 | 120 | 94 | | |
| 0.1 | 100 | 74 | | 15 m from auto at 55 km/hr |
| 0.01 | 80 | 54 | Ambient sound, Sea state 4 | Speech in noise at 1 m |
| 0.001 | 60 | 34 | Ambient sound, Sea state 0 | Speech in quiet at 1 m |
| 0.001 | 40 | 14 | | |
| 20 µ | 26 | 0 | | Human threshold |

**Notes:** dB re 1 Pa = decibels referenced to 1 microPascal; m = meters; km = kilometers; hr = hour
**Source:** Richardson et al. (1995)

When evaluating acoustic impacts, it is also important to take into account the temporal characteristics of the sound. A sound may be *transient* in nature (a relatively short duration with an obvious start and stop) or *continuous* (no obvious start or stop). NMFS considers transient sound as *pulsed* and continuous sound as *non-pulsed*. Examples of transient sounds include explosions, airguns, impact pile drivers, and sonar. Examples of continuous sounds include an operating drillship or ship underway. However, it is important to note that that source-path-receiver model discussed below will influence how a sound is perceived by the receiver. For example, sound from a ship underway is continuous at the source, but will not be a continuous to a stationary receiver once it has passed by. Another example is that transient sound such as

airguns are impulsive at the source, but due to the many factors that influence propagation, may be perceived as non-pulse at a farther distance by a receiver. As described in detail in Southall et al. (2007), pulses are transient sounds with rapid rise-time and high peak pressures and are possibly injurious to mammalian hearing. Non-pulsed sounds may not result in as much damage, but may still cause behavioral changes.

*Ambient noise* is the background noise, encompassing a myriad of sources, some of which are known and others are unknown. Noise sources may include natural and anthropogenic sources near and far. Ambient noise varies with season, location, time of day, and frequency. The ambient noise in an environment will influence how well a receiver may detect a sound source of interest.

## Propagation of Sound

*Transmission loss* underwater is the decrease in acoustic intensity as a sound wave propagates out from a source through *spreading loss*, *reflection* and *fraction*, and *absorption*. Simply, spreading loss refers to the decrease in pressure that results from the increasing surface area a sound wave covers as it moves further from the source. The sound energy becomes spread over larger areas, so the energy per unit area, and consequently pressure, decreases. In a uniform and boundless medium, sound spreads out from the source in a spherical dimension – sound levels in this situation typically diminish by approximately 6 dB due to spreading loss when the distance is doubled. When the propogation environment is shallow water where acoustic paths are bounded by the surface and seabottom, the acoustic energy tends to spread in to cylindrical fashion – sound levels in this situation typically diminish by approximately 3 dB per doubling distance. Reflection (sound waves "bouncing" off a surface) and refraction (bending of the propagation path) affect sound propagation and can lead to areas of higher or lower sound level than if they were not present. Absorption is the loss of acoustic energy by internal scattering and conversion of pressure energy into heat within the propagation medium. Transmission loss parameters underwater vary with frequency, temperature, sea conditions, source and receiver depth, water chemistry, bottom composition, and topography. Transmission loss parameters in air vary with frequency, air temperature and humidity, wind, turbulence, cloud cover, type of ground cover between source and receiver, and source and receiver height. It is important to note that when comparing different sound levels, attention must be paid to the reference pressure, distance from the source to the receiver, units, and frequencies. For example, sound levels of airguns are often reported as 230 to 240 dB re 1 µPa at 1 m – if the 1 m were omitted from the sound level, it could mean that this was a measured level at some unknown distance, which would mean the actual sound level at the source of the sound would be even higher than 230 to 240 dB.

Richardson et al. (1995) describe a useful method for considering the process of sound generation, propagation and perception. This method is referred to as the "source-path-receiver" model:

- ***Source:*** the source of the emitted sound (such as an airgun or drillship). It has particular acoustic characteristics including its pitch and intensity.
- ***Path:*** the route from source to the receiver of the sound wave. The path may alter the nature of the source sound as it travels from the source to the receiver (terms often used are transmission or propagation). The path can include segments through air or water, or both.
- ***Receiver:*** the human or animal that perceives the sound after it has left the source and propagated over the path. Receivers have specific detection abilities, so not all receivers will detect or perceive a sound the same way.

As noted previously, this section provides a very basic introduction to acoustic terminology that will be used in this EIS. For more details, there are many textbooks available that provide more details (e.g., Richardson et al. 1995, Au and Hastings 2008, Harris 1998). Furthermore, a website with some basic introductions to sound in the sea is located at: http://www.dosits.org/.

Due to the differences in the acoustic environment of the U.S. Beaufort and Chukchi seas (both underwater and airborne), they are discussed separately in the following text. For the purposes of the acoustics section of this EIS only, the region around Barrow will be included in the Chukchi Sea discussion.

### 3.1.6.2 Beaufort Sea

**Airborne Acoustics**

The existing airborne noise environment in the coastal areas of the Beaufort Sea is influenced by sounds from natural and anthropogenic sources. Similar to the Chukchi Sea (discussed below in Section 3.1.6.3), the primary natural source of airborne noise on the offshore, nearshore, and onshore regions is wind, although wildlife can produce considerable sound during specific seasons in certain nearshore and onshore regions. Anthropogenic noise levels in the Beaufort Sea region are higher than the Chukchi Sea due to the oil and gas developments of the nearshore and onshore regions of the North Slope, particularly in the vicinity of Prudhoe Bay. Noise sources consist of regular air traffic, vehicular traffic on the numerous roads within the development areas (such as around Deadhorse). Noise is also produced by the operations of heavy construction and industrial equipment that service the wells, processing facilities, pipelines, camps, etc. Industrial activities occur throughout the region on a year-round basis. There have been numerous airborne noise studies along the North Slope throughout development of the area. Sound levels near oil and gas development sites with equipment are similar to other industrial sites with levels 70 to 90 dBA (e.g., Shepard et al. 2001, EPA 1974). Sound levels farther from equipment are closer to the natural background levels of 45 to 60 dBA (BLM 2004). Noise sources and associated sound levels near the communities of Nuiqsut and Kaktovik will be similar to those described for the Chukchi Sea.

**Underwater Acoustics**

Underwater noise is comprised of natural and anthropogenic sources. It varies temporally (daily, seasonally, annually) depending on weather conditions and the presence of anthropogenic and biological sources. Natural sound sources in the Arctic Ocean include earthquakes, wind, ice, and sounds from several animal species. Figure 3.1-9 shows the Wenz curves (Wenz 1962), which summarized the range of ocean background noise at different frequencies (as reported in NRC (2003a). Earthquakes and other geologic processes (subduction, spreading, faulting, volcanic, hydrothermal vent activity) typically generate loud, low frequency (<100 Hz) sounds that propagate for long distances. Atmospheric effects, such as wind, lightning, thunder, and rain at the surface have a significant effect on ambient sound levels. Sources of underwater noise in the Beaufort Sea are the same as those described below for the Chukchi Sea (Section 3.1.6.3); however, due to different bathymetry, current, and level of anthropogenic activities, the ambient noise environment is more variable. The Beaufort Sea offshore environment can be divided into three primary acoustic environments: a) shallow bays bounded by barrier islands; b) shelf region with water depths from 10 m to 250 m depth [33 to 820 ft]; and c) basin slope with depths 1,000 to 3,000 m (3,280 to 9,843 ft). The basin floor is 3,000 to 3,500 m (9,843 to 11,483 ft) further offshore but fewer marine mammals are present there, and anthropogenic activities are limited in the very deep ocean region. The shallow bays are less conducive to low frequency sound propagation, and this generally reduces both anthropogenic and natural sound levels relative to the deeper Beaufort Sea environment. However, past oil and gas activities have largely been concentrated in these regions, so anthropogenic noise is more prevalent here. The shelf region has similar depth and acoustic properties to the Chukchi shelf environment. Recent seismic surveys have been performed on the Beaufort Sea shelf in Camden and Harrison Bays that have generated exploration noise footprints similar to those produced by exploration over the Chukchi Sea lease areas. Underwater sound channels form when there is a change in the velocity of the water column. The deeper basin slope and basin include a near-surface sound channel that can support long-range propagation of distant sounds, but at relatively low levels – distant seismic survey sounds are commonly detected here and over deeper parts of the shelf. Those sounds are believed to have

propagated from long distances through the sound channel and then with increasing attenuation as they encounter shallower water when propagation over the shelf.

Natural sound sources (such as from fish and marine mammals) in the Beaufort Sea region vary somewhat from those in the Chukchi Sea in that there are few walrus and bearded seals in the Beaufort Sea. Bowhead vocalizations will contribute during the spring and fall migrations, but the migration corridor in the Beaufort, and consequently the region exposed to vocalizations, is predominantly along a narrower path that follows approximately 10 to 30 miles from offshore. Wind and sea ice contribute greatly to the noise environment (e.g., Blackwell and Greene et al. 2004, Blackwell and Greene 2006, Blackwell et al. 2009) in the Beaufort Sea.

Anthropogenic sounds are primarily in the nearshore and shelf region, and include noise from vessel traffic, primarily in the Prudhoe Bay region, as there are three docks with deep draft capability. During the open water season, there are barges and tugs present with supplies ranging from fuel and food to large modules for oil and gas processing onshore, research vessels, and crew supply vessels from Northstar to West Dock (Blackwell and Greene 2006).

Existing North Slope production operations extend from Alpine in the west to Point Thomson and Badami in the east. Most of the production operations on the North Slope are onshore, but there are a few offshore units that contribute to the underwater noise environment. The Northstar oilfield was discovered in 1983 and developed by BP in 1995. The offshore oilfield is 10 km (6 mi) from Prudhoe Bay in about 10 m (39 ft) of water. Sounds in the near and far shore have been measured from Northstar throughout construction and operation and these measurements continue today (BP 2009) with analysis of potential effects of the island on bowhead migration. Broadband noise from Northstar reaches background noise levels during drilling by 9.4 km (5.8 mi) from the island (Blackwell et al. 2004). The Oooguruk Unit is located adjacent to Kuparuk River Unit in shallow waters of Harrison Bay. Pioneer and its partner, Eni, constructed an offshore drill site and onshore production facilities pad in 2006 on State of Alaska leases, and this unit has been operating since 2008. Studies during construction of Oooguruk showed noise from drilling were not detected outside the barrier islands, and vessels were the primary noise source (Pioneer 2009). The Nikaitchuq Unit is located at Spy Island, north of Oliktok Point and the Kuparuk River unit and northwest of the Milne Point Unit and has been operating since 2010.

### 3.1.6.3 Chukchi Sea

**Airborne Acoustics**

The existing airborne environment in the coastal areas of the Chukchi Sea is comprised of natural and anthropogenic sources. The primary natural source of airborne noise on both the offshore, nearshore, and onshore regions is wind, although wildlife will contribute some during specific seasons in the nearshore and onshore regions. For example, shorebirds are often quite loud in the summer season in breeding areas. Walrus produce several types of grunts, snorts, and whistle sounds while on-land haulout sites; these haulout sites are often many thousands of animals. Anthropogenic activity is relatively limited in the Arctic offshore relative to other seas, but occasional vessel traffic from tourism, research, or oil and gas activities and local activity generates some airborne noise. Anthropogenic noise levels in the nearshore and onshore region will be higher in populated areas – the coastal communities of Wainwright, Point Lay, Point Hope, Kivalina, and Barrow – with increasing noise levels associated with the larger communities. Community noise consists of aircraft, vehicular traffic (including all-terrain vehicles and snow machines), construction equipment, people talking/yelling, dogs barking, power plants, skiffs used for hunting, generators, etc. There have been no detailed existing noise surveys in these communities, but overall sound levels associated with smaller communities with smaller roads and relatively few aircraft range from very quiet during periods of low wind (<20 dBA) to 65 to 70 dBA during periods of higher human activity and wind (EPA 1974). Typical community noise levels during the daytime are likely 50-65 dBA, and levels during the nighttime are likely 35 to 45 dBA (EPA 1974).

Noise from offshore vessels will contribute very little to the ambient airborne noise environment as there are no existing ports or docks in any of these communities deep enough for the larger vessels to come within a few miles.

## Underwater Acoustics

Sources of underwater noise in the Chukchi Sea are the same as those described above for the Beaufort Sea (Section 3.1.6.2). In the Chukchi Sea, surface wind affects ambient noise levels, causing variations in up to 20 dB in the ambient noise environment (Hannay et al. 2011). The presence of sea ice can dramatically change the ambient noise environment, either by affecting propagation or as a source of noise. Areas with 100 percent sea ice coverage may reduce or eliminate noise from waves or surf (Richardson et al. 1995). As ice forms in shallower waters, sound propagation of the water below the ice can reduce the transmission efficacy of low frequency sound (NRC 2003a). The movement of the ice can also be a significant source of noise in the Arctic Ocean. In areas of continuous fast-ice cover, the ice cracking due to thermal stresses can be a dominant source of noise, usually between 100 to 1,000 Hz (Milne and Ganton 1964). Hannay et al. (2001) also report ice as being a major source of noise throughout the Chukchi Sea.

Biological acoustic sources include marine mammals and fish. During specific seasons, marine mammal calls contribute substantially to the ambient noise levels in the Chukchi Sea. As described in Section 3.2.4, there are a variety of marine mammals that occur in the Chukchi Sea, all of which produce sounds throughout the open water season. Since the late 1970s and early 1980s, seafloor mounted passive acoustic monitoring devices have been deployed near Barrow as part of the bowhead whale acoustic census (e.g., Clark and Johnson 1984). Since 2006, there have been detailed passive acoustic monitoring recorders deployed throughout the Chukchi Sea as part of oil and gas-sponsored environmental studies. The recent recorder locations range from Cape Lisburne to Barrow and from 5 nautical miles (NM) nearshore to more than 100 NM offshore (e.g., Cornell 2010, Hannay et al. 2011). Bowhead whales pass through the region during their spring and fall migrations. They produce a variety of sounds in the 20 to 3,500 Hz frequency range (George et al. 2004, Cornell 2010, Hannay et al. 2011). Walrus are in the Chukchi Sea from late spring through the fall. They produce a variety of sounds ranging from grunts to knocks that are fairly broadband (100 Hz – 10 kHz). In 2008, walrus were detected most frequently in late September (Cornell 2010). In 2009, walrus were detected most frequently in late August to mid-September, particularly between Hanna Shoal and Wainwright (Hannay et al. 2011). Bearded seals are detected throughout the year on recorders throughout the Chukchi Sea, but during the breeding season (May), sounds from the male bearded seals increase the ambient background levels by as much as 20 dB in the 400 Hz range (Hannay et al. 2011).

Anthropogenic noise sources include vessel traffic, oil and gas exploration, and other miscellaneous sources. Vessel traffic includes a wide range of vessel sizes with varying noise levels. Vessel types include small skiffs used for whaling, scientific research vessels, re-supply barges for the communities, large barges carrying oil and gas processing modules to the North Slope (see Transportation Section 3.3.7 for more details on traffic), some tourism and recreation vessels, icebreakers, and vessels associated with oil and gas exploration activities. As summarized in several acoustic texts (e.g., Richardson et al. 1995, NRC 2003a, Au and Hastings 2008), sounds associated with vessel traffic are primarily generated by cavitation of the propeller, but some sound from on-board machinery is also transmitted through the hull into the water. Source levels for smaller vessels are typically between 120 and 150 dB re 1 µPa at 1 m with most of the energy below 5,000 Hz (Richardson et al. 1995), while source levels for tugs pulling large barges are typically lower frequency (below 1,000 Hz) with greater source levels (~170 dB re 1 µPa at 1 m). In the Chukchi Sea, tugs and barges typically travel approximately 50 NM from shore from the Bering Strait through to Prudhoe Bay or into Canada. Research and oil and gas vessels transit throughout the lease sale area that is more than 50 NM from shore. However, these vessels make occasional transits to within a few miles from shore to change out the research and crew personnel as required.

Sources of anthropogenic sound in the Chukchi Sea associated with oil and gas exploration include all of the activities identified in Chapter 2: deep penetration seismic surveys; high resolution geophysical surveys; and exploratory drilling. The sound levels and associated frequencies were described in Chapter 2. There are no production islands in the Chukchi Sea at this time. There are no ports or docks in the Chukchi Sea, so there has been little introduction of construction noise (such as pile driving or dredging) in this region to date.

Because the Chukchi Sea continental shelf has a highly uniform depth of 30 to 50 m, it strongly supports sound propagation in the 50 Hz to 500 Hz frequency band (Funk et al. 2008). This is of particular interest because most of the industrial sounds from large vessels, seismic sources, and drilling are in this band, and this is likely within the greatest hearing sensitivity of bowhead whales.

## 3.1.7 Water Quality

Water quality is a term used to describe the physical, chemical, and biological characteristics of water, usually with regard to its ability to perform or support a particular function. Water quality criteria or standards can be generally defined using an established set of parameters that are related to the utility of the water for a particular set of purposes (e.g. protection of marine biota, maintenance of subsistence food resources).

Since drilling of the first OCS exploration well in 1981, a variety of onshore and offshore oil exploration and development projects have been conducted in and adjacent to both the Alaskan Beaufort and Chukchi seas (NRC 2003b). Over 20 discoveries have been made in areas such as Endicott (an offshore field in state waters), Sagavanirktok Delta North (onshore near Prudhoe Bay), and Badami (Beaufort Sea) (Brown et al. 2010). Brown et al. (2010) report that, "because of this past development, the Alaska Arctic Region OCS is not considered to be "pristine" from a chemical perspective." In addition to inputs resulting from oil and gas exploration and development, anthropogenic materials may be introduced to the Beaufort and Chukchi seas through influx from the Bering Sea, river runoff, coastal erosion, and atmospheric deposition (Woodgate and Aagaard 2005).

However, the majority of the water flowing into the Beaufort and Chukchi seas is relatively free from the influence of human activity, and there are currently no impaired waters (as defined by the Clean Water Act Section 303(d)) identified within the Arctic Region by the State of Alaska (ADEC 2010).

### 3.1.7.1 Applicable Regulations

State of Alaska water quality standards for designated uses of marine and fresh water are available in the most recent version of 18 AAC 70, or from the ADEC web site (www.dec.state.ak.us/water/wqsar/).

Current USCG regulations related to pollution prevention and discharges for vessels carrying oil, noxious liquid substances, garbage, municipal or commercial waste, and ballast water are found in the Code of Federal Regulations (33 CFR Part 151).

Certain discharges from oil and gas exploration facilities in the Beaufort and Chukchi seas are authorized by the EPA under the NPDES General Permit AKG-28-0000 (EPA 2006b).

The latest information on water-quality standards from the EPA is available in the current edition of 40 CFR Part 131. The EPA National Recommended Water Quality Criteria are available at (http://water.epa.gov/scitech/swguidance/standards/current/index.cfm).

### 3.1.7.2 Water Quality Parameters

The following water quality variables are discussed because of their importance to the functioning of the potentially affected ecosystem.

## Temperature and Salinity

Temperature often dictates the ability of water to support a particular biological community and also influences a wide range of other chemical and physical parameters. It is therefore an important variable for establishing baseline water quality of the affected environment. Higher water temperatures decrease the ability of water to hold oxygen, reduce the density of the water, and may also increase the likelihood of an algal bloom. Rapid temperature shifts impact the health of marine species, while long-term temperature changes may have a considerable impact on ecosystems. Increases in water temperature encourage the growth of heat-tolerant organisms, which may include introduced species. Decreases in water temperatures generally slow down biological productivity and may decrease food availability to fish and other grazing animals. Factors that influence water temperature include time of day, season, depth of water, flow rate, tidal influence, nearby cooling water outfalls, and the location of the sampling point.

Salinity influences the density of water and can fluctuate due to ice formation and melting, freshwater influx from rivers, rainfall, evaporation, and tidal cycles. Due to the need to maintain a balance of water and salts within cells (osmoregulation), many organisms have narrow salinity tolerance ranges. The salinity of typical open ocean seawater is usually about 35 ppt (35,000 milligrams per kilograms [mg/kg]), or 35 grams of salt dissolved in 1,000 grams of seawater. Salinity may also be quantified using psu, which correspond closely to ppt. The salinity measurement represents the total of all the salts dissolved in the water. Although the salt is comprised of many different ions, those ions are present in relatively constant proportions to each other in open ocean seawater. The principal ions in standard open ocean seawater are chloride, sodium, and magnesium. Together, they constitute over 89 percent of the ions dissolved in standard seawater (Millero 1996).

Strong seasonal variation is apparent in temperature and salinity profiles from the Beaufort and Chukchi seas.

Throughout the spring and early summer, surface warming and associated ice melting increase the sea surface temperature (a maximum value near 8° C), decrease the sea surface salinity (a minimum value near 20 psu), and cause both the thermocline and halocline to occur at relatively shallow depths (20 to 50 m) (Chu et al. 1999). During summer, profiles of temperature and salinity in the Beaufort and Chukchi seas show a multilayer structure, with a shallow mixed layer of warm low-salinity water overlying cooler saltier deep layers.

During winter, low solar energy input resulting from long periods of darkness leads to radiative heat loss from the surface. Cooling at the sea surface destabilizes the shallow mixed layer through strong upward heat flux and salt rejection by ice freezing and results in an isothermal/isohaline structure characterized by relatively uniform temperatures and salinities over the entire depth of the water column (Chu et al. 1999).

## Turbidity and Total Suspended Solids

Turbidity is an expression of the optical property that causes light to be scattered and absorbed by a water sample. Turbidity measurements are expressed in Nephelometric Turbidity Units (NTU). Turbidity is caused by suspended matter or other impurities that interfere with the clarity of the water. These impurities may include silt, eroded soils, suspended organic solids, and plankton and other microorganisms (EPA 1999b). Turbidity is an optical property that is closely related to the concentration of total suspended solids in the water. Measurements of total suspended solids are expressed in milligrams per liter (mg/L).

In the Beaufort and Chukchi seas, natural turbidity is caused by particles from riverine discharge, coastal erosion, and resuspension of seafloor sediment, particularly during summer storms. Because the particles that interfere with the clarity of the water are predominantly from terrestrial sources, naturally-occurring turbidity levels in the Beaufort Sea are greatest in near shore waters and generally decrease with distance from shore as particles settle out of the water column (Trefry et al. 2009). Similar spatial trends in

turbidity can be expected to occur in the Chukchi Sea; however due to the current regime in the Chukchi Sea and the relatively wide shallow Chukchi shelf, resuspended seafloor sediments may contribute substantially to offshore turbidity levels in the Chukchi Sea (Pickart et al. 2005).

Turbidity can affect phytoplankton growth by limiting the depth to which light penetrates the water column. High turbidity levels may also affect filter-feeding organisms and influence the ability of fish gills to absorb dissolved oxygen. Pollutants and pathogens may be associated with suspended solids, such that changes in turbidity may indicate changes in the ability of the water to support marine biota.

Turbidity in the Beaufort and Chukchi seas varies depending on the season of the year, weather conditions, and the location. Turbidity levels are generally higher during the summer open-water period relative to the winter ice-covered period.

Measurements of turbiditiy in nearshore Beaufort Sea waters during summer show large variations due to changes in wind conditions. Under relatively calm conditions (winds less than 5 knots) during late summer, turbidity levels are likely to be less than 3 Nephelometric Turbidity Units and under high winds (greater than 25 knots), turbidity may be in excess of 80 Nephelometric Turbidity Units (Figure 3.1-10) (Boehm 2001).

Nearshore waters generally have high concentrations of suspended material during spring and early summer because runoff from the rivers produces very high turbidity adjacent to the river mouths. Maximum values correspond to midseason river-discharge peaks following large rainfall events in the Brooks Range. The highest levels of suspended particles in the discharge are found during breakup; maximum concentrations of total suspended solids ranged from 60 mg/L to 106 mg/L in the Kuparuk River during 2006 and 285 mg/L (2004) to 353 mg/L (2006) in the Sagavanirktok River (Trefry et al. 2009). Turbidity is also affected by natural erosion of organic material along the shorelines. Erosion and flooding associated with autumn and spring storms may increase inputs of organic material from the shorelines and locally increase turbidity (MMS 2008). The resulting turbidity limits light availability and measurably reduces primary productivity of shallow coastal waters (Dunton et al. 2004).

In winter, the turbidity in water under the sea ice is generally lower compared to the summer open water season. As sea ice forms during fall, particulates are removed from the water column by ice crystals and are locked into the ice cover. Formation of surface ice also causes a decrease in waves and currents in response to wind. As a result of decreased wind energy input, the capability of the water to retain particles in suspension diminishes. Settling of particles decreases the turbidity in the water column.

In April 2000, as part of the Arctic Nearshore Impact Monitoring in Development Area (ANIMIDA) project, the turbidity levels at various depths in the water column under about 2 m (6.6 ft) of ice were determined from water samples collected from stations in the vicinity of the Endicott development island, the Northstar Island, and in Foggy Island Bay (Boehm 2001). Turbidity measurements ranged from 0.15 to 1.35 Nephelometric Turbidity Units (Boehm 2001). These levels are 10 to >100 times lower than values obtained during the open-water period of August 1999 (Figure 3.1-10) and provide a good indication of turbidity under the 1.6 to 2.4-m (5.3 to 7.9-ft) thick layers of sea ice (Boehm 2001). The lowest levels of turbidity were observed at the more-offshore stations.

## Metals

Concentrations of solid-phase metals in sediment, and dissolved-phase metals in marine waters, help identify spatial and temporal trends in the distribution of potential anthropogenic chemicals (Brown et al. 2010).

In the marine environment, metals are found in the dissolved, solid, and colloidal phases. The distribution of metals among the three phases depends upon the chemical properties of the metal, the properties of other constituents of the seawater, and physical parameters. Current EPA water quality criteria for metals in marine waters are based on dissolved-phase metal concentrations because they most

accurately reflect the bioavailable fraction, and hence the potential toxicity of a metal (EPA 2009b). The State of Alaska has adopted these criteria for protection of state waters in 18 AAC 70. EPA also uses these criteria to ensure protection of federal waters (EPA 2006b).

The main inputs of naturally-occurring metals to the Arctic Ocean are derived from terrestrial runoff, riverine inputs, and advection of water into the Arctic Ocean via the Bering Strait inflow and the Atlantic water inflow. Atmospheric inputs of metals to the environment should be relatively small compared to inputs from marine and terrestrial sources (Moore 1981, Yeats and Westerlund 1991). Naturally occurring concentrations of metals are generally higher in the Chukchi Sea relative to those in the Beaufort Sea. The higher concentrations are thought to come from Bering Sea water that passes first through the Chukchi Sea and then through to the Beaufort Sea (Moore 1981, Yeats 1988). Metals from the Bering Sea may be deposited in Chukchi Sea sediments as Bering Sea water flows over the relatively shallow Chukchi Sea Shelf.

Concentrations of dissolved metals were measured in seawater samples from the coastal Beaufort Sea during both the ANIMIDA and Continuation of Arctic Nearshore Impact Monitoring in Development Area (cANIMIDA) projects (Table 3.1-7) (from Neff 2010). Concentrations of dissolved arsenic, chromium, and lead were lower than reported values for surface seawater worldwide. Arsenic concentrations in the low-salinity nearshore samples were below the world average for open ocean waters because dissolved arsenic concentrations in seawater vary concomitant with salinity. In contrast, concentrations of dissolved cadmium, copper, and zinc were higher than in typical surface seawater. Concentrations of dissolved barium were similar to those in typical surface seawater, except during 2000 and 2001, when more nearshore samples were collected (Neff 2010).

Another part of the cANIMIDA program involved measurement of existing concentrations of fourteen metals (Ag, As, Be, Cd, Co, Cr, Cu, Hg, Ni, Pb, Sb, Tl, V, and Zn) in sediment from the nearshore Alaskan Beaufort Sea (Brown et al. 2010). Four other metals (Al, Fe, Ba, and Mn) were included in the study as indicator metals because they provide insight into sediment composition (Al in clays and Fe in iron oxide coatings), the presence of drilling discharges (barium in barite, a common additive in drilling fluids), and sediment redox conditions (manganese, a redox-sensitive metal) (Brown et al. 2010).

Aluminum rarely is introduced into the environment by anthropogenic activities. Normalizing concentrations of other metals to those of aluminum provides a valuable tool for identification of potential sources of contamination. This technique was used by Brown et al. (2010) to identify a total of about 17 minor anomalies in the concentrations of measured metals relative to aluminum (0.9 percent of data points) in the cANIMIDA area. However, the authors concluded that concentrations of potential contaminants in suspended sediments, as well as dissolved and particulate metals and hydrocarbons in the development area, are primarily from terrestrial sources and are nearly always at background levels (Neff 2010).

## Hydrocarbons and Organic Contaminants

Hydrocarbons are organic compounds comprised entirely of hydrogen and carbon. Hydrocarbons can be divided into three general categories based on their molecular structures: 1) saturated hydrocarbons (alkanes) contain only single bonds; 2) unsaturated hydrocarbons (alkenes and alkynes) contain one or more double or triple bonds; 3) aromatic hydrocarbons (including polycyclic aromatic hydrocarbons [or PAH]) contain one or more aromatic ring. Because of their nonpolar molecular structures, most hydrocarbon compounds have very low solubility in water, and tend to associate with organic material or solid phase particles (such as sediments) in the environment.

Petroleum is a complex mixture of saturated, unsaturated, and aromatic hydrocarbons, and other related compounds.

**Table 3.1-7 Mean concentrations of dissolved metals and salinity in seawater water collected from the coastal Beaufort Sea and near Northstar Island during the open-water season in 2000 through 2006.** All dissolved metal concentrations are µg/L (parts per billion).

| Year | Salinity (psu) | As | Ba | Cd | Cr | Cu | Hg | Pb | Zn |
|---|---|---|---|---|---|---|---|---|---|
| 2000 | 22 | 0.49 | 26.8 | 0.02 | 0.06 | 0.54 | 0.0005 | 0.005 | 0.20 |
| (n = 49) | | | | | | | | | |
| 2001 | 17 | 0.38 | 31.9 | 0.02 | 0.09 | 0.64 | 0.001 | 0.01 | 0.16 |
| (n = 34) | | | | | | | | | |
| 2002 | 20 | 0.51 | 14.2 | 0.03 | 0.07 | 0.47 | 0.0009 | 0.07 | 0.11 |
| (n = 31) | | | | | | | | | |
| 2004 | | | | | | | | | |
| Area wide | 23 | 0.72 | 13 | 0.04 | 0.11 | 0.36 | - | 0.01 | 0.16 |
| (n = 42) | | | | | | | | | |
| 2004 NS | 25 | 0.81 | 12 | 0.04 | 0.10 | 0.40 | - | 0.01 | 0.14 |
| (n =7) | | | | | | | | | |
| 2005 | | | | | | | | | |
| Area wide | 27 | 0.93 | 10.6 | 0.05 | 0.09 | 0.31 | 0.0007 | 0.01 | 0.32 |
| (n = 65) | | | | | | | | | |
| 2005 NS | 25 | 0.88 | 11.5 | 0.04 | 0.09 | 0.30 | 0.0008 | 0.02 | 0.28 |
| (n = 9) | | | | | | | | | |
| 2006 | | | | | | | | | |
| Area wide | 23 | 0.60 | 13 | 0.04 | 0.09 | 0.31 | - | 0.008 | 0.17 |
| (n = 26) | | | | | | | | | |
| 2006 NS | 21 | 0.56 | 14 | 0.03 | 0.08 | 0.31 | | 0.007 | 0.20 |
| (n =12) | | | | | | | | | |
| Average Surface | 35 | 1.2 | 13 | 0.01 | 0.16 | 0.10 | 0.0002 | 0.02 | 0.1 |
| Seawater[a] | | | | | | | | | |
| EPA Marine | Chronic | 36 | - | 8.8 | 50[c] | 3.1 | 0.94[d] | 8.1 | 81 |
| Water | | | | | | | | | |
| Quality Criteria[b] | | | | | | | | | |

**Notes:**
a Millero (1996); c Criterion for hexavalent chromium Cr (VI);
b EPA (2009); d Criterion for inorganic mercury.
**Source:**
(Trefry et al. 2009; Neff 2010)

Background hydrocarbon concentrations in Beaufort Sea water are present at concentrations of one part per billion or less (Trefry et al. 2004). Whole water samples from three areas of the Beaufort Sea sampled as part of the cANIMIDA study contained 37 to 69 ng/L (parts per trillion) total petroleum hydrocarbons (Neff 2010). Most of the PAH compounds in the whole water samples were associated with the particulate fraction (Neff 2010). Concentrations of dissolved PAH ranged from 13 to 19 ng/L. The low molecular weight 2- and 3-ring PAH were much more abundant than the higher molecular weight 4- through 6-ring PAH in both the particulate and dissolved fractions, indicating that much of the PAH content in surface waters was from a petroleum source (Neff 2010).

Hydrocarbons analyzed in Beaufort Sea sediments include total saturated hydrocarbons (SHC) C9 through C40, PAH, and triterpanes (Brown et al. 2010). An established technique of evaluating the significance of the measured sediment hydrocarbons to overall ecological risk of the region involves comparisons to sediment quality guidelines or benchmarks. Sediment quality guidelines have been developed to assess possible adverse biological effects from metals, polychlorinated biphenyls (PCBs), pesticides, and PAH. The commonly utilized criteria are the Effects Range Low (ERL) and Effects Range Median (ERM) presented by Long et al. (1995). (It should be noted that more recent consensus-based sediment quality guidelines are available (*e.g.*, MacDonald et al. 2000, Buchman 2008)). The general applications of the guidelines have been to state that adverse biological effects are "rarely" observed when PAH levels are less than the ERL, "occasionally" observed when contaminants are present at levels between the ERL and ERM, and "frequently" observed when concentrations exceed the ERM. ERL and ERM values have been developed for 13 individual PAH compounds and three classes of PAH (low- and high-molecular-weight PAH, and Total PAH).

## Saturated Hydrocarbons

For most Beaufort Sea stations, the total saturated hydrocarbon concentrations in surficial sediments are low relative to the guideline concentrations, ranging from 0.21 to 16 milligrams per kilogram (mg/kg) (Boehm 2001). These hydrocarbons are a mixture of terrestrial plant waxes with lower levels of petroleum hydrocarbons.

Samples of river sediments and peat have total saturated hydrocarbon values of 5.8 to 36 mg/kg and 21 to 32 mg/kg, respectively (Boehm 2001). Sediments were sampled in the Colville, Kuparuk, and Sagavanirktok rivers. Peat samples came from areas along the Colville and Kuparuk rivers. The compositions of saturated hydrocarbons in the river and peat samples were similar to the composition in Beaufort Sea surficial sediments. This similarity indicates a common source of saturated hydrocarbons for river sediments and nearshore surficial sediments.

The highest total saturated hydrocarbon value, 50 mg/kg, for this suite of samples was found at the station west of West Dock in Prudhoe Bay (Boehm 2001). The sample from this station also contained high concentrations of metals and indicated contamination from an anthropogenic source.

## Polycyclic Aromatic Hydrocarbons

PAH concentrations measured during the ANIMIDA project were within the range of values reported from previous studies in the Beaufort Sea and other areas (Boehm 2001). The PAH distributions for most of the surficial sediments sampled during the cANIMIDA project show that the PAHs are primarily of a combined fossil fuel origin (i.e., petroleum and coal) with a biogenic component (perylene), and a smaller fraction of pyrogenic or combustion-related constituents (e.g., 4-, 5-, and 6-ring PAHs) (Brown et al. 2010).

ERL and ERM values have been developed for 13 individual PAH compounds and three classes of PAH (low- and high-molecular-weight PAH, and Total PAH). A comparison of the Total PAH from all ANIMIDA and cANIMIDA sediments from the study region in 1999 through 2006 to the ERL and ERM criteria shows that none of the measured Total PAH concentrations exceed the ERL (Brown et al. 2010). The mean Total PAH values from each study region were generally an order of magnitude lower than the

respective ERLs (Brown et al. 2010). Similarly, the individual PAH concentrations did not exceed the ERLs for the individual 13 PAHs (Brown et al. 2010).

Based on sediment quality criteria, the concentrations of PAH found in the cANIMIDA study area sediments are not likely to pose ecological risk to marine organisms (Brown et al. 2010).

**Triterpanes**

Triterpanes are biogenic organic molecules found in both petroleum and non-petroleum sediment extracts and applied as biomarkers to identify the origins of hydrocarbon mixtures (Waples and Machihara 1990). The structures of triterpane molecules generally include from 19 to 30 carbon atoms, with some exceptions up to 45. Because triterpane molecules are relatively stable in the environment and easily analyzed using widely available instrumentation, the size distribution of triterpane molecules in a sample can be often provide useful information about the source of the sample (Simoneit et al. 1990).

Several surficial sediment samples analyzed from the cANIMIDA study area have triterpane distributions indicative of a petroleum source (Neff 2010). At the site west of West Dock, the triterpane distributions corroborate other organic data indicative of diesel fuel contamination in this area. However, the triterpanedistribution data also indicate the presence of petroleum products "heavier" than diesel, as the distillation process typically removes triterpanes from diesel-range fuels. The cANIMIDA Task 2 final report, "Hydrocarbon and Metal Characterization of Sediments in the cANIMIDA Study Area," suggests that petroleum contamination at the site west of West dock is comprised of a complex hydrocarbon mixture including diesel and heavier hydrocarbons such as heavy fuel oil or crude oil (Brown et al. 2010). Drilling mud/cutting residues from historical exploratory drilling in the area (i.e., Tern Island) could be the source of this contamination , as the historical standard practices involved disposal of used drill muds on the ice during winter drilling (Brown et al. 2010). At other sampled sites, triterpane distributions are indicative of naturally occurring hydrocarbon inputs to the sediments (e.g. erosional inputs of regional shales, coal, peat, etc.) (Brown et al. 2010).

**Other Organic Contaminants**

Surface samples were also analyzed for pesticides, polychlorinated biphenyls, semivolatile organic compounds, and selected volatile organic compounds. Concentrations of these substances were within a low range, and were usually below the limits of detection for the analysis (MMS 2008).

## 3.1.8 Environmental Contaminants and Ecological Processes

This section includes descriptions of ecological processes and ecosystem functions in the affected environment and the environmental contaminants that potentially affect those processes and functions.

Brief descriptions of the 'ecosystem goods and services' provided by the Arctic OCS marine ecosystem will provide context for subsequent evaluation of potential cumulative impacts on the ecosystem and impacts on the local communities that depend on healthy ecosystems for their social, cultural and subsistence way of life.

### 3.1.8.1 Arctic OCS Marine Ecosystem Goods and Services

"Ecosystem functions" refer to properties of the Alaska Arctic region habitat, biological and geochemical systems and the processes facilitated by those systems. Ecosystem goods (such as subsistence foods) and services (such as waste assimilation) represent the benefits that human populations derive, directly or indirectly, from those ecosystem functions (Costanza et al. 1997). Ecosystem services consist of the flows of materials, energy, and information from natural capital stocks (*i.e.* habitats, biological and geochemical systems) that combine with human actions to produce value or welfare for humans (Costanza et al. 1997). A large number of Alaska Arctic region OCS ecosystem functions can be identified, and many of the goods and services that depend on those ecosystem functions are discussed in

other sections of this document. Some examples of relevant ecosystem functions, goods, and services from the Alaska Arctic region OCS are summarized in Table 3.1-8.

**Table 3.1-8 Examples of Arctic Ecosystem Functions, Goods, and Services.**

| Ecosystem goods and services | Ecosystem Functions | Examples |
|---|---|---|
| Subsistence food | Primary production, nutrient cycling, and trophic processes | Edible animals and plants; fish (subsistence food resources) |
| Waste treatment; water purification | Recovery of mobile nutrients and or breakdown of contaminants | Pollution control; detoxification |
| Climate regulation | Regulation of temperature, precipitation, albedo | Climate change mitigation; biogeochemical stability |
| Raw materials | Provision of raw materials, fuel | Oil and gas |
| Recreation resources | Provision of opportunities for recreation | Wildlife viewing; recreational boating; tourism |
| Cultural Resources | Provision of opportunities for non-commercial uses | Aesthetic, spiritual, educational, and scientific values |

The values of ecosystem goods and services in the Alaska Arctic Region OCS are usually derived from interplay among various ecosystem components— the physical environment, chemical environment, and biological communities. Ecosystem goods and services are only rarely the product of a single species or component. Therefore, the interactions of various ecosystem components must be considered as important aspects of the affected environment.

### 3.1.8.2 Identification of Stressors of Potential Concern

A stressor can generally be defined as anything that negatively affects human health and/or ecological processes. Stressors can be physical (e.g. temperature), chemical (i.e. contaminants), or biological (e.g. bacterial contamination). In order to assess potential ecological effects, and related impacts to ecosystem goods and services, stressors potentially resulting from oil and gas exploration activities in the Beaufort and Chukchi seas must be identified. All three types of stressors may be directly or indirectly associated with oil and gas exploration. However, this section will focus on chemical Stressors of Potential Concern (SOPCs) (i.e., contaminants) resulting from oil and gas exploration activities in the Beaufort and Chukchi seas. Particular consideration will be given to levels of anthropogenic chemicals in the environment that may be accessible to organisms for assimilation and possible toxicity (i.e., bioavailable).

Existing development in the project area provides multiple sources of contaminants that may be bioavailable. Chronic discharges of contaminants occur during every breakup from fluids entrained in the ice roads. Entrained contaminants from vehicle exhaust, grease, antifreeze, oil, and other related fluids pass into the Beaufort Sea system. These discharges may involve organic contaminants with high potential for bioaccumulation (Brown et al. 2010). Although drilling fluids and cuttings are usually disposed of through onsite injection into a permitted disposal well, or transported offsite to a permitted disposal location, some drilling fluids are discharged at the sea floor before well casings are in place. Drill cuttings and fluids contain relatively high concentrations of contaminants that have high potential for bioaccumulation, such as dibenzofuran and PAHs (see Table 3.1-9). Historically, drill cuttings and fluids have been discharged from oil and gas developments in the project area, and residues from historical discharges may be present in the affected environment (Brown et al. 2010).

## Table 3.1-9 Water Quality Data for Drill Cuttings

| Pollutant | Range of Concentrations Before Washing | After Washing |
|---|---|---|
| **Conventional Parameters** | | |
| pH | 5.70 – 8.42 | 7.00 – 9.20 |
| Specific gravity (kg/L) | 1.26 – 2.07 | 0.98 – 1.59 |
| BOD-5 (mg/kg) (Biological Oxygen Demand) | 325 – 4,130 | 3,890 – 8,950 |
| UOD-20 (mg/kg) (Universal Oxygen Demand) | 2,640 – 10,500 | 12,800 – 26,600 |
| TOC (mg/kg) (Total Organic Carbon) | 58,300 – 64,100 | 23,000 – 27,200 |
| COD (mg/kg) (Chemical Oxygen Demand) | 190,000 – 291,000 | 90,600 – 272,000 |
| Oil & Grease (mg/kg) | 54,200 – 130,000 | 8,290 – 108,000 |
| **Metals (mg/kg) (average of duplicate samples on a dry weight basis)** | | |
| Zinc | 107 – 2,710 | 114 – 3,200 |
| Beryllium | <1.0 | <1.0 |
| Aluminum | 6,020 – 10,900 | 5,160 – 10,500 |
| Barium | 34 – 84.8 | 27.2 - 235 |
| Iron | 16,600 – 30,800 | 17,400 – 20,600 |
| Cadmium | 0.402 – 16.4 | 0.408 – 15.8 |
| Chromium | 9.48 – 11.7 | 10.7 - 12 |
| Copper | 20.6 – 55.3 | 20.4 – 42.6 |
| Nickel | <6 – 12.1 | 6.2 – 15.9 |
| Lead | 21.4 - 298 | 47.6 - 264 |
| Mercury | 0.09333 – 0.4893 | 0.0920 – 0.944 |
| Silver | 0.447 – 0.574 | 0.222 – 0.568 |
| Arsenic | 7.07 – 10.3 | 7.0 – 10.6 |
| Selenium | <3.0 | <3.0 |
| Antimony | <0.06 - <0.35 | <0.06 - <0.35 |
| Thallium | 0.235 – 0.57 | 0.134 – 0.866 |
| **Organics (µg/kg) (wet weight basis)** | | |
| Acenaphthene | 677 – 38,800 | |
| Naphthalene | 3582 – 149,000 | 63,500 |
| 4-Nitrophenol | 30,400 | |
| N-Nitrosodiphenylamine | 2,870 – 56,500 | 3,150 – 24,300 |
| Bis (2-ethylhexyl) Phthalate | 17,300 | |

| Pollutant | Range of Concentrations Before Washing | After Washing |
|---|---|---|
| Phenanthrene | 59,900 – 145,000 | 25,800 – 65,700 |
| Pyrene | 18,900 | 7,860 |
| Dibenzothiophene | 37,300 | 15,000 |
| Dibenzofuran | 2,150 – 33,700 | 21,700 |
| N-Dodecane | 23,000 – 403,000 | 6,300 – 185-000 |
| Diphenylamine | 56,500 | 5,900 – 23,400 |
| Alphaterpineol | 6,310 | |
| Biphenyl | 4,230 – 69,400 | 1,170 – 33,000 |

**Source:** (CENTEC 1984; EPA 1985; EPA 2006b).

While chemical concentration data are useful for determining the relative degrees of contamination among sampling sites, they provide neither a measure of adverse biological effects nor an estimate of the potential for ecological effects (Calow and Forbes 2003). One way to relate chemical concentrations to the potential for adverse effects involves comparisons of measured values to established threshold values. Previous studies in the Alaska Arctic OCS have employed the system described by Long and Morgan (1990), and Long et al. (1995) for comparison of measured values to ERL and ERM concentrations for contaminants in marine and estuarine sediments. Brown et al. (2010) used ERL concentration values as the thresholds above which adverse effects are predicted to occur to sensitive life stages and/or species. The ERM values for the chemicals were the concentrations equivalent to the 50 percentile point in the screened available data. They were used as the concentration above which effects were frequently or always observed or predicted among most species. Because the ERL and ERM concentrations account for the effects of individual chemical stressors on multiple species from different trophic levels, this approach may provide a basis for predicting the likelihood of ecosystem-level impacts that could result from inputs of chemical contaminants.

Many of the organic contaminants associated with past development in the project area (*e.g.*, PAH) have low solubility in water due to their nonpolar molecular structures. As a result of low aqueous solubility, these compounds tend to associate with organic material or solid-phase particles (such as sediments) in the environment. Similarly, the elemental forms of some potentially toxic metals, such as lead and mercury, have low aqueous solubility. However, these metals may react with other naturally occurring chemical species to form soluble compounds. For example, elemental mercury (Hg) is relatively insoluble in water, while mercuric chloride ($HgCl_2$) and dimethyl mercury ($C_2H_6Hg$) are considerably more soluble. The aqueous solubility of a contaminant is an important parameter for determining its behavior in the environment, and the potential pathways through which organisms could be exposed to the contaminant.

The differential solubility of a contaminant between organic and aqueous phases can be expressed as the octanol-water partition ratio. Contaminants with high octanol-water partition ratios are relatively hydrophobic and tend to associate with organic molecules in the environment (*e.g.*, sediments and lipids). Contaminants with lower octanol-water partition ratios are relatively hydrophilic, and elevated concentrations of these soluble contaminants may be found in the water. The behavior of a contaminant in the environment, and the potential pathways for exposure of organisms, depend upon the aqueous solubility of the contaminant as well as the physical, chemical, and biological characteristics of the environment. For these reasons, chemical concentration data from different matrices (*e.g.*, water, sediments, and biota) must be considered in combination with an understanding of the processes that connect ecosystem components in order to meaningfully predict the impacts of chemical contaminants on ecosystem processes.

The relationships between chemical contaminants and ecosystem processes must be considered when assessing the potential for ecological and societal consequences of pollution (Calow and Forbes 2003).

### 3.1.8.3 Exposure of Biological Communities

The fundamental theoretical basis for assessing the environmental impacts of contaminants is provided by the dose–response model, in which the number of individual organisms in a test population responding to different doses of a chemical is used as a measure of the chemical toxicity (Calow and Forbes 2003). Results of dose-response experiments are often expressed in terms of a fixed percentile (*e.g.*, the $LD_{50}$, or the dose at which 50 percent of the test population suffers a lethal response). However, it is generally recognized that the dose-response model is an oversimplification of real ecological conditions and fails to take into account the ecosystem-level effects of contaminants (Calow and Forbes 2003). The dose-response model traditionally used in environmental impact assessment only considers the effects of stressors on individuals or populations and does not account for impacts that may occur at the ecosystem level (Figure 3.1-11).

Ecology is rarely concerned only with individuals or populations. Communities (mixed species groups) and ecosystems (communities in interaction with their abiotic surroundings) can persist, within limits, despite losses of individuals or populations. What matters is persistence of ecosystem functions and prevention of irreversible reductions that could lead to extinction (Calow and Forbes 2003). The Alaska Arctic Region OCS ecosystem is dynamic, and there are complex relationships between biological community structure, environmental chemistry, and the ecosystem functions responsible for the provision of ecosystem goods and services. Extrapolating the results of toxicity tests to likely ecosystem-level effects involves a number of uncertainties (Calow and Forbes 2003). However, there are some general trends, which should increase confidence in relating the results from toxicity tests to more complex ecological systems.

When ecosystems are not affected by strong external perturbations, certain well-defined developmental trends can be observed. For example, in the absence of external disturbance, the biomass in a system tends to increase, and net community production tends to decrease (Odum 1985). An increase in respiration at the community-level should be the first early warning sign of stress because repairing damage caused by stress requires diverting energy from growth and production to maintenance. Thus, the respiration to biomass ratio (R/B) increases as damage induced by a stressor is repaired (Odum 1985). Accordingly, stressed ecosystems tend to exhibit a decreased ratio of biomass to energy flow, or a low efficiency of converting energy to biological structure. In practice, it is difficult to detect small increases in respiration in large open systems. However, changes in the rates of physiochemical processes (*e.g.* respiration and photosynthesis) can be measured at the community level, and this is the level at which we should search for early warning signs of stress (Odum 1985). Changes in rates of production and respiration relative to biomass are more useful than lethal responses as indicators of early system-level stress.

Stressed systems also exhibit changes in nutrient cycling, which are analogous to the changes in energetics described in the previous paragraph. Rates of nutrient turnover increase in perturbed systems, and the recycling of nutrients within systems becomes less efficient. In an unperturbed system, the transfer of nutrients between trophic levels is relatively complete, and net nutrient loss from the system is accordingly low (Odum 1985). However, in response to system-level stress the couplings between trophic levels become less organized and nutrients are lost from the system as a result. Exported or unused primary production tends to increase in response to system-level stress (Odum 1985). As a result, food chains become shorter because of reduced energy and nutrients at higher trophic levels, and diversity of apex species tends to decline.

Measurement of ecosystem-level responses to stress involves a number of uncertainties. However, energy flows and nutrient cycles provide robust information about ecosystem functions, and must be

considered in order to assess the cumulative effects of environmental contaminants in the Alaska Arctic regions OCS.

### 3.1.8.4 Oil Spill History

The state of knowledge related to Beaufort Sea oil spills, including an extensive literature review, is presented by SL Ross Environmental Research Ltd. et al. (2010).

The responses to five spills on the North Slope of Alaska, in particular the March 2006 pipeline release from an infield pipeline onto snow-covered tundra, are described by Majors and McAdams (2008).

Because sufficient historical data on offshore oil spills do not exist for the Alaska Arctic OCS regions, agencies rely upon estimates to represent expected frequency and severity of oil spills in these regions (Bercha International Inc. 2006a and 2006b (in OCS Study MMS 2006-033 and OCS Study MMS 2005-O61) and (MMS 2007a).

Oil spill occurrence estimates have been generated for several expected future oil and gas development scenarios (including exploration, production, and abandonment) in the Beaufort and Chukchi seas (Bercha International Inc. 2006a and 2006b (in OCS Study MMS 2006-033 and OCS Study MMS 2005-O61) and (MMS 2007a). The above referenced reports describe oil spill occurrence models based on fault-tree analysis. Fault-tree analysis is a method for estimating spill rates resulting from the interactions of other events. Fault trees are logical structures that describe the causal relationship between the basic system components and events resulting in system failure. Fault-tree models are graphical techniques that provide a systematic description of the combinations of possible occurrences in a system, which can result in an undesirable outcome. Using fault trees, base data from the Gulf of Mexico were modified and augmented to represent expected Arctic offshore oil spillage frequencies.

### 3.1.8.5 Existing Regulatory Control of Discharges

Regulatory control of ocean discharges associated with oil and gas exploration activities in the Alaska Arctic Region OCS is largely under the purview of the EPA. A more detailed discussion of the existing regulatory controls of ocean discharges, including national and regional contingency plans for response to oil and hazardous substance discharges and releases, can be found in Section 2.3.3.

# 3.2 Biological Environment

## 3.2.1 Lower Trophic Level Ecology

The following section will describe the lower trophic level environments in the Beaufort and Chukchi seas, trophic level interactions, and the influence of climate change on lower trophic level ecology. Descriptions of the physical environment such as physical oceanography and water quality have been discussed in Sections 3.1.1 and 3.1.7 respectively, so therefore will not be repeated here. Lower trophic levels have been described in several EISs for oil and gas lease sales in both the Beaufort and Chukchi seas (MMS 1990, 1991, 2007c, 2008 and 2009a); these descriptions are incorporated in this document by reference and are summarized below.

### 3.2.1.1 Lower Trophic Level Environments

Lower trophic levels can be categorized as: epontic (living on the underside of or in sea ice); pelagic (living in the water column); and benthic (living on or in the sea bottom) (MMS 1991).

**Epontic**

Microalgae are found in sea ice as it forms in the fall, but the origin of the cells is not known (Horner and Schrader 1982). One possibility is that the species may be present in low numbers in the water column and may be incorporated into the ice as it forms (Horner and Schrader 1982, MMS 1991). The primary producers in the epontic community are ice algae, which live within or attached to the undersurface of sea ice. The ice algae form a concentrated food source for a variety of animals, including amphipods, copepods, ciliates, worms, and fishes, especially in the early spring (Gradinger et al. 2009).

The primary production of epontic communities is largely tied to under-ice light levels, which decrease with increasing ice thickness, snow cover, and sedimentation. Gradinger and Bloom (2005) found that algal blooms were up to two orders of magnitude lower in ice that had high sedimentation loads. Light appears to be the major factor controlling the distribution, development, and production of the ice algal assemblage. These epontic algal communities provide the sole source of fixed carbon for higher trophic levels in ice covered waters, when other sources do not exist (NRC 2004). For example, Lee et al. (2010) documented increases in primary productivity in benthic communities resulting from additions by epontic organisms during winter months and as ice recedes.

**Pelagic**

Planktonic organisms occur in the water column and are subject to the movement of the water, as they are unable to effectively swim against currents. Plankton is comprised of two basic groups, phytoplankton, the primary producers or plant component of the plankton, and zooplankton, the animal component of the plankton (MMS 1991).

The timing of sea ice breakup is critical for phytoplankton production as it provides a stable surface layer with an abundance of light needed for photosynthesis. Spring algal blooms often occur near the sea-ice edge due to wind-driven upwelling of nutrients. Phytoplankton abundance and distribution can be determined with the use of satellite technology by measuring chlorophyll concentrations or ocean color, i.e. “greenness” of the surface water (Wang et al. 2005). High chlorophyll concentrations have been recorded in the southwestern Chukchi Sea and along the coast of the Beaufort Sea (Wang et al. 2005). In fact, primary production rates in the southwest Chukchi Sea are among the highest ever recorded. Generally, these values are much lower near the coast, yet there are areas of high productivity on the continental slope of the Beaufort Sea, in the northern part of the Chukchi shelf between the 50- and 100 m- isobaths, in the southern part of the Chukchi southwest of Point Hope, and on the shelf northwest of Point Barrow (Sukhanova et al. 2009).

Zooplankton life histories and community structures are intricately coupled to phytoplankton production as prey resources. Therefore, areas with high primary phytoplankton productivity will also possess high zooplankton abundance and diversity (Hopcroft et al. 2010). In addition, the spatial distribution of zooplankton communities is strongly tied to physical and chemical differences in water masses (Iken et al. 2010). The zooplankton communities in the Beaufort and Chukchi seas are largely dominated by copepods, mostly *Calanus* and *Pseudocalanus*, followed by larvaceans, and euphausids (Ashijan et al. 2003, Hopcroft et al. 2010). Zooplankton samples in the Beaufort Sea also have included coelenterates, nematodes, annelids, mollusks, tunicates, decapod crustaceans, and barnacles (MMS 1991). Pteropods, cnidarians, and ctenophores are also important constituents of these pelagic communities. This community structure is more similar to that in the Pacific and Bering Seas compared to the Arctic due to the high transport rate of water masses northward along the Anadyr current.

## Benthic

The shallow continental shelves of the Beaufort and Chukchi seas are among the largest in the world (Grebmeier et al. 2006). Each possess varying substrates such as fine sands, muds, and silts (BOEM 2010a) and each of these substrates is closely tied to the distribution of benthic fauna. For example, in benthic communities, you will find patchily distributed mollusks, polychaete worms, and amphipods in sandy, silty, or muddy sediments (Conlan et al. 2008, Feder et al. 2007). Among the benthic biota, there are localized areas of abundant and diverse marine life where boulders provide a hard substrate for algae and epibenthic macrofauna, such as kelp, to attach (Dunton et al. 2006). The benthic communities in the Beaufort and Chukchi seas can be categorized as: benthic microalgae (microscopic plants); macroscopic algae (large seaweeds); and benthic invertebrates (organisms that live on the bottom of a water body).

### *Benthic Microalgae*

Benthic-microalgal assemblages, consisting primarily of diatoms, have been studied in the nearshore area off Barrow (Matheke and Horner 1974), off Narwhal Island (Horner and Schrader 1982), and in Stefansson Sound (Horner and Schrader 1982, Dunton 1984). The relationship of the species found in sediments with those found in the ice-algal assemblage is unclear, although some species occur in both assemblages. Primary productivity of the benthic microflora in the Chuckchi Sea in the nearshore area off Barrow, as reported by Matheke and Horner (1974), ranged from less than 0.5 mg C/m$^2$/hr in winter (when the sampling area was covered with ice), to almost 57.0 mg C/m$^2$/hr in August. This peak-productivity value was about eight times the peak value for ice-algal production and approximately twice that of the phytoplankton. The productivity of these various assemblages peaked at different times: ice-algal productivity peaked in May; phytoplankton productivity peaked in the first half of June; and productivity of the benthic microalgae peaked during late July and August. Although Matheke and Horner (1974) reported high productivities for benthic microalgae over the summer, Horner and Schrader (1982) and Dunton (1984) estimate that benthic microalgae contribute about two percent of the annual carbon produced in the Stefansson Sound Boulder Patch, with production in the absence of turbid ice figured at about 0.4 g C/m$^2$/yr.

### *Macroscopic Algae*

Although most substrates in the Beaufort and Chukchi seas are unsuitable for settlement and growth of large algae, some still persist. Hard substrates (such as cobbles and boulders) occur sporadically, allowing for larger kelp communities. The occurrence of such substrates does not always coincide with large algae since ice gouging can prevent its establishment or growth.

Kelp beds are known to fulfill many diverse habitat functions in other regions of the world's coastal oceans, such as providing three-dimensional space, protection, food, and nursery areas for juvenile life stages (Iken 1999, Iken et al. 1997, Dean et al. 2000, Beck et al. 2003) and as such, often increase the number of associated fauna (Taylor 1998). In the Boulder Patch, located in the central Alaskan Beaufort Sea, for example, an important portion of carbon channeling through the food web is derived from

macroalgae and approximately 60 percent of the particulate organic matter found in the environment (Dunton and Schell 1987, Dunton 1984).

Kelp beds have been found in the Beaufort Sea in Stefansson Sound in the Boulder Patch and in Camden Bay. The Boulder Patch is an isolated macroalgal-dominated rocky bottom habitat within the usually soft-sediment environment of the Beaufort Sea. The Boulder Patch has been studied extensively, and more than 140 species of invertebrates have been identified including sponges, byrozoans, and hydrozoans with the dominant taxa being red and brown algae (Dunton et al. 2007; MMS 2007c, 2003). The biodiversity and community structure patterns vary among different locations within the Boulder Patch, mainly due to differences in light levels and substrate type. Light limits the growth of kelp in the winter when nutrient levels are high, and, in the summer, nutrients limit the growth when light levels are high (Dunton and Schell 1986). Kelp also has been observed shoreward in an area behind a shoal near Konganevik Point in Camden Bay; although its spatial distribution and density are not known (MMS 2008).

Although systematic surveys for macroscopic algae, especially kelp beds, have not been undertaken in the northeastern Chukchi Sea, records from a variety of sources indicate the presence of at least two kelp beds along the nearshore coast. One first described by Mohr et al. (1957) and confirmed by Phillips et al. (1982) is located about 20 kilometers (km) (12.4 mi) northeast of Peard Bay, near Skull Cliff. Another was reported by Phillips and Reiss (1985a) approximately 25 km (15.5 mi) southwest of Wainwright in water depths of 11 to 13 meters (m) (36 to 43 ft). Even without detailed surveys, it appears that kelp beds are not frequently encountered in the Chukchi Sea. Mohr et al. (1957) remarked that kelp were found at only one of 18 stations sampled by the Arctic Research Lab's LCM William E. Ripley as it traveled from Point Barrow to Wainwright; the one station where it found algae was near Skull Cliff. The predominant alga at this station was the kelp, *Phvllaria dermatodea*. Two other known algae, *Laminaria saccharina* and *Desmarestia viridis*, also were abundant; and seven species of red algae were sampled. Johnson et al. (1993) reported observing very large quantities of green algae (probably *Ulva* and *Enterornorpha*) which were being utilized as a feeding area by brant. Other macroscopic algae have been noted in Peard Bay, as drift algae and when fouling anchors (Truett 1984). The areal extent and the inherent possibility of variability in areal extent have not been determined.

### *Benthic Invertebrates*

Benthic invertebrates in the Beaufort and Chukchi seas can generally be divided into two main categories: epifauna and infauna, based on their relationship with the substrate. Infaunal organisms live within the substrate and, as a result, are often sedentary. Epifaunal organisms, on the other hand, generally live on or near the surface of the substrate (MMS 1990). Benthic communities offshore can be quite diverse. Organisms commonly found in surveys include echinoderms, sipunculids, mollusks, polychaetes, copepods, and amphipods (Dunton, Schonberg, and McTigue, 2009; Rand and Logerwell, 2011).

Blanchard et al. (2010) reported that infauna in Burger and Klondike survey areas, associated with the Chukchi Sea Lease Sale 193, are abundant, contain many animals with high biomass, and comprise diverse communities. They found that average abundance, biomass, and number of taxa of infauna were significantly higher in Burger than in Klondike, but macrofaunal communities in both survey areas were similarly diverse. Macrofaunal community structure was found to be correlated with environmental characteristics such as percent sand, salinity, and phaeopigment concentrations, associated with topography, water currents and other related factors within their survey areas. The Lease Sale 126 EIS (MMS 1991) explains that the area around the Burger Prospect is inhabited by polychaete *Maldane*, brittle star *Ophiura*, sipunclid (peanut worm) *Golfingia*, and bivalve *Astarte*. Ambrose et al. (2001) found that brittle stars were overwhelmingly dominant in some parts of the northeastern Chukchi Sea.

Blanchard et al. (2010) also sampled a gray whale feeding area northwest of Wainwright and found the site to be dominated by amphipods, whereas the faunal communities found in Burger and Klondike were dominated by bivalves and polychaete worms.

As with the infauna, Blanchard et al. (2010) reported that the epifaunal communities of Burger and Klondike comprise taxon groups with high abundance and biomass reflecting diverse communities. Immobile fauna such as sponges, encrusting bryozoans, hydroids, soft corals, and tube worms thrive on the rocky and macroalgal substrates (Dunton et al. 2007, Konar and Iken 2005).

#### 3.2.1.2 Trophic Level Interactions

In the Beaufort and Chukchi seas, the trophic levels not only interact, but are interdependent (Figure 3.2-1). For example, it is believed that incomplete grazing of ice algae may allow a significant portion of the algal-cell population to remain intact, serving as a direct food source for the pelagic level, and if not fully consumed, may enhance the benthic level by sinking as either detritus (dead) or living, photosynthetically active, cells (Alexander and Chapman 1981, Niebauer et al. 1981, Stoker 1981).

Dynamics within the pelagic community are mostly influenced by transport of nutrients, phytoplankton, and consumers from the Bering Sea, plus the seasonal retreat of ice and subsequent bloom of open-water phytoplankton. Other primary producers such as kelp, benthic microalgae, or ice-algae may be locally or temporally important sources of carbon (the ice algae providing a burst of production before the open-water phytoplankton bloom). Zooplankton in the Chukchi Sea are thought to be similar to those of the middle Bering Sea shelf in species composition and as small, inefficient grazers of phytoplankton.

Thus, much of the local production, as well as plankton and detritus transported into the Chukchi Sea, may sink to the ocean floor and support benthic organisms. It has been suggested that the epibenthic (living on the surface of bottom sediments) community is dependent on detritus (Stoker 1981). Both the epifauna and infauna are important components in the diets of higher-order consumers.

In the spring, the melting and retreating ice edge of the Chukchi Sea leads to a highly productive and estuary-like near shore corridor that serves as the base of the food chain for coastal and marine Arctic species. The Chukchi Sea's shallow and highly productive sea floor also allows benthic species such as crustaceans and mollusks to flourish and create an important food source for wildlife specialized to feed at the ocean floor, such as walrus, seals, gray whales, and deep-diving sea birds (Audubon 2011).

The benthic faunal biomass is relatively high in the northeastern Chukchi, compared to the central and western Chukchi and compared to the rest of the Arctic seas (Grebmeier and Dunton 2000). Grebmeier and Dunton (2000) explain that the richness probably is due partly to the inability of Chukchi pelagic fauna to consume all of the primary production, thereby allowing a lot of organic matter to sink to the seafloor. They refer to the situation as weak or loose trophic “coupling,” and the Arctic Climate Impact Assessment (ACIA) refers to such loose coupling as “mismatch” between trophic levels (ACIA 2005).

#### 3.2.1.3 Influence of Climate Change on Lower Trophic Level Ecology

Global climate change is altering the physical environment in the Arctic as described in Section 3.1.4.4. Such changes include warming air and sea temperatures, declining sea ice extent and thickness, salinity changes, rising sea level, increasing precipitation and decreasing snow extent, loss of permafrost, and changes in terrestrial vegetation composition. These changes in the physical environment will precipitate changes on lower trophic level ecology as described here.

The Beaufort and Chukchi seas are characterized by short, open-water summer periods and long, ice-covered winters. However, the extent of the Arctic sea ice has decreased by approximately three percent over the last decade while the extent of the summer ice has decreased up to nine percent during this time period (IPCC 2007a). The 2007 summer ice extent was 39 percent below long term averages from 1979 to 2000 and changes such as these will likely impact the epontic community, and subsequently, the pelagic and benthic communities (MMS 2007c).

Information on generation times, life spans and doubling times are important in any assessment of effects on primary producers or other planktonic organisms. The doubling time for phytoplankton is short, even

in the Arctic. Recent studies have shown that plankton growth rates in the Chukchi Sea range from $0.4d^{-1}$ (equivalent to a doubling in 2.5 days) to $0.16d^{-1}$ (equivalent to a doubling in 6.25 days) which results in doubling times of a few days (Grebmeier et al. 2009). In contrast, many Arctic zooplankton reproduce only once per year resulting in generation times of one year (Hopcroft et al. 2010). However, there are studies showing faster growth rates in warmer water (Feder et al. 2005). Therefore, warming ocean temperatures associated with climate change may increase zooplankton growth rates and generation times in the Beaufort and Chukchi seas.

Atmospheric climate variation and its impact on circulation, heat, salt and nutrient content of shelf waters and sea/shore fast ice formation are central issues in the Arctic seas. It is unlikely that ecosystem change will be understood until more studies examine the Arctic Oscillation-ecosystem interactions (NRC 2004a). Understanding the proximate and ultimate controlling factors of various trophic level standing stocks and production rates is essential for interpreting ecosystem change occurring presently in the Arctic (Aagaard et al. 1999). The impacts of climate change to the ecosystem are commonly thought to be from the bottom up through the nutrient-phytoplankton-zooplankton sequence, while human impacts are top down (Carmack and Macdonald 2002). However, the presence of sea ice as habitat for top-level predators such as polar bears means that climate change will directly affect higher trophic levels. An added element of the ecosystem in Arctic seas is shore-fast ice and its attendant phenomena (turbulence under ice, formation of freshwater pools due to blockage of river inflow).

### 3.2.2 Fish and Essential Fish Habitat

The following description of fish resources of the Beaufort and Chukchi seas largely adopts the "Fish Resources" section from the Beaufort and Chukchi Sea Planning Area Lease Sale 209, 212, 217, and 221 DEIS (MMS 2008). This section is almost fully incorporated into this document with some modifications, primarily to include the most recent information available since publication.

Over 400 fish species are known to inhabit Arctic seas and adjacent waters, which include marine, migratory (mostly anadromous), and freshwater fish species that enter brackish water. The Alaskan Chukchi and western Beaufort seas support at least 107 fish species, representing 25 families (Mecklenburg et al. 2002, Logerwell and Rand 2010, Love 2005, Harris 1993, Johnson et al. 2010) (see Table 3.2-1). Families include lampreys, sleeper sharks, dogfish sharks, herrings, smelts, whitefish, trout and salmon, lanternfish, cods, sticklebacks, greenlings, sculpins, sailfin sculpins, fathead sculpins, poachers, lumpsuckers, snailfish, eelpouts, pricklebacks, gunnels, wolffish, sand lances, and righteye flounders. Forty-nine known species are common to both the Beaufort and Chukchi seas. A recent study by Logerwell and Rand (2010) discovered 5 new species formerly unidentified in Arctic waters. Additional species are likely to be found as coastal and offshore waters become more thoroughly surveyed. A similar situation has been reported for waters of the Canadian Arctic where the most recent compilation of marine and anadromous fish has resulted in an updating of the species known to occur in this area (Coad and Reist 2004). The list currently consists of 189 species comprised of 115 genera in 48 families. Another 83 species occur in waters adjacent to the Canadian Arctic and could be found in Canadian waters during future surveys (Coad and Reist 2004). Still another 36 species of primarily freshwater taxa occasionally may occur in brackish marine areas (Coad and Reist 2004).

Freshwater species inhabiting the Arctic coastal plain have been much better described than marine species (Table 3.2-1). However, while freshwater habitats and freshwater fish species are important, this section focuses more extensively on coastal and marine fish/fishery resources and habitats occurring in nearshore and offshore waters of the Beaufort and Chukchi seas, because there is likely greatest potential for impacts in these areas by Arctic exploration activities. Few species currently covered by fishery-management plans occur in these waters; however, an Arctic Fishery Management Plan was approved in August of 2009 by the North Pacific Fisheries Management Council (NPFMC) to address Arctic fisheries issues. The NPFMC's policy as articulated in that plan is to *"prohibit commercial harvest of all fish resources of the Arctic Management Area until sufficient information is available to support the*

*sustainable management of a commercial fishery"* (NPFMC 2009). No timeline has been set for such a decision to be made.

**Table 3.2-1 Freshwater, Migratory, and Marine Fish Species of the Alaskan Arctic**

| Order/Family | *Species Name* | Common name | Primary Assemblage[1] | Source[2] |
|---|---|---|---|---|
| **Petromyzontiformes** | | | | |
| Petromyzontidae | *Lampetra tridentata* | Pacific lamprey | MI | MMT |
| | *Lampetra camtschatica* | Arctic lamprey | MI | MMT |
| **Squaliformes** | | | | |
| Dalatiidae | *Somniosus pacificus* | Pacific sleeper shark | MA | MMT |
| Squalidae | *Squalus acanthias* | spiny dogfish | MA | MMT |
| **Clupeoiformes** | | | | |
| Clupeidae | *Clupea pallasii* | Pacific herring | MA | MMT |
| **Esociformes** | | | | |
| Esocidae | *Esox lucius* | northern pike | FW | |
| **Osmeriformes** | | | | |
| Osmeridae | *Mallotus villosus* | capelin | MA | MMT |
| | *Osmerus mordax* | rainbow smelt | MA | MMT |
| **Salmoniformes** | | | | |
| Salmonidae / Coregoninae | *Stenodus leucichthys* | inconnu | MI | MMT |
| | *Coregonus sardinella* | least cisco | MI | MMT |
| | *Coregonus autumnalis* | Arctic cisco | MI | MMT |
| | *Coregonus laurettae* | Bering cisco | MI | MMT |
| | *Coregonus nasus* | broad whitefish | MI | MMT |
| | *Coregonus pidschian* | humpback whitefish | MI | MMT |
| | *Thymallus arcticus* | Arctic grayling | FW | |
| Salmonidae / Salmoninae | *Salvelinus alpinus* | Arctic char | MI | MMT |
| | *Salvelinus malma* | Dolly Varden | MI | MMT |
| | *Oncorhynchus gorbuscha* | pink salmon | MI | MMT |
| | *Oncorhynchus kisutch* | coho salmon | MI | MMT |
| | *Oncorhynchus tshawytscha* | Chinook salmon | MI | MMT |
| | *Oncorhynchus keta* | chum salmon | MI | MMT |
| | *Oncorhynchus nerka* | sockeye salmon | MI | MMT |
| **Myctophiformes** | | | | |
| Myctophidae | *Benthosema glaciale* | glacier lanternfish | MA | MMT |
| **Gadiformes** | | | | |
| Gadidae | *Boreogadus saida* | Arctic cod | MA | MMT |
| | *Arctogadus glacialis* | polar cod | MA | MMT |
| | *Arctogadus borisovi* | toothed cod | MA | MMT |
| | *Eleginus gracilis* | saffron cod | MA | MMT |

| Order/Family | *Species Name* | Common name | Primary Assemblage[1] | Source[2] |
|---|---|---|---|---|
| | *Theragra chalcogramma* | walleye pollock | MA | MMT |
| | *Gadus macrocephalus* | Pacific cod | MA | LR |
| | *Gadus ogac* | ogac | MA | MMT |
| Lotidae | *Lota lota* | burbot | FW | |
| **Gasterosteiformes** | | | | |
| Gasterosteidae | *Gasterosteus aculeatus* | threespine stickleback | FW | MMT |
| | *Pungitius pungitius* | ninespine stickleback | FW | MMT |
| **Scorpaeniformes** | | | | |
| Hexagrammidae | *Hexagrammos stelleri* | whitespotted greenling | MA | MMT |
| Cottidae | *Triglops pingelii* | ribbed sculpin | MA | MMT |
| | *Hemilepidotus papilio* | butterfly sculpin | MA | MMT |
| | *Hemilepidotus jordani* | yellow Irish lord | MA | MMT |
| | *Icelus spatula* | spatulate sculpin | MA | MMT |
| | *Icelus bicornis* | twohorn sculpin | MA | MMT |
| | *Gymnocanthus tricuspis* | Arctic staghorn sculpin | MA | MMT |
| | *Cottus aleuticus* | coastrange sculpin | MA | MMT |
| | *Enophrys diceraus* | antlered sculpin | MA | MMT |
| | *Megalocottus platycephalus* | belligerent sculpin | MA | MMT |
| | *Myoxocephalus quadricornis* | fourhorn sculpin | MA | MMT |
| | *Myoxocephalus scorpius* | shorthorn sculpin | MA | MMT |
| | *Myoxocephalus scorpioides* | Arctic sculpin | MA | MMT |
| | *Myoxocephalus jaok* | plain sculpin | MA | MMT |
| | *Myoxocephalus verrucosus* | warty sculpin | MA | LR |
| | *Triglops nybelini* | bigeye sculpin | MA | LR |
| | *Microcottus sellaris* | brightbelly sculpin | MA | MMT |
| | *Artediellus gomojunovi* | spinyhook sculpin | MA | MMT |
| | *Artediellus scaber* | hamecon | MA | MMT |
| | *Artediellus pacificus* | hookhorn sculpin | MA | MMT |
| | *Artediellus ochotensis* | Okhotsk hookear sculpin | MA | MMT |
| | *Cottus cognatus* | slimy sculpin | FW | |
| Hemitripteridae | *Blepsias bilobus* | crested sculpin | MA | MMT |
| | *Nautichthys pribilovius* | eyeshade sculpin | MA | MMT |
| Psychrolutidae | *Eurymen gyrinus* | smoothcheek sculpin | MA | MMT |
| | *Cottunculus sadko* | Sadko sculpin | MA | MMT |
| Agonidae | *Hypsagonus quadricornis* | fourhorn poacher | MA | MMT |
| | *Pallasina barbata* | tubenose poacher | MA | MMT |
| | *Occella dodecaedron* | Bering poacher | MA | MMT |
| | *Leptagonus decagonus* | Atlantic poacher | MA | MMT |
| | *Podothecus veternus* | veteran poacher | MA | MMT |
| | *Ulcina olrikii* | Arctic alligatorfish | MA | MMT |

| Order/Family | *Species Name* | Common name | Primary Assemblage[1] | Source[2] |
|---|---|---|---|---|
| | *Aspidophoroides monopterygius* | alligatorfish | MA | MMT |
| Cyclopteridae | *Eumicrotremus derjugini* | leatherfin lumpsucker | MA | MMT |
| | *Eumicrotremus andriashevi* | pimpled lumpsucker | MA | MMT |
| Liparidae | *Liparis gibbus* | variegated snailfish | MA | MMT |
| | *Liparis tunicatus* | kelp snailfish | MA | MMT |
| | *Liparis bristolensis* | Bristol snailfish | MA | MMT |
| | *Liparis fabricii* | gelatinous seasnail | MA | MMT |
| | *Liparis callyodon* | spotted snailfish | MA | MMT |
| | *Careproctus sp. cf. rastrinus* | salmon snailfish | MA | LR |
| | *Liparis marmoratus* | festive snailfish | MA | LR |
| **Perciformes** | | | | |
| Zoarcidae | *Gymnelus hemifasciatus* | halfbarred pout | MA | MMT |
| | *Gymnelus viridis* | fish doctor | MA | MMT |
| | *Lycodes seminudus* | longear eelpout | MA | MMT |
| | *Lycodes mucosus* | saddled eelpout | MA | MMT |
| | *Lycodes turneri* | estuarine eelpout | MA | MMT |
| | *Lycodes polaris* | polar eelpout | MA | MMT |
| | *Lycodes raridens* | marbled eelpout | MA | MMT |
| | *Lycodes rossi* | threespot eelpout | MA | MMT |
| | *Lycodes sagittarius* | archer eelpout | MA | MMT |
| | *Lycodes palearis* | wattled eelpout | MA | MMT |
| | *Lycodes pallidus* | pale eelpout | MA | MMT |
| | *Lycodes squamiventer* | scalebelly eelpout | MA | MMT |
| | *Lycodes eudipleurostictus* | doubleline eelpout | MA | MMT |
| | *Lycodes concolor* | ebony eelpout | MA | MMT |
| Stichaeidae | *Eumesogrammus praecisus* | fourline snakeblenny | MA | MMT |
| | *Stichaeus punctatus* | Arctic shanny | MA | MMT |
| | *Chirolophis snyderi* | bearded warbonnet | MA | MMT |
| | *Leptoclinus maculatus* | daubed shanny | MA | MMT |
| | *Anisarchus medius* | stout eelblenny | MA | MMT |
| | *Lumpenus fabricii* | slender eelblenny | MA | MMT |
| Pholidae | *Pholis fasciata* | banded gunnel | MA | MMT |
| Anarhichadidae | *Anarhichas orientalis* | Bering wolffish | MA | MMT |
| Ammodytidae | *Ammodytes hexapterus* | Pacific sand lance | MA | MMT |

| Order/Family | *Species Name* | Common name | Primary Assemblage[1] | Source[2] |
|---|---|---|---|---|
| **Pleuronectiformes** | | | | |
| Pleuronectidae | *Hippoglossus stenolepis* | Pacific halibut | MA | MMT |
| | *Hippoglossoides robustus* | Bering flounder | MA | MMT |
| | *Reinhardtius hippoglossoides* | Greenland turbot | MA | MMT |
| | *Platichthys stellatus* | starry flounder | MA | MMT |
| | *Pleuronectes quadrituberculatus* | Alaska plaice | MA | MMT |
| | *Pleuronectes glacialis* | Arctic flounder | MA | MMT |
| | *Limanda proboscidea* | longhead dab | MA | MMT |
| | *Limanda aspera* | yellowfin sole | MA | MMT |
| | *Limanda sakhalinensis* | Sakhalin sole | MA | MMT |

[1]FW = Freshwater; MI = Migratory; MA = Marine
[2]MMT = Mecklenburg, Mecklenburg, and Thorsteinson 2002; LR = Logerwell and Rand 2010

### 3.2.2.1 Major Surveys of Coastal and Marine Fish Resources and Habitats

MMS (2008) identified the following as some important surveys conducted in the Beaufort and Chukchi seas in the last century.

In 1932 and 1933 Russians A.P. Andriyashev, K.I. Panin, and P.V. Ushakov made the first major scientific collections of fish in the Chukchi Sea (Raymond 1987). Andriyashev (1955; a translation of a report published in 1937) described basic information concerning fish collected by Russian expeditions of the Bering and Chukchi seas.

Frost and Lowry (1983) reported on thirty-five successful otter-trawl tows that were conducted in the northeastern Chukchi and western Beaufort seas in August-September of 1976 and 1977. In 1976, two tows were made in the western Beaufort Sea in water 40 m (131 ft) and 123 m (404 ft) deep. In 1977 (August 2 to September 3), 33 tows were made in the northeastern Chukchi and western Beaufort seas in waters 40 to 400 m (131 to 1,312 ft) deep. Many were conducted near the southern edge of pack ice. Frost and Lowry (1983) caught 133 fish belonging to 14 species in trawls made in 1976. In the more extensive trawls conducted in 1977, they caught 512 fish belonging to 17 species, of which 65 percent were represented by just three species (*Boreogadus saida*, *Lycodes Polaris* and *Icelus bicornis*).

Fechhelm et al. (1984) reported results of an ichthyological survey conducted in 1983 that focused primarily on Arctic fish usage of, and ecological dependence on, marine estuarine environments along the northeastern Chukchi Sea coast from Peard Bay to Point Hope. Data were collected for the most part during the open-water summer season and, to a lesser extent, in winter. Their survey revealed the most prominent species encountered during 1983 were arctic cod, Arctic staghorn sculpin, fourhorn sculpin, capelin, shorthorn sculpin, hamecon, Arctic flounder, and saffron cod. Fourhorn sculpin and Arctic flounder occurred in nearshore waters (<1 km [<0.6 mi]), while the remaining sculpins were found exclusively in deeper, offshore (>1 km [<0.6 mi]) waters. Arctic and saffron cod were found to occupy both nearshore and offshore waters.

Barber et al. (1993) reported data obtained in the northeastern Chukchi Sea between Cape Lisburne in the south to the ice edge in the north between 1989 and 1992. Collectively, these surveys and associated studies reflected a sparse sampling of fish resources across the northeastern Chukchi Sea. Sampling effort has been spatially and temporally irregular and disjunct. More recent survey efforts, such as those by Logerwell and Rand (2010), Norcross et al. (2009) and by Shell Oil and ConocoPhillips (yet to be released) have added, and will add, to this body of knowledge.

A 3-year study (1988, 1990, and 1991) of epipelagic fish inhabiting Beaufort Sea coastal waters in Alaska documented spatial and temporal patterns in fish distribution and abundance and examined their relationships to thermohaline features during summer (Jarvela and Thorsteinson 1999). Significant interannual, seasonal, and geographical differences in surface water temperatures and salinities were observed. In 1990, sea ice was absent and marine conditions prevailed, whereas, in 1988 and 1991, heavy pack ice was present and the dissolution of brackish water along the coast proceeded more slowly. Arctic cod, capelin, and snailfish were the most abundant marine fish in catches, while Arctic cisco was the only abundant diadromous species. The epipelagic fish survey is the most recent pelagic fish survey conducted in the western Beaufort Sea.

In summer 2004, a Russian-American Long-term Census of the Arctic expedition was conducted in the Bering and Chukchi seas (Stein et al. 2005). The primary study area lay between Wrangel Island and Herald Canyon in Russia Federation territorial waters to Cape Lisburne, Alaska, to Point Barrow, Alaska, and south to the Bering Strait. Fish biologists on the expedition noted the following qualitative conclusions: (1) the Chukchi benthic community is highly diverse and patchy; and (2) both fish abundance and diversity seem lower in the Chukchi Sea than in the Bering Sea. The largest catches occurred to the south and were usually at least one order of magnitude higher than those in the north. Also, biologists noted several range extensions or rare species.

A more recent study performed in the Alaskan Arctic was by Logerwell and Rand (2010). The study was a joint effort by NMFS, the University of Washington, and the University of Alaska Fairbanks and surveyed the offshore marine fish and invertebrates and physical and biological oceanography of the western Bering Sea in the vicinity of Cape Simpson to Cape Halkett. The study assessed benthic and demersal communities separately and reported arctic cod was by far the most common species encountered. Both demersal and pelagic fish were most common along the outer edge of the continental shelf, particularly in the northwest portion of the Beaufort Sea. Five new species never previously documented in the Arctic were reported.

A recent study surveyed benthic and demersal fish in the region, but the only previous pelagic survey is more than 20 years old. Fish assemblages and populations in other marine ecosystems of Alaska (e.g. Gulf of Alaska, Bering Sea) have undergone observable shifts in diversity, distribution, and abundance during the last 20 to 30 years, and the recent findings of Logerwell and Rand (2010) suggest that a similar trend is occurring in the Arctic. Five new species were encountered in a small pilot study, so it is likely that most other existing research no longer accurately and precisely reflects the current distribution, abundance, and habitat-use patterns of fish resources in the northeastern Chukchi and western Beaufort seas. It is also reasonable to suggest that because of the sparseness of data from limited surveys in the past, that new species being observed in recent studies may simply be the result of sample locations.

Logerwell and Rand (2010) made a concerted effort to address this by recording Catch Per Unit Effort (CPUE) in order to provide a baseline for future comparisons.

Recent efforts have also been made to document traditional ecological knowledge of the region's fishery resources by Iñupiat residents. Brewster (2011) noted that the Iñupiat have identified many of the large fish congregation areas and migratory routes and placed their fishing camps accordingly. Therefore, cabin locations could be used as an indicator of critical fish habitat in coastal areas.

### 3.2.2.2 The Ecology of Alaskan Arctic Fish

Three large marine ecosystems (LMEs) encompass coastal and offshore waters of Arctic Alaska. They are the Bering Sea, Chukchi Sea, and Beaufort Sea. Each LME is characterized by distinct hydrographic regimes, submarine topographies, productivity, and trophically-dependent populations. The Chukchi Sea LME represents a transition zone between the fish assemblages of the Beaufort and Bering LMEs. Aspects of these three LMEs are discussed below because they interact and influence the others.

Aquatic systems of the Arctic undergo extended seasonal periods of ice cover and other harsh environmental conditions. Fish inhabiting such systems must be biologically and ecologically adapted to surviving such conditions so as to produce offspring that eventually do the same. Behavioral strategies of each life stage are evolutionarily timed to coincide with environmental conditions favoring survival to the next lifestage (MMS 2008). The process of natural selection favors individuals that are adapted to survive such conditions. Important environmental factors that Arctic fish must contend with include reduced light, seasonal darkness, ice cover, low biodiversity, and low seasonal productivity (see McAllister 1975 for a description of environmental factors relative to Arctic fish).

The lack of sunlight and extensive ice cover in the Arctic during winter months influence primary and secondary productivity, making food resources very scarce during this time; most of a fish's yearly food supply must be acquired during the brief Arctic summer (Craig 1989). The Chukchi Sea is warmer, more productive, and supports a more diverse fish population than occurs in the western Beaufort Sea (Craig 1984 citing Morris 1981, Craig and Skvorc 1982), although Arctic waters support fewer fish species than warmer waters to the south such as the Bering Sea or Gulf of Alaska.

Marine waters of the Beaufort and Chukchi seas offer 2- and 3-dimensional area for Arctic fish to exploit; these include nearshore waters and substrates (occurring landward of the continental shelf break, as delimited by the 200-m isobath) and oceanic waters and substrates (occurring seaward of the continental shelf break [>200-m isobath]) (Figure 3.1-12. The fish of the eastern Chukchi and western Beaufort seas use a range of waters and substrates for spawning, breeding, feeding, or growing to maturity (MMS 2006c).

### 3.2.2.3 Primary Fish Assemblages

Arctic fish of Alaska have been categorized into assemblages that take into account habitat use and life-history strategies (Craig 1984, Craig 1989, Moulton and George 2000, Gallaway and Fechhelm 2000). A life-history strategy is a set of co-adapted traits designed by natural selection to solve particular ecological problems (Craig 1989 citing Stearns 1976).

The primary assemblages of Arctic fish are:

- Freshwater fish that spend their entire life in freshwater systems (although some also might spend brief periods in nearshore brackish waters);
- Marine fish that spend their entire life in marine waters (some also spend brief periods in nearshore brackish waters along the coast); and
- Migratory fish that move between and are able to use fresh, brackish, and/or marine waters due to various biological stimuli or ecological factors.

While some Arctic fish species are described in the scientific literature and in surveys as being abundant in the region, they have been thought to be only so in a relative context and were considered to be of low overall abundance compared to lower latitude marine environments. The recent report by Logerwell and Rand (2010), which documents the presence of commercially valuable walleye pollock and Pacific cod and confirming the extension of their ranges, leaves open the question of relative abundance of these species.

#### 3.2.2.3.1 Freshwater Fish

The freshwater environment of the Arctic Coastal Plain west of Barrow is characterized by low relief and poor drainage due to underlying permafrost and a shallow active layer; factors that keep water near the surface. A large portion of the plain is covered by thaw lakes with north-northwest oriented alignments on their long axis. Ice-wedge polygons are found throughout the coastal plain. Major flowing waters of the coastal plain from west to east include the Kukpowruk, Utukok, and Kuk rivers (Arvey et al. 1995).

The freshwater environment of the eastern Arctic Coastal Plain, from Barrow east to the Canadian border, consists of rivers and streams in addition to lakes, ponds, and a maze of interconnecting channels. While some water bodies are completely isolated, most are permanently, seasonally, or sporadically connected. Seasonally connected lakes are flooded during breakup, while sporadically connected lakes are flooded only during high-water years (Parametrix, Inc. 1996). Many of these waters support freshwater and migratory fish populations. As an example, at least 20 species of fish have been collected in or near the Colville drainage system (11 freshwater and 9 migratory species) (Moulton et al. 1985, Bendock 1997). The distribution and abundance of freshwater and migratory fish on the Arctic Coastal Plain depend on: (1) adequate overwintering areas; (2) suitable feeding and spawning areas; and (3) access to these areas (typically provided by a network of interconnecting waterways) (Parametrix, Inc. 1996).

Studies on the Sagavanirktok River have shown that different fish dominate at different times of the year:

- Summer: Arctic grayling, round whitefish, Dolly Varden char (formerly called Arctic char), broad whitefish, and slimy sculpin (Hemming 1988, Woodward-Clyde Consultants 1980);
- March: broad and humpback whitefish, Arctic grayling, round whitefish, burbot, and slimy sculpin in the lower part of the river (MMS 2008);
- April: broad and humpback whitefish, Arctic and least cisco, Arctic grayling, round whitefish, burbot, and slimy sculpin (MMS 2008); and
- May: broad whitefish, Arctic and least cisco, Arctic grayling, round whitefish, and burbot (Craig 1989).

Freshwater fish inhabit many of the rivers, streams, and lakes of the coastal plain, including lake trout, Arctic grayling, Alaska blackfish, northern pike, longnose sucker, round whitefish, burbot, ninespine stickleback, slimy sculpin, Arctic lamprey, and threespine stickleback (rare). Freshwater fish are found almost exclusively in freshwater (Moulton et al. 1985), although those with access to rivers such as the Colville and Sagavanirktok (e.g. Arctic grayling), are sometimes found in the nearshore band of brackish coastal water described earlier. All of the freshwater species mentioned have been collected near the mouth of the Colville River during summer (BLM 1978a); however, their presence in the coastal environment is sporadic and brief, with a peak occurrence expected during or immediately following spring breakup.

Many of the streams on the coastal plain serve as interconnecting links to the many lakes in the area (Bendock 1997). Some waters are used primarily as nursery areas, others for feeding, others for spawning and/or overwintering, and others as corridors linking these areas together. Juvenile fish prefer the warmer shallow-water habitats that become available during the ice-free period (Hemming et al. 1989). The most abundant freshwater fish is the ninespine stickleback (Hemming 1996). The highest numbers are found in waters having emergent and submerged vegetation suitable for spawning and rearing, with overwintering sites nearby (Hemming 1993). In streams, the most common freshwater fish include Arctic grayling, ninespine stickleback, and slimy sculpin (Netsch et al. 1977, Bendock and Burr 1984). In lakes, the most common freshwater fish include lake trout, Arctic grayling, round whitefish, and burbot. Older lake fish usually are dominant. In general, the larger, deeper, clearer lakes with outlets and suitable spawning areas are more likely to support fish. Smaller lakes that are more shallow and turbid, without outlets or suitable spawning areas, are not likely to support fish (Netsch et al. 1977, BLM 1978a). Bodies of freshwater less than 2 m (6 ft) deep generally do not have resident fish populations, although some may be used during summer for feeding, rearing, or as access corridors to other waters.

Outlet streams of deeper lakes are used heavily by broad whitefish for wintering habitat, and during the spring time fish move into the warmer tributaries emptying into Lakes, which contained higher numbers of prey populations (Morris 2006). Moulton (2007) in a study of fish in the Teshekpuk Lake region concluded that factors that appear to increase the value of specific tributaries include the extent of connected lake habitat, and temperature. Broad whitefish, least cisco and Arctic grayling were found to

seek out warmer habitats to feed and grow, "especially when fish are dispersing from wintering areas to begin feeding after the long period of winter fasting." He found that slightly warmer habitats had higher primary productivity, which leads to abundant prey populations for northern pike, lake trout, and burbot.

Freshwater fish feed on terrestrial and aquatic insects and their larvae, zooplankton, clams, snails, fish eggs, and small fish (Bendock and Burr 1984, BLM 1978a, Hemming et al. 1989). Lake trout and burbot are reported to forage heavily on least cisco, round whitefish, grayling, and particularly on slimy sculpin and ninespine stickleback. Lake trout also have been reported to feed on voles (BLM 1978b) and burbot on Arctic lamprey (Bendock and Burr 1984). Except for burbot, which spawn under ice in late winter, freshwater fish spawn from early spring to early fall in suitable gravel or cobble. With the onset of winter, freshwater fish move into the deeper areas of lakes, rivers, and streams. Smaller rivers such as the Kadleroshilik River support only small numbers of ninespine stickleback, Dolly Varden (a migratory species), and Arctic grayling (Hemming 1996).

In winter, bodies of freshwater <2 m (6 ft) deep are frozen to the bottom (Craig 1989). Most streams east of the Colville River are braided and cross broad gravel flats that are often blocked in winter by aufeis (fields of ice that form continuously downstream from spring water sources) that cause local flooding (Selkregg 1976). In deeper waters that do not freeze to the bottom, the amount of dissolved oxygen is of critical importance. Flowing waters exceeding 2 to 4 m (6 to 12 ft) in depth (depending on water velocity) generally are considered deep enough to support overwintering fish. However, in standing waters, the ice becomes thicker, and dissolved oxygen becomes less available as the winter progresses. In such cases, depths of up to 9 m (18 ft) have been suggested as being the minimum required to support overwintering freshwater fish (BLM 1990).

#### 3.2.2.3.2 Marine Fish

Most of the surveys/studies of marine fish in the EIS project area have been performed in coastal waters landward of the 200-m (656-ft) isobath (e.g. Logerwell and Rand 2010, Frost and Lowry 1983, Jarvela and Thorsteinson 1999). In areas where coastal surveys have been conducted, seasonal trends in relative abundance of dominant (abundant) fish species are evident (Logerwell and Rand 2010, Jarvela and Thorsteinson 1999). Robust population estimates or trends for marine fish of the region are unavailable. However, sufficient information is currently available to support sound scientifidc judgements and reasoned managerial decisions. Distribution or abundance data for marine fish species are known only generally at the coarsest grain of resolution (e.g. common, uncommon, rare), although a few studies include abundance estimates (qualitative or quantitative) for localized areas (Logerwell and Rand 2010, Frost and Lowry 1983, Griffiths et al. 1998, Jarvela and Thorsteinson 1999). Detailed information generally is lacking concerning the spread, density, or patchiness of their distribution in either the Beaufort or Chukchi seas, although Logerwell and Rand (2010) has made a concerted effort to address this issue by providing a baseline CPUE for future comparison. Data concerning habitat-related densities; growth, reproduction, or survival rates within regional or local habitats; or productivity rates by habitat, essentially are unknown for fish inhabiting waters seaward of the nearshore, brackish-water ecotone. There will be some level of incomplete information on distribution and habitat-related data for marine fish; however, sufficient information is available to support sound scientific judgements and reasoned managerial decisions.

Logerwell and Rand (2010) recently reported on the results of a study in the western Beaufort Sea that used bottom trawls to sample for demersal fish and hydroaccoustics and mid-water trawls to sample for pelagic fish. They found that invertebrates dominated the demersal catch, with arctic cod being the most common fish species caught. Arctic cod were the most prevalent species caught in pelagic habitats. Thirty-two species of fish were identified, and comparison of results with historical data suggests the northward expansion of some species ranges, such as pollock and Pacific cod.

Frost and Lowry (1983) reported anatomical, reproductive, and prey statistics for selected species sampled (arctic cod, polar eelpout, twohorn sculpin, hamecon, arctic alligatorfish, leatherfin lumpsucker,

fish doctor, and spatulate sculpin) from 35 otter-trawl tows performed in the northeastern Chukchi and western Beaufort seas in August-September 1976 and 1977. Prey of the summarized species as a group consists of copepods, amphipods, isopods, mysids, euphasiids, polychaete worms, cumaceans, caprellids, shrimp, brittle stars, and arctic cod. Nineteen species of fish were identified; three species (arctic cod, polar eelpout, and twohorn sculpin) accounted for 65 percent of all fish caught.

Marine fish prefer the colder, more saline coastal water seaward of the nearshore brackish-water zone. As summer progresses, the nearshore zone becomes more saline due to decreased freshwater input from rivers and streams. During this time, marine fish often share nearshore brackish waters with diadromous fish (e.g. salmon), primarily to feed on the abundant epibenthic fauna or to spawn (Craig 1984). In fall, when diadromous fish have moved out of the coastal area and into freshwater systems to spawn and overwinter, marine fish remain in the nearshore area to feed.

Marine fish in the region primarily feed on marine invertebrates and/or fish. They rely heavily on epibenthic and planktonic crustacea such as amphipods, mysids, isopods, and copepods. Because the feeding habits of marine fish in nearshore waters are similar to those of diadromous fish, some marine fish are believed to compete with diadromous fish for the same prey resources (Craig 1984, Fechhelm, Buck, and Link 2006). Competition is most likely to occur in the nearshore brackish water ecotone, particularly in or near river deltas. As nearshore ice thickens in winter, marine fish probably continue to feed under the ice but eventually depart the area as ice freezes to the bottom some 2 m (6 ft) thick. Seaward of the bottomfast ice, marine fish continue to feed and reproduce in coastal waters all winter (Craig 1984). Many evidently spawn during winter, some in shallow coastal waters, and others in deeper waters. Arctic cod spawn under the ice between November and February (Craig and Halderson 1981). Snailfish spawn farther offshore by attaching their adhesive eggs to rock or kelp substrate (MMS 2008).

### *Ecological Groups (secondary Assemblages) of Marine Fish*

To better understand fish resources and the potential impacts of disturbances to their populations and habitats, we further refined the scale of the primary marine fish assemblage into ecological groups (secondary assemblages) based on fish behavior and ecology, and general oceanographic/landscape features, such as the continental shelf break or polar ice. The purpose of characterizing finer scale hierarchical organization of Arctic fish is to enhance our analysis of potential impacts in a data-deficient setting, particularly concerning marine fish. Many species overlap to some degree in these ecological groups, due in part to the different habitat areas used by different lifestages (e.g. arctic cod occur in both nearshore-demersal [as adults] and cryopelagic [as juveniles] groups) (MMS 2008).

Based on the general ecology and three-dimensional occurrence of marine fish in the sea, the following secondary marine fish assemblages have been identified: nearshore-demersal, nearshore-pelagic, oceanic-demersal, and oceanic-pelagic. An additional and important assemblage that is unique to polar regions is the cryopelagic fish assemblage. Following are characterizations of each secondary fish assemblage, and Table 3.2-2 identifies species associations for secondary fish assemblages.

**Table 3.2-2 Species Associations in Secondary Marine Fish Assemblages[1]**

| Species Name | Common name | Secondary Assemblage[2] | | | | |
|---|---|---|---|---|---|---|
| | | ND | NP | OD | OP | CP |
| *Somniosus pacificus* | Pacific sleeper shark | X | | X | | |
| *Squalus acanthias* | spiny dogfish | X | | X | | |
| *Clupea pallasii* | Pacific herring | | X | | X | |
| *Mallotus villosus* | capelin | | X | | | |
| *Osmerus mordax* | rainbow smelt | | X | | | |

| Species Name | Common name | Secondary Assemblage[2] | | | | |
|---|---|---|---|---|---|---|
| | | ND | NP | OD | OP | CP |
| *Benthosema glaciale* | glacier lanternfish | | X | | | |
| *Boreogadus saida* | Arctic cod | X | X | X | X | X |
| *Arctogadus glacialis* | polar cod | X | X | X | X | X |
| *Arctogadus borisovi* | toothed cod | X | | | | X |
| *Eleginus gracilis* | saffron cod | X | | | | |
| *Theragra chalcogramma* | walleye pollock | X | X | X | X | |
| *Gadus macrocephalus* | Pacific cod | X | | X | | |
| *Gadus ogac* | ogac | | | X | | |
| *Hexagrammos stelleri* | whitespotted greenling | X | | | | |
| *Triglops pingelii* | ribbed sculpin | X | | X | | |
| *Hemilepidotus papilio* | butterfly sculpin | X | | X | | |
| *Hemilepidotus jordani* | yellow Irish lord | X | | X | | |
| *Icelus spatula* | spatulate sculpin | X | | X | | |
| *Icelus bicornis* | twohorn sculpin | X | | | | |
| *Gymnocanthus tricuspis* | Arctic staghorn sculpin | X | | | | |
| *Enophrys diceraus* | antlered sculpin | X | | | | |
| *Megalocottus platycephalus* | belligerent sculpin | X | | | | |
| *Myoxocephalus quadricornis* | fourhorn sculpin | X | | | | |
| *Myoxocephalus scorpius* | shorthorn sculpin | X | | X | | |
| *Myoxocephalus scorpioides* | Arctic sculpin | X | | | | |
| *Myoxocephalus jaok* | plain sculpin | X | | | | |
| *Myoxocephalus verrucosus* | warty sculpin | X | | | | |
| *Triglops nybelini* | bigeye sculpin | X | | | | |
| *Microcottus sellaris* | brightbelly sculpin | X | | | | |
| *Artediellus gomojunovi* | spinyhook sculpin | X | | X | | |
| *Artediellus scaber* | hamecon | X | | | | |
| *Artediellus pacificus* | hookhorn sculpin | X | | | | |
| *Artediellus ochotensis* | Okhotsk hookear sculpin | X | | | | |
| *Blepsias bilobus* | crested sculpin | X | | | | |
| *Nautichthys pribilovius* | eyeshade sculpin | X | | | | |
| *Eurymen gyrinus* | smoothcheek sculpin | X | | | | |
| *Cottunculus sadko* | Sadko sculpin | | X | | | |
| *Hypsagonus quadricornis* | fourhorn poacher | X | | | | |
| *Pallasina barbata* | tubenose poacher | X | | | | |
| *Occella dodecaedron* | Bering poacher | X | | | | |
| *Leptagonus decagonus* | Atlantic poacher | X | | | | |
| *Podothecus veternus* | veteran poacher | X | | | | |
| *Ulcina olrikii* | Arctic alligatorfish | X | | | | |

| Species Name | Common name | Secondary Assemblage[2] | | | | |
|---|---|---|---|---|---|---|
| | | ND | NP | OD | OP | CP |
| *Aspidophoroides monopterygius* | alligatorfish | X | | | | |
| *Eumicrotremus derjugini* | leatherfin lumpsucker | X | | | | |
| *Eumicrotremus andriashevi* | pimpled lumpsucker | X | | | | |
| *Liparis gibbus* | variegated snailfish | X | | | | |
| *Liparis tunicatus* | kelp snailfish | X | | | | |
| *Liparis bristolensis* | Bristol snailfish | X | | | | |
| *Liparis fabricii* | gelatinous seasnail | X | | X | | |
| *Liparis callyodon* | spotted snailfish | X | | | | |
| *Careproctus sp. cf. rastrinus* | salmon snailfish | X | | | | |
| *Liparis marmoratus* | festive snailfish | X | | | | |
| *Gymnelus hemifasciatus* | halfbarred pout | X | | | | |
| *Gymnelus viridis* | fish doctor | X | | | | |
| *Lycodes seminudus* | longear eelpout | | | X | | |
| *Lycodes mucosus* | saddled eelpout | X | | | | |
| *Lycodes turneri* | estuarine eelpout | X | | | | |
| *Lycodes polaris* | polar eelpout | X | | | | |
| *Lycodes raridens* | marbled eelpout | X | | | | |
| *Lycodes rossi* | threespot eelpout | X | | X | | |
| *Lycodes sagittarius* | archer eelpout | | | X | | |
| *Lycodes palearis* | wattled eelpout | X | | | | |
| *Lycodes pallidus* | pale eelpout | X | | X | | |
| *Lycodes squamiventer* | scalebelly eelpout | | | X | | |
| *Lycodes eudipleurostictus* | doubleline eelpout | X | | | | |
| *Lycodes concolor* | ebony eelpout | X | | X | | |
| *Eumesogrammus praecisus* | fourline snakeblenny | X | | | | |
| *Stichaeus punctatus* | Arctic shanny | X | | | | |
| *Chirolophis snyderi* | bearded warbonnet | X | | | | |
| *Leptoclinus maculatus* | daubed shanny | X | | X | | |
| *Anisarchus medius* | stout eelblenny | X | | | | |
| *Lumpenus fabricii* | slender eelblenny | | X | | | |
| *Pholis fasciata* | banded gunnel | X | | | | |
| *Anarhichas orientalis* | Bering wolffish | X | | | | |
| *Ammodytes hexapterus* | Pacific sand lance | | X | | X | X |
| *Hippoglossus stenolepis* | Pacific halibut | X | | X | | |
| *Hippoglossoides robustus* | Bering flounder | X | | | | |
| *Reinhardtius hippoglossoides* | Greenland turbot | X | | X | | |
| *Platichthys stellatus* | starry flounder | X | | | | |
| *Pleuronectes quadrituberculatus* | Alaska plaice | X | | | | |

| Species Name | Common name | Secondary Assemblage[2] | | | | |
|---|---|---|---|---|---|---|
| | | ND | NP | OD | OP | CP |
| *Pleuronectes glacialis* | Arctic flounder | X | | | | |
| *Limanda proboscidea* | longhead dab | X | | | | |
| *Limanda aspera* | yellowfin sole | X | | X | | |
| *Limanda sakhalinensis* | Sakhalin sole | X | | X | | |

[1]Table based on Table III.F-2 in MMS 2007c and Table C-1 (Appendix C) in BOEMRE 2011b.
[2]ND = Nearshore Demersal, NP = Nearshore Pelagic, OD = Offshore Demersal, OP = Offshore Pelagic, CP = Cryopelagic

### The Nearshore-Demersal Assemblage

This assemblage is comprised of marine fish living at or near the seafloor of the continental shelf (landward of the 200-m [656 ft] isobath) and capable of active swimming. Species of this assemblage that are attributed as being widespread and/or abundant include the fourhorn sculpin, twohorn sculpin, polar eelpout, and Arctic flounder (BOEMRE 2011b).

### The Nearshore-Pelagic Assemblage

Fish inhabiting the water column over the continental shelf (landward of the 200-m isobath) comprise the nearshore-pelagic assemblage. Some fish of this assemblage are prone to occupying the upper water column (pelagic species), while others exhibit greater use of the lower depths or the entire water column and seafloor (benthopelagic species). Species of this assemblage regarded as widespread or abundant include the Pacific herring, arctic cod, capelin, and Pacific sand lance. Two benthopelagic species are uncommon (fourline snakeblenny and slender eelblenny); the polar cod is regarded as rare.

### The Oceanic-Demersal Assemblage

Fish living on or close to substrates below oceanic waters are encompassed in the oceanic-demersal assemblage. The ogac, ribbed sculpin, spatulate sculpin, shorthorn sculpin, spinyhook sculpin, archer eelpout, pale eelpout, and daubed shanny are among the fish included in this assemblage (MMS 2008).

### The Oceanic-Pelagic Assemblage

Fish inhabiting the water column of oceanic waters seaward of the 200-m isobath comprise this assemblage; most species exhibit some preference of bathymetric stratification. Those species chiefly occurring within the upper 200 m (656 ft) of the water column are called epipelagic fish. Fish inhabiting oceanic waters between 200 m and 1,000 m (656 to 3,281 ft) in depth are termed mesopelagic fish. Bathypelagic fish are those species inhabiting depths >1,000 m (3,281 ft) in depth; as yet, there are no known bathypelagic fish in the Alaskan Beaufort Sea. Several of the epipelagic species include the walleye pollock, Pacific herring, arctic cod, polar cod, and Pacific sand lance (note that several of these species also use nearshore and ice-covered waters).

### The Cryopelagic Assemblage

The term “cryopelagic” is used to describe fish that actively swim in nearshore or oceanic waters but, during their lifecycle, are associated in some way or other with drifting or fast ice (Andriyashev 1964). The cryopelagic fish assemblage is further described by Andriyashev (1970) as such:

> *Both young and adult fish can be associated with ice or water immediately below the ice. These relationships are usually trophic in nature, but in some cases ice provides fish with a shelter from predators or even a substratum for sucking. The association of fish with ice can be observed easily and often. The more intimate aspects of their behavior are, however, still little known….*

Andriyashev (1970) described what may be the first known cryopelagic fish species, the arctic cod (*Boreogadus saida*; previously known as polar cod). Arctic cod often occur in ice holes, cracks, hollows, and cavities in the lower surface of the ice and are most common near the ice edge or among broken ice. As the ice thaws at these margins, plankton grow and provide a food source. It is also possible that they also feed on the amphipod-diatom ice community inhabiting the lower ice layer. Arctic cod are a common food of Greenland seal (*Pagohoca groenlandica*), ringed seal (*Phoca hispida*), bearded seal (*Erignathus barbatus*), white whale (*Delphinapterus leucas*), narwhal (*Monodon monoceros*) and other marine mammals, many marine birds (including gulls, guillemots, etc.) and fish (citing Klumov 1937, and Andriyashev 1954). The arctic cod is abundant in the region, and their enormous autumn-winter pre-spawning swarms are well known. The species also is very widely distributed and makes distant migrations, not only along the shelf areas in the Arctic Basin, but also in higher latitudes. In addition to the arctic cod, other cryopelagic fish of the Alaskan Arctic Region include polar cod, toothed cod, and Pacific sand lance.

#### 3.2.2.3.3 Migratory Fish

Migratory (or diadromous) fish can move between and are able to live in fresh, brackish, and/or marine waters due to various biological stimuli such as feeding or reproduction; or ecological factors such as temperature, oxygen level, or specific spawning-habitat needs. Numerous strategies exist for the use of these different habitats, and as such, different terms are used to define those life histories. The term diadromous is considered the most inclusive category because its definition incorporates all migration types (anadromous and amphidromous) between marine and freshwaters, including single lifetime events, repetitive multiyear events, spawning migrations, feeding migrations, and seasonal movements between environments Craig 1989).

##### *Anadromous Fish*

Anadromous fish employ a life history pattern involving single or repeated migrations between overwintering sites and coastal waters, followed by a spawning migration into freshwater at maturity. This cycle consists of three broad phases: spawning; freshwater residency (of juveniles); and anadromy (Craig 1989). The most commonly studied anadromous fish are salmon, of which all five Pacific species are found within the project area.

**Pacific Salmon**

All five species of Pacific salmon occur in the Alaskan Beaufort and Chukchi seas (Craig and Halderson 1986, NMFS 2005): the pink, chum, sockeye, chinook, and coho salmon. A large body of information exists on the life histories and general distribution of salmon in Alaska (NMFS 2005). Pacific salmon life history, general distribution, fisheries background, relevant trophic information, habitat, and biological associations are described by NMFS (2005:Appendix 5) and incorporated herein by reference. More information regarding the biology, ecology, and behavior of Pacific salmon is described in Augerot (2005), Quinn (2005), and Johnson and Daigneault (2008).

Salmon numbers decrease north of the Bering Strait (Craig and Halderson 1986). Spawning runs in Arctic streams are minor compared to those of commercially important populations farther south (Craig and Halderson 1986). Rivers south of Point Hope support comparatively large runs of chum and pink salmon (Craig and Halderson 1986). Craig and Halderson (1986) noted that only a few pink salmon and, to a lesser degree, chum salmon, occur with any regularity in Arctic waters north of Point Hope and presumably maintain small populations in several of the northern drainages; most occurring in streams along the Chukchi Sea coast west of Barrow.

**Chinook, Sockeye, and Coho Salmon**

The northernmost known spawning population of chinook salmon is believed to be in Kotzebue Sound (Healey 1991); however, there are indications of a small run of chinook salmon in the Kugrua River

southwest of Point Barrow at Peard Bay (Fechhelm and Griffiths 2001, citing George, pers. commun.). Small numbers of chinook salmon reportedly are taken each year in the Barrow domestic fishery, which operates in Elson Lagoon (Fechhelm and Griffiths 2001, citing George, pers. commun.). Strays have been captured in the Kuk River, near Wainwright (Craig and Halderson 1986).

The northernmost known population of spawning coho salmon is in the Kuchiak River (Johnson and Daigneault 2008), and coho salmon have occasionally been captured in marine waters farther east, near Prudhoe Bay (Craig and Halderson 1986). This is particularly important because juvenile fish must overwinter at least one winter in freshwater before entering the marine environment. Overwintering stream habitat may be reduced by as much as 97 to 98 percent by late winter (Craig 1989).

There are no known stocks of sockeye salmon in Arctic waters north of Point Hope (Craig and Halderson 1986). Sockeye salmon have their northernmost known spawning population in Kotzebue Sound (Stephenson 2006, citing Burgner 1991).

Warming in Arctic Alaska may facilitate the range expansion of chinook, sockeye, and coho salmon (Babaluk et al. 2000).

**Pink Salmon**

Pink salmon are widely distributed over the northern Pacific Ocean and Bering Sea; they also occur to a lesser degree in Arctic waters (Augerot 2005). Pink salmon are the most abundant salmon species in the Beaufort and Chukchi seas, although their abundance is greatly reduced compared to waters farther south (Craig and Halderson 1986, Fechhelm and Griffiths 2001). Their abundance generally increases from east to west along the Alaskan Beaufort Sea coast. Augerot (2005) depicts pink salmon of limited spawning distribution in the Alaskan Arctic.

Craig and Halderson (1986) proposed that pink salmon spawn successfully and maintain small but viable populations in some Arctic drainages. Small runs of pink salmon occur in nine drainages north of Point Hope (Craig and Halderson 1986, Fechhelm and Griffiths 2001), including the Kuk, Kokolik, Kugrua, and Kukpowruk rivers (Fechhelm et al. 1983 as cited in Kinney 1985). They are reported as present in the Pitmegea and Utukok rivers.

Unlike other nonsalmonid anadromous fish species in Arctic Alaska, the pink salmon is a short-lived species that places all its reproductive effort into a single spawning event and then dies. With its rigid 2-year lifecycle, there is virtually no reproductive overlap between generations; therefore, every spawning event must be successful for the continued survival of the stock (Craig and Halderson 1986).

Run timings are inexact. Along the northeastern Chukchi Sea coast, run times in spawning streams may occur in mid-July; while along the western Beaufort coast, run times appear to commence in late July until the end of August (Craig and Halderson 1986). Occurrence of adult salmon in spawning streams in mid- to late July indicates their presence in marine waters along the Arctic coast as much as several weeks in advance of the runs.

Pink salmon eggs hatch in the winter but do not emerge from the gravel until the spring. At that time, the fry move downstream and remain in the estuary for up to a month prior to moving offshore (Schmidt et al. 1983). Schmidt et al. (1983) state: *"It is likely the North Slope populations move westerly towards the Chukchi Sea and upon maturing at the age of 2 years, the salmon then return to their natal streams to spawn in the fall."*

Generally, early marine schools of pink salmon fry, often in large, dense aggregations, tend to follow shorelines and, during the first weeks at sea, spend much of their time in shallow water only a few centimeters deep (NMFS 2005:Appendix F). It has been suggested that this nearshore period involves a distinct ecological life-history stage in both pink and chum salmon. In many areas throughout their ranges, pink salmon and chum salmon fry of similar age and size commingle in both large and small schools during early life in the marine environment.

Diet studies show that pink salmon are both opportunistic and generalized feeders, and, on occasion, they specialize in specific prey items (NMFS 2005:Appendix F). Young-of-the-year probably do not feed significantly during the short period spent in natal streams but feed on copepods and other zooplankton in the estuary (Schmidt et al. 1983). As the fish grow, larger prey species become important, including amphipods, euphausiids, and fish (Schmidt et al. 1983 citing Morrow 1980 and Scott and Crossman 1973). Craig and Halderson (1986) state that most (adult) pink salmon caught in Simpson Lagoon had not fed recently (88 percent empty stomachs, n=17). The only available information on marine feeding is from Kasegaluk Lagoon, where stomachs of 17 captured adult salmon contained mostly fish (chiefly arctic cod), with some amphipods and mysids (Craig and Halderson 1986, citing Craig and Schmidt 1985). Studies indicate that juvenile pink salmon are primarily diurnal feeders (NMFS 2005:Appendix F).

**Chum Salmon**

Chum salmon are widely distributed in Arctic waters but are relatively less common than pink salmon (Craig and Halderson 1986, Babaluk et al. 2000, Fechhelm and Griffiths 2001). The Pitmegea, Kukpowruk, Kuk, Kukolik, Kuchiak, and Kugrua rivers along the northeastern Chukchi Sea coast are reported to support small populations of chum salmon. They are reported as present in the Utukok and Kuchiak rivers. Individual salmon and small schools have been collected in the Kukpuk River, Kasegaluk Lagoon, and along the Wainwright Coast (Craig and Halderson 1986, Fechhelm and Griffiths 2001).

Generally, chum salmon return to spawn as two to seven year olds (NMFS 2005). In general chum salmon get older from south to north. Seven-year-old chum are rare and occur mostly in the northern areas (e.g. the Arctic). Slow to rapid growth in the ocean can modify the age chum salmon reach maturity. For example, slower growth during the second year at sea causes some chum salmon to mature one to two years later.

Chum salmon fry, like pink salmon, do not overwinter in streams but migrate (mostly at night) out of streams directly to sea shortly after emergence. The timing of outmigration in the Arctic is unknown but occurs between February and June (chiefly during April and May) in more southern waters. More accurate information on the timing of outmigration is not essential for making reasoned managerial decisions. Chum salmon have two habitat requirements that are essential in their life history that make them very vulnerable: (1) reliance on upwelling ground water for spawning and incubation and (2) reliance on estuaries/tidal wetlands for juvenile rearing after migrating out of spawning streams. Chum salmon tend to linger near their natal stream and forage in estuaries and intertidal areas at the head of bays during summer. Estuaries are very important for rearing chum salmon. Rearing juvenile chum salmon use a wide variety of prey species, including invertebrates (including insects) and gelatinous organisms (NMFS 2005).

In late summer, juvenile chum salmon migrate southward toward the Bering Sea, thereby avoiding the cold waters of the Arctic marine environment in winter. Chum salmon eat a variety of foods during their ocean life, e.g. amphipods, euphausiids, pteropods, copepods, fish, and squid larvae.

### *Amphidromous Fish*

Amphidromous fish migrate from freshwater to marine waters (or vice-versa) for non-reproductive purposes Craig (1989). In the Arctic, amphidromous species live much longer, grow much slower, and become sexually mature much later in life than Arctic anadromous fish. Unlike anadromous Pacific salmon, they do not make one far-ranging ocean migration and return years later to freshwater to spawn and die. Instead, they make many migrations between freshwater and the sea for purposes other than just spawning. Amphidromous Arctic fish spend much more time in brackish coastal waters than they do in marine waters. Additionally, they migrate to freshwater to overwinter. In fact, amphidromous fish typically have multiple migrations to freshwater before reaching spawning age. Even after reaching

spawning age, spawning occurs only if their nutritional requirements were met during the brief Arctic summer. When they do spawn, they do not necessarily die; some return years later to spawn again. Amphidromous fish inhabit many of the lakes, rivers, streams, interconnecting channels, and coastal waters of the North Slope. Common species include Arctic cisco, least cisco, Bering cisco, rainbow smelt, humpback whitefish, broad whitefish, Dolly Varden char, and inconnu. The highest concentration and diversity of amphidromous fish in the area occurs in river-delta areas, such as the Colville and the Sagavanirktok (Bendock 1997), while the most common species found in nearshore waters are Arctic and least cisco (Craig 1984). Lakes that are accessible to amphidromous fish typically are inhabited by them in addition to resident freshwater fish. The least cisco is the most abundant amphidromous fish found in these lakes.

With the first signs of spring breakup (typically June 5 to 20), adult migratory fish (and the juveniles of some species) move out of freshwater rivers and streams and into the brackish coastal waters nearshore Craig (1989). They disperse in waves parallel to shore, each wave lasting a few weeks or so. Some disperse widely from their streams of origin (e.g. Arctic cisco and some Dolly Varden char). Others, like broad and humpback whitefish and least cisco, do not; they are seldom found anywhere except for near the mainland shore (Craig 1984). Fechhelm (1999) suggested that humpback whitefish dispersing eastward along the coast from their overwintering grounds in the Colville River had been blocked by a solid-fill gravel causeways (West Dock) and that construction of a breach allowed these fish to extend their summer foraging range farther to the east. Similar results were reported by Fechhelm et al. (1999) for Arctic cisco and least cisco suggesting that small fish traveling eastward along the coast failed to bypass a causeway. Most migratory fish initiate relatively long and complex annual migrations to and from coastal waters (Bendock 1997). However, some populations of Dolly Varden char, least cisco, and broad and humpback whitefish never leave freshwater (Craig 1989). Many believe that Arctic cisco in the Colville River area originated from spawning stocks of the Mackenzie River in Canada (Gallaway et al. 1983, Fechhelm and Fissel 1988, Fechhelm and Griffiths 1990), although there are reports from fishermen that Arctic cisco in spawning condition have been caught in the upper Colville and Chipp rivers (Moulton et al. 1985 citing Matumeak 1984, pers. commun.). However, the scientific evidence is overwhelming that the vast majority of the Arctic cisco inhabiting the Alaskan Beaufort Sea were carried there from Canada by westerly currents.

During the 3-to-4-month open-water season that follows spring breakup, migratory fish accumulate energy reserves for overwintering, and, if sexually mature, they spawn. They prefer the nearshore brackish zone, rather than the colder, more saline waters farther offshore. While their prey is concentrated in the nearshore zone, their preference for this area is believed to be more correlated with its warmer temperature (Craig 1989, Fechhelm et al. 1993).

Migratory fish are more abundant along the mainland and island shorelines, but they also inhabit the central waters of bays and lagoons. Larger fish of the same species are more tolerant of colder water (e.g. Dolly Varden char and Arctic and least cisco) and range farther offshore (Moulton et al. 1985, Thorsteinson et al. 1991). Smaller fish are more abundant in warmer, nearshore waters and the small, freshwater streams draining into the Beaufort Sea (Hemming 1993).

Infaunal prey density in the nearshore substrate is very low and provides little to no food for migratory fish. However, prey density in the nearshore water column is high, about five times that of freshwater habitats on the coastal plain, and the nearshore feeding area also is much larger (Craig 1989). For these reasons, both marine and migratory fish come to feed on the relatively abundant prey found in nearshore waters during summer. Migratory fish feed on epibenthic mysids and amphipods (often greater than 90 percent of their diet) and on copepods, fish, and insect larvae (Craig and Halderson 1981, Craig et al. 1984, Craig 1989). In early to midsummer when migratory fish are most abundant in nearshore waters, little dietary overlap is observed among them. However, in late summer when they are less abundant and their prey is more abundant, dietary overlap becomes common (Moulton et al. 1985). Marine birds also compete for the same food resources during this time. Migratory fish do little to no feeding during their

migration back to freshwater and when spawning, but some resume feeding during winter. Most migratory fish return to freshwater habitats in the late summer or fall to overwinter and, if sexually mature, to spawn. Others, such as cisco and whitefish, return much earlier, arriving 6 to 10 weeks before spawning starts, thus forfeiting about half of the nearshore-feeding period (Craig 1989). Char, cisco, and whitefish spawn in streambed gravels in fall in the Sagavanirktok River. Spawning in the Arctic environment can take place only where there is an ample supply of oxygenated water during winter. Because of this and the fact that few potential spawning sites can meet this requirement, spawning often takes place in or near the same area where fish overwinter (Craig 1989). Variation in recruitment between years may be highly influence by variability in weather patterns, like the strength of easterly winds (ABR, Inc. et al. 2007).

#### 3.2.2.4 The Influence of Climate Change

Changes in the climate of the Arctic are being documented. While climatic warming is not distributed evenly across the Arctic, the Bering, Chukchi, and Beaufort seas are clearly experiencing a warming trend (ACIA 2005). This warming is altering the distribution and abundance of marine life in the Arctic. The better known fish resources such as capelin, arctic cod, Pacific sand lance, and Bering flounder can exhibit very large interannual fluctuations in distribution, abundance, and biomass. Climate change experienced in the past and apparently accelerating in Arctic Alaska likely is altering the distribution and abundance of their respective populations from what was known from past surveys. For a more detailed discussion of climate change in the Arctic, see Section 3.1.4.4.

Climate change can affect fish production at both the individual and population level through a variety of means (Loeng 2005). Direct effects of temperature on the metabolism, growth, and distribution of fish occur. Food-web effects also occur through changes in lower trophic-level production or in the abundance of predators, but such effects are difficult to predict. Fish-recruitment patterns are strongly influenced by oceanographic processes such as local wind patterns and mixing and by prey availability during early life stages. Recruitment success sometimes is affected by changes in the time of spawning, fecundity rates, survival rate of larvae, and food availability MMS 2008). An analysis of the Arctic cisco data in the Colville Delta suggests, for example, that survival of certain age classes is reduced during summers with above average temperature and below average ice concentrations (ABR, Inc. et al. 2007).

For example, a climate shift occurred in the Bering Sea in 1977, abruptly changing from a cool to a warm period (ACIA 2004 and 2005). The warming brought about ecosystem shifts that favored herring stocks and enhanced productivity for Pacific cod, skates, flatfish, and noncrustacean invertebrates. The species composition of seafloor organisms changed from being crab dominated to a more diverse assemblage of echinoderms, sponges, and other sea life. Historically high commercial catches of Pacific salmon occurred. The walleye pollock catch, which was at low levels in the 1960s and 1970s (2 to 6 million metric tons), has increased to levels >10 million metric tons for most years since 1980 (ACIA 2005). Additional recent climate-related impacts observed in the Bering Sea LME include significant reductions in seabird and marine mammal populations, unusual algal blooms, abnormally high water temperatures, and low harvests of salmon on their return to spawning areas. While the Bering Sea fishery has become one of the world's largest, numbers of salmon have been far below expected levels, fish have been smaller than average, and their traditional migratory patterns appear to have been altered.

Regarding the Beaufort and Chukchi seas, the Arctic Climate Impact Assessment, published in the mid-2000s (ACIA 2004 and 2005) concluded that the southern limits of distribution for colder water species such as arctic cod, and more southerly species from the Bering Sea, are both anticipated to move northward. Adjustments by one or more fish populations often require adjustments within or among LMEs, influencing the distribution and/or abundance of competitors, prey, and predators. Consequently, it appears reasonable to believe that the composition, distribution, and abundance of fish resources in the Beaufort and Chukchi seas are changing and are now different from that measured in the surveys conducted 16 to 18 years ago or earlier. Pacific cod, herring, walleye pollock, and some flatfish are likely

to move northward and become more abundant, while capelin, arctic cod, and Greenland turbot are expected to have a restricted range and decline in abundance. Recent work supports this, with Logerwell and Rand (2010) concluding that climate change may have resulted in northward expansion of some species' ranges, including commercially valuable species such as pollock and Pacific cod (*Gadus macrocephalus*). This survey was also the first to document commercial-sized opilio crab (*Chionoecetes opilio*) in the North American Arctic.

The occurrence of pink and chum salmon in Arctic waters probably is due to their relative tolerance of cold water temperatures and their predominantly marine lifecycle (Craig and Halderson 1986 citing Salonius 1973). The expansion of chinook, sockeye, and coho salmon into the Arctic appears restricted by cold water temperatures, particularly in freshwater environments (Craig and Halderson 1986). Babaluk et al. (2000) noted that significant temperature increases in Arctic areas as a result of climate change may result in greater numbers of Pacific salmon in Arctic regions. The recent range extensions of pink, sockeye, and chum salmon in the Canadian Arctic, as described by Babaluk et al. (2000), indicate that some Pacific salmon may be expanding their distribution and abundance in the proposed project area.

A period of warming in the region between 1990 and 2007, documented and discussed by Moulton (2010) reviewed a number of biological response by freshwater fish in the Teshekpuk Lake region to warming temperatures, mostly relating to growth and condition. Least cisco showed faster growth rates during the warmer period and lake trout distribution may be influenced by the resulting additional prey distribution.

#### 3.2.2.5 Essential Fish Habitat

The Magnuson-Stevens Fishery Conservation and Management Act includes provisions concerning the identification and conservation of EFH. The Magnuson-Stevens Act defines EFH as *"those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity"* (NPFMC 2009). The NMFS and regional Fishery Management Councils (Councils) must describe and identify EFH in fishery management plans (FMPs), minimize to the extent practicable the adverse effects of fishing on EFH, and identify other actions to encourage the conservation and enhancement of EFH. Federal agencies that authorize, fund, or undertake actions that may adversely affect EFH must consult with NMFS, and NMFS must provide conservation recommendations to federal and state agencies regarding actions that would adversely affect EFH. Councils also have the authority to comment on federal or state agency actions that would adversely affect the habitat, including EFH, of managed species.

In Alaska, the NPFMC is the regional council responsible for fisheries management within the 3- to 200-nautical mile (nm) Exclusive Economic Zone (EEZ). This task is carried out through the development of FMPs, which guide the management of commercially harvested fish and shellfish. There are six FMPs that apply to Alaskan waters, and 2 of these apply to Arctic waters: the *Fishery Management Plan for the Salmon Fisheries in the EEZ off the Coast of Alaska* (Salmon FMP) (NPFMC 1990) and the *Fishery Management Plan for Fish Resources of the Arctic Management Area* (Arctic FMP) (NPFMC 2009). The Arctic FMP was completed in 2009 and governs commercial harvests of fish resources in U.S. waters of the Beaufort Sea and Chukchi Sea (NPFMC 2009). The Salmon FMP governs management of all salmon fisheries that occur within the EEZ, including the Arctic.

FMPs must describe EFH in text, including reference to the geographic location or extent of EFH using boundaries such as longitude and latitude, isotherms, isobaths, political boundaries, and major landmarks. If differences exist among the descriptions of EFH in text, maps, and tables, the textual description is ultimately determinative of the limits of EFH (NPFMC 2009). FMPs must also include maps that display, within the constraints of available information, the geographic location of EFH or the geographic boundaries within which EFH for each species and life stage is found. EFH descriptive maps depict, and are complimentary to, each life history EFH text description, if known.

Presently, EFH has been described in the Alaskan Arctic for all five species of Pacific salmon, in addition to arctic cod, saffron cod, and opilio (snow) crab (NPFMC 2009). The vastness of Alaska and the large

number of individual fish species managed by FMPs make it challenging to describe EFH by text using static boundaries, and descriptions are therefore often vague. Further, species are likely to have EFH described in the future, as conditions and resources require and allow.

The EFH for Pacific salmon species has been described and mapped by NMFS (2005). Salmon EFH includes all those freshwater streams, lakes, ponds, wetlands, and other water bodies currently or historically accessible to salmon. Marine EFH for the salmon fisheries in Alaska includes all estuarine and marine areas used by Pacific salmon of Alaska origin, extending from the influence of tidewater and tidally submerged habitats to the limits of the EEZ. This habitat includes waters of the continental shelf (to the 200-m [656 ft] isobath). In the deeper waters of the continental slope and ocean basin, salmon occupy the upper water column, generally from the surface to a depth of about 50 m (164 ft). Chinook and chum salmon use deeper layers, generally to about 300 m (984 ft), but on occasion to 500 m (1,640 ft). A more detailed description of marine EFH for salmon found in Arctic Alaska is provided below, taken from the *Final EIS for Essential Fish Habitat Identification and Conservation in Alaska* (NMFS 2005):

## Chinook Salmon

- *Estuarine EFH for juvenile Chinook salmon* is the general distribution area for this life stage, located in estuarine areas, as identified by the salinity transition zone (ecotone) and the mean higher tide line, within nearshore waters. Chinook salmon smolts and postsmolt juveniles may be present in these estuarine habitats from April through September.
- *Marine EFH for juvenile Chinook salmon* is the general distribution area for this life stage, located in all marine waters off the coast of Alaska from the mean higher tide line to the 200-nm limit of the EEZ, including the Gulf of Alaska, eastern Bering Sea, Chukchi Sea, and Arctic Ocean. Juvenile marine chinook salmon are at this life stage from April until annulus formation in January or February during their first winter at sea.
- *EFH for immature and maturing adult Chinook salmon* is the general distribution area for this life stage, located in marine waters off the coast of Alaska and ranging from the mean higher tide line to the 200-nm limit of the EEZ, including the Gulf of Alaska, eastern Bering Sea, Chukchi Sea, and Arctic Ocean.

## Sockeye Salmon

- *Estuarine EFH for juvenile sockeye salmon* is the general distribution area for this life stage, located in estuarine areas, as identified by the salinity transition zone (ecotone) and the mean higher tide line, within nearshore waters. Under-yearling, yearling, and older smolts occupy estuaries from March through early August.
- *Marine EFH for juvenile sockeye salmon* is the general distribution area for this life stage, located in all marine waters off the coast of Alaska to depths of 50 m (164 ft) and range from the mean higher tide line to the 200-nm limit of the EEZ, including the Gulf of Alaska, eastern Bering Sea, Chukchi Sea, and Arctic Ocean from midsummer until December of their first year at sea.
- *EFH for immature and maturing adult sockeye salmon* is the general distribution area for this life stage, located in marine waters off the coast of Alaska to depths of 200 m (656 ft) and range from the mean higher tide line to the 200-nm limit of the EEZ, including the Gulf of Alaska, eastern Bering Sea, Chukchi Sea, and Arctic Ocean.

## Coho Salmon

- *Estuarine EFH for juvenile coho salmon* is the general distribution area for this life stage, located in estuarine areas, as identified by the salinity transition zone (ecotone) and the mean higher tide

line, within nearshore waters. Juvenile coho salmon require year-round rearing habitat and also migration habitat from April to November to provide access to and from the estuary.

- *Marine EFH for juvenile coho salmon* is the general distribution area for this life stage, located in all marine waters off the coast of Alaska from the mean higher tide line to the 200-nm (230 mi) limit of the EEZ, including the Gulf of Alaska, eastern Bering Sea, Chukchi Sea, and Arctic Ocean.
- *EFH for immature and maturing adult coho salmon* is the general distribution area for this life stage, located in marine waters off the coast of Alaska to 200 m (656 ft) in depth and range from the mean higher tide line to the 200-nm (230 mi) (limit of the EEZ, including the Gulf of Alaska, eastern Bering Sea, Chukchi Sea, and Arctic Ocean.

## Pink Salmon

- *Estuarine EFH for juvenile pink salmon* is the general distribution area for this life stage, located in estuarine areas, as identified by the salinity transition zone (ecotone) and the mean higher tide line, within nearshore waters and generally present from late April through June.
- *Marine EFH for juvenile pink salmon* is the general distribution area for this life stage, located in all marine waters off the coast of Alaska from the mean higher tide line to the 200-nm limit of the EEZ, including the Gulf of Alaska, eastern Bering Sea, Chukchi Sea, and Arctic Ocean.
- *EFH for immature and maturing adult pink salmon* is the general distribution area for this life stage, located in marine waters off the coast of Alaska to 200 m (656 ft) in depth and range from the mean higher tide line to the 200-nm limit of the EEZ, including the Gulf of Alaska, eastern Bering Sea, Chukchi Sea, and Arctic Ocean.

## Chum Salmon

- *Estuarine EFH for juvenile chum salmon* is the general distribution area for this life stage, located in estuarine areas, as identified by the salinity transition zone (ecotone) and the mean higher tide line, within nearshore waters from late April through June.
- *Marine EFH for juvenile chum salmon* is the general distribution area for this life stage, located in all marine waters off the coast of Alaska to approximately 50 m (164 ft) in depth from the mean higher tide line to the 200-nm (230 mi) limit of the EEZ, including the Gulf of Alaska, eastern Bering Sea, Chukchi Sea, and Arctic Ocean.
- *EFH for immature and maturing adult chum salmon* is the general distribution area for this life stage, located in marine waters off the coast of Alaska to depths of 200 m (656 ft) and ranging from the mean higher tide line to the 200-nm (230 mi) limit of the EEZ, including the Gulf of Alaska, eastern Bering Sea, Chukchi Sea, and Arctic Ocean.

EFH for Arctic species has thus far been limited to 3 species identified in the Arctic FMP (NPFMC 2009). An attempt has been made to be as specific as possible regarding habitat use, but little reliable data exists on which to base these assessments. Therefore, the descriptions are omitted for some life stages and necessarily general for others. The full description of EFH for these species has been included below, taken from the *Essential Fish Habitat 5-Year Review for 2010 Summary Report* (NMFS 2010a):

## Arctic Cod

- *Eggs, Larvae, and Early Juveniles* - Insufficient information is available to determine EFH for eggs, larvae, and early juveniles.
- *Late Juveniles* - EFH for late juvenile arctic cod is the general distribution areas for this life stage located in pelagic and epipelagic waters from the nearshore to offshore areas along the entire

shelf (0 to 200 m [0 to 656 ft]) and upper slope (200 to 500 m [656 to 1,640 ft]) throughout Arctic waters and often associated with ice floes which may occur in deeper waters.

- *Adults* - EFH for adult arctic cod is the general distribution area for this life stage located in pelagic and epipelagic waters from the nearshore to offshore areas along the entire shelf (0 to 200 m [0 to 656 ft]) and upper slope (200 to 500 m [656 to 1,640 ft]) throughout Arctic waters and often associated with ice floes which may occur in deeper waters.

**Saffron Cod**

- *Eggs, Larvae, and Early Juveniles* - Insufficient information is available to determine EFH for eggs, larvae, and early juveniles.
- *Late Juveniles* - EFH for late juvenile saffron cod is the general distribution area for this life stage, located in pelagic and epipelagic waters along the coastline, within nearshore bays, and under ice along the inner (0 to 50 m [0 to 164 ft]) shelf throughout Arctic waters and wherever there are substrates consisting of sand and gravel.
- *Adults* - EFH for adult saffron cod is the general distribution area for this life stage, located in pelagic and epipelagic waters along the coastline, within nearshore bays, and under ice along the inner (0 to 50 m [0 to 164 ft]) shelf throughout Arctic waters and wherever there are substrates consisting of sand and gravel.

**Snow Crab (*C. opilio*)**

- *Eggs* - Essential fish habitat of snow crab eggs is inferred from the general distribution of egg-bearing female crab (see Adults).
- *Larvae and Early Juveniles* - Insufficient information is available to determine EFH for larvae and early juveniles.
- *Late Juveniles* - EFH for late juvenile snow crab is the general distribution area for this life stage, located in bottom habitats along the inner (0 to 50 m [0 to 164 ft]) and middle (50 to 100 m [164 to 328 ft]) shelf in Arctic waters south of Cape Lisburne, wherever there are substrates consisting mainly of mud.
- *Adults* - EFH for adult snow crab is the general distribution area for this life stage, located in bottom habitats along the inner (0 to 50 m [0 to 164 ft]) and middle (50 to 100 m [164 to 328 ft]) shelf in Arctic waters south of Cape Lisburne, wherever there are substrates consisting mainly of mud.

### 3.2.3 Marine and Coastal Birds

This section provides a baseline description of the marine and coastal birds that are likely to occur in the EIS project area and that may be affected by the actions described in the EIS. This section includes species of particular conservation concern, such as those listed under the ESA, and several groups of species that share certain characteristics important to the analysis of environmental consequences in Chapter 4.

Several million migratory marine and coastal birds occur in the Beaufort and Chukchi sea regions. Most occur on a seasonal basis related to the availability of open water. These birds occupy offshore and coastal marine, freshwater, and tundra habitats during the summer breeding and summer/fall migration seasons. Spring migrations into the Arctic typically occur from late March into June. Departure times during post-breeding or fall migration vary between species and also by sex within the same species. Most birds will be out of the Beaufort and Chukchi seas by late fall, typically in September or October, to avoid the formation of sea ice (Divoky 1987). The Beaufort and Chukchi seas' coastal lagoons are used

by substantial numbers of breeding and post-breeding migratory birds during the short Arctic summer when waters are mostly ice free. Table 3.2-3 provides a list of marine and coastal birds in the EIS project area with common English names, scientific names, and Iñupiaq names.

### Table 3.2-3 Birds Occurring in Marine and Coastal Environments of the Alaska Beaufort and Chukchi Seas

Nomenclature for common and scientific names and taxonomic order has been taken from the Check-list of North American Birds (American Ornithologists' Union 2010). Iñupiaq names are provided for some species (Bacon and Akpik 2010).

| Common Name | Scientific Name | Iñupiaq Name |
|---|---|---|
| Greater White-fronted Goose | *Anser albifrons* | Nibliq |
| Emperor Goose | *Chen canagica* | |
| Snow Goose (Lesser) | *Chen caerulescens* | Kaffuq |
| Brant | *Branta bernicla* | Niblinbaq |
| Canada Goose | *Branta canadensis* | Iqsrabutilik |
| Tundra Swan | *Cygnus columbianus* | Qubruk |
| American Wigeon | *Anas americana* | Ugiihiq |
| Mallard | *Anas platyrhynchos* | Kurugaqtaq |
| Northern Shoveler | *Anas clypeata* | Aluuttag, Qailuutag |
| Northern Pintail | *Anas acuta* | |
| Green-winged Teal | *Anas crecca* | Qaiffiq |
| Greater Scaup | *Aythya marila* | Qaqjuktuuq |
| Steller's Eider | *Polysticta stelleri* | Igniqauqtuq |
| Spectacled Eider | *Somateria fischeri* | Qavaasuk |
| King Eider | *Somateria spectabilis* | Qifalik |
| Common Eider | *Somateria mollissima* | Amauliqruaq |
| Surf Scoter | *Melanitta perspicillata* | |
| White-winged Scoter | *Melanitta fusca* | |
| Black Scoter | *Melanitta americana* | |
| Long-tailed Duck | *Clangula hyemalis* | Aaqhaaliq |
| Red-breasted Merganser | *Mergus serrator* | Aqpaqsruayuuq |
| Willow Ptarmigan | *Lagopus lagopus* | |
| Rock Ptarmigan | *Lagopus muta* | Niksaaktufiq |
| Red-throated Loon | *Gavia stellata* | Qaqsraupiabruk |
| Arctic Loon | *Gavia arctica* | |
| Pacific Loon | *Gavia pacifica* | Qaqsrauq |
| Common Loon | *Gavia immer* | |
| Yellow-billed Loon | *Gavia adamsii* | Tuullik |
| Red-necked Grebe | *Podiceps grisegena* | |
| Pelagic Cormorant | *Phalacrocorax pelagicus* | |
| Rough-legged Hawk | *Buteo lagopus* | |
| Golden Eagle | *Aquila chrysaetos* | |
| Gyrfalcon | *Falco rusticolus* | |
| Peregrine Falcon | *Falco peregrinus* | |
| Sandhill Crane | *Grus canadensis* | Tatirgak |
| Black-bellied Plover | *Pluvialis squatarola* | |
| American Golden-Plover | *Pluvialis dominica* | Tuulligouk |
| Pacific Golden-Plover | *Pluvialis fulva* | |
| Whimbrel | *Numenius phaeopus* | Siituvuk, Siituvak |
| Hudsonian Godwit | *Limosa haemastica* | |
| Bar-tailed Godwit | *Limosa lapponica* | |
| Ruddy Turnstone | *Arenaria interpres* | Taliqvak, Tuullignaq |

| Common Name | Scientific Name | Iñupiaq Name |
|---|---|---|
| Semi-palmated Sandpiper | *Calidris pusilla* | Liva Livaqpauraq, Nivilivilakpak |
| Western Sandpiper | *Calidris mauri* | |
| Pectoral Sandpiper | *Calidris melanotos* | Puvviaqtuuq |
| Sharp-tailed Sandpiper | *Calidris acuminata* | |
| Rock Sandpiper | *Calidris ptilocnemis* | |
| Dunlin | *Calidris alpina* | Iooauqtulik, Siggukpaligaraq |
| Long-billed Dowitcher | *Limnodromus scolopaceus* | |
| Red-necked Phalarope | *Phalaropus lobatus* | Qayyiubun |
| Red Phalarope | *Phalaropus fulicarius* | Auksruaq |
| Black-legged Kittiwake | *Rissa tridactyla* | |
| Ivory Gull | *Pagophila eburnea* | |
| Ross' Gull | *Rhodostethia rosea* | |
| Mew Gull | *Larus canus* | |
| Herring Gull | *Larus argentatus* | |
| Glaucous Gull | *Larus hyperboreus* | Nauyyaq, Nauyaq |
| Aleutian Tern | *Onychoprion aleuticus* | |
| Arctic Tern | *Sterna paradisaea* | |
| Pomarine Jaeger | *Stercorarius pomarinus* | |
| Parasitic Jaeger | *Stercorarius parasiticus* | |
| Long-tailed Jaeger | *Stercorarius longicaudus* | |
| Dovekie | *Alle alle* | |
| Common Murre | *Uria aalge* | Akpa |
| Thick-billed Murre | *Uria lomvia* | Akpa |
| Black Guillemot | *Cepphus grylle* | Ifabiq |
| Pigeon Guillemot | *Cepphus columba* | |
| Kittlitz's Murrelet | *Brachyramphus brevirostris* | |
| Parakeet Auklet | *Aethia psittacula* | |
| Least Auklet | *Aethia pusilla* | |
| Crested Auklet | *Aethia cristatella* | |
| Horned Puffin | *Fratercula corniculata* | |
| Tufted Puffin | *Fratercula cirrhata* | |
| Snowy Owl | *Bubo scandiacus* | Ukpik |
| Short-eared Owl | *Asio flammeus* | |
| Common Raven | *Corvus corax* | |
| American Robin | *Turdus migratorius* | |
| Yellow Wagtail | *Motacilla tschutschensis* | |
| Lapland Longspur | *Calcarius lapponicus* | |
| Snow Bunting | *Plectrophenax nivalis* | |
| American Tree Sparrow | *Spizella arborea* | |
| Savannah Sparrow | *Passerculus sandwichensis* | |
| Common Redpoll | *Acanthis flammea* | |
| Hoary Redpoll | *Acanthis hornemanni* | |

### 3.2.3.1 Threatened and Endangered Birds

**Spectacled Eider**

Spectacled eiders are medium sized, diving sea ducks that spend most of the year in marine waters and nest along the Beaufort and Chukchi coastal areas, as well as the Yukon Kuskokwim Delta and in Siberia. They feed on benthic invertebrates in marine waters, primarily mollusks and crustaceans but also eat

insects and insect larvae on the breeding grounds (Peterson et al. 2000). Biologists estimate that about 5,000 pairs currently nest on Alaska's Arctic coastal plain and at least 40,000 pairs nest in Arctic Russia. The current worldwide population estimate is between 200,000 and 300,000 birds, which is derived from winter surveys in the Bering Sea and includes non-breeding birds (USGS 2010).

Spectacled eiders are present in the Chukchi Sea during spring migration in May and June. After breeding, male eiders fly to nearshore marine waters in late June where they undergo a complete molt of their flight feathers. Nesting females remain on the coastal tundra until late August to early September and then congregate in molting areas. In Arctic Alaska, the primary molting area is Ledyard Bay, where males occur in the summer and breeding females occur in the fall (MMS 2008). Movement between nesting and molting areas takes several weeks because birds make many stops along the Beaufort and Chukchi coasts. Figure 3.2-7 shows the seasonal distribution of spectacled eiders in the EIS project area.

Spectacled eiders were listed as threatened under the ESA in 1993 as a result of severely declining populations in western Alaska, and possible declining populations in northern Alaska and eastern Russia (58 FR 27474, May 10, 1993). The USFWS published a Recovery Plan for the species in 1996 (USFWS 1996) and designated critical habitat in 2001 (66 FR 9146, February 6, 2001). Critical habitat includes several areas in the Bering Sea and also Ledyard Bay in the Chukchi (Figure 3.2-7).

### Steller's Eider

Steller's eiders are the smallest species of eider. They spend most of the year in marine waters and nest in coastal tundra habitats. This species feeds on crustaceans, gastropods, mollusks, and marine worms. There are two geographical populations of Steller's eiders, one that winters in the North Atlantic Ocean and one in the Pacific Ocean. Most of the Pacific population nests in the coastal tundra of northeast Siberia, with less than five percent of the breeding population nesting in Alaska on the Yukon-Kuskokwim Delta and the Arctic coastal plain, especially around Barrow (USFWS 2002).

Steller's eiders return to the Arctic as spring thaw allows, migrating north in May and June. Along open coastline, Steller's eiders usually remain within about 400 m (1,312 ft) of shore in water less than 10 m (33 ft) deep but they can also be found in waters well offshore in shallow bays and lagoons or near reefs (USFWS 2000a). Molting patterns are similar to spectacled eiders, with males returning to molting areas in nearshore marine waters after breeding in late June or July and females molting after nesting season, including substantial use of Izembek Lagoon. Immature birds usually remain at sea until reaching breeding age at two to three years old (Fredrickson 2001). Figure 3.2-8 shows the seasonal distribution of Steller's eiders in the EIS project area.

The Alaska breeding population of Steller's eiders was listed as threatened under the ESA in 1997 due to a decline in breeding in Alaska (62 FR 31748, June 11, 1997). The USFWS designated critical habitat for Steller's eiders in 2001 (66 FR 8850, February 2, 2001), all of which is adjacent to the Bering Sea, and published a Recovery Plan for the species in 2002 (USFWS 2002).

### Kittlitz Murrelet

Kittlitz's murrelets are small diving seabirds that eat fish and zooplankton. They occur discontinuously from Southeast Alaska to the eastern edge of the Alaskan Beaufort Sea and east to the Arctic National Wildlife Refuge (Day et al. 2011). They nest in rugged mountains near glaciers or in previously glaciated areas, sometimes up to 45 miles inland. In the EIS project area, the only known nesting habitat is on the Lisburne Peninsula (Figure 3.2-9). Population estimates for Kittlitz's murrelet are difficult to determine and range from 9,000 to 25,000 birds, the great majority of which are in Prince William Sound and Southeast Alaska (Denlinger 2006). There appears to be a great deal of annual variation in their occurrence in the Chukchi Sea (Day et al. 1999).

In response to a petition to list Kittlitz's murrelet under the ESA, the USFWS ruled in 2004 that conservation concerns warrant further investigation and that the species is considered a candidate for

listing under the ESA, which was updated in 2011 (76 FR 66370, October 26, 2011). A candidate species is one for which there is enough information to support a proposal to list as endangered or threatened, but for which preparation and publication of a proposal is precluded by higher-priority listing actions. The USFWS has conducted numerous surveys and studies on this species since 2004.

**Yellow-billed Loon**

The yellow-billed loon is a large diving seabird which spends most of the year in marine waters feeding on fish and invertebrates and nests in Arctic tundra regions. This species migrates from wintering areas in more southern waters, arriving at breeding areas along the Arctic coast between mid-May and mid-June (North 1994). Yellow-billed loons are regular migrants along the coastlines of northern Canada, northern Alaska, and northwestern Alaska, and a rare migrant along the western Alaska coastline (Earnst 2004). Satellite telemetry data indicate that nesting yellow-billed loons have variable movement patterns on their nesting grounds (Rizzolo and Schmutz 2010). Yellow-billed loons that nested on inland lakes (>20 km from marine waters) between Barrow and Teshekpuk Lake did not travel to marine waters to forage but loons that nested nearer to the shore on the Seward Peninsula frequently foraged in marine waters (Rizzolo and Schmutz 2010).

Of the approximately 3,300 yellow-billed loons present on the breeding grounds on the Arctic coast, 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 birds are non-breeders (Earnst et al. 2005). Additionally, there are approximately 1,500 yellow-billed loons, presumably immatures and non-breeding adults, which remain in near shore 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). In addition, approximately 8,000 yellow-billed loons that nest in the Canadian Arctic (Fair 2002, as cited in Earnst et al. 2005) also must travel through the Beaufort and Chukchi seas during spring and fall migration between Canada and wintering grounds in eastern Asia (Schmutz et al. 2010). Figure 3.2-10 shows the seasonal distribution of yellow-billed loons in the EIS project area.

In response to a petition to list yellow-billed loons under the ESA, the USFWS determined in 2009 that listing the yellow-billed loon is warranted but precluded by other higher priority listing actions and that the species should be considered a candidate for listing (74 FR 12932, March 25, 2009). The USFWS has not made any additional determinations on the petition to list the species under the ESA.

### 3.2.3.2 Seabirds

There are many species of seabirds that occur in both the Beaufort and Chukchi seas, including representatives from several orders of birds, all of which are adapted for spending the majority of their time at sea. Most only come near land during the breeding season. Some species feed at or near the surface of the water while others dive deep to feed in the benthic environment.

**Loons**

There are five species of loons in the Arctic, including the yellow-billed loon described above, Arctic and common loons which are rare in the Beaufort and Chukchi seas, and the Pacific and red-throated loons which are common nesters. Loons are extremely good swimmers and divers but awkward on land, therefore they nest within one meter of water, near large, deep, tundra lakes and wetlands. Loons eat invertebrates, aquatic insects, and small fish (USFWS 2009a).

The majority of loons migrate along coastal routes, although some migrate using inland routes (Johnson and Herter 1989). Most of the loon's fall migration takes place in September, and they are commonly observed in flight as they migrate to southern locations for the winter (Divoky 1987). In a survey of bird density and distribution at the Burger and Klondike lease areas in the Chukchi Sea (Gall and Day 2009). Pacific loons were one of the eight most abundant species observed. Most of the observations occurred in

mid-September to early October, and none were observed in late summer. Both red-throated and yellow-billed loons were rare during these surveys. USFWS surveys indicate the Pacific loon population on the North Slope has been growing substantially over the past ten years and has totaled about 27,000 birds the past few years (Larned et al. 2010).

The red-throated loon is the smallest of the loon species. USFWS surveys indicate the red-throated loon population on the North Slope has been relatively stable over the last 10 years and has totaled about 2,600 birds the past few years (Larned et al. 2010).

### Short-tailed Shearwaters

Short-tailed shearwaters breed in the southern hemisphere and occur in the Bering Sea and Arctic waters during their non-breeding season, eating primarily crustaceans, fish and squid.

Short-tailed shearwaters are most common in the southern portion of the Chukchi Sea but are often found in the central and northern portions from late August to late September. They have been reported as far north as Barrow depending on the presence of sea ice. An estimated 100,000 passed Point Barrow in one day in mid-September 1984 (Divoky 1987). At the Burger and Klondike lease areas, Short-tailed shearwaters were observed in most seasons but were most abundant in early fall when they were by far the most common species seen (Gall and Day 2009).

### Northern Fulmars

The northern fulmar is abundant in the offshore waters of the Chukchi Sea. There are approximately 1.4 million fulmars in Alaska, almost all of which breed in colonies in the Bering Sea (Denlinger 2006). Northern fulmars do not breed in the Chukchi Sea (Divoky 1987). Fulmars observed in the Chukchi, estimated at 45,000, from late August to mid-September are non-breeders or failed breeders (Divoky 1987). Reproduction rate is low, and breeding does not occur until they are 8 to 10 years old (Hatch and Nettleship 1998). Northern fulmars eat a wide variety of fish, squid, and zooplankton (especially copepods and amphipods) from near the sea surface and also commonly scavenge offal generated by commercial fishing and whaling operations (Hatch and Nettleship 1998). At the Burger and Klondike lease areas, northern fulmars were observed in all seasons but were most abundant in early fall at Klondike when they were the second most abundant species seen (Gall and Day 2009).

### Ross' Gull

Ross' gull is a small Arctic species which is rare in the Beaufort Sea during the summer time because most breed in coastal areas in the Russian Arctic. If they are in the Beaufort during the summer, they are found in close association with the ice edge (Divoky et al. 1988). Ross' gulls were rarely observed at Burger in late fall (Gall and Day 2009). However, they are common migrants in the Beaufort and Chukchi seas around Point Barrow in the fall (Divoky et al. 1988). Up to 16,000 birds have been observed migrating east past Point Barrow in late September, presumably from their breeding grounds in the Russian Chukchi, and westward back into the Chukchi in mid-October. Ross' gulls are commonly seen during these fall migrations along the coast from Wainwright to Cape Halkett, approximately 100 miles (160 km) west of Point Barrow (Divoky et al. 1988).

### Ivory Gull

The ivory gull breeds in areas of the high Arctic outside of Alaska and move to the Bering Sea in the winter (Mallory et al. 2008). They are present in the Beaufort and Chukchi seas in limited numbers during the spring and fall migrations and are uncommon to rare in the summer (Divoky 1987). These gulls eat invertebrates and ice-associated fish (walleye pollock and arctic cod). These birds tend to concentrate at the ice edge and at polynyas (recurring areas of open water), and may occasionally stop along the shores of Kasegaluk Lagoon, of Peard Bay, and near Barrow (Mallory et al. 2008). Ivory gulls were rarely observed at Burger in late fall (Gall and Day 2009). In the Canadian population of Ivory gulls, aerial surveys, bird counts, and observations of local native people found that there was an

80 percent decline in the number of breeding birds since the 1980s due to rising temperatures melting their polar sea-ice habitat (Defenders of Wildlife 2011).

## Glaucous Gull

Glaucous gulls occur in low densities in the offshore areas of the Chukchi Sea but commonly congregate at food sources (Divoky 1987). These birds are found in higher densities along the coasts of both the Beaufort and Chukchi seas. They breed inland near freshwater but sometimes breed within coastal seabird colonies. Glaucous gulls nest in many habitats including: barrier islands; sea cliffs; open tundra; ice edges; freshwater lakes and ponds; and islets on river deltas (Denlinger 2006). An adjusted population for Alaska, including those that nest inland, is approximately 100,000 individuals (Denlinger 2006). Glaucous gulls are most common in the Chukchi Sea from late July to late September within 70 km (43.5 mi) of shore between Icy Cape and Barrow (Divoky 1987). They were observed in all seasons at Burger and Klondike but were most common in early fall (Gall and Day 2009).

## Black-Legged Kittiwake

Black-legged kittiwakes nest on narrow cliff ledges in colonies that range from a few nests to several thousand (Denlinger 2006). They breed in colonies along the coast of the Chukchi Sea from Cape Thompson to Cape Lisburne, which are at the northern limit of the species range in Alaska (Denlinger 2006). Their diet consists of mostly fish including capelin, pollock, and herring. They are common in the Chukchi Sea north of Cape Thompson from mid-July until late September. From late August to late September, the population density for the central and southern portion of the Chukchi Sea is 2.3 birds/km$^2$ or an estimated population in excess of 400,000 birds in the pelagic Chukchi Sea (Divoky 1987). They were one of the most commonly observed species in all seasons at Burger and Klondike but were most common in early fall (Gall and Day 2009).

## Jaegers

Pomarine jaegers, parasitic jaegers, and long-tailed jaegers are common in the Chukchi Sea in the summer until late September. Jaeger densities at sea tend to be higher in years when there is low breeding on the tundra (Divoky 1987). Breeding occurs along the Arctic coast and on the Yukon Delta. Jaegers are found sporadically at any one site, but sometimes are in large numbers near Barrow. They primarily feed by scavenging, predation on small birds, bird eggs, and young birds, and stealing food from other birds (Denlinger 2006). Pomarine and parasitic jaegers were observed in low numbers at Burger and Klondike and were most common at Burger in early fall (Gall and Day 2009).

## Arctic Terns

Arctic terns nest near fresh or marine waters in open, treeless environments and are distributed widely along the Arctic coastal plain of the Beaufort and Chukchi seas. Population estimates in Alaska show that there may be several hundred thousand, most nesting inland (Denlinger 2006). They are rare in the pelagic waters of the Beaufort and Chukchi seas but congregate in nearshore areas to feed on zooplankton. Studies have found concentrations of arctic terns in Kasegaluk Lagoon and between Omalik Lagoon and Point Barrow (Dau and Larned 2005). Most leave the Arctic by mid-September, following a coastal route out of the Chukchi Sea in the fall (Divoky 1987). A few arctic terns were observed at Burger and Klondike, primarily in early fall (Gall and Day 2009).

## Phalaropes

Red phalaropes and red-necked phalaropes are closely related to other shorebirds but are often considered to be seabirds because they spend most of the year at sea and nest in coastal tundra. Both species are common in the Chukchi Sea during open-water periods but few are found further north than Point Barrow (Divoky 1987). There is a minimum of one million phalaropes in the Chukchi Sea during the summer. These seabirds are found in pelagic waters and also within a few meters of shore due to zooplankton abundance; therefore, their distribution tends to be patchy (Divoky 1987). Red phalaropes are considered

more common than red-necked phalaropes in Peard Bay (important for migrating juvenile red phalaropes) and Kasegaluk Lagoon (ASWG 2008). Small numbers of both species were observed in mixed-species flocks at Burger and Klondike, primarily in September (Gall and Day 2009).

## Murres

Murres have a unique breeding strategy with high nesting density, colony departure in synchrony, and the majority of chick development taking place at sea with the male parent (Ainley et al. 2002). The flightless period for juvenile murres at sea lasts from early September to mid-November when they, along with attendant adult males (part of this period males will be flightless and molting), move quickly from the Chukchi Sea to winter locations in the Bering Sea (Hatch et al. 2000). Murres use their wings to propel themselves underwater and can dive as deep as 210 m (689 ft) to catch fish and invertebrate prey (Ainley et al. 2002).

There are two main breeding colonies of common murres and thick-billed murres along the Chukchi Sea coast (Hatch et al. 2000). Approximately 100,000 murres nest at Cape Lisburne, with about 70,000 being common murres. At Cape Thompson, there are about 390,000 nesting murres, of which 75 percent are thick-billed. The foraging ranges of these two breeding colonies are almost completely separate. The Cape Lisburne colony forages primarily northwest to northeast of Point Hope, while the Cape Thompson colony forages primarily southwest to southeast of Point Hope (Hatch et al. 2000). Thick-billed murres were one of the most common species observed at Klondike in the summer and early fall but were rare or absent at Burger and during other seasons (Gall and Day 2009). Common murres were also observed at Klondike in fair numbers, primarily in late summer and early fall.

## Puffins

Tufted puffins nest in beach habitat by digging burrows or hiding under large pieces of driftwood or debris. They dive deep for fish and invertebrate prey. Around 18,000 horned puffins breed at colonies at Cape Lisburne and Cape Thompson. Only 100 breeding tufted puffins occur in these areas (USFWS 2006). Horned puffins are commonly observed in the Chukchi Sea by Cape Lisburne after the breeding season in September. They have also been seen near Barrow and are now breeding on Cooper Island in the western Beaufort Sea (USFWS 2006). Both species were observed at Klondike in low numbers, primarily in summer (Gall and Day 2009).

## Black Guillemots

Black guillemots have a small breeding population in Alaska, with a combined total of fewer than 2,000 birds in both the Beaufort and Chukchi seas. Their breeding range is from Cape Thompson northward. Black guillemots nest in driftwood piles and manmade structures due to the low coastal tundra bluffs and gravel beaches lacking fissures or spaces that are suitable for breeding (Denlinger 2006). These birds tend to stay close to sea ice throughout their lifetime to feed on arctic cod. If the sea ice is beyond their foraging range, they will switch prey to other fish species as necessary (Divoky 1987). The black guillemots that breed on Cooper Island (between late June and early September), in the Beaufort Sea, also are found in the Chukchi Sea by Point Barrow during the early part of the breeding season (Divoky 1987). Black guillemots were also observed at Klondike in low numbers, primarily in summer (Gall and Day 2009).

## Auklets

Parakeet auklets, least auklets, and crested auklets breed as far north as the Bering Strait, but move north into the Chukchi Sea from late August through early October where they feed on small zooplankton, often far from shore where strong vertical mixing carries the prey to the surface (Denlinger 2006). Based on limited data, crested auklets appear to be the most numerous auklet species in the Chukchi Sea during this time period (Divoky 1987). Perhaps a total of 100,000 auklets are present in the Chukchi Sea when combining all three species (Divoky 1987). Least and crested auklets were two of the most common

species observed at Klondike, especially in fall, but were much less common at Burger (Gall and Day 2009).

### 3.2.3.3 Waterfowl

Many ducks, geese, and swans migrate to the Arctic for the summer to nest on the tundra. Some species, such as long-tailed ducks and eiders, spend most of their non-breeding seasons on marine waters and are often considered as seabirds. Other species are not often associated with marine waters but nest in coastal areas in the EIS project area and may be affected by associated onshore activities identified in this EIS.

#### Long-tailed Ducks

The long-tailed duck is a small sea duck that nests on marshy grass tundra, especially around polygon ponds, lakes, bogs, slow rivers, and barrier islands (Robertson and Savard 2002). They feed on crustaceans, shrimp, amphipods, clams and fish in marine waters and will eat freshwater insects, fish eggs, and plant material on their breeding grounds. Alaska is home to about 20 percent of the North American population of one million (Kirchhoff and Padula 2010). This species breeds in the Arctic and western Alaska and winters along the southern coast of Alaska south to Washington state. Long-tailed ducks migrate north along the Chukchi Sea coast and east along the Beaufort Sea coast from wintering areas to breeding areas in Arctic Alaska and Canada (Lysne et al. 2004). During the open-water period in the Beaufort Sea, long-tailed ducks are abundant in and near lagoons, but they also molt in Kasegaluk Lagoon on the Chukchi Sea coast (Flint et al. 2003). Kasegaluk Lagoon and Peard Bay are major long-tailed duck molting and pre-migratory areas (Lysne et al. 2004). In late June and early July, most male and nonbreeding females assemble in massive flocks in lagoons along the Beaufort Sea to molt, while a smaller number molt on large, freshwater lakes (Flint et al. 2003). Females and immature birds leave in August to October. Long-tailed ducks were the most common waterfowl observed at Burger and Klondike, but numbers were still relatively low. They were observed at both sites and in all seasons (Gall and Day 2009).

USFWS surveys indicate the long-tailed duck population on the North Slope has been above the 18 year mean but below the 20 year mean and has totaled about 34,000 birds the past few years (Larned et al. 2010).

#### Eiders

King and common eiders are two of the four world eider species (spectacled and Steller's eiders are discussed above). These large sea ducks breed in the Arctic and winter in marine waters along the southern coast of Alaska. They are always found near water and nest on Arctic tundra near lakes, bogs, and streams near the coast and up to 50 km (31.1 mi) inland. They eat mostly benthic organisms while at sea, and mollusks, aquatic insects, and plants on breeding grounds (Suydam 2000). Both eider species begin migration in April and arrive at their breeding grounds in May to early June; males leave breeding areas in late June and July to migrate to molting areas, while females and immature birds follow later.

The population status of king eiders is in question because of migration counts at Point Barrow, which declined 56 percent between 1976 and 1996, from 802,556 birds to about 350,835 birds, as well as a significant decrease in birds in the Northwest Territories (Suydam 2000). An estimated 499,423 king and 174,063 common eiders passed Point Barrow in the summer/fall migrations of 2002. In 2003, the summer/fall surveys estimated 365,680 king and 132,404 common eiders had passed Point Barrow. In the spring migrations, 304,966 king and 114,998 common eiders passed Point Barrow in 2003 while 591,961 king and 110,561 common eiders passed in 2004. This study indicated that, since 1996, the numbers of king eiders passing Point Barrow remained stable while common eiders have increased (Quakenbush et al. 2009).

King eiders nest in highest densities on the Arctic coast between Wainwright and Prudhoe Bay, with concentration areas near Atqasuk and from Teshekpuk Lake to Deadhorse. Telemetry work by Oppel

(2008) found that potentially all king eiders breeding in western North America use Ledyard Bay, Kasegaluk Lagoon, and Peard Bay as staging areas during migration.

An estimated 170,000 common eiders exist globally with about 54,000 nesting in Alaska, with populations remaining stable or slightly increasing (Kirchhoff and Padula 2010). Common eiders nest on barrier islands and spits along the coast from Kasegaluk Lagoon to Prudhoe Bay. Common molt areas in the Chukchi Sea are near Point Lay, Icy Cape, and Cape Lisburne, including Peard Bay (Johnson and Herter 1989). Small numbers of both king and common eiders were observed at Burger and Klondike (Gall and Day 2009).

**Geese and Swans**

Brant typically nest on barrier islands, offshore spits, or islands in large river deltas, no more than 40 km (24.8 mi) inland from the coast (Derksen et al. 1981). They migrate along the west coast of Alaska enroute to breeding areas on the Alaska coast or the Canadian High Arctic. The main nesting area for brant in Alaska is the Yukon-Kuskokwim delta but smaller colonies exist from the Seward Peninsula to Kasegaluk Lagoon (about 200 birds) and along the Beaufort coast east to the Canning River (about 3,000 birds) (Pacific Flyway Council 2002). The USFWS conducts waterfowl surveys along the Alaska Arctic coast every year and found a significant increase in the brant breeding population between 2001 and 2004 followed by stability at the higher level through 2009 (Larned et al. 2010). However, the USFWS survey design may not be the most appropriate to track population trends and more focused surveys have indicated a stable number of nests (346 to 386 nests total) at small colonies between Barrow and the Coleville Delta (Ritchie et al. 2002 and 2007, as cited in Larned et al. 2010). The largest concentrations of colonies and nests have been located in the Sagavinirktok River Delta, Prudhoe Bay, and Kuparuk areas (Stickney and Ritchie 1996). Kasegaluk Lagoon and Peard Bay are important stopover locations during the post breeding migration of this species.

Greater white-fronted geese breed along the coasts of the Bering, Chukchi, and Beaufort seas. The first week of June and the last week of August are peak migration times out of Kasegaluk lagoon. They typically breed on the tundra, within 30 km (18.6 mi) of the coast (Johnson and Herter 1989). USFWS surveys indicate the white-fronted goose population on the North Slope has been growing substantially over the past ten years and has totaled about 160,000 birds the past few years (Larned et al. 2010).

Lesser snow geese use Kasegaluk lagoon, an island in the Kukpowruk River delta (about 60 km [37.3 mi] south of Point Lay), and the Ikpikpuk River delta near Prudhoe Bay on the Arctic coast to nest (Ritchie and Rose 2009). Recent brood rearing monitoring surveys on sites east of Barrow found increases in populations on the Ikpikpuk River and growth in the colonies on both the Colville River delta and the Sagavanirktok River delta. Based on a combination of group sizes from points north and south of Point Lay at least 2,315 snow geese summered in Kasegaluk lagoon in 2008 (Ritchie and Rose 2009). USFWS surveys indicate the snow goose population on the North Slope has been growing substantially over the past ten years and has totaled about 28,000 bids the past few years (Larned et al. 2010).

Tundra swans nest in Arctic wetlands throughout Alaska. They form monogamous pairs, and the young remain with the parents until arrival on the breeding grounds the following year. Tundra swans eat submerged aquatic vegetation and benthic organisms (Limpert and Earnst 1994). USFWS surveys indicate the tundra swan population on the North Slope has been growing substantially over the past ten years and has totaled about 10,000 birds the past few years (Larned et al. 2010).

### 3.2.3.4 Shorebirds

Many species of shorebirds migrate long distances to nest in Arctic regions, often congregating in large numbers at favorable staging areas along the coast. Many shorebirds stop to replenish energy reserves and rest at high productivity sites like Kasegaluk Lagoon and Peard Bay. The Colville River Delta hosts 41,000 to 300,000 shorebirds between the end of July and early September each year (Andres 1994,

USSCP 2004). Shorebird chicks leave their nests within 24 hours of hatching and never return but are protected by both parents until they are able to fly. Juvenile birds often group together in flocks, typically along the coast, to feed and prepare for their migration (Weiser 2008).

Dunlin are one of the main species of shorebirds that use Kasegaluk Lagoon for staging during migration. They are listed as a species of concern because of declining populations (USSCP 2004).

Semipalmated sandpipers nest on flat marshy tundra and raise their young in just a few weeks of Arctic summer. This species appears on the breeding territories in the first few weeks of June (Hicklin and Trevor 2010).

Pectoral sandpipers arrive on the breeding grounds in late May or early June. In Barrow, egg laying begins as early as the first week of June but most laying occurs from mid-June to the beginning of July. In the breeding areas, they feed on larvae and adult arthropods (Holmes and Pitelka 1998).

Bar-tailed godwits breed in sub-Arctic and Arctic tundra in western and northern Alaska. In September and early October, nearly 100,000 post breeding birds move along the Bering Sea Coast at staging grounds before flying nonstop to New Zealand. Both breeding and non-breeding sites show a rapid population decline (McCaffery and Gill 2001).

Buff-breasted sandpipers are rare breeders and visitors in northwestern Alaska and are considered highly imperiled due to threats in their winter habitat in South America (Brown et al. 2001).

American golden-plovers breed in dwarf shrub habitats and stage in dwarf-shrub and salt-grass meadows. The North American population is of conservation concern due to a decreasing population trend and threats during the non-breeding season in South America (USSCP 2004).

#### 3.2.3.5 Terrestrial Species

There are relatively few terrestrial species that nest in the Arctic. The following species forage and nest in coastal areas of Arctic Alaska and may be affected by associated onshore activities of the EIS Proposed Action and Alternatives.

Rock and willow ptarmigan have a circumpolar distribution and are residents of the Arctic throughout the year. Rock ptarmigans spend their entire life cycle on Arctic and alpine tundra. They breed throughout Alaska in suitable habitat (Montgomerie and Holder 2008). Movements between summer and winter ranges are short, usually within 30 to 50 km (18.6 to 31.1 mi) (Hannon et al. 1998). Willow ptarmigan nest in tall shrub zoned areas on the tundra, in willow or birch thickets (Hannon et al. 1998). Both species of ptarmigan are harvested for subsistence all year round but most are captured in the winter and spring (Montgomerie and Holder 2008).

Rough-legged hawks, peregrine falcons, short-eared owls, and snowy owls are the most common raptors present on the Arctic coast. Gyrfalcons and golden eagles are also present. They are typically more common within 20 km (12.4 mi) of the Brooks Range foothills with population densities lower near the coast, especially during the breeding season. Lack of suitable nesting areas and prey has prevented other species from occurring along the coast of the Chukchi Sea. Snowy owls are commonly encountered in close proximity to Kasegaluk Lagoon (Johnson and Herter 1989).

Lapland longspurs, snow buntings, common redpolls, hoary redpolls, yellow wagtails, common ravens, savannah sparrows, American robins, American tree sparrows are the main passerines/songbirds that regularly breed on the Arctic coast in Alaska. Ravens and redpolls are the only passerines that reside year round in the Alaskan Arctic. Male snow buntings return in early April to the high Arctic breeding grounds, when the temperature is still well below freezing and many food sources are covered in snow. Females arrive about four to six weeks later when the temperatures start to warm up. This species nests in rock cavities but they also nest on human structures and are common in the coastal communities (Lyon et al. 1995).

Common ravens are often found where humans are abundant, and numbers on the Arctic coast have increased where human activities are concentrated. Breeding ravens scavenge and forage for a variety of food and can be selective predators at times (Backensto 2009). Increasing numbers of breeding ravens are associated with higher predation on local prey species near nest sites. In the treeless Arctic, ravens only nest on cliffs and buildings (Weiser 2008).

#### 3.2.3.6 Traditional Knowledge about Birds

Most efforts to document traditional knowledge in the Arctic have focused mainly on harvested species of caribou, polar bears, and whales. This does not mean that traditional knowledge about birds does not exist or that it is not important. A few studies have been conducted in Canada to document traditional knowledge on marine birds, including common eiders (Amauliqruaq), harlequin ducks, ivory gulls, and thick-billed murres (Akpa). In these Canadian studies, Inuit knowledge showed that eider populations in Hudson Bay declined due to changes in sea ice conditions which limited locations of open water for feeding eiders. Having this local knowledge helped scientists discover a problem that would have gone undetected (Gilchrist et al. 2005). In addition, local knowledge and western science was used in a study by Gearheard et al. (2006) comparing the sea ice in the Nunavut (Clyde River) region in Canada with the sea ice in the Barrow region in Alaska and how it affected hunting in those regions. For people in Barrow, changes in the seasonal sea ice patterns affected hunting activities for spring and fall whaling, which may affect seasonal harvest patterns for birds and other subsistence species.

### 3.2.4 Marine Mammals

#### 3.2.4.1 Marine Mammals

Fifteen marine mammal species occur in the Beaufort and Chukchi seas (Table 3.2-4). All are federally protected under the MMPA. Four species – bowhead whale, humpback whale, fin whale, and polar bear – are listed as either threatened or endangered under the ESA. The Pacific walrus is a candidate species for listing and ringed and bearded seals are proposed for listing. The remaining species are neither listed nor currently proposed for listing under the ESA. The USFWS has jurisdiction over Pacific walrus and polar bears. The remainder is under the jurisdiction of NMFS.

This section includes information on population status and trends; distribution, migration and habitat use; reproduction and growth; survival; mortality; disease; hearing and other senses; and climate change. Information is derived from peer-reviewed papers, published and unpublished reports, and recent summary documents available for several species of concern, such as stock assessment reports (e.g. Allen and Angliss 2010) and status reviews (e.g. Boveng et al. 2008, Boveng et al. 2009, Cameron et al. 2010, Garlich-Miller et al. 2011, and Kelly et al. 2010a).

#### 3.2.4.2 Cetaceans

**<u>Bowhead Whale: Western Arctic Stock</u>**

***Species Description***

Bowhead whales are baleen whales of the family Balaenidae. They are large, rotund whales that lack a dorsal fin and are darkly colored with varying amounts of white on the chin, tail stock, and underside. The amount of white around the tail increases with age. In addition, whales often acquire distinctive scars, observed as white marks on the body, over time, which can be used to identify individuals (Rugh and Shelden 2009). The region by the blowholes (nostrils) is prominent and makes the head appear triangular in profile. Bowheads also have a distinctive neck area, or indentation between the head and back. The bowed shape of the mouth is what earned this whale its name (Rugh and Shelden 2009).

**Table 3.2-4 Marine Mammal Species Found in the Beaufort and Chukchi Seas EIS Project Areas**

| Common Name | Scientific Name | Iñupiaq Name[a] | ESA Status |
|---|---|---|---|
| ***Cetaceans*** | | | |
| Bowhead whale | *Balaena mysticetus* | Abviq | Endangered |
| Humpback whale | *Megaptera novaeangliae* | | Endangered |
| Fin whale | *Balaenoptera physalus* | | Endangered |
| Minke whale | *Balaenoptera acutorostrata* | | Not listed |
| Gray whale | *Eschrichtius robustus* | | Not listed |
| Beluga whale | *Delphinapterus leucas* | Qixalugaq/Sisuaq | Not listed |
| Narwhal | *Monodon monoceros* | | Not listed |
| Killer whale | *Orcinus orca* | | Not listed |
| Harbor porpoise | *Phocoena phocoena* | | Not listed |
| ***Pinnipeds*** | | | |
| Ringed seal | *Phoca hispida* | Natchiq | Proposed Threatened |
| Spotted seal | *Phoca largha* | Qasibia | Threatened [b]/Not listed |
| Ribbon seal | *Phoca fasciata* | Qaibulik | Not listed |
| Bearded seal | *Erignathus barbatus* | Ugruk | Proposed Threatened |
| Pacific walrus | *Odobenus rosmarus divergens* | Aiviq | Candidate |
| ***Fissipeds*** | | | |
| Polar Bear | *Ursus maritimus* | Nanuq | Threatened |

[a] **Source:** Bacon, Joshua and Robert Akpik, Jr. List of subsistence resources utilized by residents of the NSB (revised by L. Pierce, May 2010). NSB Department of Wildlife Management, Barrow, AK

[b] Only the Southern Distinct Population Segment, found in the Yellow Sea and Sea of Japan, is listed as threatened. The Alaska stock is not listed.

Bowheads can weigh up to 75 to 100 tons (150,000 to 200,000 lbs) and grow to 14 to 18 m (46 to 59 ft) in length, with the head comprising over a third of the body. Bowheads have the longest baleen plates of any whale, reaching lengths up to 4 m (13 ft) (Reeves and Leatherwood 1985). They may also have the largest mouth of any animal. They are well insulated from Arctic waters by blubber that is 5.5 to 28 cm (2.2 to 11 in) thick covered by 2.5 cm (1.0 in) of skin – the thickest blubber and skin combination of any whale (Rugh and Shelden 2009).

### *Population Status and Trends*

The International Whaling Commission (IWC) historically recognized five bowhead whale stocks for management purposes: the Spitsbergen stock; Davis Strait stock; Hudson Bay stock; Okhotsk Sea stock; and the Western Arctic (Bering-Beaufort-Chukchi seas) stock. The current working hypothesis is that the Davis Strait and Hudson Bay bowhead whales comprise a single Eastern Arctic stock. Confirmation of stock structure awaits further scientific analyses (IWC 2011). The Western Arctic stock is the largest remnant population and the only stock within U.S. waters (Allen and Angliss 2010). It is also the only bowhead whale stock that occurs in the EIS project area.

Bowhead whales were severely depleted throughout their range during intense commercial whaling prior to the 20th century. They received international protection from commercial whaling beginning in 1931 (NMFS 2008b). The Western Arctic stock has since recovered significantly.

Systematic ice-based counts to assess abundance of bowhead whales migrating past Barrow during spring began in 1976. Initial estimates were based solely on visual observations. Traditional knowledge of Iñupiat Eskimo whalers pointed out shortcomings in these early counts, such as not accounting for and

correcting for whales that continued to migrate under the ice of closed leads or that migrate farther offshore. As a result, an acoustic component was added to the census, allowing for the detection of whales not detectable by visual observers and for the development of correction factors (Huntington 2000). The whalers' traditional knowledge proved accurate and invaluable in advancing the accuracy of census estimates.

The most recent estimate of abundance derived from an ice-based census in 2001 was 10,470 bowhead whales in the Western Arctic stock (George et al. 2004). The estimated annual rate of increase from 1978 to 2001 was 3.4 percent. The 2001 estimate was subsequently revised to 10,545 bowhead whales (Zeh and Punt 2004 cited in Allen and Angliss 2010). The population may be approaching carrying capacity despite showing no sign of a slowing in the population growth rate (Brandon and Wade 2006).

Capture-recapture analysis based on aerial photographs of individually identified bowhead whales provided alternative, and comparable, estimates of abundance. Schweder et al. (2009) calculated an estimate for 2001 of 8,250 whales and a yearly growth rate of 3.2 percent. Results based on images from 2003 through 2005 provided an estimated population abundance in 2004 of 12,631 whales, excluding calves (Koski et al. 2010). The abundance estimates calculated from photographic data were consistent with expected abundance and trend estimates from ice-based surveys (Koski et al. 2010).

The Western Arctic stock of bowhead whales remains listed as endangered under the ESA and is considered depleted under the MMPA.

### *Distribution, Migration and Habitat Use*

Western Arctic bowhead whales are distributed in seasonally ice-covered waters north of 60°N latitude and south of 75°N latitude in the western Arctic Basin (Braham 1984, Moore and Reeves 1993). They retain a close association with ice for most of the year. Most migrate annually from wintering areas in the northern Bering Sea, through the Chukchi Sea in the spring to summer in the Beaufort Sea before returning to the Bering Sea in the fall (Allen and Angliss 2010) (Figure 3.2.-11). Some animals remain in the eastern Chukchi and western Beaufort seas during the summer (Clarke et al. 2011a, Ireland et al. 2008).

During winter, the Western Arctic stock is in the central and western Bering Sea associated with the marginal ice front and polynyas near St. Matthew and St. Lawrence Islands and the Gulf of Anadyr (Moore and Reeves 1993, NMFS 2008b). Recent satellite tagging studies provided a more detailed look at winter distribution. Winter density was generally confined to the Bering Shelf north of Navarin Canyon and the 200 m (656 ft) isobath. Areas of higher use extended from the Bering Strait through the Anadyr Strait to Navarin Canyon. Two whales migrated into the Chukchi Sea in March, although most did not begin migrating north until April (Quakenbush et al. 2010a).

The spring migration from April to June follows leads in the sea ice through the Bering Strait to the Chukchi Sea and past Barrow and into the Beaufort Sea (Figure 3.2.-12). Tagged whales began migrating north in early April, passed into the Chukchi Sea by mid-April, on average, and all passed Barrow by May 6 in 2009. Travel was parallel to and within 40 km (24.8 mi) of the coast. Once past Barrow, all tagged whales traveled directly to the Amundson Gulf polyna (Quakenbush et al. 2010a) (Figure 3.2-13).

The migratory corridor used by tagged whales in spring to travel from the Bering Strait, to Barrow, and across the Beaufort Sea to Amundsen Gulf was well defined (Quakenbush et al. 2010a). Tagged whales generally did not stop between the Bering Strait and Amundsen Gulf. This may be due to limited feeding opportunities or ice configurations (Quakenbush et al. 2010a).

Temporal segregation by size and sex class occurs during the spring migration. The first wave consists of sub-adults, the second of larger whales, and the third is comprised of even larger whales and cows with calves (NMFS 2008b, Rugh 1990, Suydam and George 2004). Yupik whalers of St. Lawrence Island also note that the first to pass by are the smaller whales—*ingutuk* in both Yupik and Iñupiaq, which are rotund

yearlings --then the mid-sized whales, followed by the largest whales and the mothers with calves (Noongwook et al. 2007). The reverse order is seen in the fall throughout the migration corridor (Koski and Miller 2009, Noongwook et al. 2007).

During the summer, most of the population is in the southern and eastern Beaufort Sea. Only a few bowheads have been noted in the northeastern Chukchi Sea during the summer (Ireland et al. 2008). In June and July 2009, a group of bowhead whales were observed feeding in nearshore waters between Point Franklin and Barrow along the Chukchi Sea coast. No bowheads were observed there in 2008 or 2010 and few were sighted in the Chukchi Sea in August during surveys in 2008 through 2010 (Clarke et al. 2011a).

In autumn, bowheads begin their migration across the Beaufort Sea to the Chukchi Sea. From early September to mid-October, bowheads migrate west out of the Beaufort Sea across inner shelf waters (Figure 3.2-15). From mid-September to mid-October, bowheads occur in the northeast Chukchi Sea. Most of the tagged whales in 2006 through 2008 traveled west from Point Barrow through the Chukchi Sea between 71˚ and 74˚ N latitude. All whales traveled through the Chukchi Sea 193 Lease Sale area in the northeastern Chukchi Sea at least once (Figure 3.2-15) (Quakenbush et al. 2010b). Brueggeman et al. (2009, 2010) sighted two and three bowhead whales in October 2008 and October 2009, respectively, on the Burger prospect of this lease sale area.

The area of highest probability of use by satellite tagged whales in September was concentrated northeast of Point Barrow. The high probability use area also extended to the east, west and south of the shelf break and 200-m isobath (Quakenbush et al. 2010a). Aerial surveys of bowhead whale distribution in the Beaufort Sea (BOEM-funded Bowheadd Whale Aerial Survey Project or BWASP) during fall are conducted annually by NMFS. BWASP surveys were previously flown by the Minerals Management Service (now BOEM). Four of the most recent survey years (2006 through 2009) were light ice years. Median distance from shore ranged from as close as 6.6 to 16.9 km (4.1 to 10.5 mi) in 2009 to 34.3 to 39.2 km (21.3 to 24.4 mi) in 2006. The latter was significantly farther from shore than during other light ice years, possibly due to grounded ice near the coastline, locations of prey concentrations, or nearshore shallow hazards work. Median depth of sightings was relatively shallow all years, ranging from 15 to 44 m (49 to 144 ft) (Clarke et al. 2011b, 2011c). Behaviors included milling, swimming, and feeding, to a lesser degree. Highest numbers of sightings were in the central Beaufort and east of Point Barrow.

Most tagged whales were crossing the Chukchi Sea in September heading to Wrangel Island and Chukotka (Figure 3.2-14). The Chukchi Sea Lease Sale Area was most commonly used by tagged whales in September. However, the areas with the highest probability of use were in the northeastern section of the Lease Area, not in the area of the leased blocks. Leased blocks contained only two percent of the total probability of use by bowhead whales (Quakenbush et al. 2010a). Bowhead whales increased in the Chukchi Offshore Monitoring in Drilling Area (COMIDA) in September and October 2008 through 2010, with sighting rates highest in October (Clarke et al. 2011a). This was similar to the previously observed distribution during surveys conducted from 1989 through 1991 (Clarke et al. 2011a).

In October, probability of use was highest northeast of Point Barrow and along the Chukotka coast. In November, highest probability of use was also along the Chukotka coast. By December, use concentrated along the Chukotka coast, from Cape Serdtse-Kamen to the Bering Strait (Quakenbush et al. 2010a).

The fall migratory corridor from Amundsen Gulf back to Barrow was less defined than during the spring migration. Some whales travel inshore and some travel offshore. The migratory corridor across the Chukchi Sea, from Barrow to Chukotka, was the least defined, with whales crossing the Chukchi Sea between 71˚ and 74˚ N latitude. Some whales crossed farther to the north and some migrated down the Alaskan coast (Quakenbush et al. 2010a). Whales that stay later in the fall near to Barrow have not been observed to migrate to Wrangel Island, as they either cross the Chukchi Sea farther to the south or migrate down the Alaskan coast (Quakenbush et al. 2010a).

Bowhead whales feed seasonally in response to food availability and abundance. Feeding occurs in the spring during migration, but is not as common as later in the summer and fall when zooplankton abundance peaks. Primary prey are copepods and euphausiids (krill). A greater preponderance of euphausiids is eaten in the Bering–Chukchi region, and more copepods are taken in the eastern Beaufort Sea (Lee et al. 2005).

The Barrow area is commonly used as a feeding area during spring and fall. A higher proportion of photographed individuals showed evidence of feeding in fall than in spring (Mocklin 2009). A bowhead whale feeding "hotspot" (Okkonen et al. 2011) commonly forms on the western Beaufort Sea shelf off Point Barrow in late summer and fall (see Section 3.2.6, Special Habitat Areas). Favorable conditions concentrate euphausiids and copepods, and bowhead whales congregate to exploit the dense prey (Ashjian et al. 2010, Moore et al. 2010, Okkonen et al. 2011). Surveys have also noted bowhead whales feeding in the Camden Bay area during the fall (Koski and Miller 2009, Quakenbush et al. 2010a). Opportunistic sampling of zooplankton near bowheads suggest they prefer to feed on swarms of euphausiids (*T. raschii*) or copepods (*Pseudocalanus* spp.) (Moore et al. 2000).

On February 22, 2000, NMFS received a petition to designate critical habitat in the nearshore areas from the U.S.-Canada border to Barrow for the Western Arctic stock of bowhead whales. On May 22, 2001, NMFS found the petition to have merit (66 FR 28141), but on 30 August 2002 (67 FR 55767), NMFS announced the decision to not designate critical habitat. NMFS determined that critical habitat designation was unnecessary. The population is increasing and nearing its pre-commercial whaling population size, and no known habitat issues are impeding population growth (Allen and Angliss 2010).

### *Reproduction and Growth*

Bowheads likely mate in late winter or early spring, although mating behavior has been observed at other times of the year. Gestation is about 13 to 14 months, and calves are usually born between April and June, during the spring migration. The calving interval is about three to four years. Juvenile growth is relatively slow. Bowheads reach sexual maturity at about 15 years of age (12 to 14 m [39 to 46 ft] long) (Nerini et al. 1984). Growth for both sexes slows markedly at about 40 to 50 years of age (George et al. 1999).

### *Survival and Mortality*

Bowhead whales are long-lived animals, likely living longer than any other mammals. Based on aspartic racemization of eye lenses, George et al. (1999) calculated ages greater than 150 years. Discoveries of traditional stone, ivory, and metal whale-hunting tools recovered from several harvested whales further corroborated longevity beyond 150 years.

Pelagic commercial whaling was the single greatest historical source of mortality for bowhead whales. The Bering Sea fishery primarily operated from 1848 to 1919. By 1870, 60 percent of the pre-whaling population was estimated to have been taken (Braham 1984). The estimated catch of 18,684 western Arctic bowhead whales by pelagic whalers (Woodby and Botkin 1993) was likely an underestimate due, in part, to under-reporting of Soviet catches (Yablokov 1994)Bowhead whales are an important subsistence resource for Alaska natives (see Section 3.3.2, Subsistence) and have been hunted by Eskimos for at least 2,000 years. Takes are regulated by quotas established under the authority of the IWC and average about 40 to 50 strikes per year (NMFS 2008b).

Incidental mortality or injury from entanglement in commercial fishing gear is known to occur. Scarring attributed to ropes or entanglements have been observed on harvested whales. Stranding reports document entanglements between 2001 and 2005, including a bowhead whale observed near Point Barrow with fishing net and line around the head (Allen and Angliss 2010). A dead bowhead whale found floating in Kotzebue Sound in July 2010 was entangled in crab pot gear similar to that used in the Bering Sea crab fishery. The entanglement through the mouth and around the tail stock may have been the cause of death (Suydam et al. 2011).

Incidence of injury caused by vessel collisions appears to be low (one percent, based on scarring). This could be due to either collisions resulting in death (and not accounted for) or a low incidence of co-occurrence of ships and bowhead whales (George et al. 1994).

Little is known about naturally occurring diseases and sources of mortality in bowhead whales. Periodic ice entrapment and predation by killer whales have been documented in most bowhead whale stocks (Nerini et al. 1984). The frequency of killer whale attacks is unknown, although a small percent (4 to 8 percent) of bowheads examined had scars indicative of killer whale attacks (George et al. 1994, NMFS 2008b).

### *Hearing and Other Senses*

Bowhead whales likely hear in low frequency ranges, with an estimated auditory bandwidth of 7 Hz to 22 kHz (Southall et al. 2007). Whalers on St. Lawrence Island noticed that bowheads are sensitive to noise when traveling alone or in small groups, so they use sails to power their boats when hunting bowheads (Noongwook et al. 2007). Barrow whalers hunting bowheads in ice leads in the spring use umiaqs made of bearded seal skin and paddle silently so as not to scare the whales; aluminum boats produce too much noise (Rexford 1997).

Bowhead whales produce a broad repertoire of sounds. Included are songs, recorded during the spring migration from the Bering Sea, composed of one to three themes in a frequency range generally below 1,000 Hz. Songs have also been recorded during fall and early winter in the Chukchi Sea (Delarue et al. 2009). Other calls are both simple and complex. Low frequency-modulated (FM) calls are less than 400 Hz; the more complex pulsed tonal and pulsed calls are produced at frequencies generally between 400 and 1,000 Hz. Calling – and counter-calling – is common during migration (Frankel 2009, George et al. 1989).

Bowhead whales appear to have good lateral vision. Recognizing this, whalers approach bowheads from the front or from behind, rather than from the side (Noongwook et al. 2007). In addition, whalers wear white parkas on the ice so that they are not visible to the whales when they surface (Rexford 1997).

Olfaction may also be important to bowhead whales. Recent research on the olfactory bulb and olfactory receptor genes suggest that bowheads not only have a sense of smell but one better developed than in humans (Thewissen et al. 2011). The authors suggest that bowheads may use their sense of smell to find dense aggregations of krill upon which to prey.

## Humpback Whale

### *Species Description*

Humpback whales are medium sized baleen whales, reaching lengths of 16 to 17 m (52.5 to 55.8 ft) (Clapham and Mead 1999). They are easily recognized at close range by their extremely long flippers, which may be one-third the length of the body. The flippers are white on the bottom and may be white or black on top, depending on the population. The body is black on top with variable coloration ventrally and on the sides. The head and jaws have numerous knobs which are diagnostic for the species. The dorsal fin is small and variable in shape. The underside of the tail exhibits a unique pattern of white to black that is individually identifiable (Clapham 2009).

### *Population Status and Trends*

The three stocks of humpback whales in the North Pacific are: 1) the California/Oregon/Washington and Mexico stock, which migrates seasonally between coastal Central America and Mexico and the coast of California to southern British Columbia in summer/fall; 2) the Central North Pacific stock, that migrates between the Hawaiian Islands and northern British Columbia/Southeast Alaska, the Gulf of Alaska, and the Bering Sea/Aleutian Islands; and 3) the Western North Pacific stock, that migrates between Asia and Russia and the Bering Sea/Aleutian Islands (Allen and Angliss 2010).

It is uncertain as to whether the individuals that venture into the Chukchi Sea are from the Central or Western North Pacific stock. The Western North Pacific stock may be the more likely of the two, given the known geographic range. Population estimates are provided for both stocks.

The most recent estimates derive from a large-scale study of humpback whales throughout the North Pacific conducted in 2004 through 2006 (Structure of Populations, Levels of Abundance, and Status of Humpbacks [SPLASH]). The abundance estimate for the entire North Pacific was 19,594 (Calambokidis et al. 2008). However, Barlow et al. (2011) revised the estimate based on capture-recapture methods using over 18,000 fluke identification photographs collected in 2004-2006. Their best estimation of abundance was 21,808. After using simulation models to estimate biases, Barlow et al. (2011) derived a best estimate of abundance of 21,063. Barlow et al. (2011) state, "Results confirm that the overall humpback whale population in the North Pacific has continued to increase and is now greater than some prior estimates of pre-whaling abundance."

Initial abundance estimates for the Kamchatka feeding ground area of the Western North Pacific stock in Russia ranged from about 100 to 700 individuals. Estimates for the other areas in Russia, the Gulf of Anadyr and the Commander Islands were included in the estimate of abundance of 6,000 to 14,000 for the Bering Sea and Aleutian Islands (Calambokidis et al. 2008). Point estimates of abundance for Asia were 938 to 1,107 individuals (Calambokidis et al. 2008). Trend data were unreliable for this stock (Allen and Angliss 2010). The estimated abundance for the Aleutian Islands, Bering Sea, and Gulf of Alaska combined ranged from 6,000 to 19,000 (Allen and Angliss 2010).

The humpback whale is listed as endangered under the ESA and designated as depleted under the MMPA.

### *Distribution, Migration and Habitat Use*

Humpback whales occur in all oceans of the world from the tropics to sub-polar regions (Perry et al. 1999). They undertake extensive seasonal migrations between low-latitude breeding and calving areas and high latitude feeding grounds (Perry et al. 1999). The summer feeding range of humpback whales in the North Pacific includes coastal and inland waters of California, the Gulf of Alaska, and Bering Sea, along the Aleutian Islands to the Kamchatka Peninsula and into the Sea of Okhotsk, and north of the Bering Strait. Wintering areas include Japan, the Phillipines, Hawaii, Mexico, and Central America (Allen and Angliss 2010, Calambokidis et al. 2008).

The migratory destination of western North Pacific humpbacks is not well known. Data from the SPLASH study suggests Russia is the migratory destination for whales breeding in Okinawa and the Philippines, although some Asian whales go to Ogasawara, the Aleutian Islands, Bering Sea, and Gulf of Alaska (Calambokidis et al. 2008).

Humpback whales photographed in Russia during SPLASH occurred along the Kamchatka Peninsula, near the Commander Islands between Kamchatka and the Aleutians Islands, and in the Gulf of Anadyr just southwest of the Bering Strait. Historical whaling data indicate catches of humpback whales were taken in the Bering Strait and Chukchi Sea from August through October (Allen and Angliss 2010).

Humpback whales have recently been observed in the Beaufort and Chukchi seas. In August 2007, a mother-calf pair was sighted from a barge approximately 87 km (54.1 mi) east of Barrow in the Beaufort Sea (Hashagen et al. 2009). Additionally, Ireland et al. (2008) reported three humpback sightings in 2007 and one in 2008 during surveys of the eastern Chukchi Sea. A single humpback was observed between Icy Cape and Wainwright feeding near a group of gray whales during aerial surveys of the northeastern Chukchi Sea in July 2009 as part of COMIDA (Clarke et al. 2011a). This may be a recent phenomenon as no humpback whales were sighted during the previous COMIDA surveys in the Chukchi Sea from 1982 through 1991 (Clarke et al. 2011a). Additional sightings of four humpback whales occurred in 2009 south of Point Hope, while transiting to Nome (Brueggeman 2010).

Humpback whales feed on euphausiids (krill) and various schooling fishes, including herring, capelin, sand lance, and mackerel (Krieger and Wing 1986, Nemoto 1957, 1959, Witteveen et al. 2008). They are considered "lunge feeders" that predate dense prey patches by engulfing the patch and distending the ventral grooves of the throat area. They also blow nets, or curtains, of bubbles around or below prey patches to concentrate the prey in one area, and then lunge with mouths open through the middle (Clapham 2009).

### *Reproduction and Growth*

Humpbacks give birth and presumably mate on low-latitude wintering grounds in January to March in the Northern Hemisphere. Females attain sexual maturity at 5 years in some populations and exhibit a mean calving interval of approximately two years (Barlow and Clapham 1997, Clapham 1992). Gestation is about 12 months, and calves probably are weaned by the end of their first year (Perry et al. 1999).

### *Survival and Mortality*

The greatest source of mortality of humpback whales was commercial whaling. An estimated 28,000 humpbacks were reportedly removed from the North Pacific during the 20$^{th}$ century (Rice 1978 cited in Allen and Angliss 2010). Reported catches in Asia totaled 3,277 whales from 1910 to 1964. Humpback whales were, ostensibly, awarded international protection from whaling in the North Pacific starting in 1965, but illegal takes by the Soviet Union continued until 1972 (Ivashchenko et al. 2007). The Soviet Union illegally killed 6,793 humpback whales between 1961 and 1971, many of which were taken from the Gulf of Alaska and Bering Sea (Doroshenko 2000 cited in Allen and Angliss 2010).

Subsistence hunters in Alaska reportedly took one humpback whale in South Norton Sound in 2006. There are no other reports of subsistence takes (Allen and Angliss 2010). Subsistence hunters in Alaska are not authorized to take whales from the Central North Pacific stock, and none have been reported (Allen and Angliss 2010).

Mortality or injury due to interactions with commercial fisheries is possible. Incidental serious injuries and mortalities of Western North Pacific humpback whales were reported in the Bering Sea/Aleutian Islands sablefish pot fishery between 2002 and 2006. The average annual mortality was calculated as 0.2 humpbacks. However, stock identification was uncertain, and the incident may have involved a whale from the central North Pacific stock of humpback whales. The estimated fishery-related minimum mortality and serious injury rate incidental to commercial fisheries for the northern part of the central North Pacific stock is 1.4 humpback whales per year (Allen and Angliss 2010).

Natural sources of mortality include predation by killer whales and paralytic shellfish poisoning. The latter was a highly unusual event wherein 14 humpbacks died during a two month period in the vicinity of Cape Cod, Massachusetts (Geraci et al. 1990, NMFS 1991).

### *Hearing and Other Senses*

Humpback whales are in the low-frequency functional hearing group, with an estimated auditory bandwidth of 7 Hz to 22 kHz (Southall et al. 2007). Humpback whales produce three classes of vocalizations: "songs" in the late fall, winter, and spring by solitary males; social sounds made on the wintering (calving) grounds; and social sounds on the feeding grounds (Richardson et al. 1995). Songs are the most complex and varied of the sounds, with frequencies ranging broadly from 20 Hz to 24 kHz or higher (Frankel 2009). Vocalizations recorded on high latitude feeding grounds were in the 20 Hz to 2 kHz range, with source levels of 175 to 192 dB re 1 μPa-m (Richardson et al. 1995).

## <u>Fin Whale: Northeast Pacific Stock</u>

### *Species Description*

Fin whales are baleen whales of the family Balaenopteridae. They are the second largest whale in the world reaching lengths of about 22 m (72 ft) in the northern hemisphere (Aguilar 2009). Females are

larger than males (Gambell 1985). Fin whales are slender, with a narrow rostrum and prominent falcate dorsal fin. The pigmentation is uniquely asymmetrical. The right lower jaw and right side baleen plates are white to yellow-white, while the corresponding left side is dark gray, as are the upper body, flippers and flukes. They are considered "gulp" feeders and have a series of ventral groves that expand during feeding, enabling the whale to engulf large quantities of water and prey (Aguilar 2009).

### *Population Status and Trends*

The IWC recognizes one stock of fin whales in the North Pacific, but NMFS recognizes three stocks in U.S. Pacific waters for management purposes: Alaska (Northeast Pacific); California/ Oregon/Washington; and Hawaii (NMFS 2010b, Allen and Angliss 2010). The Northeast Pacific stock is the only one that may occur in the EIS project area.

There are currently no reliable estimates of abundance for the entire Northeast Pacific stock of fin whales. Surveys in the Bering Sea and coastal waters from southcentral Alaska to the central Aleutian Islands provide the only data from which estimates could be derived. The estimate of 5,700 whales is considered a minimum for this stock, since surveys only covered a small part of the range (Allen and Angliss 2010).Zerbini et al. (2006) estimated an annual rate of increase of 4.8 percent from 1987 through 2003 for fin whales in coastal waters south of the Alaska Peninsula.

For fin whales, the pre-commercial whaling population for the entire North Pacific was estimated to be 42,000 to 45,000, with the "American population" east of 180° W longitude estimated as 25,000 to 27,000 whales (Ohsumi and Wada 1974). By the early 1970s, there may have been as few as 8,000 to 11,000 remaining in the eastern North Pacific (Ohsumi and Wada 1974).

The fin whale is listed as endangered under the ESA and as depleted under the MMPA.

### *Distribution, Migration and Habitat Use*

Fin whales occur throughout the North Pacific from Central Baja California to the Chukchi Sea (Mizroch et al. 2009, Nasu 1974, Rice 1974). Occurrence in Alaskan waters in summer and fall has been documented primarily in the Gulf of Alaska and Bering Sea (Mizroch et al. 2009). There are no reports of fin whales in the Beaufort Sea. In 2010, fin whales were among the species commonly detected acoustically in the Chukchi Sea during August and September (Crance et al. 2011, Hannay et al. 2011). Visual observations are rare. One fin whale was observed north of Cape Lisburne during COMIDA aerial surveys in July 2008 (Clarke et al. 2011a). Also in 2008, there were two sightings of four fin whales recorded by Marine Mammal Observers during Chukchi Sea seismic surveys (Funk et al. 2010).

Little is known of their migratory movements. There is evidence of whales year-round in high latitude regions, and they may occur at several different latitudes during any one season (Mizroch et al. 2009, NMFS 2010b, Stafford et al. 2007a). In the northern North Pacific and Bering Sea, fin whales generally occur along frontal zones or mixing zones, corresponding with the 200 m (656 ft) isobath (Nasu 1974).

In general, fin whales in the North Pacific prey on euphausiids (krill) and large copepods, as well as schooling fish such as herring, walleye pollock, and capelin (Nemoto 1970, Kawamura 1982).

### *Reproduction and Growth*

Age at sexual maturity is between 5 and 15 years (Perry et al. 1999). Mating and calving occur primarily during winter (November to March, with a peak in December to January). Gestation is probably less than a year. Calves nurse for six to seven months, and the average calving interval is two to three years (Agler et al. 1993).

### *Survival and Mortality*

Fin whales were heavily targeted by 20$^{th}$ century commercial whaling operations. More than 47,000 fin whales were reported killed throughout the North Pacific between 1925 and 1975 (unpublished IWC data

cited in Allen and Angliss 2010). Commercial whaling for fin whales in the North Pacific ended in 1976. There is no subsistence whaling for fin whales in U.S. waters, and there are no reports of other direct human caused injury or mortality to fin whales in Alaska waters (Allen and Angliss 2010).

Fin whales may, occasionally, be injured or killed incidental to commercial fishery operations. The incidence of occurrence is low in Alaska waters. One fin whale was reported incidentally killed in the Bering Sea/Aleutian Islands pollock trawl fishery between 2002 and 2006 (Allen and Angliss 2010).

Causes of natural mortality are not well known. The rate of natural mortality for adult fin whales is estimated as 4 to 6 percent (Perry et al. 1999).

### *Hearing and Other Senses*

Fin whales are in the low-frequency functional hearing group, with an estimated auditory range of 7 Hz to 22 kHz (Southall et al. 2007). They most frequently vocalize at low frequencies of 15 to 30 Hz, with the loud, short calls ("20 Hz pulses") most common (Frankel 2009, Moore et al. 1998, Watkins et al. 2000).

## Minke Whale: Alaska Stock

### *Species Description*

The minke whale is in the family Balaenopteridae and is the second smallest baleen whale in the world. Females, at 8.5 m (27.9 ft), are somewhat larger than males at 7.9 m (25.9 ft) (Perrin and Brownell 2009). Minkes weigh about 10 tons. The body is dark gray to brownish above and white to cream colored below. The flipper has a distinctive white patch and the dorsal fin is relatively tall and falcate. The rostrum is very narrow and pointed (thus the species name *acutorostrata*) (Perrin and Brownell 2009).

### *Population Status and Trends*

Minke whales are widely distributed in all oceans with three recognized subspecies: in the North Atlantic (*B. a. acutorostrata*); in the southern hemisphere (*B. a. bonaerensis*); and in the North Pacific (*B. a. scammoni*) (Rice 1998). The two stocks of North Pacific minke whales recognized in U.S. waters are the Alaska Stock and the California/Washington/Oregon stock (Allen and Angliss 2010).

There are no abundance estimates for minke whales in the entire North Pacific, or for the Alaska stock. Provisional estimates exist for minke whales in the central-eastern (810) and southeastern (1,003) Bering Sea (Moore et al. 2002). These numbers include only a portion of the stock's range, so could not be extrapolated out to the entire stock. There are no data on abundance trends in Alaska waters (Allen and Angliss 2010). There will be some level of incomplete information on population status of minke whales in Alaska waters. However, sufficient information is available to support sound scientific judgments and reasoned managerial decisions. More accurate counts are not essential for a reasoned choice among alternatives. Furthermore, the missing information pertains to impacts that are common to all alternatives, limiting the utility of this information to the decision maker.

Minke whales are not listed as depleted under the MMPA or listed as threatened or endangered under the ESA.

### *Distribution, Migration and Habitat Use*

Minke whales are common and the most numerous baleen whales found throughout the world. In the Northeast Pacific Ocean, minke whales range from the Chukchi Sea south to Baja California (Perrin and Brownell 2009). There are only a few documented sightings of minke whales in the Chukchi Sea during summer (Ireland et al. 2008). Recent ship-based surveys of the Klondike and Burger areas of the northeastern Chukchi Sea sighted one and two minke whales in 2008 and 2009, respectively (Brueggeman 2009, 2010). Fourteen sightings of 16 minke whales were documented during Joint Monitoring Program surveys in the Chukchi Sea, 2006 through 2008, with 3 in 2006, 3 in 2007, and 8

sightings in 2008 (Funk et al. 2010). They are rare in the Beaufort Sea, with only one observation in 2007 during vessel surveys in the region (Funk et al. 2010).

Minke whales in the North Pacific typically consume euphausiids, anchovies, Pacific saury, walleye pollock, small fish, and squid (Perrin and Brownell 2009).

### *Reproduction and Growth*

Little is known of the natural history of minke whales. They presumably breed in winter in warm, low latitude waters, give birth to a single calf every other year, and reach sexual maturity when 7 to 9 m (23 to 30 ft) long (Perrin and Brownell 2009).

### *Survival and Mortality*

Minke whales were never targeted by the modern shore-based whale fishery in the eastern North Pacific (Rice 1974). Subsistence takes by Alaska Natives are rare, but have occurred, with seven minke whales reported taken for subsistence between 1930 and 1987 (C. Allison, International Whaling Commission, United Kingdom, pers. comm. cited in Allen and Angliss 2010).

Incidental mortality in commercial fisheries is known to occur at a low level. There was one mortality of a minke whale reported in the Bering Sea/Aleutian Islands groundfish trawl fishery in 2000 (Allen and Angliss 2010).

Minke whales are preyed upon by killer whales (Perrin and Brownell 2009).

### *Hearing and Other Senses*

Minke whales are in the low-frequency functional hearing group with an estimated auditory bandwidth of 7 Hz to 22 kHz (Southall et al. 2007). Minke whales produce a variety of calls ranging from 60 Hz to 20 kHz (DoN 2011). Common sounds include clicks, tonals, and FM signals that range in frequency from 80 to 800 Hz. North Pacific minke whales were recently discovered to be the source of the “boing” sound that has been recorded since the 1950s (Frankel 2009, Rankin and Barlow 2005).

## Gray Whale: Eastern North Pacific Stock

### *Species Description*

The gray whale is a robust, slow-moving baleen whale recognized by a mottled gray color with numerous light patches scattered along the body and lack of a dorsal fin (Jones and Swartz 2009). They have more external parasites than other cetaceans (Jones and Swartz 2009). Instead of a dorsal fin, they have a low hump, followed by a series of 10 or 12 knobs along the dorsal ridge of the tail. Adults are 10 to 15 m (33 to 49 ft) long and weigh between 16 and 45 tons (Jones and Swartz 2009).

### *Population Status and Trends*

There are two populations of gray whales in the North Pacific. The eastern North Pacific population migrates along the coasts of eastern Siberia, North America, and Mexico (Allen and Angliss 2010, Weller et al. 2002). The western North Pacific population migrates primarily between the South China Sea and the Okhotsk Sea. Some members of the western North Pacific stock may occasionally migrate to the eastern Pacific. A 13 year old male from the western population satellite-tagged off Sakhalin Island, Russia in 2010 departed Russia in mid-December, traveled across the Okhotsk Sea, the Bering Sea and Gulf of Alaska to the coast of Oregon by early February 2011. The last location overlapped in time and space with the end of the typical eastern North Pacific population’s southbound migration. Photo-identification and genetics studies revealed that this individual and others from the western population previously visited the eastern North Pacific (Mate et al. 2011). The eastern North Pacific stock, however, is the only one considered in this EIS.

The eastern North Pacific gray whale population has been increasing over the past several decades. Recent abundance estimates from southbound migration surveys in 1997/98, 2000/01, and 2001/02 were 29,758, 19,448 and 18,178 whales, respectively (Rugh et al. 2005). The 1997/98 estimate was the highest since the survey began in 1967. The lower subsequent estimates were likely related to high levels of mortality during 1999 and 2000 (Rugh et al. 2005). Buckland and Breiwick (2002) estimated a population increase of 2.5 percent per year between 1967/68 and 1995/96. Rugh et al. (2005) incorporated the most recent survey data to estimate a 1.9 percent rate of increase from 1967/68 through 2001/02.

These abundance trends are consistent with a population approaching carrying capacity (Allen and Angliss 2010), which Wade and Perryman (2002) calculated as 19,830 to 28,740 whales for the eastern North Pacific stock. Abundance estimates will likely rise and fall in the future as the population finds a balance with the carrying-capacity of the environment (Rugh et al. 2005).

The steadily increasing population abundance warranted delisting of the eastern North Pacific gray whale stock in 1994, as it was no longer considered endangered or threatened under the ESA (Rugh et al. 1999). A five-year status review determined that the stock was neither in danger of extinction nor likely to become endangered in the foreseeable future, thus, retaining the non-threatened classification (Rugh et al. 1999).

### *Distribution, Migration and Habitat Use*

The gray whale migration may be the longest of any mammalian species. They migrate over 8,000 to 10,000 km (5,000 to 6,200 mi) between breeding lagoons in Mexico and Arctic feeding areas each spring and fall (Rugh et al. 1999). The southward migration out of the Chukchi Sea generally begins during October and November, passing through Unimak Pass in November and December, then continues along a coastal route to Baja California (Rice et al. 1984). The northward migration usually begins in mid-February and continues through May (Rice et al. 1984).

The summer feeding range for eastern North Pacific gray whales extends from California to the high-latitude waters of the Arctic. Most feed in the northern and western Bering and Chukchi Seas (Figure 3.2-17). Feeding also occurs near Kodiak Island, Southeast Alaska, British Columbia, Washington, Oregon, and California (Calambokidis et al. 2002, Darling 1984, Moore et al. 2007, Nerini 1984, Rice and Wolman 1971, Rice et al. 1984). Those remaining throughout the summer and fall along the Canadian/Washington/Oregon coast are known as the Pacific Coast Feeding Aggregation (Allen and Angliss 2010).

Sightings of gray whales in the Beaufort Sea near Point Barrow increased in recent years. Native hunters observed growing numbers of gray whales during late summer and autumn (Moore et al. 2006). Gray whales were observed in all survey months and years (2008 through 2010) during COMIDA aerial surveys of the northeastern Chukchi Sea. They were consistently observed within 50 km (31.1 mi) of shore between Wainwright and Barrow and west of Point Hope. Most were feeding. Low numbers of gray whales were dispersed throughout the survey area beyond 50 km (31.1 mi) of shore; there was little indication they were feeding. This differed markedly from surveys of 1982 through 1991 when gray whales frequented Hanna Shoal (Clarke et al. 2011a). Gray whales were regularly feeding in the vicinity of Barrow during 2006-2007 fall BWASP aerial surveys of the Beaufort Sea coast. Only two were seen in 2008, and none were seen in 2009 (Clarke et al. 2011b, 2011c). Throughout the summer of 2010, gray whales regularly occurred in small groups north of Point Barrow and west of Barrow (George et al. 2011). Calls recorded by moored autonomous acoustic recorders northeast of Barrow throughout the winter of 2003/2004 provide evidence of gray whales overwintering in the Beaufort Sea (Stafford et al. 2007b). Increasing population size and habitat changes associated with decreased sea ice may be contributing to the northward shift in distribution.

Gray whales are the most coastal of all the large whales and inhabit primarily inshore or shallow, offshore continental shelf waters (Jones and Swartz 2009). They prefer shoal areas (<60 m [197 ft] deep) with low (<7 percent) ice cover (Moore and DeMaster 1997). These areas provide habitat rich in gray whale prey. Gray whales are suction-feeders and prey upon a variety of benthic amphipods, decapods, and other invertebrates in the Bering and Chukchi Seas. Ampeliscid amphipods were the predominant prey targeted in Chirikov Basin in the northern Bering Sea (Moore et al. 2003). There are indications that this resource was being stressed by overgrazing and that gray whales may be expanding their summer range in search of alternative feeding grounds (Rugh et al. 1999).

### *Reproduction and Growth*

Female gray whales usually breed once every two years. The breeding season is limited primarily to a three-week period in late November and early December during the southbound migration (Jones and Swartz 2009). Gestation lasts approximately 13.5 months (Rice et al. 1984), with an estimated median calving date of January 13 (Perryman and Lynn 2002). Weaning occurs approximately seven months later on the feeding grounds (Rice et al. 1984).

Calf production indices (calf estimate/total population estimate) fluctuated broadly between 1994 and 2000, from a high of 5.8 percent in 1997 to a low of 1.1 percent in 2000. These fluctuations positively correlated with how long the primary feeding area was free of seasonal ice during the previous year (Perryman et al. 2002).

### *Survival and Mortality*

Gray whales suffered heavy exploitation through commercial whaling in the 19$^{th}$ and early 20$^{th}$ centuries, resulting in a dwindled population of only a few thousand whales. Protection from commercial whaling began in 1937 (Rugh et al. 2005). As described above, the population now appears fully recovered.

Current sources of human-caused mortality and serious injury include commercial fisheries, subsistence harvest, and ship strikes. An estimated 6.7 gray whales died annually from interactions with commercial fishing gear between 1999 and 2003 (Allen and Angliss 2010). This includes the entire U.S. west coast from California to Alaska and is a minimum estimate due to lack of observer coverage for most Alaska gillnet fisheries known to interact with gray whales (Allen and Angliss 2010).

Russian and Alaskan subsistence hunters traditionally harvested whales from this stock. Most are taken by Russian hunters. Alaska Natives reportedly took two gray whales in 1995 (IWC 1997). In 1997, the IWC approved a five-year quota (1998 through 2002) of 620 gray whales, with an annual limit of 140 whales. The U.S. and Russia share the quota, with an average annual allowable take of 120 whales by the Russian Chukotka people and four whales by the Makah Indian Tribe of Washington State (U.S.) (IWC 1998). The annual subsistence take averaged 122 whales from 1999 to 2003, including the single whale harvested by the Makah Tribe in 1999 (Allen and Angliss 2010).

The coastal habitat use and migrations of gray whales leaves them vulnerable to ship strikes, although this is not currently a major source of mortality. In 1997, one fatal ship strike of a gray whale was reported in Alaska (B. Fadely, AFSC-NMML, pers. comm., cited in Allen and Angliss 2010).

Predation by killer whales has been well documented and is the primary natural, non-human cause of mortality in gray whales (Rice et al. 1984). Iñupiat Eskimo hunters have observed killer whale attacks on gray whales off Point Hope and between Point Franklin and Barrow. In addition, several young gray whales stranded along the Chukchi Sea coast have had injuries indicative of killer whale attacks (George and Suydam 1998). Weller et al. (2002) observed that at least 1/3 of identified western gray whales bore killer whale tooth rake marks on their bodies.

### *Hearing and Other Senses*

Gray whales are in the low-frequency cetacean functional hearing group, with an estimated auditory bandwidth of 7 Hz to 22 kHz (Southall et al. 2007). Gray whales produce broadband signals ranging from 100 Hz to 4 kHz (and up to 12 kHz). The most common sounds on the breeding and feeding grounds are knocks, which are broadband pulses from about 100 Hz to 2 kHz and most energy at 327 to 825 Hz. The source level for knocks is approximately 142 dB re 1 μPa-m (Jones and Swartz 2009, Richardson et al. 1995).

## Beluga Whale: Beaufort Sea and Eastern Chukchi Sea Stocks

### *Species Description*

The beluga whale is a toothed whale of the family Monodontidae. The white coloring and lack of dorsal fin are two distinguishing characteristics for which the scientific name derives ("…apterus" means without a fin and "leucas," from the Greek leukos, means white). Unlike other toothed whales, beluga neck vertebrae do not fuse, allowing for flexibility of the head and neck (O'Corry-Crowe 2009). They are medium sized, growing to 3.5 to 4.5 m (11 to 15 ft) in length and weigh up to 1,500 kg (3,307 lbs) (Burns and Seaman 1986). Calves are dark gray when born and grow progressively lighter with age, until they are pure white at about age 14 for females and 18 for males (O'Corry-Crowe 2009). In northwest Alaska, age at which animals become all white is highly variable. For males, it ranged from 9 to 38 years and from 6 to 33 years for females (Burns and Seaman 1986).

### *Population Status and Trends*

There are five stocks of beluga whales recognized in U.S. waters: Cook Inlet; Bristol Bay; eastern Bering Sea; eastern Chukchi Sea; and Beaufort Sea (Allen and Angliss 2010). The latter two are of interest here, as both of these stocks are likely to occur in the EIS project area.

Opportunistic and systematic observations have been used to estimate abundance for belugas off northern Alaska and western Canada. Based on the most recent aerial survey s in 1992 (Harwood et al. 1996) and correction factors to account for availability bias, the best available abundance estimate for the Beaufort Sea stock is 39,258 (Allen and Angliss 2010). Telemetry data from 1993 and 1995 showed belugas ranging well beyond the aerial survey area, suggesting the 1992 abundance may have been greatly underestimated (Richard et al. 2001).

Survey data are also outdated for the eastern Chukchi stock. It was not possible to estimate abundance from the most recent survey in 1998. The most reliable estimate continues to be 3,710 whales derived from 1989-91 survey counts corrected for animals diving and not visible at the surface and for newborns and yearlings missed due to their small size and dark coloring (Allen and Angliss 2010). There is currently no evidence that the eastern Chukchi Sea stock of beluga whales is declining (Allen and Angliss 2010).

Neither the Beaufort Sea beluga whale stock nor the eastern Chukchi Sea stock is listed as depleted under the MMPA or threatened or endangered under the ESA.

### *Distribution, Migration and Habitat Use*

Beluga whales closely associate with open leads and polynyas in ice-covered regions throughout Arctic and sub-Arctic waters of the Northern Hemisphere. Distribution varies seasonally. Whales from both the Beaufort Sea and eastern Chukchi Sea stocks overwinter in the Bering Sea. Belugas of the eastern Chukchi may occur in offshore, although relatively shallow, waters of the western Bering Sea (Richard et al. 2001) and the Beaufort Sea stocks may occur in more nearshore waters of the northern Bering Sea (R. Suydam, pers. comm.). In the spring, belugas migrate to coastal estuaries, bays, and rivers. Annual migrations may cover thousands of kilometers (Figure 3.2-16) (Allen and Angliss 2010).

Belugas of the eastern Chukchi Sea stock congregate in nearshore waters of Kotzebue Sound and Kasegaluk Lagoon (near Point Lay) in June and July (Frost et al.1993, Huntington et al. 1999). Iñupiat hunters in Point Lay describe Omalik Lagoon, south of Kasegaluk Lagoon, as an important gathering area for belugas in June, except in years when there is heavy ice along the shore. Hunters also note that belugas enter inlets to Kasegaluk Lagoon when tides or currents are outgoing (possibly following fish), then stay in the deeper channels near the inlets (Huntington et al. 1999).

Satellite telemetry data from 23 whales tagged in Kaseguluk Lagoon in 1998 through 2002 provided information on movements and migrations of eastern Chukchi Sea belugas. Animals initially traveled north and east into the northern Chukchi and western Beaufort Seas after capture (Suydam et al. 2001, 2005).

Movement patterns between July and September vary by age and/or sex classes. Adult males frequent deeper waters of the Beaufort Sea and Arctic Ocean (79-80°N), where they remain throughout the summer. All of the belugas that moved into the Arctic Ocean (north of 75°N) were adult males that traveled through 90 percent pack ice cover to reach the higher latitudes by late July through early August. Females, both adult and immature, remained mostly in the vicinity of the Beaufort and Chukchi seas shelf break.

Immature males moved farther north than immature females but not as far north as adult males. All of the belugas frequented water deeper than 200 m (656 ft) along and beyond the continental shelf break. Use of the inshore waters within the Beaufort Sea Outer Continental Shelf lease sale area was rare (Suydam et al. 2005).

Most information on distribution and movements of belugas of the Beaufort Sea stock was similarly derived using satellite tags. A total of 30 belugas were tagged in the Mackenzie River Delta, Northwest Territories, Canada, during summer and autumn in 1993, 1995, and 1997 (Richard et al. 2001). In 1993 and 1995, most of the tagged males left the estuary and traveled farther north than expected into the permanent pack ice of the Beaufort Sea and Arctic Ocean. In late July, most males were in Viscount Melville Sound, while most of the females were in Amundsen Gulf. This differed in 1997, when the males' movements were more similar to the females in 1993 and 1995 (Richard et al. 2001).

Beaufort Sea belugas migrate westward in September. Approximately half of the tagged whales traveled far offshore of the Alaskan coastal shelf, while the remainder traveled on the shelf or near the continental slope (Richard et al. 2001). Migration through Alaskan waters lasted an average of 15 days. In 1997, all of the tagged belugas reached the western Chukchi Sea (westward of 170°W) between September 15 and October 9. Belugas remained north and east of Wrangel Island until mid- to late-October. Two tags transmitted into November revealing movements along and offshore of the Chukotka Peninsula and, for the male, across the Bering Strait and into the Bering Sea (Richard et al. 2001).

Beluga whales are regularly sighted during the September-October BWASP aerial surveys of the Alaska Beaufort Sea coast. In 2006, distribution offshore along the shelf-break and slope overlapped with that observed in previous years. Sighting rates were much lower in 2007 and 2008 (117 and 15, respectively, compared to 525 in 2006), possibly because of the absence of sea ice in the area or survey effort offshore. Sighting rates in 2009 were similar to years prior to 2007, with distribution highest in Barrow Canyon and offshore shelf break and slope areas (Clarke et al. 2011b, 2011c). Belugas seen during those surveys could have been from either the Beaufort Sea or Chukchi Sea stocks.

In fall, most belugas migrate to the Bering Sea where they spend the winter. Satellite tag transmissions from one male suggest that the area northwest of St. Lawrence Island is used as an overwintering area for the Chukchi Sea stock (Suydam et al. 2005, Robert Suydam, Department of Wildlife Management, NSB, Barrow, AK, pers. comm.), although determining what a population does from a sample of one should be done cautiously.

Acoustic detections of beluga whales provide additional insight into distribution and movements of belugas in the northeastern Chukchi Sea. Belugas were detected during every month from April to November in 2007 and 2008 (Delarue et al. 2011). Detections were more restricted in summer and ranged more broadly in the spring. Calls in July and August were concentrated near Barrow Canyon. Calls were detected between mid-April and June 2008 over a large area 90 to 150 km (60.0 to 93.2 mi) off Point Lay and Wainwright. These spring detections of belugas may have included whales from both the eastern Beaufort and Chukchi Sea stocks (Delarue et al. 2011). Calls were also detected in November 2007 off Point Lay (Delarue et al. 2011). It is not clear from which stock those animals originated. Most acoustic detections of belugas from late-October to late-November 2008 were at stations located 56.3 km (35 mi) and 80.5 km (50 mi) off Wainwright (Hannay et al. 2011). Detections in spring 2009 began in mid-April 177 km (110 mi) off Point Lay, suggesting that migrating belugas may travel in offshore leads that form southwest of Hanna Shoal before inshore leads form (Hannay et al. 2011). High call counts shifted from the southwest to the northeast from April to June, as belugas migrated to the Beaufort Sea. Spring detections ended mid-June 144.8 km (90 mi) off Wainwright. Belugas were only detected on 4 occasions during summer 2009 (Hannay et al. 2011). There were no recorders deployed inshore.

Despite being acoustically detected in the Chukchi Sea, no beluga whales were visually detected by observers aboard vessels surveying the Burger and Klondike prospects from July to October 2008 and August to October 2009 (Brueggeman 2009, 2010) possibly because the observation vessels influenced the distribution, behavior, and sightability of animals.

Belugas were seen, however, during aerial surveys conducted June through November in the northeastern Chukchi Sea, 2008 to 2010, as part of the COMIDA project. They were sighted every month except September, and none were sighted within Lease Sale Block 193. Beluga sightings were spread throughout the study area within 150 km (93.2 mi) of shore. Group size ranged from 1 to 480 individuals. The highest sighting rate per depth zone was in shallow water (≤35 m [≤114 ft] depth) (Clarke et al. 2011a). More beluga whales (127 sightings) were seen near Barrow during the summer of 2010 than in previous years. They were observed feeding inside and near to Elson Lagoon in July through August and September, with over 500 belugas reported on July 25 (George et al. 2011).

### *Reproduction and Growth*

Females become sexually mature at 9 to 12 years old; males at a later age (O'Corry-Crowe 2009), although this varies by population. Heide-Jøregensen and Teilmann (1994) estimated age of sexual maturity at 6 to 7 years for males and 4 to 7 years for females off West Greenland. Suydam (2009) estimated that 50 percent of females were sexually mature at age 8.25 and the average age at first birth was 8.27 years for belugas sampled near Point Lay.

The gestation period calculated for the eastern Chukchi stock is 14.9 months, and the calving interval is 2 to 3 years. The pregnancy rate of 0.41 for females harvested at Point Lay is consistent with this interval (Suydam 2009). Pregnancy rates decline after females reach 25 years old (Suydam 2009). A single calf is born in late spring to mid-summer and may remain with its mother until 2 years old (Brodie 1971, Suydam 2009). Most births occur from mid-June to mid-July (Burns and Seaman 1986). Length at birth for eastern Chukchi belugas was estimated to be 1.57 m (5.15 ft) and length at separation from mothers was estimated as 2.46 m (8.07 ft) (Suydam 2009). Mating is thought to occur from late-February to June, with a peak in March. Some breeding may occur in late-June to early-July (Burns and Seaman 1986, Suydam2009).

### *Survival and Mortality*

The primary sources of human caused mortality in beluga whales are subsistence hunting and, possibly, interactions with commercial fisheries. The average annual subsistence take from the Beaufort Sea beluga stock by Alaska Natives was 41 during 1987 to 2006. For the eastern Chukchi Stock, annual subsistence take by Alaska Natives averaged 62 belugas during 1987 to 2006 (Frost and Suydam 2010).

These annual harvests represent 0.1 percent and 1.7 percent of the estimated stock sizes for the Beaufort Sea stock and eastern Chukchi Sea stock, respectively (Frost and Suydam 2010). Subsistence is further discussed in Section 3.3.2.

The total commercial fishery mortality and serious injury is estimated to be zero for both the Beaufort Sea and eastern Chukchi Sea stocks (Allen and Angliss 2010). Beluga whales are occasionally entangled in subsistence nets (R. Suydam pers. comm.).

### *Hearing and Other Senses*

Beluga whales are in the mid-frequency hearing group with an estimated auditory bandwidth of 150 Hz to 160 kHz (Southall et al. 2007). Average hearing thresholds of captive belugas were measured at 65 and 120.6 dB re 1 µPa at frequencies of 8 kHz and 125 Hz, respectively (Awbrey et al. 1988). Belugas create a diverse repertoire of sounds, earning them the name "sea canary." Sounds are divided into whistles and pulsed calls, typically at frequencies between 0.1 and 12 kHz. Nearly 50 different call types have been recognized, including groans, whistles, buzzes, trills, and roars (Bel'kovitch and Sh'ekotov 1990). Call types recorded in the Chukchi Sea include low and high whistles, buzzes, chirps, and clicks (Hannay et al. 2011).

## Narwhal

### *Species Description*

The narwhal is a toothed whale in the family Monodontidae, along with beluga whales. This species was given its scientific name for its most unique feature -- the up to 3 m (9.8 ft) long spiraled tusk. Adult narwhals only have two teeth, and, in males, the left tooth develops into a tusk. Some females grow tusks, some males lack tusks, and some grow double tusks. The tusk is likely a secondary sexual characteristic (Heide-Jørgensen 2009).

Narwhals lack dorsal fins. Calves are uniformly dark in coloration, while adults are mottled in appearance. Adult females are approximately 400 cm (157.5 in) long and weigh 1,000 kg (2,205 lbs), and males are 450 cm (177.2 in) and 1,600 kg (3,527 lbs) (Garde et al. 2007).

### *Population Status and Trends*

Abundance surveys of narwhals in the Canadian High Arctic (Prince Regent Inlet, Barrow Strait, and Peel Sound) were conducted during summer 1996. The resulting estimated total abundance for that area was 45,358 (Innes et al. 2002).

### *Distribution, Migration and Habitat Use*

Narwhals predominantly inhabit Arctic waters of the Atlantic Ocean—the Canadian high Arctic, northern Hudson Bay, Davis Strait, Baffin Bay and the Greenland Sea, and the Arctic Ocean between Svalbard and Franz Josef Land. There are a few records of sightings in the Pacific side of the Arctic (Heide-Jørgensen 2009).

Occurrence of narwhals in the Alaskan Beaufort and Chukchi seas is rare and, likely, extralimital. The NSB Department of Wildlife Management collected about a dozen incidental observations of narwhals made by Alaska Native hunters. Two were sighted in the spring leads off of Barrow with a group of belugas in 1989. Between 2001 and 2006, there were nine narwhal sighted in July and August from Wainwright to off Point Barrow. In 2008, a narwhal tusk was found on Cape Sabine. Most of the narwhals sighted live were associated with beluga whales (JC George pers. comm.). Incidental sightings of narwhals in the Beaufort and Chukchi seas are thought to be from the Baffin Bay population that are known to move into the Canadian Arctic Archipelago and as far north and west as ice conditions will permit (COSEWIC 2005).

### *Reproduction and Growth*

Age at sexual maturity is estimated as six to seven years for females and nine years for males (Garde et al. 2007). Mating likely occurs in April through May, and, at least in Greenland and Canada, calving occurs from June through August, suggesting a gestation of 13 to 16 months. Lactation lasts one to two years, and females are thought to calve every three years (Heide-Jørgensen 2009).

### *Survival and Mortality*

Recent studies using aspartic racemization suggest that female narwhals can reach 115 years of age (Garde et al. 2007).

Killer whales and polar bears are the only non-human predators of narwhals (Heide-Jørgensen 2009).

Narwhals are hunted for their tusks and skin in Greenland and Canada, with 433 taken during 2000 to 2004 in Canada. Narwhals appear susceptible to ice entrapment, particularly in areas of unpredictable ice conditions, such as Disko Bay in West Greenland (Heide-Jørgensen 2009).

### *Hearing and Other Senses*

Narwhals are in the mid-frequency hearing group with an estimated auditory bandwidth of 150 Hz to 160 kHz (Southall et al. 2007). Narwhals produce a variety of sounds. Echolocation clicks have been measured at maximum amplitudes of 48 kHz. Whistles have also been recorded with frequencies of 300 Hz to 18 kHz (Ford and Fisher 1978, Miller et al. 1995).

Narwhals are called “unicorns” of the sea because of the tooth, or tusk, that emerges from its upper jaw. Researchers have come up with several explanations over the decades as to its function. A recent theory proposed by Nweeia et al. (2009) that it may in fact be a chemoreceptor capable of reacting and responding to varying salinity gradients. Being able to detect salinity gradients could help these animals survive in the Arctic environment. Additionally, it could also allow the animals to detect water particles characteristic of the fish upon which they prey (Science Daily 2005).

## Killer Whale: Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock

### *Species Description*

Killer whales are toothed whales and the largest member of the dolphin family. Adults are sexually dimorphic. Males reach a maximum body length of 9 m (30 ft) and a maximum weight of 6,600 (14,550 lbs). Females reach lengths of 7.7 m (25.5 ft), with a maximum measured weight of 4,700 kg (10,361 lbs) (Ford 2009, Yamada et al. 2007). In addition to being overall larger than females, the prominent dorsal fin on males can be as tall as 1.8 m. Directly behind the dorsal fin is a gray area of variable shape called the saddle patch. Killer whales are strikingly black and white in coloration with a conspicuous elliptically shaped white patch behind the eye. Individuals can be identified using variation in the shape and color of the eye patch, saddle patch, and the size and shape of the dorsal fin (Ford 2009).

### *Population Status and Trends*

The three recognized ecotypes of killer whales—resident, transient, and offshore—are distinguished based on morphology, ecology (including prey preferences), genetics, acoustics, and behavior (Baird and Stacey 1988, Baird et al. 1992, Ford and Fisher 1982, Hoelzel and Dover 1991, Hoelzel et al. 1998, 2002).

Within these three ecotypes, there are six putative stocks of killer whales in Alaska: the Alaska Resident stock, occurring from southeastern Alaska to the Aleutian Islands and Bering Sea; the Northern Resident stock, occurring from British Columbia through part of southeastern Alaska; the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock, occurring mainly from Prince William Sound through the Aleutian Islands and Bering Sea; the AT1 transient stock, occurring in Alaska from Prince William Sound

through the Kenai Fjords; the West Coast transient stock, occurring from California through southeastern Alaska; and the Offshore stock, occurring from California through Alaska (Allen and Angliss 2010).

The Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock is the one most likely to occur in the Beaufort and Chukchi seas. The minimum population estimate for this stock is 314, based on photographic identification of individuals (Allen and Angliss 2010). Data are currently not available for determining trends in abundance.

The Gulf of Alaska, Aleutian Islands, and Bering Sea transient stock of killer whales is not listed as threatened or endangered under the ESA or considered depleted under the MMPA.

### *Distribution, Migration and Habitat Use*

Killer whales are a cosmopolitan species found in all oceans and most seas. They are most commonly found in coastal and temperate waters of high productivity (Forney and Wade 2006). Killer whales range throughout the North Pacific. Along the west coast of North America, they occur from Alaska to California. Seasonal and year-round occurrence has been noted for killer whales throughout Alaska (Barlow 1995, Bigg et al. 1990, Braham and Dahlheim 1982, Forney et al. 1995).

Killer whales are occasionally reported in the northeastern Chukchi and western Beaufort Seas. Iñupiat Eskimo hunters reported observing killer whale attacks on gray whales in Peard Bay, northwest of Barrow and Point Hope. Other observations include attacks on beluga whales and bearded seals and possible foraging on whitefish and chum salmon near Peard Bay (George and Suydam 1998).

Killer whales were acoustically detected throughout the 2007 and 2009 Chukchi Sea open water season (Hannay et al. 2011). They were detected primarily off Cape Lisburne and Point Lay, with a few detections off Wainwright, plus one off Barrow in fall 2007. Analysis of the 2007 data indicated that the sounds were produced by transient killer whales (Hannay et al. 2011).

The killer whale is an apex marine predator with a diverse prey base. Transient killer whales are mammal-hunters whose prey includes various seal species. They are also known to attack minke whales and gray whale calves, as well as other large whale species, as evidenced by scars incurred during attacks (Ford 2009, George et al. 1994).

### *Reproduction and Growth*

Births may occur in any month but most are in October through March. Females become reproductively mature between 11 and 16 years of age with a 5-year interval between births. Gestation is 15 to 18 months (Ford 2009) and weaning is about 1 to 2 years after birth. Females typically give birth for the first time at about 12 to 14 years of age (Olesiuk et al. 2005). Males attain sexual maturity at about 15 years of age (Ford 2009).

Killer whales are very social. The basic social unit is based on matriline relationships and linked by maternal decent. A typical matriline is composed of a female, her sons and daughters, and the offspring of her daughters (Ford 2009).

### *Survival and Mortality*

Killer whales are long-lived. Life expectancy for females is about 50 years with a maximum of 80 to 90; males typically live to about 29 years of age (Ford 2009).

Sources of human-caused mortality include entanglement in fishing gear and ship strikes. Mortality has been reported in the Bering Sea/Aleutian Islands pollock trawl fishery. The mean annual estimated level of serious injury and mortality for Gulf of Alaska, Aleutian Islands, Bering Sea transient stock of killer whales is 0.4 per year (Allen and Angliss 2010). One ship strike of a killer whale was reported in the Bering Sea groundfish trawl fishery in 1998 (Allen and Angliss 2010). Killer whales have no known predators other than humans.

There is no subsistence harvest of killer whales in Alaska.

### *Hearing and Other Senses*

Killer whales are highly vocal and use sound for social communication and to find and capture prey. The sounds include a variety of clicks, whistles, and pulsed calls (Ford 2009). Most of the pulsed sound frequencies range from 0.5 to 25 kHz. Source levels for echolocation clicks range from 195 to 224 dB re 1 μPa-m, with dominant frequencies from 20 to 60 kHz. Source levels associated with social sounds range from 131 to 168 dB re 1 μPa-m (DoN 2011). Acoustic studies of resident killer whales in British Columbia have found there to be dialects, which are likely used to maintain group identity and cohesion, and may serve as indicators of relatedness (Ford 1989, 1991). The vocal behavior of transient killer whales differs from residents, which is likely related to the hearing capabilities of their prey. They remain silent much of the time and communicate less frequently than residents (Barrett-Lennard et al. 1996, Saulitis et al. 2005). The killer whale has the lowest frequency of maximum sensitivity and one of the lowest high frequency hearing limits known among toothed whales. The frequency range of hearing is 1 to 100 kHz, with highest sensitivity at 20 kHz (DoN 2011).

## Harbor Porpoise: Bering Sea Stock

### *Species Description*

Harbor porpoise are toothed whales of the family Phocoenidae. They are one of the smaller porpoises in the world and the smallest cetacean in Arctic waters. They are characterized by a short, stocky body and a small, triangular dorsal fin. Females average 1.6 m (5.2 ft) in length and 60 kg (132.3 lbs), while males reach 1.4 m (4.6 ft) and 50 kg (110 lbs) (Bjørge and Tolley 2009). They have dark gray backs and light undersides. Harbor porpoise tend to avoid ships and rarely bow ride (Bjørge and Tolley 2009).

### *Population Status and Trends*

There are currently three stocks of harbor porpoise recognized in Alaska: the Southeast Alaska stock; the Gulf of Alaska stock; and the Bering Sea stock (Allen and Angliss 2010). The latter occurs throughout the Aleutian Islands and all waters north of Unimak Pass.

The best–and most recent—population estimate for the Bering Sea stock was 48,515. This was based on surveys of the Bristol Bay area in 1997 through 1999 (Hobbs and Waite 2010). There is no reliable information on trends in abundance for this stock (Allen and Angliss 2010).

Harbor porpoise are not listed as depleted under the MMPA or listed as threatened or endangered under the ESA.

### *Distribution, Migration and Habitat Use*

Harbor porpoise in the eastern North Pacific range from Point Barrow and along the west coast of North America from Alaska to Point Conception, California (Gaskin 1984). The harbor porpoise are primarily coastal and most commonly occur in waters less than 100 m (328 ft) deep (Hobbs and Waite 2010). Harbor porpoise often feed on bottom-dwelling fishes and small pelagic schooling fishes with high lipid content; herring and anchovy are common prey (Bjørge and Tolley 2002, Leatherwood et al. 1982).

Harbor porpoise are seen in both the Beaufort and Chukchi seas. Incidences of entanglement in subsistence nets, beached carcasses, and live sightings near Point Barrow suggest regular use of, at least, the northeast Chukchi and far western Beaufort Seas (Suydam and George 1992). They are also occasionally seen during the fall BWASP aerial surveys (Clarke et al. 2011c). Harbor porpoise were sighted during vessel surveys of the Chukchi Sea in 2006 through 2009 (Brueggeman 2009, 2010; Ireland et al. 2008) in higher numbers and farther offshore than previously documented (Ireland et al. 2008). Harbor porpoise comprised 14 percent of cetacean sightings in the offshore areas (>37 km, or 23 mi, from shore) of the Chukchi Sea during Joint Monitoring Program surveys in 2006 through 2008 (Funk et al. 2010). More harbor porpoise (five sightings of 10 individuals) were also seen during boat surveys off

Barrow in 2010 than in any previous year (George et al. 2011). The increased number of harbor porpoise may represent a range extension (Funk et al. 2010).

### *Reproduction and Growth*

Harbor porpoise become sexually mature at 3 to 4 years old. Females generally give birth in summer from May through July. Mating occurs about one and a half months later. Calves remain dependent for at least six months and are generally weaned by 1-year of age (Bjørge and Tolley 2009, Leatherwood et al. 1982).

### *Survival and Mortality*

Mortality incidental to fisheries is possible. The estimated minimum annual mortality rate for the Bering Sea stock of harbor porpoise incidental to commercial fisheries is currently zero. That estimate is, however, unreliable due to lack of observers on several gillnet fisheries in Alaska (Allen and Angliss 2010).

Subsistence fishermen in Barrow occasionally catch harbor porpoise in their nets during the summer (Suydam & George 1992).

### *Hearing and Other Senses*

Harbor porpoise are in the high-frequency functional hearing group, whose estimated auditory bandwidth is 200 Hz to 180 kHz (Southall et al. 2007). Their vocalizations range from 110 to 150 kHz, and echolocation signals are in the 1.4 to 2.5 kHz range (DoN 2011).

## 3.2.4.3 Pinnipeds

### Ringed Seal

### *Species Description*

Ringed seals are one of the smallest of the true seals (family Phocidae). Adults reach 1.5 m (4.9 ft) in length and 70 kg (154 lbs) in weight. They have a small head, short cat-like snout, and a plump body. Ringed seal pelage can be either light or dark phase, and they have silver rings on their back and sides with a silver belly (McLaren 1966, Murdoch 1885, Ognev 1935).

### *Population Status and Trends*

The five recognized subspecies of ringed seals are the Arctic ringed seal (*Phoca hispida hispida*), the Baltic ringed seal (*Phoca hispida botnica*), the Okhotsk ringed seal (*Phoca hispida ochotensis*), the Ladoga ringed seal (*Phoca hispida ladogensis*), and the Saimaa ringed seal (*Phoca hispida saimensis*). The Arctic ringed seal is the most abundant of the subspecies and is further subdivided by geographical region: Greenland Sea and Baffin Bay; Hudson Bay; Beaufort and Chukchi seas; and the White, Barents and Kara Seas. Arctic ringed seals of the Beaufort and Chukchi seas will be discussed here, as they are the only ones anticipated to occur in the EIS project area.

Several factors—from the seals' distribution and ecology to cross political boundaries--make assessing the population difficult. Recent surveys estimated a population of at least 300,000 ringed seals in the Alaskan Beaufort and Chukchi seas, although this was likely an underestimate (Bengtson et al. 2005, Frost et al. 2004). Accounting for seals inhabiting the pack ice and the eastern Beaufort and Amundson Gulf areas, the total population of ringed seals in the Beaufort and Chukchi seas was estimated to be 1 million (Bengtson et al. 2005, Frost et al. 2004). Kelly et al. (2010a) estimates that over 1,000,000 ringed seals inhabit the Beaufort, Chukchi, and Bering Seas based on information from existing surveys and studies. Kelly et al. (2010) placed their maximum density estimate of ringed seals at Prudhoe Bay and along the coast south of Kivalina at 1.62 seals/km$^2$.

On December 10, 2010, NMFS announced a proposed rule and a 12-month finding on a petition to list the ringed seal as a threatened or endangered species in the *Federal Register* (75 FR 77476). In this *Federal Register* notice, NMFS determined that all of the subspecies, except for the Saimaa ringed seal, are likely to become endangered throughout all or a significant portion of their range in the foreseeable future and therefore proposed to list them as threatened under the ESA. The basis for the determination was the likelihood of sea-ice habitat modification due to climate change and marine habitat modification due to ocean acidification.

### *Distribution, Migration and Habitat Use*

Ringed seals are circumpolar and occur in all seasonally ice-covered seas of the northern hemisphere (King 1983) (Figure 3.2-18). Ringed seals are strongly ice-associated, and the seasonality of ice cover dictates their movements, feeding, and reproductive behavior. The ringed seal year consists of three distinct periods: the "foraging period" during the open water season when foraging is most intensive; the "subnivean period" from early winter through late May or early June when seals are using subnivean lairs on the ice; and the "basking period" between the time seals leave their lairs in May or June and the ice breaks up in June or July (Kelly et al. 2010b).

Ringed seals that breed on shorefast ice may either forage within 100 km (62.1 mi) of their breeding habitat or undertake extensive foraging trips to more productive areas at distances of 100s to 1,000s of kilometers (Kelly et al. 2010b). Foraging movements of pack-ice breeding seals are not known (Kelly et al. 2010b). Adult Arctic ringed seals return to the previously used subnivean site after the foraging period ends. Movements are limited during the subnivean period.

The Arctic subspecies typically hauls out exclusively on sea ice for resting, pupping, and molting. In the Beaufort and Chukchi seas, time spent on the ice increased from 12 percent in March to 43 percent in early June to more than 60 percent while molting in June (Kelly and Quakenbush 1990, Kelly et al. 2010b). After molting, and, as the sea ice breaks up in summer, ringed seals spend less time on the ice and more time in the water foraging. Time on the ice was 10 percent or less from August to November and remained less than 20 percent from December to March (Kelly et al. 2010b).

Ringed seals are able to remain in areas of dense ice cover throughout the fall, winter, and spring by maintaining breathing holes in the ice. They excavate lairs in the snow (subnivean) over their breathing holes as pupping season approaches (Helle et al. 1984).

Factors most influencing seal densities during May through June in the central Beaufort Sea between Oliktok Point and Kaktovik were water depth, distance to the fast ice edge, and ice deformation. Highest densities of seals were at depths of 5 to 35 m (16 to 144 ft) and on relatively flat ice near the fast ice edge (Frost et al. 2004).

Ringed seals are relatively common in May and June in the eastern Chukchi Sea (north of the Bering Strait to Point Barrow), with average densities of 1.62 to 1.91 seals/km$^2$ (Bengston et al. 2005). Densities were higher on nearshore fast ice and pack ice than on offshore pack ice. Highest densities of ringed seals were in the coastal waters south of Kivalina and near Kotzebue Sound (Bengston et al. 2005).

Ringed seals typically prey on small schooling fish and crustaceans (Kovacs 2007). Arctic cod, polar cod and saffron cod, plus sculpins in the Chukchi Sea, are among preferred fish prey of ringed seals (Kelly et al. 2010a). Shrimp, amphipods, euphausiids, and mysids were also found in stomachs of ringed seals from the Chukchi Sea (Quakenbush and Sheffield 2007).

### *Reproduction and Growth*

Female ringed seals reach sexual maturity at 4 to 8 years old and males at 5 to 7 years. They breed annually and produce a single pup each year. Mating typically occurs in May. Gestation lasts about 240 days after a 3 to 3.5 month period of delayed implantation (Smith 1987). Pupping occurs in late winter to early spring in subnivean lairs on the sea ice (Finley et al. 1983).

Pups are 60 to 65 cm (23.6 to 25.6 in) long and weigh 4.5 to 5.0 kg (10 to 11 lbs) at birth (McLaren 1958a, Smith and Stirling 1975, Tikhomirov 1968). Pups nurse for 5 to 9 weeks and, when weaned, are four times their birth weights. Ringed seal pups are more aquatic than other ice seal pups and spend roughly half their time in the water during the nursing period (Lydersen and Hammill 1993b).

### *Survival and Mortality*

Survival rates are not well known. The average life span is 15 to 28 years (Holst et al. 1999), but ringed seals can live longer than 40 years (Lydersen and Gjertz 1987, McLaren 1958a).

Sources of mortality include commercial fisheries, subsistence harvests, and predation. Mortality incidental to commercial fishing operations is low, with one report during 2002 to 2006 (Allen and Angliss 2010).

Ringed seals are hunted for subsistence by Alaska Natives from communities along the coasts of the northern Bering, Beaufort, and Chukchi seas. See Section 3.3.2, Subsistence Resources and Uses, for further discussion.

Common predators of ringed seals are polar bears and Arctic foxes, and, occasionally, other terrestrial carnivores, sharks, walrus and killer whales (Stirling and McEwan 1975, Stirling and Øritslsand 1995, Burns and Eley 1976, Heptner et al. 1976a, Sipila 2003). Ringed seals constitute 98 percent of the polar bear diet in the Beaufort Sea. Gulls and ravens will prey on newborn pups, but concealment in subnivean lairs usually prevents that from occurring (Kelly et al. 2010a).

Ringed seals co-evolved with numerous parasites and diseases, and distemper virus has been reported in Arctic ringed seals. There is currently no evidence of impacts of disease or pathogen on ringed seal populations (Kelly et al. 2010a). During the summer of 2011 numerous ringed seals, bearded seals, and Pacific walruses began appearing along the Chukchi coastline with ulcerated skin, enlarged lymph nodes, organ failure, and extensive hair loss, eventually leading to death. The cause of this outbreak is presently being investigated. However no viruses or pathogens have been identified to be the source of these events (NOAA 2011b, Alaska Dispatch 2011).

### *Hearing and Other Senses*

The estimated auditory bandwidth of ringed seals is 75 Hz to 75 kHz in water and 75 Hz to 30 kHz in air (Southall et al. 2007). Ringed seals produce at least six types of underwater calls. These include clicks (2 to 6 kHz), burst pulses, knocks (150 Hz to 2 kHz), chirps (500 to 1000 Hz), yelps (modulate around 1 kHz), and other low-frequency sounds (as summarized in Frankel 2009). Call activity varies seasonally in the Arctic. Most noises produced by ringed seals consist of sounds from scratching ice to maintain their breathing holes in the ice, otherwise they produce much less noise than other seal species (Cummings and Holliday 1984). Seals do not echolocate; however they can hear low-frequency sounds. Foraging by seals is believed to integrate vision and tactile senses such that they can see in almost total darkness, having the ability to track moving prey from as far as 100+ ft (30+ m) away using their vibrissae (Schusterman et al. 2004, Riedman 1990, Wieskotten et al. 2010, Dehnhardt et al. 2001, Schulte-Pelkum et al. 2007).

## Spotted Seal

### *Species Description*

Spotted seals, also called largha seals, are true seals of the family Phocidae. Males and females are similar in size and appearance. Adult females in the Bering Sea and Sea of Okhotsk typically weigh 65 to 115 kg (143.3 to 253.5 lbs) and are 151 to 169 cm (59.4 to 66.5 in) long. Adult males typically weigh 85 to 110 kg (187.4 to 242.5 lbs) and are 161 to 176 cm (63.4 to 69.3 in) long. They are generally light-colored with densely scattered dark grey and black spots (Heptner et al. 1976b, Wilke 1954).

### *Population Status and Trends*

Spotted seals are divided into three Distinct Population Segments (DPSs) based on genetics, geography and breeding groups: the Bering DPS; the Okhotsk DPS; and the Southern DPS (Boveng et al. 2009). The Southern DPS includes spotted seals breeding in the Yellow Sea and Peter the Great Bay in the Sea of Japan.

There are no accurate abundance estimates for spotted seals across their entire range or for the Bering DPS, specifically. Data from 2007 and 2008 surveys are being analyzed to estimate abundance for the central and eastern Bering Sea. A provisional estimate of 101,568 spotted seals was provided in the interim by the National Marine Mammal Laboratory (Goodman 1960, Ver Hoef et al. 2010). Population trend assessments are currently unavailable.

In response to a petition to list the spotted seal as threatened or endangered under the ESA due to concerns over impacts of habitat loss due to climate change, NMFS conducted a status review of the species (Boveng et al. 2009). NMFS determined that only the Southern DPS is likely to become endangered throughout all or a significant portion of its range in the foreseeable future and should be listed as threatened. A proposed rule to list the Southern DPS of the spotted seal as a threatened species was published in the *Federal Register* on October 20, 2009 (74 FR 53683). NMFS published the final rule for the listing in the *Federal Register* on October 22, 2010 (75 FR 65239).

No listing action was proposed for the Okhotsk and Bering Sea DPSs (74 FR 53683, October 20, 2009). The Okhotsk and Bering Sea DPSs are not considered in danger of extinction or likely to become endangered in the foreseeable future.

### *Distribution, Migration and Habitat Use*

Spotted seals are widely distributed on continental shelf areas of the Beaufort, Chukchi, southeastern East Siberian, Bering, and Okhotsk Seas, and south through the Sea of Japan and the northern Yellow Sea. This encompasses more than 40 degrees of latitude from Point Barrow in Alaska to the Yangtze River in China (Burns and Fay 1972, Lowry 1985, Naito and Konno 1979, Naito and Nishiwaki 1972).

Habitat use and distribution are closely linked to seasonal sea ice from late fall through spring (November/December to March in the Bering Sea). The seals haul out on the ice during the whelping, nursing, breeding, and molting periods. Before whelping and breeding, spotted seals are scattered among drifting ice floes (Heptner et al. 1976b).

Spotted seals congregate in herds on ice floes as the ice begins to disappear in late spring. Adults molt, and pups are weaned during this time. Adult spotted seals in the Bering Sea molt over a 2 to 2.5 month period from late April or early May to mid-July (Boveng et al. 2009). In summer, when the usable sea ice disappears, herds disperse, and seals move toward the ice-free coastal waters (Heptner et al. 1976a).

Spotted seals in the eastern Bering Sea use coastal haul-out sites from Kuskokwim Bay to the Bering Strait from May to July. Primary haul-outs in the eastern Chukchi Sea are along the coast of Kotzebue Sound and in Kasegaluk Lagoon (near Point Lay) during summer and fall (Figure 3.2-19) (Frost et al. 1982, Frost et al. 1983).

Based on satellite tagging studies, spotted seals in the Chukchi Sea migrated south to breeding and whelping areas in the Bering Seas in October, passing through the Bering Strait in November. In summer, the seals either traveled to nearshore areas of the Bering Sea or headed north into the Beaufort and Chukchi seas. Tagged seals undertook foraging trips from haul-out sites in Kasegaluk Lagoon that averaged 9 days in length and ranged over 1,000 km (621 mi) towards the Bering Strait, Beaufort Sea, or the Russian coast (Lowry et al. 1998).

Spotted seals are generalists that eat a broad array of fish, crustaceans and cephalopods from continental shelf and shelf break waters. They tend to feed more pelagically than benthically (Dehn et al. 2007).

### *Reproduction and Growth*

The annual timing of reproduction coincides with the period of maximum sea ice extent. In the Bering Sea, whelping generally occurs between late March and the end of April. Breeding occurs from late April to mid-May. Gestation lasts seven to nine months, after a two to four month period of delayed implantation. Males and females become sexually mature at about four to five years old. Most mature females annually give birth to a single pup (Heptner et al. 1976b).

Pups weigh 7 to 12 kg (15.4 to 26.5 lbs) at birth and 75 to 92 cm (29.5 to 32.6 in) long. Nursing lasts two to four weeks. Pups may more than triple their weight by the time of weaning. Pups are dependent on the sea ice and rarely enter the water while nursing, and early break up of ice can lead to high levels of pup mortality. Weaning occurs abruptly when the mother abandons the pup (Boveng et al. 2009).

### *Survival and Mortality*

Spotted seals may live 30 to 35 years. Potential sources of mortality are commercial fisheries, subsistence hunts, and predation. No incidental serious injuries or mortalities of spotted seals were reported in any of the observed commercial fisheries in Alaska prior to 2004. In 2004, the Bering Sea/Aleutian Islands flatfish trawl fishery incidentally killed three spotted seals (Allen and Angliss 2010).

Spotted seals are an important species for Alaskan subsistence hunters, primarily in the Bering Strait and Yukon-Kuskokwim regions (see Section 3.3.2, Subsistence Resources and Uses).

There is little evidence of predation on spotted seals, and they are not considered primary prey of any predators. Predators include polar bears, brown bears, walrus, killer whales, Pacific sleeper sharks, foxes, wolves, sea lions, eagles, and gulls (Quakenbush 1988).

A variety of pathogens, diseases, helminthes, cestodes, and nematodes have been found in spotted seals, yet the prevalence is not unusual for seals (Boveng et al. 2009).

### *Hearing and Other Senses*

The estimated auditory bandwidth of spotted seals is 75 Hz to 75 kHz in water and 75 Hz to 30 kHz in air (Southall et al. 2007). Spotted seals in captivity produced six underwater sounds, including growls, clicks, snorts, and “cranky door U.” Frequencies ranged from 500 Hz to 3.5 kHz (summarized in Frankel 2009). Additional information on hearing and other senses for seals in general can be found in the ringed seal description above.

## Ribbon Seal: Alaska Stock

### *Species Description*

Ribbon seals are one of the most strikingly marked and easily recognizable seals in the world. The distinctive ribbon pattern consists of four light-colored bands on a background of darker pelage. One band encircles the neck and nape, another the trunk around the lower back and hips, and two ovals encircle each front flipper. Adult males are more brightly patterned than adult females (Boveng et al. 2008).

Ribbon seals are medium-sized seals. Adults reach lengths of 150 to 175 cm (59.0 to 68.9 in) and weights of about 70 to 90 kg (154 to 198.4 lbs) (Burns 1981, Lowry and Boveng 2009).

### *Population Status and Trends*

The two main breeding areas for ribbon seals are in the Sea of Okhotsk and the Bering Sea. They are not separated into DPSs.

Data from aerial surveys in the eastern Bering Sea in 2003, 2007, and 2008 are currently being analyzed to develop abundance estimates for that region. An interim provisional population estimate of ribbon seals in the eastern and central Bering Sea (i.e. the EEZ) is 49,000 individuals (Boveng et al. 2008).

NMFS received a petition to list ribbon seals under the ESA in December 2007 due to loss of sea ice habitat caused by climate change in the Arctic. NMFS published a notice in the *Federal Register* on March 28, 2008 (73 FR 16617) indicating that there were sufficient data to warrant a status review of the species (Boveng et al. 2008). Findings of the review were published in the *Federal Register* on December 30, 2008 (73 FR 79822), wherein it was determined that listing of the ribbon seal was not warranted at the time, as it is not in danger of extinction or likely to become an endangered species within the foreseeable future.

### *Distribution, Migration and Habitat Use*

Ribbon seals occur in the northern North Pacific Ocean and adjoining sub-Arctic and Arctic seas, primarily the Sea of Okhotsk and Bering Sea. They are strongly associated with sea ice during whelping, mating, and molting from mid-March through June (Burns 1970). The rest of the year is mostly spent at sea. Ribbon seals are rarely observed on land or near land and appear to prefer the continental shelf slope (Heptner et al. 1976c).

In Alaska, ribbon seals are found in the open sea, on pack ice, and only rarely on shorefast ice. They range from Bristol Bay in the Bering Sea to the Chukchi and western Beaufort Seas (Figure 3.2-20). From late March to early May, they inhabit the Bering Sea ice front (Braham et al. 1984, Burns 1970). During May and June, ribbon seals haul out on ice floes where weaned pups become self–sufficient and adults molt. As summer progresses and ice melts, at least part of the Bering Sea population migrates into the Bering Strait and Chukchi Sea (Fay 1974, Lowry 1985).

Research from the 1970s through 1980s, including observations by Eskimo hunters, concluded that few ribbon seals passed through the Bering Strait. Ribbon seals were rarely seen by Eskimo hunters from villages along the southern Chukchi Sea coast in Alaska and were rare in the northern Chukchi Sea (Burns 1981).

Satellite tag data from 2005 and 2007 indicated that ribbon seals disperse widely and into the Chukchi Sea. Eight seals tagged in the central Bering Sea in 2007 moved to the Bering Strait, Chukchi Sea, or Arctic Basin as ice retreated northward and remained there for at least part of the summer and autumn. Three moved south of the Bering Strait before ice reformed in the Chukchi Sea. Most of the seals tagged in the central Bering Sea did not travel north of the Bering Strait (Boveng et al. 2008).

Ribbon seals primarily consume pelagic and nektobenthic prey, including demersal fishes and cephalopods. Arctic cod were important prey in the northern Bering Sea (Ziel et al. 2008).

### *Reproduction and Growth*

Ribbon seals reach sexual maturity at one to five years of age, depending on environmental conditions. Adult females annually give birth to a single pup (Boveng et al. 2008). Whelping in the Bering Sea occurs from late March to mid-May, with a peak in early to mid-April (Burns 1981). Pups are nursed for three to four weeks, during which time their weight may triple from about 9.5 to 28.5 kg (20.9 to 62.8 lbs) (Burns 1981). Breeding takes place after weaning, at the end of April to early May (Boveng et al. 2008).

### *Survival and Mortality*

Very little is known about survival rates, but ribbon seals may live 20 to 30 years. An estimated 25 percent of ribbon seals survive to reach sexual maturity at age five. Mortality for pups in their first year was estimated to be 45 percent; this decreased to 8 to 10 percent for adults annually (Boveng et al. 2008).

Ribbon seals were commercially harvested by the Soviet Union beginning in the Sea of Okhotsk in the 1930s. Catches increased to approximately 20,000 ribbon seals annually during the 1960s (Heptner et al. 1976c).

Commercial sealing expanded to the Bering and Chukchi Seas in 1961. Due to overharvest, the Bering Sea ribbon seals declined (Burns 1981) from an estimated 80,000 to 90,000 in 1963 through 1964 (Fedoseev 2000) to about 60,000 to 70,000 in 1969. Harvest restrictions were imposed in 1969 (Fedoseev 2000).

Ribbon seals are harvested by Alaska Native subsistence hunters, primarily from villages along the Bering Strait and to a lesser extent at villages along the Chukchi Sea coast (See Section 3.3.2, Subsistence Resources and Uses).

Incidental mortality in commercial fisheries is minimal. There was one observed mortality of a ribbon seal in the Bering Sea/Aleutian Islands flatfish trawl fishery between 2002 and 2006 (Allen and Angliss 2010).

There is little evidence of predation on ribbon seals, and they are not considered primary prey of any predators. Polar bears and killer whales are the most likely opportunistic predators (Boveng et al. 2008).

A variety of pathogens, diseases, helminthes, cestodes, and nematodes have been found in ribbon seals, yet the prevalence is not unusual for seals. Population impacts are unknown (Boveng et al. 2008).

### *Hearing and Other Senses*

The estimated auditory bandwidth of ribbon seals is 75 Hz to 75 kHz in water and 75 Hz to 30 kHz in air (Southall et al. 2007). There is some information available about the vocalizations of ribbon seals. The only recordings of underwater sounds were off St. Lawrence Island in the 1970s (Watkins and Ray 1977 cited in Frankel 2009). The two recorded sounds were described as “intense downward frequency sweeps” and a “broadband puffing” sound. The downsweeps were of three types: long (from 7100 to 200 Hz); medium (from 5300 to 100 Hz); and short (from 2000 to 300 Hz). The puffing sounds were below 5 kHz (Frankel 2009). Additional information on hearing and other senses for seals in general can be found in the ringed seal description above.

## Bearded Seal: Alaska Stock (Beringia Distinct Population Segment)

### *Species Description*

Bearded seals are the largest of the true seals, or phocids. They are distinguished by their girth; small head in proportion to body size; unpatterned gray to brown pelage; long, mustache-like whiskers; and square-shaped front flippers. Some individuals have a rust-colored head and fore flippers (Lydersen et al. 2001). Adults are 2 to 2.5 m (6.5 to 8.2 ft) long, with an average weight of 250 to 300 kg (551.1 to 661.4 lbs). Sexes are generally indistinguishable, although females may be larger than males and weigh more than 425 kg (937.0 lbs) in the spring (Kovacs 2009).

### *Population Status and Trends*

The two subspecies of bearded seals are *E. b. barbatus* in the Atlantic and *E. b. nauticus* in the Pacific. *E. b. nauticus* was further divided into an Okhotsk DPS and a Beringia DPS (Heptner et al. 1976c, Ognev 1935). The Beringia DPS was named for the land bridge—Beringia--that was exposed during the last glaciation and over which the range of bearded seals in the Bering, Chukchi, Beaufort, and East Siberian lies (Cameron et al. 2010).

Aerial surveys were flown along the Chukchi Sea coastal regions from Shishmaref to Barrow during May to June 1999 and 2000. The average density of bearded seals was 0.07 seals/km$^2$ in 1999 and 0.14 seals/km$^2$ in 2000. Highest densities were along the coast south of Kivalina (Bengtson et al. 2005). Accurate abundance estimates were not calculated due to lack of correction factors. A rough estimate, based on the densities, was 13,600 bearded seals for the U.S. coastal portion for the Chukchi Sea. If the Russian portion of the Chukchi Sea has similar numbers of bearded seals, a combined total would then be roughly 27,000 seals (Cameron et al. 2010).

Estimates for the Beaufort Sea, extrapolated from surveys in the eastern Beaufort in the 1970s and not corrected for seals in the water, was 3,150 seals (Stirling et el. 1982). This is likely a gross underestimate (Cameron et al. 2010).

On December 10, 2010, NMFS announced a 12-month finding on a petition to list the bearded seal as a threatened or endangered species in the *Federal Register* (75 FR 77496). In the *Federal Register* notice NMFS determined the Beringia DPS and the Okhotsk DPS are likely to become endangered throughout all or a significant portion of their ranges in the foreseeable future, but that such a determination is not warranted for *E. b. barbatus*. This announcement issued the proposed rule to list the Beringia DPS and the Okhotsk DPS of the bearded seal as threatened species; no listing action was proposed for *E. b. barbatus*. The basis for the determination was the likelihood of current and future sea-ice habitat modification due to climate change and marine habitat modification due to ocean acidification.

### *Distribution, Migration and Habitat Use*

Bearded seal distribution is circumpolar (Burns 1967, Burns and Frost 1979, Kelly 1988) and extends from the Arctic Ocean (85°N) to Sakhalin Island (45°N) in the Pacific (Allen 1880, Ognev 1935). Distribution and seasonal movements are closely associated with seasonal changes in sea ice. Sea ice provides an important platform on which bearded seals haul out to give birth, nurse pups, rest, and molt. Bearded seals prefer ice in constant motion, with natural openings and areas of open water, such as leads, fractures, and polynyas (Heptner et al. 1976d). Bearded seals in the Beaufort Sea were most abundant where drifting pack ice interacts with fast ice, creating leads and other openings (Burns and Frost 1979).

Most adult bearded seals move north from the Bering Sea into the Bering Strait and Beaufort and Chukchi seas in spring as the ice retreats. From summer to early fall, they occur along the southern edge of the Beaufort and Chukchi Sea pack ice (Heptner et al. 1976d). Most bearded seals migrate south through the Bering Strait to the Bering Sea ahead of the advancing ice in the fall and winter. During late winter and early spring, bearded seals are widely distributed in the broken, drifting pack ice from the Chukchi Sea to the ice front in the Bering Sea (Figure 3.2-21) (Cameron et al. 2010).

Recent acoustic data indicate that bearded seals are present in the Chukchi Sea throughout the year. Acoustic detections of calls were highest off Wainwright and Barrow during the breeding season in May and June (Hannay et al. 2011). Bearded seals were visually detected during June to November COMIDA in all years (2008 through 2010) of the aerial surveys. Sightings were concentrated between Wainwright and Barrow during summer but otherwise spread throughout the survey area (Clarke et al. 2011a).

Bearded seals are commonly observed during BWASP fall surveys. Distribution for 2006 through 2009 was consistently across the Beaufort Sea survey area and into the northeastern part of the Chukchi Sea (Clarke et al. 2011b, 2011c).

Pregnant females generally overwinter on drifting ice in the Bering Sea where they whelp and wean before migrating north. Wintering and whelping bearded seals are also found in coastal leads of the Bering and Chukchi Seas, including Bristol and Kuskokwim Bays, Norton and Kotzebue Sounds, the Gulf of Karaginskiy, the Gulf of Anadyr, and near Point Hope (Coffing et al. 1998, Georgette et al. 1998).

It is unusual for bearded seals in the Bering, Beaufort and Chukchi seas to haul out on land. Younger bearded seals have, however, been seen hauled out on land in lagoons and up rivers near Wainwright and on sandy islands near Barrow (Nelson 1981).

Since bearded seals feed benthically (on the ocean bottom), they generally associate with seasonal sea ice over shallow water of less than 200 m (656 ft). In the Beaufort Sea, bearded seals prefer areas of open ice cover and water depths of 25 to 75 m (82 to 246 ft) (Stirling et al. 1982). In the eastern Chukchi Sea, highest densities in May and June were in the offshore pack ice where benthic productivity is high (Bengtson et al. 2005). The shallow continental shelf area of the Bering and Chukchi Seas includes about

half of the Bering Sea, the Bering Strait, and most of the Chukchi Sea. Bearded seals can dive to the bottom all along the shallow shelf, making it a favorable foraging habitat (Burns 1967).

Bearded seals prey on benthic organisms, such as epifaunal and infaunal invertebrates and demersal fishes. Crabs, shrimp, and clams are major prey for bearded seals in the Bering, Beaufort, and Chukchi seas. Tanner crabs are important in the southern Bering Sea, and spider crabs are important in the northern Bering, Beaufort, and Chukchi seas. Sculpins, arctic cod, polar cod, or saffron cod can also be important prey (Allen 1880, Antonelis et al. 1994, Dehn et al. 2007, Finley and Evans 1983, Heptner et al. 1976d, Kenyon 1962, Lowry et al. 1980, Ognev 1935, Wilke 1954). Prey preferences apparently changed over time. The consumption of fish increased while invertebrate consumption decreased from the 1960s-1970s to the year 2000 (Quakenbush et al. 2011).

### *Reproduction and Growth*

Female bearded seals reach sexual maturity at five to six years, and males become sexually mature at six to seven years. Most adult female bearded seals annually produce a single pup. Pupping takes place from mid-March to early-May in the central Bering Sea. The peak pupping in the Bering Strait and central Chukchi Sea occurs in late April (Heptner et al. 1976d).

Newborn bearded seals in the Bering and Chukchi Seas weigh an average of 33.6 kg (74.1 lbs) and are 131.6 cm (51.8 in) long. Pups grow rapidly and gain an estimated 2.8 to 3.6 kg (6.2 to 7.9 lbs) per day (Kovacs and Lavigne 1986, Lydersen and Kovacs 1999). Weight increases to about 85 kg (187.4 lbs) by the time of weaning at 12 to 18 days. The pups are able to enter the water within hours of birth and begin to forage while still nursing (Cameron et al. 2010).

### *Survival and Mortality*

Bearded seals typically live 20 to 25 years (Kovacs 2009), with a maximum of around 30 years (Cameron et al. 2010).

Sources of mortality include subsistence hunting, fisheries interactions, and predation. Bearded seals have been an important subsistence species for Alaska Natives for thousands of years and continue to be so today. See Section 3.3.2, Subsistence Resources and Uses, for details on the subsistence harvest of bearded seals.

Mortality incidental to the Bering Sea/Aleutian Islands pollock trawl fisheries is rare but known to occur. In 2006, there were two observed mortalities in the fishery (Allen and Angliss 2010).

Mortalities incidental to permitted marine mammal research activities may occasionally occur. One mortality, resulting from research on the Alaska stock of bearded seals, was reported between 2003 to 2007 (Tammy Adams, Permits, Conservation, and Education Division, Office of Protected Resources, NMFS, cited in Allen and Angliss 2010).

Polar bears are the primary predators of bearded seals. Other predators include brown bears, killer whales, sharks, and walrus (Cameron et al. 2010).

Relatively little is known about diseases and causes of natural mortality in bearded seals, other than predation by polar bears. A variety of diseases and parasites, with which the seals likely co-evolved, have been documented in bearded seals. The observed prevalence is not unusual (Cameron et al. 2010).

### *Hearing and Other Senses*

As with other pinnipeds, the estimated auditory bandwidth of bearded seals is 75 Hz to 75 kHz in water and 75 Hz to 30 kHz in air (Southall et al. 2007).

Male bearded seals vocalize during the breeding season. They produce four basic call types: trill; moan; sweep; and ascent. Trills, the predominant call during the breeding season, are one of the more distinctive calls of any marine mammals. The frequency modulated vocalizations with long downsweeps that begin

between 3 and 6 kHz, can propagate up to 30 km (18.6 mi), and last up to 60 s (Cameron et al. 2010, Frankel 2009). The sounds of bearded seals during their breeding season (May) increases the ambient noise level by as much as 20 dB (Hannay et al. 2011).

Another sensory adaptation of bearded seals is that for which they were named—their well-developed facial whiskers. Theirs are among the most sensitive in the animal world with 1,300 nerve endings associated with each whisker. This extreme sensitivity is thought to be an adaptation to benthic feeding (Kovacs 2009). Additional information on hearing and other senses for seals in general can be found in the ringed seal description above.

## Pacific Walrus

### *Species Description*

The walrus is the only living member of the pinniped family Odobenidae. The species' Latin name *Odobenus rosmarus* means "tooth walking sea horse" (Kastelein 2009), in honor of one of their more distinguishing characteristics. The upper canine teeth are enlarged to form prominent tusks, which are longer and thicker in males than in females (Garlich-Miller et al. 2011).

The walrus is the largest pinniped species in the Arctic. Males are larger than females, with an average body length of 230 cm (90.5 in) and weight of 1,200 to 1,500 kg (2,646 to 3,307 lbs), compared to 270 cm (106.3 in) and 600 to 850 kg (1,323 to 1,874 lbs) for females (Kastlein 2009). Females attain maximum size by about 10 years old and males at about 15 to 16 years (Fay 1982).

Walrus are social and gregarious animals. They tend to travel and haul out on ice or land in densely packed groups. When hauled out, walrus tend to lie close together, with young animals often on top of adults. Group size can range from a few individuals, up to several thousand animals (Gilbert 1999, Kastelein 2002).

### *Population Status and Trends*

The three modern subspecies of walrus are the Atlantic walrus (*O. r. rosmarus*), the Pacific walrus (*O. r. divergens*), and the Laptev walrus (*O. r. laptevi*) (ITIS 2010). The Pacific walrus is represented by a single population that inhabits continental shelf waters of the Bering and Chukchi Seas (Fay 1982), and is the only subspecies expected to occur in the EIS project area.

The size of the Pacific walrus population is currently unknown. There will be some level of incomplete information on population status of walrus in the Chukchi Sea. However, sufficient information is available to support sound scientific judgments and reasoned managerial decisions. More accurate population counts are not essential for a reasoned choice among alternatives at this stage. This information pertains to impacts that would be common under each action alternative, a fact which further reduces the utility of this information to the decision-maker. The MMPA and its implementing regulations would ensure that potential impacts remain negligible under each alternative. A portion of the range was surveyed in 2006 using a combination of thermal imaging and satellite transmitters. The number of walrus within the area of the Bering Sea pack ice that was surveyed was estimated at 129,000 individuals (Garlich-Miller et al. 2010, Speckman et al. 2010). This represents only a partial population estimate, since only about half of the potential walrus habitat was surveyed (Speckman et al. 2010).

On February 10, 2011, the USFWS published a notice of a 12-month finding in the *Federal Register* (76 FR 7634 [2011a]) on a petition to list the Pacific walrus as threatened or endangered under the ESA. It was determined that listing the Pacific walrus was warranted, but precluded by higher priority actions to list other species. The two factors considered primary threats to the Pacific walrus in the foreseeable future and the reason for the determination are loss of sea ice in summer and fall, and associated impacts, and subsistence harvest. Upon publication of the notice, the Pacific walrus was added to the USFWS list of candidate species.

### *Distribution, Migration and Habitat Use*

Pacific walrus range across continental shelf waters of the northern Bering Sea and southern Chukchi Sea (Figure 3.2-22). Adult males remain in the Bering Sea to forage from coastal haul outs during the ice free season. The rest of the population migrates seasonally in conjunction with seasonal advance and retreat of sea ice (Garlich-Miller et al. 2011).

Walrus congregate in the Bering Sea pack-ice adjacent to areas with open water, such as leads and polynyas, during the breeding season from January to March (Fay et al. 1984b). Breeding aggregations are common southwest of St. Lawrence Island, south of Nunivak Island and south of the Chukotka Peninsula in the Gulf of Anadyr (Speckman et al. 2010).

Most of the population migrates north through the Bering Strait to summer feeding areas over the continental shelf in the Chukchi Sea when the ice in the Bering Sea breaks up in spring. Summer distribution in the Chukchi Sea depends on sea ice distribution and extent. Walrus form patchy aggregations across the continental shelf when loose pack ice is abundant. Aggregations range in size from less than 10 to more than 1,000 individuals (Gilbert 1999, Ray et al. 2006). Walrus concentrate in loose pack ice off the northwest coast of Alaska between Icy Cape and Point Barrow and along the coast of Chukotka, Russia, to Wrangel Island (Belikov et al. 1996, Gilbert et al. 1992). The return southbound migration to the Bering Sea wintering areas occurs in September and October in advance of sea ice formation in the Chukchi Sea. Large herds may gather to rest during migration at haul outs in the southern Chukchi Sea (Belikov et al. 1996).

Walrus were observed in June to October 2008 through 2010 during aerial surveys of the northeastern Chukchi Sea. Distribution was broad and associated with sea ice in June to early August. It then shifted to nearshore open water and coastal habitat in late August and September. Few were seen in the area in October (Clarke et al. 2011a). Walrus detected during fall BWASP surveys in 2006 and 2007 were north and east of Barrow (Clarke et al. 2011b, 2011c).

Acoustic detections indicate that walrus are present in the Chukchi Sea from early June through December. Calls peaked in August and September, with the highest level of detections occurring off Wainwright (Hannay et al. 2011).

Sea ice serves as a platform for resting between feeding bouts, breeding, calving, and care of dependent young (Fay et al. 1984b, Kelly 2001). Walrus may haul out on land when sea ice is not available, which has occurred during several years since the mid-1990s. Females avoid using terrestrial haul outs, when possible, since calves are more vulnerable to trampling (Fishbach et al. 2009).

Foraging trips last for a few hours to several days. Foraging trips from sea ice tend to be shorter than those from land. It is, presumably, more cost effective to haul out near the productive feeding areas and expend less energy traveling (Cooper et al. 2006).

Recent use of coastal haul outs along the northwestern Alaska coast is influenced by the availability of sea ice. In 2006 and 2008 walrus remained with the ice pack throughout the summer and fall, but in 2007, 2009, and 2010, the pack-ice retreated beyond the continental shelf and walrus hauled out on land at several locations between Point Barrow and Cape Lisburne (Clark et al. 2011a, Thomas et al. 2009). Between 2 and 13 September 2009, approximately 2,500 walrus were observed hauled out on Icy Cape. In 2010, walrus were distributed throughout the northeast Chukchi Sea in the water and on scattered ice floes in early August. In late August, most shifted nearshore between Point Lay and Barrow. On 30 August 2009, several large coastal haul outs with 2,500, 1,000, and 200 animals were documented east of Cape Lisburne. A coastal haul out near Point Lay had approximately 4,000 animals. The Point Lay haul out persisted through much of September, with counts ranging from <1,000 to >15,000 animals (Clarke et al. 2011a).

Walrus are benthic feeders, specializing in invertebrates. Prevalent prey in both the Bering and Chukchi Seas includes bivalves, gastropods, and polychaete worms. Bivalves were more common in walrus stomachs from the Bering Sea and polychaete worms were more common in the Chukchi Sea (Sheffield and Grebmeier 2009). Sheffield and Grebmeier (2009) suggest that walrus exploit different benthic prey throughout their range depending on biomass availability and not just species.

### *Reproduction and Growth*

Males reach sexual maturity at 6 to 7 years old, but are not likely to successfully compete for females until they are at least 15 years old (Fay 1982, Fay et al. 1984a). Females reach sexual maturity at 4 to 7 years old (Garlich-Miller et al. 2006). Mating takes place from January through March, and a single calf is born in May of the following year (Fay 1982). Newborn calves weigh 65 kg (143.3 lbs) and are 113 cm (44.5 in) long (Fay 1982).

Walrus have the lowest birth rate of any pinniped species. This is offset by a high level of maternal investment and the resulting high rates of calf survival. Females and newborn calves remain on ice floes until calves develop enough energy reserves to thermoregulate properly. The calf remains with its mother for at least two years. The prolonged nursing period of 1 to 2 years may suppress ovulation so that the birth interval is 3 or more years (Garlich-Miller and Stewart 1999). Young female walrus generally remain with groups of adult females after weaning, whereas young males associate with groups of other males (Fay 1982).

### *Survival and Mortality*

Walrus may live to be 40 to 45 years old. Estimated survival rates for the first year of life are between 0.5 and 0.9. Survival rates may be as high as 0.96 to 0.99 for juveniles and adults (4 to 20 years old) (DeMaster 1984, Fay et al. 1997).

Walrus were historically harvested commercially. American whalers in the Bering Sea intensified hunts in the mid- to late-1880s. An estimated 15,000 to 20,000 were harvested annually between 1860 and 1880, with 60,000 reportedly taken between 1868 and 1872 (Fay 1957). The population decreased dramatically as a result, as did harvest levels. Annual harvests of 5,000 to 7,000 continued from 1910 to 1950 (Fay 1957). In 1960 and 1961, the State of Alaska imposed restrictions on subsistence takes in order to promote recovery of the population, which, by the 1980s appeared to be recovered to its pre-exploitation level (Fay et al. 1989).

The Pacific walrus is an important subsistence resource in many coastal communities along the Bering and Chukchi Sea coasts of Alaska (U.S.) and Chukotka (Russia). See Section 3.3.2, Subsistence Resources and Uses, for further details.

Incidental mortality of Pacific walrus in commercial fisheries is insignificant. Observed mortality in the Bering Sea/Aleutian Islands flatfish fishery averaged 1.8 walrus per year between 2002 and 2006 (Allen and Angliss 2010).

Disturbance-induced stampedes from haul outs can lead to injuries and mortalities. Calves and young animals are particularly vulnerable to trampling injuries (Garlich-Miller et al. 2011). A mortality event documented by USFWS in September 2009 may have resulted from trampling of young walrus hauled out onshore near Icy Cape. One hundred thirty one (131) carcasses were counted on sandy beaches from Wainwright to Icy Cape. This is the first reported large mortality event for walrus hauling out on the Alaskan Chukchi Sea coast and may relate to the loss of sea ice over the Chukchi Sea continental shelf (Fischbach et al. 2009).

Pacific walrus are one of the largest animals of the Bering and Chukchi Seas. As such, they have relatively few natural predators. The principal natural predators of Pacific walrus are polar bears and killer whales.

Diseases and predation are not currently posing significant threats to the Pacific walrus population (Garlich-Miller et al. 2011).

### *Hearing and Other Senses*

As with other pinnipeds, the estimated auditory bandwidth of walrus is 75 Hz to 75 kHz in water and 75 Hz to 30 kHz in air (Southall et al. 2007).

Walrus produce a variety of sounds in and out of water. Acoustic threats when hauled out include roars, grunts, guttural sounds, and barks, ranging in frequency from 13 Hz to 4 kHz. Males sing on the mating grounds. Songs include sequences of pulsed sounds and bell-like sounds. Pulsed sounds include intense "knocks" of 0.2 to 8 kHz and "taps" produced more rapidly at 0.2 to 4 kHz. Males also produce gong-like sounds (Frankel 2009).

## 3.2.4.4 Fissipeds

### Polar Bear: Chukchi/Bering Seas Stock and Southern Beaufort Sea Stock

### *Species Description*

Polar bears are the largest of the living bear species and have a longer neck and proportionately smaller head than other bears (DeMaster and Stirling 1981). Adult males are larger than adult females. Males can be 230 to 285 cm (90.5 to 112.2 in) long and weigh over 650 kg (1,433.0 lbs). Females range in size from 180 to 240 cm (70.8 to 94.5 in) in length and 181 to 317 kg (399.0 to 698.9 lbs) in weight (Amstrup 2003). The fur ranges in color from white, to yellow, to grey, to almost brown. The nose, lips, and skin are black (Amstrup 2003, DeMaster and Stirling 1981).

Adaptations to living on sea ice include white fur with water repellent guard hairs and a dense under-coat; a short snout; small ears; teeth specialized for eating meat; and hair on the soles of the feet. The large, paddle-like feet help disperse weight when walking on thin ice and aid in swimming (Stirling 1988).

### *Population Status and Trends*

The two stocks of polar bears in Alaska are the Southern Beaufort Sea stock and the Chukchi/Bering Seas stock. Low population densities, inaccessible habitat, cross-boundary politics and budget constraints have made estimating abundance of Alaskan populations difficult (Lentfer and Galster 1987).

There is currently no reliable population estimate for the Chukchi/Bering seas stock. The IUCN Polar Bear Specialist Group estimated a population of approximately 2,000 animals by extrapolating multiple years of aerial den survey data. However, the estimate is imprecise and not useful for evaluating status and trends for this population (Lunn et al. 2002). There will be some level of incomplete information on population status of polar bears in the Chukchi and Bering Seas. However, sufficient information is available to support sound scientific judgments and reasoned managerial decisions. More accurate counts are not essential for a reasoned choice among alternatives. Furthermore, the missing information pertains to impacts that are common to all alternatives, limiting the utility of this information to the decision maker.

The southern Beaufort Sea population has been studied since 1967. The most current and valid population estimate (1,526 bears) was based on data collected from 2001 to 2006. The area to which this applies extends from Point Barrow east to the Baillie Islands in Canada (Regehr et al. 2006). The overall population growth rate declined by approximately 0.3 percent per year for the years 2001 to 2006 (Hunter et al. 2007).

A determination of threatened species status for the polar bear throughout its range was published by the USFWS in the *Federal Register* on May 15, 2008 (73 FR 28212). This determination was based on declining sea ice habitat throughout the species range and the anticipated continued decline in the

foreseeable future. This loss of sea ice habitat was considered a sufficient threat that polar bears were considered likely to become an endangered species in the foreseeable future throughout all of its range.

### *Distribution, Migration and Habitat Use*

Polar bears are distributed across ice-covered waters of the circumpolar Arctic. Sea ice is their primary habitat upon which they depend for most life functions, including hunting and feeding, breeding, travel, maternity denning areas, and resting (Stirling and Derocher 1993). Distribution and movements are intricately tied to seasonal sea ice dynamics and the polar bears range is limited to areas covered in sea ice for much of the year (Stirling et al. 1999).

Pack ice is the primary summer habitat for Alaska polar bears that use it for traveling, feeding, and denning in fall and winter. In the Beaufort Sea and to a lesser extent in the Chukchi Sea females may den and give birth to their young on the drifting pack ice (Amstrup and Gardner 1994). During the summer months when the sea-ice disappears from the Bering Sea and becomes reduced in the Chukchi Sea polar bears that occupy these areas can migrate as much as 1000 km (620 mi) to stay with the pack ice (Garner et al. 1990, 1994). During the summer months polar bears tend to concentrate along the edge or into the adjacent persistent pack ice. It is importantto note that in the last decade the distribution patterns for some populations during the open water and early fall seasons have changed. In the Beaufort Sea, it was observed that greater numbers of polar bears (up to 200 individuals) were found on shore during from 2000 to 2005 than at any previous time (Schliebe et al. 2006a). Shorefast ice is important in the spring for preying on seal pups, traveling, and occasional denning. Leads that open and close between the active pack ice and shore-fast ice are important during winter and spring for feeding and travel (Schliebe et al. 2006a).

The Chukchi/Bering stock is widely distributed on pack ice in the Chukchi Sea, northern Bering Sea, and adjacent coastal areas in Alaska and Russia (Figure 3.2-23). The range extends to the northeast near the Colville Delta in the central Beaufort Sea and to the west near Chauniskaya Bay in the Eastern Siberian Sea. The southern boundary is determined by the annual extent of pack ice (Amstrup et al. 2005, Garner et al. 1990).

The Southern Beaufort Sea stock ranges east to south of Banks Island and east of the Baillie Islands, Canada (Amstrup et al. 2000). The western boundary is near Point Hope (Figure 3.2-23). Adult female polar bears from this stock occasionally move into an area that overlaps with the range of the Chukchi/Bering stock between Point Hope and Colville Delta, centered near Point Lay (Amstrup et al. 2000, Garner et al. 1990, Garner et al. 1994). Telemetry data showed that adult female polar bears from the Southern Beaufort Sea spend about 25 percent of their time in the northeastern Chukchi Sea, whereas females tagged in the Chukchi Sea spend only six percent of their time in the Southern Beaufort Sea (Amstrup 1995).

Polar bears do not disperse evenly throughout their range. Polar bears in the Southern Beaufort Sea concentrate in waters less that 300 m (984 ft) deep over the continental shelf and in areas with >50 percent ice cover in order to access ringed and bearded seals (Durner et al. 2004, Durner et al. 2006a, Durner et al. 2009, Stirling et al. 1999).

Polar bears from the Southern Beaufort Sea population historically denned on both the sea ice and in snow drifts on land. The number denning on sea ice declined from 62 percent (1985 to 1994) to 37 percent (1998 to 2004) in response to thinning of the sea ice (Fischbach et al. 2007). Barrier islands from Barrow to Kaktovik and coastal areas up to 25 miles inland, including the Arctic National Wildlife Refuge to Peard Bay, are the primary terrestrial denning areas for the Southern Beaufort Sea population in Alaska (Amstrup and Gardner 1994, Durner et al. 2001, Durner et al. 2006b).

Distribution patterns have changed in recent years. In the Beaufort Sea more polar bears (up to 200) occurred on shore between 2000 and 2005 than at any previous time (Schliebe et al. 2006b). The reason for this is unclear, but a statistically significant relationship exists between the number of bears using the

coast and the distance of the pack ice from shore. Telemetry data and habitat use data from the southern Beaufort Sea indicate shifting distribution during summer and fall, apparently in response to ice retreating farther offshore than in the past (Schliebe et al. 2006b).

Polar bears were sighted in the northeastern Chukchi Sea all years of the COMIDA study (2008 to 2010). Most occurred west to northwest of Point Barrow during August 2008, including 10 bears observed swimming in open water. Of the ten bears, the southernmost bear was within 5 km (3.1 mi) of land and the northernmost was 90 km (60.0 mi) from the nearest land, but within 5 km (3.1 mi) of broken ice floes. Polar bears were also sighted in June of 2008, 2009, and 2010 (Clarke et al. 2011a).

Polar bear sightings are also common during fall BWASP aerial surveys of the Beaufort Sea. During 2006 to 2009, all bears, but one, were on or near shore between Cape Halkett and Kaktovik. In 2009, one bear was seen swimming in open water 140 km (87.0 mi) north of the barrier islands (Clarke et al. 2011b, 2011c).

Polar bears are apex predators in the Arctic marine ecosystem. Unlike other bear species that are generally omnivorous, polar bears are carnivores (Stirling 1988). Seals are their primary prey – particularly ringed seals and, in some areas, bearded seals or other ice seal species. Polar bears may occasionally prey on walrus, narwhals, and beluga whales (Calvert and Stirling 1990, Smith and Sjare 1990). Polar bears in the Beaufort Sea (e.g. at Barter Island, Cross Island, Barrow) gather to feed at the butchering sites of harvested bowhead whales. Bears observed feeding on these carcasses in the fall are generally large and healthy (Miller et al. 2006).

On December 7, 2010, the USFWS published a Final Rule in the *Federal Register* (75 FR 76086) designating critical habitat for U.S. populations of polar bears. Designated critical habitat is located in Alaska and adjacent territorial and U.S. waters and encompasses 484,734 $km^2$ (187,157 $mi^2$) Figure 3.2-24). Excluded from designation are five U.S. Air Force Radar Sites, the Native communities of Barrow and Kaktovik, and all existing manmade structures (regardless of land ownership status).

Three habitat units designated were sea-ice habitat, terrestrial denning habitat, and barrier island habitat (Figure 3.2-24). The sea ice critical habitat area is located over the continental shelf in water 300 m (984 ft) or less in depth. The terrestrial denning habitat includes lands within 32 km (19.8 mi) of the northern coast of Alaska between the U.S./Canadian border and the Kavik River and within 8 km (5.0 mi) between the Kavik River and Barrow. This area contains about 95 percent of known historical den sites from the southern Beaufort Sea population. Barrier island habitat includes the coastal barrier islands and spits along Alaska's coast, along with the water, ice, and other terrestrial habitat within 1.6 km (0.99 mi) of the islands.

### *Reproduction and Growth*

Polar bears have a low reproductive rate characterized by small litter sizes and extended parental investment (Angliss and Lodge 2004). Females come into estrus between March and June when breeding occurs. Mating induces ovulation (Ramsay and Dunbrack 1986).

In most areas, pregnant females come ashore in the fall (September to November) to excavate dens in snow drifts (Amstrup and Gardner 1994, Lentfer and Hensel 1980, Ramsay and Stirling 1990). Many pregnant females in the Beaufort Sea do not enter dens until late November or early December (Amstrup and Gardner 1994). In the Beaufort Sea and, to a lesser extent, the Chukchi Sea, females may den and give birth to their young on drifting pack ice (Schliebe et al. 2006a). As noted above, the use of pack ice for denning appears to be decreasing in recent years in the southern Beaufort Sea.

Females and cubs leave the dens in the spring (February through April) when their cubs are able to survive in the outside environment. They return to the sea ice soon thereafter (Amstrup 1995).

Newborn polar bears are helpless, blind, and weigh only 0.6 kg (1.3 lbs). Growth is rapid, and cubs may weigh 10 to 12 kg (22 to 26.5 lbs) when they emerge from the den. Weaning typically occurs in the

spring when cubs are about 2 years old. Young bears remain with their mothers until then. Adult females can breed again once the cubs are weaned, resulting in a typical birth interval of 3 years (Schliebe et al. 2006a).

### *Survival and Mortality*

Polar bears are long-lived. The oldest recorded age in the wild was 32 for a female and 28 for a male (Stirling 1990). The low reproductive rates of polar bears necessitate a high survival rate to maintain population levels (Schliebe et al. 2006a).

Polar bears have been harvested both commercially and for subsistence. Russia prohibited all hunting of polar bears in 1956 as populations declined (Uspenski 1986). Illegal hunting of polar bears in the Russian Arctic began to increase in 1992. As many as 150 to 250 bears may be illegally harvested from the Chukchi/Bering stock each year (Kochnev 2006). Subsistence hunting by Alaska Natives is discussed in Section 3.3.2, Subsistence Resources and Uses.

Polar bear stocks in Alaska have no direct interaction with commercial fisheries activities (Allen and Angliss 2010).

Mortality related to industrial activities has occurred in the Southern Beaufort Sea. One incident was at an offshore drilling site in the Canadian Beaufort Sea in 1968. One bear died at the Stinson site in the Alaska Beaufort Sea in 1990, and another died after ingesting ethylene glycol stored at an offshore island in the Alaska Beaufort Sea in 1988. A polar bear was killed in self-defense at a remote radar defense site in 1993 after it severely mauled a worker (Allen and Angliss 2010). More recently (August 2011), a female polar bear was shot and killed by a security guard near employee housing at the Endicott oil field (Reuters 2011).

Polar bears are not known to be particularly susceptible to disease, parasites, or injury. *Trichinella* is commonly observed in polar bears throughout their range, but infections are not normally fatal (Rogers and Rogers 1976).

### *Hearing and Other Senses*

There is limited information on the hearing of polar bears. Polar bears are not known to communicate underwater. Nachtigall et al. (2007) measured the in-air hearing of three polar bears using evoked auditory potentials. Measurements were not obtainable at 1 kHz, and best sensitivity was found in the 11.2 to 22.5 kHz range. Preliminary behavioral testing of hearing indicates that they can hear down to at least 14 Hz and up to 25 kHz (Bowles personal communication 2008 cited in URS 2009). Information on the hearing of polar bears is not essential for a reasoned choice among project alternatives in Chapter 4, as the underwater seismic activity would not interfere with their communication.

## 3.2.4.5 Influence of Climate Change on Marine Mammals

Climate change impacts on the Arctic are of growing concern. Changes to the physical environment in the Arctic are described in more detail in Sections 3.1.2.6 and 3.1.4.4. Increased temperatures, longer periods of open water with an earlier onset of melting and later onset of freeze-up, increased rain-on-snow events, warm water intrusion into the Arctic, and changing atmospheric wind patterns, are contributing to overall reduction and changes in sea ice and polar ecosystems (Allen and Angliss 2010). Loss of sea-ice is one of the most pronounced changes currently occurring and projected to continue into the future. Arctic sea ice is changing in extent, thickness, distribution, age, and timing of melt. Analysis of long-term data sets show substantial decreases in both extent (area of ocean covered by ice) and thickness of sea ice cover during the past 30 years (Perovich et al. 2010).

The impacts of climate change on marine mammals in the Arctic will likely be profound, but exactly what form these impacts will take is not easy to determine (ACIA 2005). Direct loss of habitat for feeding, breeding, pupping, and resting is likely, as are changes in prey composition and availability. Ice-obligate

species, such as walrus, ringed seals, ribbon seals, bearded seals, spotted seals, and polar bears, are intricately tied to and heavily dependent upon sea ice and particularly vulnerable to changes. Concern over habitat degradation and loss due to climate change prompted petitions to list all of these species as either threatened or endangered under the ESA. Polar bears are now listed as threatened, walrus are candidate species for listing, and ringed and bearded seals are proposed for listing (73 FR 79822; 73 FR 28212; 74 FR 53683; 75 FR 77476; 75 FR 65239; 75 FR 77496; 76 FR 7634). Detailed analyses of potential impacts of climate change on these species are available in the respective *Federal Register* notices and status reviews (see Boveng et al. 2008, Boveng et al. 2009, Cameron et al. 2010, Garlich-Miller et al. 2011, and Kelly et al. 2010a).

Recent shifts in distribution and habitat use by polar bears and walrus in the Beaufort and Chukchi seas are likely attributable to loss of sea ice habitat. The increased frequency with which female polar bears in the southern Beaufort now den on land rather than on pack ice was attributed to reductions in stable old ice, increases in unconsolidated ice, and lengthening of the melt season (Fischbach et al. 2007). Fischbach et al. (2007) anticipate this trend will continue as long as ice remains near enough to the coast in the fall to provide land access for pregnant females. Over the past decade, the number of walrus coming to shore along the coastline of the Chukchi Sea in Russia has increased, and recent use of coastal haul outs along the northwestern Alaska coast was influenced by the loss of sea ice over the Chukchi Sea continental shelf (Clarke et al. 2011a, Allen and Angliss 2010, Fischbach et al. 2009). Use of shore-based haul outs may leave walrus, particularly calves and juveniles, vulnerable to disturbance related stampedes and trampling mortalities (Fischbach et al. 2009).

Loss of sea ice habitat and associated ecosystems will impact access to prey, prey availability, and species composition. Predictions for biotic change include increased primary and secondary production, particularly in the central Arctic, during summer open-water conditions; reduced benthic and pelagic biomass in coastal/shelf areas (due to increased river runoff and changes in salinity and turbidity); and increased pelagic grazing and recycling in open-water as opposed to the current tight benthic–pelagic coupling in ice-covered shelf areas (Bluhm and Gradinger 2008). If this holds true, the feeding range for ice dependent, benthic shelf–feeding Arctic marine mammals, such as walrus and bearded seals, would decrease and nearshore areas may become less productive. This could prove advantageous to pelagic-feeding or generalist marine mammals species (Bluhm and Gradinger 2008).

Bowhead whales may be sensitive to changes in Arctic weather, sea-surface temperatures, or ice extent, and resulting impacts on prey availability. It is not, however, currently possible to make reliable predictions of the effects of climate change on the species. Research by George et al. (2006, cited in Allen and Angliss 2010) showed that the body condition of bowheads harvested by Iñupiat Eskimos was better during years of light ice cover. Thus far, it appears that the Western stock of bowhead whales is tolerating the recent ice loss in the Arctic (Allen and Angliss 2010).

Range expansion of sub-Arctic and temperate species into the Beaufort and Chukchi seas has been observed in recent years and could continue with changing Arctic conditions. Humpback whales and fin whales in the northeastern Chukchi Sea appears a relatively recent phenomenon (Clarke et al. 2011a). Thus far, potential range expansion into the Beaufort Sea is limited to one humpback whale sighting just east of Barrow in 2007. This was, incidentally, a low ice year (Hashagen et al. 2009). Along with range expansion of the more temperate species comes the possibility for competition for resources with Arctic species (ACIA 2005).

Other risks to Arctic marine mammals induced by climate change include increased risk of infection and disease with improved growing conditions for disease vectors and from contact with non-native species, increased pollution through increased precipitation transporting river borne pollution northward, and increased human activity through shipping and offshore development (ACIA 2005, Huntington 2009).

### 3.2.5 Terrestrial Mammals

There are approximately 30 species of terrestrial mammals within the vicinity of the EIS project area (Table 3.2-5). Among these species, it is expected that only barrenground caribou (*Rangifer tarandus granti*) may experience interactions with oil and gas exploration activities during critical periods of their life cycle; therefore, this report will focus only on caribou. Descriptions of distribution, life cycle, and habitat characteristics of other species are not included in this EIS.

**Table 3.2-5 Terrestrial Mammals of the North Slope of Alaska**

| Terrestrial Mammals of the North Slope of Alaska | | |
|---|---|---|
| **Common Name** | **Scientific Name[2]** | **Inupiaq Name[3,3]** |
| Arctic Ground Squirrel | *Spermophilus parryii* | Siksrik |
| Alaska Marmot | *Marmota broweri* | Siksrikpak |
| Collared lemming | *Dicrostonyx groenlandicus* | Qixafmiutauraq |
| Brown lemming | *Lemmus trimucronatus* | Aviffaq |
| Singing vole | *Microtus miurus* | Avieeaq |
| Root (Tundra) vole | *Microtus oeconomus* | Avieeaq |
| Northern red-backed vole | *Myodes rutilus* | |
| North American porcupine | *Erethizon dorsatum* | Qifabluk |
| Snowshoe hare | *Lepus americanus* | Ukalliq |
| Cinereus shrew | *Sorex cinereus* | Ugrufnaq |
| Dusky shrew | *Sorex monticolus* | |
| Tundra shrew | *Sorex tundrensis* | Ugrufnaq |
| Barren ground shrew | *Sorex ugyunak* | |
| Alaska tiny shrew | *Sorex yukonicus* | |
| Canadian lynx | *Lynx canadensis* | Niutuiyiq |
| Wolf | *Canis lupus* | Amabuq |
| Arctic fox | *Vulpes lagopus* | Tibiganniaq |
| Red fox | *Vulpes vulpes* | Kayuqtuq |
| Cross fox | *Vulpes vulpes* | Quanbaq |
| Brown bear | *Ursus arctos* | Akjaq |
| Wolverine | *Gulo gulo* | Qavvik |
| Ermine (short tailed weasel) | *Mustela erminea* | Itibiaq |
| Least weasel | *Mustela nivalis* | Itibiaq |
| Moose | *Alces americanus* | Tuttuvak |
| Barrenground caribou | *Rangifer tarandus granti* | Tuttu |
| Muskox | *Ovibos moschatus* | Umifmak |
| Dall's sheep | *Ovis dalli* | Imnaiq |

[2] Nomenclature according to MacDonald and Cook 2009
[3] Bacon and Akpik 2010
[3] Interactive Inupiaq Dictionary 2011

### 3.2.5.1 Caribou

Four caribou (also known as "*Tuttu*" to local Iñupiat residents) herds utilize habitats along Alaska's North Slope: the Western Arctic, the Porcupine, the Central Arctic, and the Teshekpuk herds (MMS 2008, ADFG 2010a). Of those, the Western Arctic and Porcupine herds make up about half of the total caribou population in Alaska (ADFG 2008). Barrenground caribou generally have large home ranges throughout this treeless tundra region often migrating long distances between winter ranges, calving grounds, and summer feeding areas. Calving areas are usually located in mountains or on open coastal tundra (ADFG 2008). North Slope caribou tend to calve in the same general areas year after year followed by movements to insect relief areas along the Arctic coast, which will be further explained below. Migration routes, however, are sometimes abandoned in favor of new routes for reasons often not clearly understood, making decisions regarding habitat management and harvest regulations challenging. Sport hunters from across Alaska, other states, and other countries hunt caribou along the Arctic coast, and local residents depend on North Slope caribou populations for subsistence food (See Section 3.3.2, Subsistence Resources and Uses).

**<u>Population Status and Trends</u>**

#### *The Western Arctic Caribou Herd*

The geographic range of the Western Arctic Caribou Herd (WAH) is more than 140,000 square miles in northwestern Alaska from the Colville River to the eastern Chukchi coast and from the Kobuk River to the southern Beaufort coast (Figure 3.2-2) (Dau 2005, ADFG 2009). During the spring, the caribou travel north toward their calving grounds, in the summer, movement is westward toward the Lisburne Hills before the herd moves eastward through the Brooks Range. The WAH are dispersed in the fall as they move southwest toward their wintering grounds. In winter, the range extends south as far as the Seward Peninsula and Nulato Hills, and east as far as the Sagavanirktok River north of the Brooks Range and the Koyukuk River south of the Brooks Range. Since 1996, much of the WAH has shifted its winter range from the Nulato Hills to the eastern half of the Seward Peninsula and has generally been more dispersed than prior to that time (Dau 2005).

The WAH is the largest caribou herd in Alaska. In 1970, the WAH numbered approximately 242,000, and, by 1976, it had declined to approximately 75,000 animals. From 1976 to 1990, the WAH grew 13 percent annually, and from 1990 to 2003, it grew 1 to 3 percent annually. In 2003 the WAH numbered more than 490,000, but, by 2009, their numbers had declined to 401,000. The WAH calving area is inland on the NPR-A. Typically, most pregnant cows reach the calving grounds by late May, calving in the Utukok uplands from May through early June. By mid-June, large post calving aggregations form, as cows with neonates move west (Dau 2005, MMS 2008).

#### *The Central Arctic Caribou Herd*

As their name suggests, the Central Arctic Caribou Herd (CAH) roam the central region of northern Alaska (USFWS 2009b). The CAH range extends from the Itkillik River east to the Canning River and south from the Beaufort coast into the Brooks Range (Figure 3.2-3). CAH's summer range extends from Fish Creek, just west of the Colville River, eastward along the coast, and slightly inland, to the Katakturuk River. The CAH winters in the foothills and mountains of the Brooks Range; often overlapping with the Porcupine Caribou Herd (PCH) during the summer and winter and overlapping with the WAH and Teshekpuk Caribou Herd (TCH) in the summer and winter (Lenart 2005, MMS 2007a). The CAH has grown from an estimated 5,000 animals in 1975 to about 31,857 animals in 2002 (Lenart 2005, Cameron and Whitten 1979, ADFG 2009). Once thought to be part of the WAH, CAHs are now recognized as a distinct herd, an identification based on where females within the herd give birth to their calves (USFWS 2009b). The female caribou of the CAH calve across a broad swath of the Arctic coastal plain from the Canning River drainage of ANWR west to the Colville River. Most calves are born in areas on either side of the Prudhoe Bay oil complex (USFWS 2009b). Soon after calving season, CAH

move outward both east and west to their summer range, which extends from the coastal plain of ANWR well west beyond Prudhoe Bay. In the fall, many of these caribou migrate south through the Brooks Range mountains to spend the winter along south slope river drainages deep within ANWR. Some members of the herd, however, remain on their summer range north of the mountains throughout the year, seeking out wind-blown valleys and tundra benches to find the lichens they need in order to survive the long, cold winters (USFWS 2009b).

Although the CAH traditionally calved between the Colville and Kuparuk rivers on the west side of the Sagavanirktok River and between the Sagavanirktok and the Canning rivers on the east side, the greatest concentration of caribou calving has shifted southwest, as oil-field development occurred in those areas (Lawhead and Johnson 2002, Lenart 2005).

### *The Porcupine Caribou Herd*

The Porcupine Caribou Herd (PCH) ranges through eastern portions of the Arctic Slope, the Brooks Range, northeastern Interior Alaska, and Canada's Northwest Territories (Figure 3.2-4). Named for the major river within its range, the Porcupine herd uses an area the size of Wyoming in the Refuge, Yukon, and Northwest Territories. A July 2010 photographic census shows the PCH has grown to an estimated 169,000 animals. The herd peaked in size in 1989 at 178,000 caribou, and the four surveys that followed over the period of 1992–2001 documented a decline in the herd to 123,000 caribou. The 2010 effort is the first successful photographic census on the PCH since 2001, due to factors such as weather, poor aggregation, and herd movements (ADFG 2010a).

The calving grounds of the PCH include the northern foothills of the Brooks Range and the Arctic coastal plain from the Tamayariak River in Alaska to the Babbage River in Canada. The most often used calving area, however, is the Refuge coastal plain between the Katakturuk and Kongakut Rivers. Commonly, one-half to three quarters or more of the calves are born within this area (USFWS 2009b, ADFG 2010a). The PCH winters in the southern portion of its range, including the Refuge, where they are an important resource for the Gwich'in people (USFWS 2009b).

### *The Teshekpuk Caribou Herd*

The Teshekpuk Caribou Herd (TCH) is found primarily within the NPR-A, with its summer range extending between Barrow and the Colville River (see Figure 3.2-5). In some years, most of the TCH remains in the Teshekpuk Lake area all winter. In other years, some, or all, of the herd winters in the Brooks Range or within the range of the WAH. The TCH numbered about 45,000 animals in 2002, and the 2008 photographic census indicates the herd had grown to 64,000; up from a little more than 28,000 in 1999 (MMS 2007a, ADFG 2010a). In 1984, the herd only numbered 11,800 animals but has grown rapidly since then (ADFG 2010a). The TCH calve on the east side of Teshekpuk Lake (this herd is also sometimes called the Teshekpuk Lake Herd based on their calving area) and near Cape Halkett, adjacent to Harrison Bay (MMS 2007a).

### *Management*

Alaska has a dual system for the management of fish and wildlife resources, as both state and federal harvest regulations apply to much of the state. The federal land management agencies regulate subsistence harvest on federal public lands, while the State of Alaska provides harvest opportunities for both recreational and subsistence purposes through the Alaska Board of Game's authorities. Subsistence harvest of caribou is discussed in more detail in Section 3.3.2, Subsistence Resources and Uses, but the foundation for the state's ungulate harvest regulations are described below.

The Alaska Legislature passed the Intensive Management Law in 1994 [Alaska Statute 16.05.255(e)-(g)]. This law requires the Alaska Board of Game to identify moose, caribou, and deer populations that are especially important food sources for Alaskan residents and to insure that these populations remain large enough to allow for adequate and sustained harvest (ADFG 2010a). Intensive management is a process

that starts with investigating the causes of low ungulate numbers and then identifying steps to increase those numbers. This can include restricting hunting seasons and bag limits, evaluating and improving habitat, liberalizing the harvest of predators, and predator control. For purposes of implementing the Intensive Management Law, the Board of Game has determined that the Central Arctic, Teshekpuk, Western Arctic, and Porcupine caribou herds are important for providing high levels of harvest for human consumptive use and has established the following population and harvest objectives (AAC 2011) (Table 3.2-6).

**Table 3.2-6 Population and Harvest Objectives**

| Caribou Herd | Population Objectives | Harvest Objectives |
|---|---|---|
| Western Arctic Caribou Herd | at least 200,000 | 12,000 - 20,000 |
| Porcupine Caribou Herd | 100,000 - 150,000 | 1,500 - 2,000 |
| Central Arctic Caribou Herd | 28,000 - 32,000 | 1,400 - 1,600 |
| Teshekpuk Caribou Herd | 15,000 - 28,000 | 900 - 2,800 |

Source: AAC 2011

## Migration

Caribou migrate seasonally between their calving areas, summer range, and winter range to take advantage of seasonally available food resources. If movements are greatly restricted, caribou are likely to overgraze their habitat, potentially leading to drastic, long-term population declines. The caribou diet shifts from season to season and depends on the availability of forage. In general, the winter diet of caribou has been characterized as consisting predominantly of lichens and mosses, with a shift to vascular plants during the spring (Thompson and McCourt 1981). However, when TCH caribou winter near Teshekpuk Lake, where relatively few lichens are present, they may consume more sedges and vascular plants (MMS 2007a).

### *Calving Grounds*

Calving takes place in the spring, generally from late May to late June (Hemming 1971). Spring migration of parturient female caribou from the overwintering areas to the calving grounds starts in late March (Hemming 1971). Often the most direct routes are used; however, certain drainages and routes probably are used during calving migrations because they tend to be corridors free of or with shallow snow (Lent 1980). Bulls and nonparturient females generally migrate later. Severe weather and deep snow can delay spring migration, with some calving occurring en route (Carroll et al. 2005). Cows calving en route usually proceed to their traditional calving grounds after giving birth (Hemming 1971, MMS 2007a).

The evolutionary significance of the establishment of the calving grounds may relate directly to the avoidance of predation on the caribou calves, particularly predation by wolves (Bergerud, 1974, 1987). Caribou calves are very vulnerable to wolf predation, as indicated by the documented account of surplus predation by wolves on newborn calves (Miller et al. 1985). By migrating north of the tree line, caribou leave the range of the wolf packs, which generally remain on the caribou winter range or in the mountain foothills or along the tree line during the wolf-pupping season (Heard and Williams 1991, Bergerud 1987). By calving on the open tundra, the cow caribou also avoid ambush by predators. The selection of snow-free patches of tundra on the calving grounds also helps to camouflage the newborn calf from other predators such as golden eagles (Bergerud 1987). It is also believed that the sequential spring migration, first by cows and later by bulls and the rest of the herd, is a strategy for optimizing the quality of forage as it becomes available with snowmelt on the Arctic tundra (Whitten and Cameron 1980, Griffith et al. 2002).

The timing of snow melt and plant "green up" on the coastal plain coincides with the caribou calving period. Traditional calving grounds consistently provide high nutritional forage to lactating females during calving and nursing periods, which is critical for the health of the cow and the growth and survival of newborn calves (USFWS 2009b). The ANWR coastal plain provides an abundance of plant species preferred by caribou, *Eriophorum*-tussock sedge buds (tussock cotton grass) appear to be very important in the diet of lactating caribou cows during the calving season (Lent 1966, Thompson and McCourt 1981, Eastland et al. 1989), while orthophyll shrubs (especially willows) are the predominant forage during the postcalving period (Thompson and McCourt 1981). The availability of sedges during spring, which is thought to be dependent on temperature and snow cover, probably affects specific calving locations and calving success. Finally, the earlier migration of parturient cow caribou to the calving grounds could also serve to reduce forage competition with the rest of the herd during the calving season (MMS 2007a).

The WAH calving area is inland on the NPR-A, outside of the EIS project area (Figures 3.2-2 and 3.2-6). Typically, most pregnant cows reach the calving grounds by late May. Most give birth in the Utukok uplands during late May through early June. By mid-June large post calving aggregations begin forming as cows with neonates move west toward the Lisburne Hills (Dau 2005). The TCH's central calving area generally is located on the east side of Teshekpuk Lake and near Cape Halkett, adjacent to Harrison Bay. The CAH generally calves within 30 km (18.6 mi) of the Beaufort coast between the Itkillik and Canning rivers. The herd separates into two segments based on the locations of the calving concentration areas, one on each side of the Sagavanirktok River (MMS 2007a). The PCH calves along the northern foothills of the Brooks Range and the Arctic coastal plain from the Tamayariak River in Alaska to the Babbage River in Canada. The most often used calving area, however, is the ANWR coastal plain between the Katakturuk and Kongakut Rivers (USFWS 2009b).

During the postcalving period in July through August, caribou generally attain their highest degree of aggregation with continuous masses of animals in herds, sometimes in excess of tens of thousands. Cow/calf groups are most sensitive to human disturbance during this period. However, during this time, most of the PCH has moved or is relocating to the Brooks Range foothills; therefore, most of this herd is no longer near the coast.

### *Summer Distribution/Insect Relief Areas*

After calving, caribou collect in large "postcalving aggregations" to avoid predators and escape mosquitoes and warble flies. These large groups of caribou stay together in the high mountains and along seacoasts where wind and cool temperatures protect them from summer heat and insects. After insect numbers decline in August, caribou scatter out and feed heavily on willow leaves and mushrooms to regain body weight.

Members of the WAH may be found in continuous herds numbering in excess of tens of thousands of individuals, and portions of the WAH may be found throughout their summer range. Insect-relief areas continue to be important during late June to mid-August during the insect season (Lawhead 1997). Insect harassment reduces foraging efficiency and increases physiological stress (Reimers 1980). For insect relief, caribou use various coastal and upland habitats such as sandbars, spits, river deltas, some barrier islands, mountain foothills, snow patches, and sand dunes, where stiff breezes prevent insects from concentrating and alighting on the caribou. In the EIS project area, members of the TCH generally aggregate close to the coast for insect relief. Some small groups, however, gather in other cool, windy areas such as the Pik Dunes located about 30 km south of Teshekpuk Lake (Hemming 1971, Philo et al. 1993). Caribou aggregations move frequently from insect-relief areas along the Arctic coast (the CAH, WAH, and especially the TCH) and in the mountain foothills (PCH and some aggregations of the WAH) to and from green foraging areas (MMS 2007a).

### *Winter range use and distribution*

The WAH caribou generally reach their winter ranges in early to late November and remain on the range through March (Hemming 1971, Henshaw 1968). The primary winter range of the WAH is located south of the Brooks Range along the northern fringe of the boreal forest (Figure 3.2-2). Since 1996, much of the WAH has shifted its winter range from the Nulato Hills to the eastern half of the Seward Peninsula and has generally been more dispersed than prior to that time (Dau 2005). However, in recent winters, >30,000 WAH caribou have wintered in the northwest portion of their range. During two of these winters (1994 to 1995 and 1999 to 2000), caribou wintering along the Chukchi Sea coast between Cape Lisburne and Cape Krusenstern experienced high, localized mortality; the investigation indicated that caribou in this area were malnourished (Dau 2005). During winters of heavy snowfall or severe ice crusting, caribou may overwinter within the mountains or on the Arctic Slope (Hemming 1971). Even during normal winters, some caribou of the WAH overwinter on the Arctic Coastal Plain. The majority of the PCH often winter on the south side of the Arctic National Wildlife Refuge or in Canada (Figure 3.2-4). The CAH overwinters primarily in the northern foothills of the Brooks Range (Figure 3.2-3) (Roby 1980) (MMS 2007a). The TCH was believed to reside in the Teshekpuk Lake area year-round (Davis et al. 1982); however, satellite-collar data from Teshekpuk caribou indicate that some animals travel great distances to the south, as far as the Seward Peninsula (Carroll 1992).

The movement and distribution of caribou over the winter ranges reflect their need to avoid predators and their response to wind (storm) and snow conditions (depth and snow density), which greatly influence the availability of winter forage (Henshaw 1968, Bergerud 1974, Bergerud and Elliot 1986). The numbers of caribou using a particular portion of the winter range are highly variable from year to year (Davis et al. 1982; Fancy et al. 1990, as cited in Whitten 1990). Range condition, distribution of preferred winter forage (particularly lichens), and predation pressure all affect winter distribution and movements (Roby 1980, Bergerud 1974, MMS 2007a).

## 3.3 Social and Economic Environment

### 3.3.1 Socioeconomics

Economic activity, broadly defined, is a basic determinant of socioeconomic change and therefore the starting point in assessing change for the affected communities. MMS (now BOEM) EIS documents define a sociocultural system as encompassing social organization, cultural values, and institutional organization of communities (MMS 2007a, MMS 2007c). The discussion of subsistence and cultural values associated with this economic activity can be found in Section 3.3.2. This chapter will outline baseline economic and demographic conditions, as well as social organizations and institutions of communities that would be directly affected by proposed offshore oil and gas exploration and seismic activities. These communities, adjacent to the Beaufort and Chukchi seas, from east to west are: Kaktovik; Prudhoe Bay/Deadhorse; Nuiqsut; Barrow; Wainwright; Point Lay; Point Hope; Kivalina; Kotzebue; and Nome. Demographic data from the 2010 U.S. Census was not available for these communities at the time of analysis.

#### 3.3.1.1 Economy

This section provides an overview of the region's (non-subsistence) economic drivers. It first describes the major economic sectors (oil and gas, government spending/administration, transportation/logistics) and activity that occurs within the project area, followed by a description of the source and relative amounts of public revenue and expenditures budgeted by these communities.

## Economic Sectors and Activity

### *Oil and Gas Exploration and Production History*

Exploration, development, production, and transportation of oil and gas are major contributors to the economy of Alaska and the NSB. These activities create employment, generate contracts for service providers within the NSB and the state, and provide royalty and tax revenue to local, state and federal government. Extensive oil and gas exploration activities have occurred on Alaska's North Slope since 1940, with large-scale development and production beginning at the Prudhoe Bay field in the 1970s. Also in the 1970s, exploration for oil and gas was initiated offshore into the Beaufort and Chukchi seas. Nearshore Beaufort Sea development and production began in the 1980s (MMS 2008); no development and production has occurred to date in the Chukchi Sea. Offshore lease sale environmental documents by BOEM and ADNR Division of Oil and Gas provide a more detailed description of the history of oil and gas development and production, available on their websites: http://www.gomr.boemre.gov/homepg/lsesale/lsesale.html and http://www.dog.dnr.state.ak.us/oil/.

The State of Alaska has held oil and gas lease sales on the North Slope and Beaufort Sea since 1964. The state leases offshore acreage for exploration (up to three miles offshore, including off of barrier islands). The Beaufort Sea Areawide oil and gas lease sales for 2009 to 2018 contain approximately two million acres in 573 tracts from Barrow to the Canadian border. This represents 19 percent of the state's total acreage for oil and gas leasing; however, 89 percent of this sale is onshore (ADNR 2009). The state's current oil and gas-leasing plan describes permits issued to Shell to conduct surveys and biological studies in the Beaufort and Chukchi seas, as well as proposed drilling in federal OCS waters from a floating drilling platform at the Sivulliq prospect (ADNR 2011 and North Slope Oil and Gas Activity 2011 Map).

The federal government has held oil and gas lease sales since 1976 in areas three or more miles offshore. MMS held 10 lease sales in the Beaufort Sea OCS between 1979 and 2006 (see Figure 1.2) (ADNR 2009). As of 2009, there were 246 active leases in the Beaufort Sea OCS where exploration activity could occur (MMS 2009a). Thirty exploratory wells have been drilled, and there is production from a joint federal/state unit of over 23 million barrels of oil since 2001 (MMS 2009a).

Federal OCS lease sales in the Chukchi Sea have only been offered since 1988. Two-dimensional seismic data collected starting in 1969 and five large prospects drilled between 1989 and 1991 resulted in no commercial development of oil or gas on the 483 leased tracts (MMS 2009a). All 483 leases have now expired. In February 2008, the federal government leased 487 tracts in the Chukchi Sea Planning Area (see Figure 1.3). Several companies have conducted seismic and scientific surveys, and exploratory drilling has been proposed for 2012 and beyond on specific lease tracts.

### *Government*

Alaska's largest employment sector is the government, which is comprised of federal (16,604 employees), state (25,121 employees or 8 percent), and local (45,608 employees or 15 percent) government employees (ADCCED 2011a). Government bodies are also the largest employer with 1,973 employees in the NSB (58.1 percent) and Northwest Arctic Borough (NAB) employs 1,245 workers (39.2 percent) (ADLWD 2005, NSB 2005; ADCCED 2011a). Major local government employers include borough and other municipal government and school districts. Government funding also influences construction employment for capital projects in the NSB and NAB.

### *Transportation*

Trade, transportation, and utilities are the largest non-government sector employers in the State of Alaska (ADCCED 2011a). Nome, Kotzebue, Barrow, and Prudhoe/Deadhorse are regional transportation and utility hubs for surrounding villages and for oil and gas and mining support activities. Transportation services are a key economic sector and source of employment for the region.

### *Mining*

Mining is a major economic sector in the NAB, and has occasionally resulted in economic activity in the NSB. The Red Dog Mine creates local and statewide employment, generates contracts for service providers within the borough and the state, and provides payment in lieu of tax (PILT) revenue to local and state government.

## Public Revenue and Expenditures

The state and local governments levy taxes on the oil and gas industry for onshore and offshore exploration and production on state and private lands and in state waters. Lease sales and production on state lands and waters also generates state royalty payment. Production on federal lands and waters generates federal royalty and tax revenue; however, revenue sharing is limited from activities in the federal OCS. Though federal revenue sharing is limited, any offshore development would require billions of dollars of onshore facilities that would likely be subject to borough and state taxes. Offshore oil production would also add to the thru put of the Trans-Alaska Pipeline System, paying tariff and extending the life of the pipeline.

### *Borough and Municipal Revenue*

***North Slope Borough*** - The predominant source of NSB revenue comes from property owned or leased by the oil industry in the Prudhoe Bay area (MMS 2008). The fiscal year (FY) 2010 budget was $306.7 million, and the FY 2009 actual revenues from property taxes were $243.6 million (NSB 2011, NSB 2010). Communities within the NSB are allowed to set sales tax and other special taxes, but the Borough property tax mill rate is set at a ceiling of 18.5 (Table 3.3-1).

**Table 3.3-1 Local Government Classification and Tax Regime**

| Community | Classification[a] | Sales Tax | Property Tax | Special Tax |
|---|---|---|---|---|
| **Kaktovik** | 2nd Class City | None | See NSB | None |
| **Prudhoe Bay (includes Deadhorse)** | Unincorporated | None | | None |
| **Nuiqsut** | 2nd Class City | None | | None |
| **Barrow** | 1st Class City | None | | Room 5%<br>Tobacco $1<br>Alcohol 3% |
| **Wainwright** | 2nd Class City | None | | None |
| **Point Lay** | Unincorporated | None | | None |
| **Point Hope** | 2nd Class City | 3% | | None |
| **North Slope Borough (NSB)** | Home Rule Borough | Deferred to cities | 18.5 mills | Deferred to cities |
| **Kivalina** | 2nd Class City | 2% | None | None |
| **Kotzebue** | 2nd Class City | 6% | None | Bed 6%<br>Alcohol 6%<br>Gaming 6% |
| **Northwest Arctic Borough (NAB)** | Home Rule Borough | Deferred to cities | None | Payment in lieu of taxes (PILT) |
| **Nome** | First Class City | 5% | 7.0 mills | Bed 6% |
| **Unalaska/Dutch Harbor[b]** | First Class City | 3% | 10.5 mils | Raw Fish 2%<br>Cap Sales 1%<br>Bed 5% |

**Note:**

a) Definitions of city and borough powers and responsibilities are defined in the AK Constitution, Article X, Section 3, 5 and 7 and AS 29.04.020

b) Unalaska/Dutch Harbor is not part of the EIS project area, but it is discussed in Section 4.5.3.1

**Source:** Alaska Department of Community and Economic Development Community Database Online Available from: http://www.commerce.state.ak.us/dca/commdb/CF_BLOCK.htm

***Northwest Arctic Borough*** – NAB generates revenue from activities related to government, mining, health care, transportation, services, and construction. The NAB FY 2011 budget is $11.6 million (NAB 2011). The Red Dog Mine, 90 miles north of Kotzebue, is the world's largest zinc and lead mine. Owned by NANA Regional Corporation and operated by Teck, Red Dog provides 370 direct year-round jobs and over a quarter of the borough's wage and salary payroll (ADCCED 2011b). NAB received $972,000 in PILT and $6.73 million from Teck in 2010 (NAB 2010). The Red Dog Mine Extension (Aqqaluk Project) EIS explains that without PILT funds from the Red Dog Mine, the NAB would be much more reliant on state and federal funds. These funds are not only important logistically but give the region a degree of self-reliance and self-determination (EPA 2009).

***City of Nome*** – The Nome FY 2011 budget is $10.8 million (City of Nome 2011a). Government services provide the majority of employment, and the largest revenue source in 2010 was capital grants and contributions ($6.71 million). Property taxes generated $1.69 million, and general sales tax generated $4.43 million (City of Nome 2010). Retail services, transportation, mining, medical, and other businesses

provide year-round income. Several small gold mines continue to provide some employment, and NovaGold Resources, Inc., a large gold mining operation, is developing a mine eight miles north of Nome. In 2009, 42 residents held commercial fishing permits.

### *State of Alaska Revenue and Expenditures*

The main source of Alaska's revenue comes from tax and royalty revenue from oil and gas production. Depending on the tax structure and price and volume of oil produced, state revenue can vary significantly. Tax revenue totaled $4.2 billion in FY 2009 (a decline from FY 2008 when $8.5 billion was collected). Approximately 90 percent of all state tax revenue is paid by the oil and gas industry ($3.8 billion, see Figure 3.3-1). Investments held by the Alaska Permanent Fund and other investment accounts, were $2.5 billion in FY 2009. Oil and gas contributed $6.1 billion through tax and royalty payments (ADCCED 2011a). State revenue peaked in FY 2008 at $13.1 billion as a result of record oil prices and changes in the state oil and gas tax structure.

For future oil and gas activities in the NSB, the state would collect $20 million in property tax and return $18.5 million to the NSB (see Table 3.3-1 for the local tax structure).

### *Federal Revenue and Expenditures*

Overall, federal revenue from personal income tax, corporate tax, and other types was $2.11 trillion in 2009 (OMB 2011). Oil and gas lease sales and production in federal lands and waters generate federal royalty revenue. For example, the recent Chukchi Seas lease sale has generated $2.66 billion in bonus bids (NEI and ISER 2011).

Federal spending for the State of Alaska totaled $14.2 billion, ranking Alaska first in the U.S., based on per capita federal spending (ADCCED 2011a). Federal spending has a significant impact on Alaska's economy through annual contributions to retirement and disability ($1.5 billion), other direct payments ($875 million), grants ($3.7 billion), procurement ($4.97 billion), and salaries and wages (military and government employment; $3.1 billion) (Census 2010). In many cases, state dollars are able to match federal funds for in-state community programs and projects.

## 3.3.1.2 Employment and Personal Income

Employment and income statistics for the State of Alaska mirror important economic sectors to some degree in the NSB and NAB. The government sector is a major employer, particularly in the NSB and NAB. The oil and mining industry generate high income jobs and service contracts for local businesses and the construction industry. Transportation and utilities also provide substantial levels of employment.

### <u>Employment</u>

About 72 percent of Alaska's potential workforce is employed (American Community Survey 2009). The most recent statewide employment figures show that statewide, the government is the largest employer (27 percent), followed by "trade, transportation, utilities" (19 percent), and "educational and health services" (14 percent) (Figure 3.3-2). Oil and gas and construction accounted for four percent each (ADLWD 2011b).

The extraction of natural resources from remote rural Alaska produces only modest direct economic benefit in the form of jobs, household income, business purchases, and public revenue for most residents (Goldsmith 2007). At the scale of Figure 3.3-3, the value of local wages generated from these industries cannot be seen on the bar chart.

### *Oil Industry Employment and Residency*

North Slope oil field operations provide employment to over 5,000 people who are not residents of the NSB. These employees arrive from Anchorage, other areas of the state, and the lower 48 (ADCCED

2011b) and rotate in and out of work sites. This transient population is not reflected in the Census numbers until 2010 as shown in Table 3.3-4.

The 2009 average unemployment rate for the State of Alaska is nine percent with 28 percent of the potential workforce not seeking work (not in the labor force) (Table 3.3-2). The average unemployment rate for the entire U.S. in 2009 was seven percent with 35 percent of the potential work force not seeking work. NSB and NAB generally experience much higher rates of unemployment than the state or nation. Unemployment rates in 2009 that appear higher than in 2000 are shown in ***bold/italics*** below. Demographic data from the 2010 U.S. Census was not available at the time of analysis.

### Table 3.3-2 Employment, Unemployment and Underemployment in the Project Area

| | 2000[a] | | 2009[b] | |
|---|---|---|---|---|
| **North Slope Borough** | **#** | **%** | **#** | **%** |
| Total Potential Work Force[c] | 4,875 | | 4,709 | |
| Not in Labor Force | 1,357 | 28 | 1,319 | 28 |
| In Labor Force | 3,518 | 72 | 3,390 | 72 |
| Armed Forces | 3 | 0.1 | N/A | |
| Civilian Labor Force | 3515 | 99.9 | N/A | |
| Employed | 2,990 | 85 | N/A | 58.1 |
| Unemployed[d] | 525 | 14.9 | N/A | ***19.4*** |
| **Nome** | **#** | **%** | **#** | **%** |
| Total Potential Work Force[c] | 2,547 | | 2,657 | |
| Not in Labor Force | 814 | 32 | 656 | 25 |
| In Labor Force | 1,733 | 68 | 2,001 | ***75*** |
| Armed Forces | 9 | 1 | N/A | |
| Civilian Labor Force | 1,724 | 99 | N/A | |
| Employed | 1535 | 89 | N/A | 69.5 |
| Unemployed[d] | 189 | 10.9 | N/A | 7 |
| **Northwest Arctic Borough** | **#** | **%** | **#** | **%** |
| Total Potential Work Force[c] | 4,535 | | 5,095 | |
| Not in Labor Force | 1,658 | 37 | 1,954 | ***38*** |
| In Labor Force | 2,877 | 63 | 3,141 | 67 |
| Armed Forces | 3 | 0.1 | N/A | |
| Civilian Labor Force | 2,874 | 99.9 | N/A | |
| Employed | 2,427 | 84.4 | N/A | 50 |
| Unemployed[d] | 447 | 15.5 | N/A | ***26*** |
| **Alaska** | | | | |
| Total Potential Work Force[c] | 458,054 | | 521,998 | |
| Not in Labor Force | 131,458 | 28.7 | 147,203 | ***28.2*** |
| In Labor Force | 326,596 | 71.3 | 374,795 | 71.8 |
| Armed Forces | 17,111 | 5.2 | N/A | |

| | 2000[a] | | 2009[b] | |
|---|---|---|---|---|
| Civilian Labor Force | 309,485 | 94.8 | N/A | |
| Employed [c] | 281,532 | 86 | N/A | 62.6 |
| Unemployed[d] | 27,953 | 9.0 | N/A | 8.7 |
| **USA** | | | | |
| Total Potential Work Force[c] | 217,168,077 | | 235,871,704 | |
| Not in Labor Force | 78,347,142 | 36 | 82,555,096 | 35 |
| In Labor Force | 138,820,935 | 64 | 153,316,608 | 65 |
| Armed Forces | 1,152,137 | 0.8 | N/A | |
| Civilian Labor Force | 137,668,798 | 99.2 | N/A | |
| Employed | 129,721,512 | 94 | N/A | 59.9 |
| Unemployed[d] | 7,947,286 | 6 | N/A | ***7.2*** |

**Notes:**

a) 2000 Census Data
b) 2005-2009 American Community Survey, 5-Year Estimates
c) Population aged 16+
d) Unemployed and seeking work

*Alaska Economic Trends* special issue on the northern region of Alaska explains that Alaska has naturally higher unemployment rates because of the nature of the state's economy rather than relative economic health (ADLWD 2005). The state's economists theorize that more jobs are temporary or seasonal, and there are greater rates of geographic mismatches between employment opportunities and available/skilled workers.

Rural communities in general have a large number of discouraged workers who are involuntarily unemployed because they have stopped attempting to find work and/or they have exhausted their employment security benefits. In addition, underemployment is a common condition where an individual involuntarily worked less than 40 weeks in the previous year and/or did not make full use of their education, skill, or abilities (NSB 2005). Employment and race data in Section 3.3.10, Environmental Justice, show that unemployment and poverty disproportionately affects Alaska Native people.

### *North Slope Borough Employment*

Oil and gas exploration and development on Alaska's North Slope is the principal industry in the NSB; however, the oil and gas industry provides a limited amount of direct employment to NSB residents. Residents with vocational or college degrees may be hired for professional and technical work in Prudhoe Bay and Anchorage. Temporary employment opportunities include subsistence and protected species observers or village liaisons. Previous MMS lease sale EIS documents include descriptions of a historic lack of Alaska Native employment in and near Prudhoe Bay (MMS 2008, MMS 2007a). Indirect employment is provided through service contracts with Alaska Native corporations and other providers. However, while a limited percentage of the direct oil and gas jobs are taken by local residents, a much larger share of the indirect jobs in other sectors of the economy that provide goods and services to support OCS exploration, development, and production are obtained by local residents from support contracts for North Slope and OCS projects (Northern Economics Inc. and ISER 2010). It is estimated that for each direct job created by future OCS activity in the oil and gas sector (and the revenues associated with production) an additional 4.8 indirect jobs are created in the Alaskan economy in the form of infrastructure, support, and state and local government employment (Northern Economics and ISER 2010).

The major employers are the NSB, North Slope School District, and the Alaska Native corporations and tribal organizations. Although dated, Figure 3.3-4a, Top Employers in the NSB, was produced from supplemental surveys to the U.S. Census. Figures 3.3-4a and 3.3-4b demonstrate that the majority of residents employed in the NSB work for the NSB and other local governments in an administrative, educational, or social service capacity. In 2009, approximately 60 percent of resident workers by industry worked for local government (ADLWD 2001a). The third largest employers (after the NSB and NSB School district) are the village corporations that provide support services to the communities and the oil and gas and mining industries. It should be noted that employment data can be difficult to interpret because of aggregation; different organizations categorize their data into different categories. For example, residents employed by the government may fall under several categories like "Education, Health and Social Services" as well as "Public Administration." The oil and gas industry may employ residents in numerous sectors including: "Transportation, Warehousing and Utilities;" "Construction;" or "Professional, Scientific, Management, Administrative."

### *Northwest Arctic Borough Employment*

The largest employers in the NAB are Teck (Red Dog Mine), Maniilaq Association (regional non-profit Alaska Native corporation), the NAB School District, Kikiktagruk Iñupiat Corporation (KIC) (Kotzebue ANCSA village corporation), and NANA Corporation (ADCCED 2011b). With the exception of KIC, all of NANA Region's ANCSA village corporations have merged with NANA Corporation, which makes it the area's largest corporation in the private sector (ADLWD 2005). Figure 3.3-4c demonstrates that the "education, health and social services" are the largest employment sector, similar to the NSB. However, the "transportation, warehousing and utilities" is a larger employment sector for the NAB than it is for the NSB, as well as a large "agriculture, forestry, fishing & hunting, mining" sector that does not rank as high for NSB. In 2009, local government accounted for 39 percent of resident employment (ADLWD 2011a).

### *City of Nome*

The City of Nome is the supply, service, and transportation center of the Bering Strait region. Government services provide the majority of employment. Retail services, transportation, mining, medical, and other businesses provide year-round income. Several small gold mines continue to provide some employment, and NovaGold Resources is developing a mine 8 miles north of Nome. In 2009, 42 residents held commercial fishing permits (ADCCED 2011b). The top employers in Nome include Bering Strait School District, Kawerak (the regional Native non-profit corporation), and Norton Sound Health Corporation (ADLWD 2011a).

## Personal Income

### *Wage Income*

Average monthly wages in Alaska total $3,886 per month per household, but the oil and gas extraction industry has the highest monthly wages at $13,924. Mining support was second at $8,164 per month (ADCCED 2011a). The most common employer is the government, where the average monthly wages were $4,293 in 2010. All industries combined produced $4.05 billion in total wages (including commission, bonuses, and other gratuities) in the state in the third quarter of 2010 (ADLWD 2011c). Table 3.3-3 shows 2002 per capita income and 2003 average annual earnings for the NSB at $35,905 and $65,556 respectively. The respective per capita income and average annual earnings for the same reporting period were $25,208 and $39,600 for the NAB, $24,156 and $29,580 for the Nome Census Area, and $32,799 and $37,356 for the State of Alaska (ADLWD 2005).

**Table 3.3-3 Regional Demographic Summary**

| | North Slope Borough | Northwest Arctic Borough | Nome Census Area | Alaska |
|---|---|---|---|---|
| Area in sq. miles | 87,860 | 35,862 | 23,012 | 570,373 |
| # of communities | 8 | 11 | 16 | |
| Pop. (2010) | 9,430 | 3,201 | 9,492 | 710,231 |
| Largest community | Barrow | Kotzebue | Nome | Anchorage |
| % of area pop. | 48% | 43% | 45% | 41% |
| | | | | |
| **Race** (2009**)** | | | | |
| Alaska Native | 71% | 81% | 67% | 13% |
| White | 19% | 12% | 13% | 68%<br>3.7% |
| African American | 2% | 0.1% | 1% | 3.7% |
| Asian | 0.3% | 1% | 8% | 4.7% |
| Native Hawaiian/ Pacific Islander | 0.0% | 0.1% | 0.4% | 0.6% |
| Other race | 1% | 0.1% | 1% | 1.7% |
| | | | | |
| **Median Age** (2009) | 26.0 | 25.3 | 27.1 | 32.9 |
| **Male/Female Ratio** (2009) | 114.5 | 113.5 | 115.9 | 107.7 |
| | | | | |
| **Educational Attainment (**2000) | | | | |
| Less than High School | 35% | 40% | 38% | 28% |
| High School | 25% | 19% | 22% | 36% |
| Some College/Associate Degree | 17% | 13% | 15% | 25% |
| Bachelor's Degree+ | 23% | 28% | 26% | 12% |
| | | | | |
| **Labor Force** (16+ population) | 4,709 | 5,095 | 6,616 | 521,998 |
| Participation in Labor Force | 72% | 67% | 68% | 72% |
| Unemployment Rate | 42% | 26% | 17% | 8.7% |
| | | | | |
| **Per capita income** (2002) | $35,905 | $25,208 | $24,156 | $32,799 |
| **Avg. Annual Earnings** (2003) | $65,556 | $39,600 | $29,580 | $37,356 |

**Source**: ADLWD 2005; US Census Bureau (2009) American Community Survey

Figure 3.3-5 demonstrates the proportion of workers making under $20,000 per year. This is likely due to a lack of opportunities with local governments, school districts, construction camps, and support facilities for both the oil and gas and mining industries.

### *Transfers and Dividends*

Transfer payments and dividends can provide a substantial contribution to household income in rural Alaska. Transfer payments can represent the value of services to individuals in government programs like

Medicaid/Medicare, food stamps, housing assistance, and Social Security payments (a more detailed description of the distribution of transfer payments in Alaska can be found in Goldsmith 2007). Dividends come in the form of Alaska Permanent Dividend Fund and shareholder dividends from Alaska Native Corporations. In 2010, the Alaska Permanent Dividend Fund was $1,281 per qualified Alaska resident. Depending on financial performance, dividends to shareholders may be paid by regional and village Alaska Native Corporations. Table 3.3-5 provides 2009 dividend per share for each of the three regional corporations in the project area: Arctic Slope Regional Corporation (ASRC); NANA Regional Corporation (NANA); and Bering Straits Regional Corporation. As an example of the higher end of dividend payments, ASRC has distributed over $423.8 million in dividends to shareholders since its incorporation (ADCCED 2011a, Stricker 2010).

#### *Contribution of Subsistence*

Subsistence is the customary and traditional uses of wild, renewable resources for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation. It is a critical component of the project area's economy. Under NMFS' MMPA implementing regulations, subsistence is defined as "the use of marine mammals taken by Alaskan Natives for food, clothing, shelter, heating, transportation, and other uses necessary to maintain the life of the taker or those who depend upon the taker to provide them with such subsistence" (50 CFR Part 216.3). Subsistence activity is inseparable from the Alaska Native cultures, including the Iñupiat Eskimo, Siberian Yupik of the Beaufort and Chukchi Sea areas, and encompasses vital economic, social, cultural and spiritual dimensions. Ronald H. Brower of Barrow was quoted, "it is a way of life that requires learning special skills, knowledge, and using one's resourcefulness" (ADLWD 2005). For the purposes of this EIS, subsistence activities are part of the non-monetized economy and a complete discussion can be found in Section 3.3.2.

#### *Craft Income*

Sale of Alaska Native crafts is an important source of income in many areas of the North Slope and Northwest Arctic regions of Alaska. Many of these crafts depend on the harvest of marine mammals. For example, detailed surveys conducted in the NSB in 2003 indicated that about 20 percent of households supplement household income by making and selling arts and crafts such as ivory and whalebone carvings, baleen baskets and boats, and clothing (mukluks, parkas, slippers). The communities vary in how much supplemental income the crafts produce. Usually, individual income is less than $500 per year, but it can represent a substantial portion of income for some households in thousands of dollars (Shepro et al. 2003).

### 3.3.1.3 Demographic Characteristics

#### State of Alaska Demographics

Alaska's population in 2010 was 710,231 (US Census 2011a). Population growth is a result of natural increases (births minus deaths) and positive net migration as a result of assignment of military personnel (ADCCED 2011a). The State of Alaska's Alaska Native population was 13 percent statewide, but the rural Arctic communities are predominantly Alaska Native. The Institute of Social and Economic Research conducted a study on the special socioeconomic features of remote rural Alaska and found that this region has more children and fewer middle-aged adults. The non-Native population is composed primarily of working age adults. Men outnumber women, particularly among young adults (Goldsmith 2007). Complete race and poverty tables can be found in Section 3.3.10, Environmental Justice.

#### Regional Demographics

Table 3.3-3 provides a snapshot of regional demographics showing numerous similarities across the northern regions in terms of populations, racial composition and educational attainment.

### *North Slope Borough Demographics*

There are eight communities within the NSB, all of which occur in the EIS project area. The population of the NSB is estimated at 9,430 (ADLWD 2005, U.S. Census Bureau American Community Survey). The vast majority the borough's population is Alaska Native. There have been short-term population spikes in the last thirty years which have been attributed to the construction of major infrastructure and resource development projects (Shepro et al. 2003). The median age of the borough is estimated at 26 years, which is substantially younger than the state median age (32.9 years) (Table 3.3-3). An estimated 60 percent of NSB residents have educational attainment of a high school diploma or less; 40 percent of the borough residents have attended some college, or attained a college diploma (Table 3.3-3).

### *Northwest Arctic Borough Demographics*

There are 11 communities within the NAB (of these Kivalina and Kotzebue occur in the EIS project area). The population of the NAB is estimated at 35,862 (ADLWD 2005, US Census Bureau American Community Survey). The vast majority of the NAB population is Alaska Native (Table 3.3-3). The median age of the borough is estimated at 25.3 years, which is substantially younger than the state median age (32.9 years) (Table 3.3-3). An estimated 59 percent of borough residents have educational attainment of a high school diploma or less; 41 percent of the borough residents have attended some college, or attained a college diploma (Table 3.3-3).

### *Nome Demographics*

There are 16 communities in Nome Census Area. However, Nome is the only community in the census area that occurs in the EIS project area. The majority of the Nome Census Area is Alaska Native (67 percent), although slightly lower than the NSB and NAB. The median age of the borough is estimated at 27.1 years, which is notably younger than the state median age (32.9 years) (Table 3.3-3). An estimated 60 percent of borough residents have educational attainment of a high school diploma or less; 41 percent (rounding error) of the borough residents have attended some college, or attained a college diploma (Table 3.3-3).

## Communities' Demographics

A summary of population trends since 1990 are shown in Table 3.3-4. Communities are organized by region, and decreases in population between 2000 and 2010 are shown in ***bold/italics***. It should be noted that the 2010 Census numbers are preliminary and may not adequately reflect actual changes. The communities described below are generally coastal communities with the potential to be affected by proposed seismic exploration and exploratory drilling.

Historically, workers in Prudhoe Bay and other industrial-enclaves commuted to the workplace and were counted as residents elsewhere. In the 2010 U.S. Census, workers that spend a majority of their time at Prudhoe Bay were counted as residents of the North Slope.

**Table 3.3-4 Population Growth Rates 1990-2010[a]**

| Community | 1990 | 2000 | 2010 [a] |
|---|---|---|---|
| **Kaktovik** | 224 | 293 | ***239*** |
| **Prudhoe Bay** | 47 | 5 | 2,174 |
| **Nuiqsut** | 354 | 433 | ***402*** |
| **Barrow** | 3,469 | 4,581 | ***4,212*** |
| **Wainwright** | 492 | 546 | 556 |
| **Point Lay** | 139 | 247 | ***189*** |
| **Point Hope** | 639 | 757 | ***674*** |
| **North Slope Borough** | 5,979 | 7,385 | 9,430 |
| **Kivalina** | 317 | 377 | ***374*** |
| **Kotzebue** | 2,751 | 3,082 | 3,201 |
| **Northwest Arctic Borough** | 6,113 | 7,208 | 7,523 |
| **Nome** | 3,500 | 3,505 | 3,598 |
| **Nome Census Area** | 8,288 | 9,196 | 9,492 |

Source: US Census Data. Available from: **http://factfinder.census.gov**
a) The only U.S. Census 2010 data released to date.

### *North Slope Borough Communities*

***Kaktovik*** is located on the northern shore of Barter Island in the eastern Beaufort Sea and has a long history as an Iñupiat meeting and trading place (Shepro et al. 2003). The City of Kaktovik was established in 1923 as a fur trading post and was moved three times, partly in response to Department of Defense Distant Early Warning (DEW) facilities. It was incorporated as a city in 1971. Kaktovik has a population of 239 residents (2010 Census), and like other North Slope communities is a highly active subsistence community for marine and terrestrial mammals. The borough provides electricity, water and sewer, and a health clinic, as well as a school that serves students from kindergarten through grade 12.

***Prudhoe Bay*** is an industrial site and oil field, not a community. As described in Section 3.3.1.1, exploration activities began in the 1940s. An industry-support community and airfield was developed at Deadhorse in the 1970s. Prudhoe Bay's inter-connected, industrial infrastructure includes roadways, pipelines, production and processing facilities, gravel mines, and docks (MMS 2008).

The ***Nuiqsut*** area on the Colville River was used for centuries for subsistence activities, but the Iñupiat village of Nuiqsut was abandoned until it was resettled in 1973 by 27 Barrow families (NSB 2005). The current population is 402 (2010 Census), and the residents participate in a high level of subsistence activity and subsistence resource use (NSB 2005). The borough provides electricity, water and sewer, and a health clinic, as well as a school that serves students from kindergarten through grade 12. The Alpine oil field and satellite infrastructure are nearby.

***Barrow*** is located at a point that is the dividing line between the Beaufort and Chukchi seas. The area was historically a hunting and fishing area for Iñupiat Eskimos with archaeological sites indicating habitation from 500-900 A.D (ADCCED 2011b). Commercial whaling and trading was established officially at the turn of the nineteenth century (NSB 2005). The City of Barrow was incorporated in 1958. It is the largest community within the NSB with 4,212 residents and only about 55 percent identified as Alaska Native (2010 Census). The population increases through the 1980s to today were stimulated by a

boom in Barrow's economy and an influx of non-Alaska Natives into the community (MMS 2008). Like Kaktovik, the military had a large influence on the community before it was incorporated into a city due to the construction and operation of military installations, including the Naval Arctic Research Laboratory and DEW Line Station. Barrow's unemployment rate (15.8 percent estimated in 2009) is still high despite having a more diverse economy than smaller NSB communities. The borough provides electricity, water and sewer, as well as a school that serves students from kindergarten through grade 12. Advanced education is available as well through Ilisagvik College. The primary healthcare facility for the North Slope region is the Samuel Simmonds Memorial Hospital, operated by Arctic Slope Native Association, the regional Native non-profit corporation.

***Wainwright*** is located on the Chukchi Sea within the region that has become the NPR-A. It is a community with 556 residents (2010 Census) that is growing slowly and steadily. The City of Wainwright was incorporated in 1962, but the construction of a school and health clinic dates back to 1904. Numerous historic and contemporary hunting and fishing camps are in the area; indigenous residents refer to themselves as the Tagiumiut or "people of the sea." Reindeer herding, oil and gas exploration, and military activities in recent history have greatly influenced the community (NSB 2005). The borough provides electricity, water and sewer, and a health clinic, as well as a school that serves students from kindergarten through grade 12.

***Point Lay*** is located on the Chukchi Sea and was established as a trading post in the 1920s after small hunting and fishing groups from the area congregated south of the Kokolik River mouth. The village has been moved a few times before its current location on the Chukchi Sea coast (NSB 2005). Point Lay has not been incorporated as a city, but the Native Village of Point Lay is a federally recognized tribe, and Cully Corporation is the ANCSA village corporation. A DEW line site just southwest of the community was removed in 2005 (ADCCED 2011b). The borough provides electricity, water and sewer, and a health clinic, as well as a school that serves students from kindergarten through grade 12. Water from a lake is treated for residents to haul to tanks at their homes. The 2010 Census estimated the population to be 189, a loss of about 58 people since the 2000 Census. This 31 percent population loss is the largest relative population loss for all the NSB communities since 2000. About 78 percent of residents over the age of 16 worked in 2009. Local government is the main industry, employing 84 percent of the area's workers. Maintenance and repair workers are the largest occupational category (ADLWD 2011).

***Point Hope*** is located on the Chukchi Sea and is the second largest NSB community (after Barrow) with 674 residents in 2010 (Census). The Point Hope peninsula is one of the oldest continuously occupied "Tikeraqmuit" Iñupiat Eskimo areas in Alaska with different settlement names over the past 2,500 years. Commercial whalers brought an influx of Westerners by 1848 who disappeared by the early 1900s. Strong influences included commercial whaling, trading, reindeer herding, the introduction of alcohol and diseases, missionaries, and federal agencies. The City of Point Hope was incorporated in 1966 and moved to its present location after a storm surge in 1978 (NSB 2005). The borough provides electricity, water and sewer, and a health clinic, as well as a school that serves students from kindergarten through grade 12.

### *Northwest Arctic Borough Communities*

***Kivalina*** is located on the northern tip of a barrier reef between the Chukchi Sea and Kivalina River. Kivalina is the only village in the NAB region that hunts bowhead whale, and it is a member of the Alaska Eskimo Whaling Commission. Historically, it was a stopping-off place for seasoned travelers between Arctic coastal areas and Kotzebue Sound communities (ADCCED 2011b). The community has been subject to severe erosion and wind-driven ice damage to the current site. Storm surges and erosion have been a concern since the community was first established (City of Kivalina 2010). The City of Kivalina was incorporated in 1969. The economy is dependent on subsistence activities, and the infrastructure is modest; water is treated and stored in a community water tank where the public hauls it to their homes. Most residents haul their own honey buckets (sewage containers) to an open disposal site

and a washeteria (public laundromat) provides showers (NSB 2005). The NAB provides kindergarten through grade 12 education.

***Kotzebue***, originally named Kikiktagruk or "place that is almost an island" has been occupied by Iñupiat Eskimos for at least 600 years (City of Kotzebue 2000). The city was formed in 1958 as a service and transportation center for all villages in the northwest region. Kotzebue has a healthy cash economy, a growing private sector, and a stable public sector. Due to its location at the confluence of three river drainages, Kotzebue is the transfer point between ocean and inland shipping. It is also the air transport center for the region. Activities related to oil and minerals exploration and development have contributed to the economy. The majority of income is directly or indirectly related to government employment, such as the school district, Maniilaq Association, the city, and the borough. The Teck Alaska Red Dog Mine is a significant regional employer. Commercial fishing for chum salmon provides some seasonal employment. In 2009, 115 residents held commercial fishing permits. Most residents rely on a combination of subsistence activities and cash income (ADLWD 2011b).

### *Nome Census Area Unorganized Borough*

***Nome*** was established as a gold mining town in 1901, but Malemiut, Kauweramiut, and Unalikmuiut Eskimos occupied the Seward Peninsula historically. All former villagers from King Island were moved to Nome by 1970. The town site was built along the Bering Sea and acts as the supply, service, and transportation center of the Bering Strait region. It has provided support for offshore activities in the Chukchi Sea. The Nome 2010 population was 2,598, which was a modest decrease from 3,505 in 2000 (U.S. Census). Nome has the largest white population in the project area (estimated at 32 percent in 2009) communities. Individual poverty rates are low in Nome (3.9 percent) compared to other communities in the project areas (see Table 3.3-51 in Section 3.3.10, Environmental Justice), however nearly all of the individuals living in poverty are Alaska Natives by ethnicity.

Complete community profiles can be found in other publications (e.g. 2005 NSB Comprehensive Plan, individual community comprehensive plans), and updated online profiles at the Alaska Department of Commerce, Community, and Economic Development (ADCCED) Division of Community and Regional Affairs (DCRA) *Alaska Community Database* website: http://www.commerce.state.ak.us/dca/commdb/CIS.cfm.

## 3.3.1.4 Social Organizations and Institutions

The following represents a brief overview of social and governmental organizations in the project area and their roles among communities. Cultural values are incorporated into governmental and tribal (governmental) bodies in the project area (see Table 3.3-6) to ensure that economic development and social services address the needs of local communities appropriately.

### Village/Tribal Governments

All communities described in this section, except for Prudhoe Bay, contain tribes recognized by the Bureau of Indian Affairs that are eligible for funding and services and receive special status as a government (75 *Federal Register* 60810, October 1, 2010). Traditional councils were formed through custom and necessity according to the system established by the particular tribe. Communities represented by traditional councils include: Kaktovik Village, Native Village of Nuiqsut, Native Village of Barrow, Native Village of Wainwright, Native Village of Kivalina, and Native Village of Kotzebue (see Table 3.3-6).

The Indian Reorganization Act of 1934 established tribal councils recognized by the federal government, also known as IRA councils. IRA councils in the project area are: Nome Eskimo Community, Native Village of Point Hope, Native Village of Point Lay, and the Iñupiat Community of the Arctic Slope (ICAS). ICAS is comprised of all the Tribal entities/membership of the Native Villages of Barrow, Atqasuk, Naqsragmuit, and Point Lay (ICAS 2011).

## Municipal Government

The state recognizes municipal governments as representing all residents, while tribal governments represent the interests of the tribal membership. Cities within the NSB and NAB receive public education from the boroughs and can exercise their power to enforce special taxes, but they do not set property taxes. The classification of project area cities can be found in Table 3.3-1.

***North Slope Borough*** is Alaska's largest borough, encompassing 88,000 square miles of land and 5,900 square miles of water. It was incorporated in 1972 and adopted its Home Rule Charter in 1974 allowing it to exercise any legal governmental power in addition to its mandatory powers of taxation, property assessment, education, and planning and zoning services. The borough provides a full range of services, including police and fire protection, search and rescue, construction and maintenance of roads and other infrastructure, water and wastewater treatment, light, power and heat, health and clinic services, fuel storage, solid waste collection and disposal (FY2009 Report). NSB is also financially accountable for a legally separate school district. In addition, there are seven incorporated municipal governments within the NSB. The borough's administrative center, Barrow, has operated as a city since 1958. Barrow is the largest community which acts as the hub of government, transportation, communications, education, and economic development (ADCCED 2011b).

***Northwest Arctic Borough*** is the second largest borough in Alaska, encompassing 35,800 square miles. It was incorporated in 1986 and adopted its Home Rule Charter in 1987, allowing it to exercise any legal governmental power in addition to its mandatory powers of taxation, property assessment, education, and planning and zoning services. NAB does not levy taxes on its residents, although Kivalina and Kotzebue do. Many local services are provided by the cities, but education is the responsibility of the borough (ADCCED 2011b). In addition, there are 11 incorporated communities with municipal governments within the NAB (of these Kivalina and Kotzebue occur in the EIS project area). Kotzebue is the largest community in the borough and serves as the hub of government, transportation, communications, education, and economic development. Kotzebue is also the gateway to four major National Park units.

The ***City of Nome*** was formed in 1901 after gold was found in the area. The region in which Nome is situated is does not have an incorporated borough; statistics are gathered for the Nome Census Area. Nome is a first class city that manages a school district, contains the offices of Bering Straits Native Corporation, Kawerak, and hosts the Norton Sound Regional Hospital. Nome is the supply, service, and transportation center of the Bering Straits region (ADCCED 2011b).

## Alaska Native Regional and Village Corporations

Alaska Native Corporations were created as a result of the 1971 Alaska Native Claims Settlement Act that divided 44 million acres (and compensation for lost lands) between 12 regions to incorporate. The three Native Regional Corporations in the EIS project area are ASRC, NANA, and Bering Straits Regional Corporation (listed in Table 3.3-5). Anthropologists describe that Native corporations reflect a mix of traditional and Western values (Braund and Kruse 2009).

The 2009 dividend per shareholder is shown in Table 3.3-5. ASRC generated 1.94 billion in revenue in 2009, the highest for the 12 Alaska regional corporations, but down from its record $2.3 billion in 2008. Since its incorporation, ASRC has distributed over $423.8 million in dividends to shareholders (ADCCED 2011a, Stricker 2010).

**Table 3.3-5 ANCSA Corporations in Project Area and Shareholder Dividends**

| ANCSA Corporation | Region | Money from ANCSA (mil) | 2009 Revenue (mil) | Net Income (mil) | Shareholders | Dividend Per Share (2009) |
|---|---|---|---|---|---|---|
| Arctic Slope Regional Corporation | North Slope | $22.5 | $1,945 | $169.3 | 9,616 | $57.12 |
| NANA Regional Corporation | Northwest Alaska | $44.0 | $1,259 | $17.1 | 12,044 | $12.00 |
| Bering Straits Native Corporation | Nome and Seward Peninsula | $38.2 | $162 | $8.1 | 6,334 | $1.00 |

Source: 2009 Alaska Economic Performance Report (ADCCED 2011a)

Native corporations have established subsidiaries to provide contract services for a variety of activities, including oil field services, ice road construction, and oil spill response. This provides a small amount of employment opportunities for North Slope and NANA regional and village corporation shareholders because many of these jobs are in Anchorage, the lower 48, or require travel to Prudhoe Bay. (Data on the numbers of shareholders that find employment with Native Corporations and their subsidiaries are unavailable.)

Along with ASRC and NANA, many North Slope Village Corporations have subsidiaries that provide oil field services (a list of village corporations can be found in Table 3.3-6). Like regional corporations, village corporations also provide services throughout the state and the world. Administrative offices are not always in their respective villages.

## Regional Non-Governmental Organizations

Native regional non-profits often function as service providers for Native members within the regions formed under the Alaska Native Claims Settlement Act. Maniilaq is the regional Native non-profit corporation for the NAB area; Kawerak for the Nome area; and Arctic Slope Native Association for the NSB area.

There are several important non-governmental organizations in the region, including the membership-based AEWC, and Eskimo Walrus Commission, Alaska and Inuvialuit Beluga Whale Committee, Alaska Nanuuq Commission, and Ice Seal Committee. These groups are consulted by state and federal agencies when making decisions about actions that could affect these resources (MMS 2007a).

AEWC was established in 1977 to protect the subsistence practice of bowhead whaling that the International Whaling Commission attempted to ban. AEWC has helped contribute to the management of the bowhead whale and provided traditional knowledge to the oil and gas industry regarding potential impacts and mitigation. More can be found on their website http://www.alaska-aewc.com/aboutus.asp

The Eskimo Walrus Commission was organized by Kawerak, Inc. of Nome in 1978 to represent coastal walrus hunting communities in issues of co-management. The member communities are listed at: http://www.kawerak.org/servicedivisions/nrd/ewc/.

The Alaska and Inuvialuit Beluga Whale Committee was established in 1988. Committee membership includes representatives from communities and regions that hunt beluga whales, including western and northern Alaska and the Mackenzie River Delta in Canada. Scientists, researchers, and technical advisors are also part of the committee, including federal, state and local government representatives (Adams et al.

1993). Within the project area, member entities include North Slope Borough, Kawerak, and NANA Regional Corporation.

The Alaska Nanuuq Commission was established in 1994 to "represent the villages in North and Northwest Alaska on matters concerning the conservation and sustainable subsistence use of polar bear" (Alaska Nanuuq Commission 2011). Committee membership includes representatives from fifteen tribal councils; communities within the project area that participate include: Kaktovik; Nuiqsut; Barrow; Wainwright; Point Lay; Point Hope; Kivalina; and Kotzebue. Additional information is available on the commission website, http://www.nanuuq.info/index.html.

Understanding that ice seals are important food sources for polar bears and coastal subsistence communities, the Alaska Nanuuq Commission established the Ice Seal Committee. The purpose of the committee is to "preserve and enhance the marine resources of ice seals including the habitat; to protect and enhance Alaska Native culture, traditions, and especially activities associated with subsistence uses of ice seals; to undertake education and research related to ice seals" (Ice Seal Committee 2005). Committee membership includes representatives from five entities located within the Alaska coastal regions with polar sea ice, including: NSB; Maniilaq; Kawerak; Association of Village Council Presidents; and Bristol Bay Native Association. Additional information may be found on the Nanuuq Commission website, http://www.nanuuq.info/iceseal.html.

## Table 3.3-6 Institutions in the EIS Project Area

| Municipality | Regional Govt. | ANSCA Regional Corp. | Regional Native Non-Profit | Tribal Govt | ANSCA Village Corp | Other Non-profit Orgs* | Housing Authority | Econ Dev. or CDQ Group | Utilities |
|---|---|---|---|---|---|---|---|---|---|
| **City of Kaktovik** | North Slope Borough (NSB) | Arctic Slope Regional Corporation (ASRC) | Arctic Slope Native Assoc. (ASNA) | Kaktovik Village (aka Barter Island) | Kaktovik Iñupiat Corp. | Alaska Eskimo Whaling Commission (AEWC) | Tagiugmiullu Nunamiullu | | |
| **Prudhoe Bay** | | N/A | N/A | N/A | N/A | N/A | N/A | | TDX Power |
| **City of Nuiqsut** | | ASRC | ASNA | Native Village of Nuiqsut | Kuukpik Corp. | AEWC | Tagiugmiullu Nunamiullu Housing Authority | | |
| **City of Barrow** | | | | Native Village of Barrow, Iñupiat Traditional Government, Iñupiat Community of the Arctic Slope (ICAS) | Ukpeagvik Iñupiat Corp. | AEWC & Eskimo Walrus Commission (EWC) | | | Barrow Utilities & Electric Coop. |
| **City of Wainwright** | | | | Village of Wainwright | Olgoonik Corporation | | | | |
| **Point Lay** | | | | Native Village of Point Lay, ICAS | Cully Corporation | EWC | | | Arctic Slope Telephone Association |
| **City of Point Hope** | | | | Native Village of Point Hope | Tikigaq Corporation | AEWC & EWC | | | |
| **City of Kivalina** | Northwest Arctic Borough (NAB) | NANA Regional Corp. (NANA) | Maniilaq Assoc. | Native Village of Kivalina | NANA | | Native Village of Kivalina | NAB Economic Development Commission | Alaska Village Electric Cooperative |
| **City of Kotzebue** | | | | Native Village of Kotzebue | Kikiktagruk Iñupiat Corp. | EWC | Northwest Iñupiat Housing Authority | | Kotzebue Electric Association |
| **City of Nome** | N/A | Bering Straits Corporation | Bering Straits Foundation, Kawerak, Inc. | Nome Eskimo Community | Sitnasuak Native Corporation | | Bering Straits Regional Housing Authority | Norton Sound Economic Development Corp. Bering Strait Development Council | Nome Joint Utility System |

**Note:** * The Alaska and Inuvialuit Beluga Whale Committee serves the entire project area; the Alaska Nanuuq Commission serves the North Slope Borough and Northwest Arctic Borough regions.

**Sources:**
"Indian Entities Recognized and Eligible to Receive Services from the United States Bureau of Indian Affairs' (75 *Federal Register* 60810, October 1, 2010)
Alaska Department of Community and Economic Development Community Database Online Available from: http://www.commerce.state.ak.us/dca/commdb/CF_BLOCK.htm

## 3.3.2 Subsistence Resources and Uses

### 3.3.2.1 Introduction

This section describes the subsistence harvest patterns of the Iñupiat communities in the EIS project area: Kaktovik; Nuiqsut; Barrow; Wainwright; Point Lay; Point Hope; Kivalina; and Kotzebue. This community-by-community description provides general information on harvest information by resource, seasonal subsistence harvest patterns, including community, timing of the subsistence harvest cycles, and harvest-area participation rates by community.

### 3.3.2.2 Definition of Subsistence and Cultural Importance

**Definition of Subsistence for this EIS**

Subsistence is central to the livelihood of many Alaskan Native communities and other rural residents. The patterns of subsistence harvests are shaped by local and regional factors of ecology, community history, culture, and economy. What is termed "subsistence" in law is in fact, on the ground, a myriad of distinct, localized traditions established by communities (Wolfe 2004). The subsistence patterns of local communities can include extensive ecological knowledge, effective harvest techniques, traditions for cooperation and sharing, and cultural ceremonial activities.

Subsistence harvest activities involve hunting, fishing, trapping, and gathering. A wide array of natural resources is harvested throughout the year in a regular cycle of seasonal efforts timed for availability, access, and condition of the resources. The composition of subsistence harvests includes many species of fish, land mammals, marine mammals and invertebrates, terrestrial invertebrates, waterfowl, berries, roots, and plants and fuel gathering. Many of these resources are migratory in nature. People rely on these locally available resources for food, clothing, fuel, transportation, construction materials, art, crafts, exchange, and customary trade (Wolfe 2000).

The MMPA and the ESA are relevant to subsistence uses. Under the MMPA (1994 amendment) and ESA, Alaska Natives are allowed to harvest marine mammals as subsistence resources. The MMPA defines subsistence as:

> *…the use of marine mammals taken by Alaskan Natives for food, clothing, shelter, heating, transportation, and other uses necessary to maintain the life of the taker or those who depend upon the taker to provide them with such subsistence (50 CFR Part 216.3).*

The NSB defines subsistence as:

> *… an activity performed in support of the basic beliefs and nutritional needs of the residents of the borough and includes hunting, whaling, fishing, trapping, camping, food gathering, and other traditional and cultural activities (NSBMC 19.20.020 (67)).*

**The Cultural Importance of Subsistence**

The Iñupiat consider subsistence to be more than just a "way of life," and for the people who live along the Beaufort Sea and Chukchi Sea coasts, subsistence is their life (NSB 2007, Maclean 1998). Subsistence defines the essence of who they are, and it provides a connection between their history, culture, and spiritual beliefs. An essential component of Iñupiat values is the sharing of subsistence resources among families, friends, elders, and those in need. *"[V]irtually all Iñupiat households depend upon subsistence resource to some degree"* (NSB 2004).

Subsistence is a term that can be interpreted in many different ways. Within Alaska, some people consider subsistence as an indicator of economic deprivation; a way of life that is necessary due to the high costs of food and absence of jobs in rural areas. "Euro-American conceptions [of subsistence] tend to be static, restrictive and minimalist, often defining subsistence as 'the minimum resources necessary to

support life" (Wheeler and Thornton 2005). However, to the Iñupiat and Siberian Yupik residents of the EIS project area, subsistence is none of these things. As described by the people of Kaktovik,

> *"[S]ubsistence" is certainly not an adequate or meaningful word here either, or at least not as it is normally defined and used outside the context of aboriginal resource use. In fact, the more we look at it, think about it, the more insult we feel by its application to our lives. We are not peasants. We do not subsist; we thrive here, live our lives with great relish.* (Kaktovik undated in NSB 2007)

Subsistence activities are assigned the highest cultural value by the Iñupiat and provide a sense of identity in addition to the substantial economic and nutritional contributions. The importance of subsistence activities was summarized by the NSB (2007):

> *The foundation of the Iñupiat sociocultural system is their utilization of the natural environment and its biotic resources. This deep attachment provides the basis of the value of subsistence (Worl 1980). Subsistence activities have provided the cohesive threads around which the Iñupiat have held their culture together during times of economic and social change. It constitutes far more than just "food on the table."*

Many species are important for the role they play in the annual cycle of subsistence resource harvests, and each subsistence food resource plays an important role. Loss of access to any subsistence food resource could have serious effects. When a subsistence resource is unavailable for any reason, families will adapt and redirect harvest effort towards other species, but the contribution of some resources to the annual food budget would be very difficult to replace. Besides their dietary benefits, subsistence resources provide materials for family use and for the sharing patterns that help maintain traditional Iñupiat family organization. Relationships between generations, among families, and within and between communities are honored and renewed through sharing, trading, and bartering subsistence foods. The bonds of reciprocity extend widely beyond the EIS project area and help to maintain ties with family members elsewhere in Alaska. Subsistence resources provide special foods for religious and ceremonial occasions; the most important ceremony, Nalukataq, celebrates the bowhead whale harvest (NMFS 2008b).

The use of traditional food in the subsistence lifestyle provides important benefits to users. Subsistence foods are often preferable as they are rich in many nutrients, lower in fat, and healthier than purchased foods. Subsistence foods consist of a wide range of fish and wildlife and vegetable products that have substantial nutritional benefits. Community studies in the 1980s and 1990s found that rural Alaskans statewide harvest more than 44 million pounds (lb) of wild foodstuffs every year. On average, food produced through hunting, fishing, and gathering amounts to just over 1 lb of wild edible products per person per day. According to 1990 estimates (Wolfe 1996), the annual wild food harvest in rural Alaska was 375 lb per person, compared to 22 lb per person in urban Alaska. Subsistence harvesting of traditional foods, including preparation, eating, and sharing of resources contributes to the social, cultural, and spiritual well-being of users and their communities (ISER 2010).

Subsistence production is also linked to the market economy. Subsistence harvest byproducts are used by many households to earn cash from crafting whale baleen and walrus ivory and from harvesting furbearing mammals.

Subsistence harvest practices have been documented in many studies over the last several decades including Worl (1980) and Nelson (1979) who describe subsistence as a central focus of North Slope personal and group cultural identity. Hopson (1976, 1978) establishes the political and ideological power of subsistence as an organizing concept for the NSB (See also Davidson 1974, Arnold 1978, Lewis 1978, Lonner 1980, Langdon and Worl 1981, Kelso 1981, 1982, Case 1984, 1989, Ellanna and Sherrod 1984, Berger 1985, Caulfield and Brelsford 1991, Bryner 1995, Naiman 1996, ADNR 1997). Communities express and reproduce their unique identities based on the enduring connections between current residents, those who used harvest areas in the past, and the wild resources of the land. Elder's

conferences, spirit camps, and other information exchange and gathering events serve to solidify these cultural connections between generations and between the people and the land and its resources.

Subsistence activities and wage economic opportunities are highly developed and highly interdependent (Kruse et al. 1981, Kruse 1981 and 1982). Subsistence activities are dependent upon cash for equipment and operating costs, but at the same time these activities are very cash efficient, in that relatively modest investments of cash produce large quantities of fresh, nutritious food. Moreover, households that are most active in subsistence activities tend also to be those highly involved in the wage economy. Monetary resources are necessary to assist in the harvest of subsistence resources, both as they affect individual harvesters (such as to purchase a boat, snow machine, all-terrain vehicle, fuel, and guns and ammunition) and as they affect the head of a whaling crew. The heads of the whaling crews traditionally occupy positions of authority and respect within their communities (EDAW-AECOM 2007). Whaling captains' are responsible for the readying of supplies, weapons, boats and gear for the hunt, distribution and storage of the meat and decisions on when and where to locate hunting camps. Full-time employment is also limiting as it affects the time a subsistence hunter can spend harvesting. In summer, extensive hunting and fishing can be pursued after work and without any daylight limitations, but, during midwinter and winter, daylight is a limiting factor (MMS 2008).

As one North Slope hunter observed:

> *The best mix is half and half. If it was all subsistence, then we would have no money for snowmachines and ammunition. If it was all work, we would have no Native foods. Both work well together.* (ACI et al. 1984 in MMS 2008)

## Cultural Importance of Subsistence Hunt of Bowhead Whales and Other Marine Mammals

Iñupiat and Siberian Yupik Eskimos have hunted bowhead whales continuously for over 2,000 years (Stoker and Krupnik 1993). Hunting bowhead whales in Arctic Alaskan waters remains a communal activity that supplies important meat and maktak (the skin and a layer of blubber used for food) for entire communities, as well as for feasts and during annual celebrations. Formalized patterns of hunting, sharing, and consumption characterize the modern bowhead harvest. In addition, whaling captains are highly respected and carry the burden of the hunts within their communities for their traditional knowledge of ice, weather, and whale behavior, which is necessary to hunt successfully, for their generosity in supporting their whaling crews, and for their stewardship of traditions of sharing and distributing maktak throughout the community (NMFS 2008b). As one whaling captain expressed:

> *We have to go 93 miles from here to go hunt, do our subsistence fall hunt and be out there until we meet our -- until we meet our quota. That's taking away from our families and very costly. It's a burden to the captain just to try and provide the needs of what we depend on; a subsistence lifestyle.* (Nuiqsut Public Scoping Meeting, March 11, 2010)

The bowhead whale hunt represents one of the greatest concentrations of community-wide effort and time. It is highly productive, accounting for a substantial percentage of the food consumed in the Beaufort communities and to a lesser extent in several of the Chukchi Sea communities. As the principal activity through which traditional skills for survival in the Arctic are passed from elders to younger generations, the bowhead hunt provides ongoing reinforcement of the traditional social structure. Thus, the bowhead subsistence hunt is a large part of the cultural tradition and modern cultural identity (Worl 1980, Braund et al. 1997). Spiritual and moral values, beliefs, and cultural identity are expressed and recreated through subsistence harvest activities. The great gifts of food from bowheads are recognized in the ceremonies of the Nalukataq festival at the conclusion of spring whaling (NMFS 2008b).

In addition to this high reliance on bowhead whales, Iñupiat and Siberian Yupik communities harvest many species throughout an intricate annual cycle of subsistence activities (NMFS 2008). The species composition of subsistence harvests provides an indication of the flexible adaptation of subsistence patterns to ecological patterns of abundance and access to various resources. For example, while

bowhead, caribou, and fish make up the majority of subsistence foods in most of the Iñupiat communities, the Chukchi Sea communities rely more heavily on beluga whales, walrus, and seal than do the Beaufort Sea communities. The Beaufort Sea communities of Kaktovik, Nuiqsut, and Barrow have high proportions of total subsistence food derived from the bowhead harvest and lower proportions from other marine mammals. The communities of Wainwright, Point Lay, Point Hope, Kivalina, and Kotzebue harvest greater numbers of marine mammals and fish (NMFS 2008b).

Additional comprehensive descriptions of subsistence harvest patterns and uses are found in BOEM (formerly MMS), BLM, and U.S. Army Corps of Engineers (USACE) EIS and EA documents and are incorporated by reference: the Liberty Development and Production Plan final EIS (MMS 2002); the Beaufort Sea Multiple Sale Final EIS (MMS 2003); the Northwest NPR-A Final IAP/EIS (BLM and MMS 2003); the Beaufort Sea Sale 195 EA (MMS 2004); the Alpine Satellite Development Plan Final EIS for potential expansion of Alpine field production near Nuiqsut (BLM 2004); the Northeast NPR-A Amendment IAP/EIS (BLM 2005) and the final supplemental IAP/EIS (BLM 2008a); the USACE Delong Mountain Terminal Project Draft EIS (USACE 2005); the Kobuk-Seward Peninsula Resource Management Plan (BLM 2006); the MMS seismic-survey PEA (MMS 2006b); the 2007-2012 5-Year Oil and Gas Leasing Program Final EIS (MMS 2006b); the Beaufort Sea Sale 202 EA (MMS 2006c); the Chukchi Sea Lease Sale 193 Final EIS (MMS 2007a) and Chukchi Sea Planning Area Oil and Gas Lease Sale 193 Final Supplemental EIS (BOEM 2011b) and USGS 2011.

Additional information is included in: ACI et al. 1984; ADFG 1995; Alaska Natives Commission 1994; Braund and Burnham 1984; Braund and Associates 1989a, 1989b; Braund and Associates and UAA, ISER 1993a, 1993b; Braund and Associates 1996; Braund and Associates 2010; Besse 1983; Brower et al. 2000; Brower and Opie 1997; Brower and Hepa 1998; Burch 1998; City of Nuiqsut 1995; Craig 1987; Fuller and George 1997; George and Kovalsky 1986; George and Nageak 1986; Hall 1983; Harcharek 1995; Hoffman et al. 1988; Huntington and Quakenbush 2009; Impact Assessment 1989, 1990a, 1990b; Huntington et al. 1999; Jacobson and Wentworth 1982; Kassam and Wainwright Traditional Council 2001; Kruse et al. 1983a, 1983b; Lowenstein 1994; Lutton 1985; Minn 1982; Moulton 1997; Nelson 1982; NMFS 2004; NSB Contract Staff 1979; NSB 1998; Northern Economics, Inc. 2006; Quakenbush and Huntington 2010; Schneider et al. 1980; Shapiro et al. 1979; Stephensen et al. 1994; Suydam et al. 1994, 2005, 2006, 2007, 2008, 2009 and 2010; and Wolfe 2004.

### 3.3.2.3 Subsistence Resources

This section describes the primary subsistence resources harvested by the Beaufort Sea and Chukchi Sea communities of Kaktovik, Nuiqsut, Barrow, Wainwright, Point Lay, Point Hope, Kivalina, and Kotzebue. A general description of the resource in relation to subsistence harvests is included in this section. Marine mammal species are discussed first, followed by fish, waterfowl, and caribou. More detailed ecological accounts of the species, including population abundance and distribution are found in Section 3.2.4, Marine Mammals.

Important subsistence resources in the EIS project area include the bowhead whale, beluga whale, seal (ringed and bearded), walrus, polar bear, fish, migratory waterfowl (including their eggs), and caribou. It is important to note that the species composition of community subsistence harvests vary from one region to another, depending largely on the ecological setting. While residents of the NSB and NAB tend to concentrate harvests on the highest value species and those species groups it should be noted that subsistence harvests are diverse (USGS 2011). For instance, walrus and belugas are harvested less in Kaktovik where their occurrence and distribution is lower in comparison to Point Lay where these two species are more prevalent in seasonal abundance. Communities which have higher rates of harvest for bowhead whales are less likely to harvest seals. Table 3.3-7 provides an overview of Community Subsistence Harvest by Species Group (percent total harvest by species, total harvest and pounds per capita). Specific harvest patterns by seasonal round and areas of use by community are described in

Section 3.3.2.4. Maps of subsistence harvest areas for subsistence resources are presented as Figure 3.3-18 through Figure3.3-27.

**Table 3.3-7 Community Subsistence Harvest by Species Group (percent total harvest by species, total harvest and pounds per capita)**

| Species | Kaktovik (1992 – 1993) | Nuiqsut (1993) | Barrow (1987 – 1989) | Wainwright (1988 - 1989) | Point Lay (1987) | Point Hope (1992) | Kivalina (2007) | Kotzebue (1986) |
|---|---|---|---|---|---|---|---|---|
| **Bowhead whale** | 63% | 29% | 38% | 35% | - | 6.9% | 5.1% | - |
| **Beluga whale** | - | - | - | 1% | 64% | 40.3% | 3.8% | 1.9% |
| **Seals** | 3% | 3% | 6% | 6% | 6% | 8.3% | 24% | 24% |
| **Walrus** | - | - | 9% | 27% | 4% | 16.4% | 8.1% | 1.1% |
| **Fish** | 13% | 34% | 11% | 5% | 3% | 9% | 33% | 40.5% |
| **Polar bear** | 1% | - | 2% | 2% | <1% | - | <1% | <1% |
| **Waterfowl** | 2% | 2% | 4% | 2% | 5% | 2.8% | 1.4% | 1.3% |
| **Caribou** | 11% | 31% | 27% | 23% | 16% | 7.7% | 18.2% | 24.4% |
| **Other terrestrial mammals and vegetation** | 6% | 2% | 3% | <1% | 2% | - | 3.5% | 4% |
| **Total Harvest in pounds** | 170,939 | 267,818 | 872,092 | 351,580 | 107,321 | 304,383 | 255,344 | 1,067,280 |
| **Per capita Harvest in pounds** | 886 | 742 | 289 | 751 | 890 | 487 | 594 | 398 |

**Sources:**
ADFG 1986, 1988, 1989, 1992, 1993, 2007 accessed on April 28, 2011; Braund and Kruse 2009; MMS 2008

## Bowhead whale

The Western Arctic bowhead whales (*Balaena mysticetus*) migrate annually from wintering areas in the northern Bering Sea, through the Chukchi Sea in the spring, and into the Beaufort Sea where they spend the summer (Figure 3.3-19). In the autumn they return to the Bering Sea to overwinter. Eleven Alaskan coastal communities along this migratory route participate in traditional subsistence hunts of these whales: Gambell, Savoonga, Little Diomede, and Wales (on the Bering Sea coast); Kivalina, Point Lay, Point Hope, Wainwright, and Barrow (on the coast of the Chukchi Sea); and Nuiqsut and Kaktovik (on the coast of the Beaufort Sea). The eight communities which are the focus of this EIS and harvest areas are shown on Figure 3.3-19. As noted, the bowhead whale hunt constitutes an important subsistence activity for these communities, providing substantial quantities of food, as well as reinforcing the traditional skills and social structure of Iñupiat culture. Partly as a result of concerns about sustainability, such hunts have been regulated by a quota system under the authority of the IWC since 1977, with Alaska Native subsistence hunters from northern Alaskan communities taking less than one percent of the stock of bowhead whales per year (NMFS 2008b). The stock has reported to continue to grow at a rate of 3.4 percent per year since 1978 (NMFS 2008b). A total of 832 whales were landed by subsistence hunters between 1974 and 2003, with Barrow landing the most whales during this time period (418 whales) (Suydam and George 2004).

The IWC is the authority which sets the quota for bowhead subsistence hunts and the Alaska Eskimo Whaling Commission allocates that quota among the whaling communities in multi-year periods. At

present there are 280 strikes allocated over the current five year period (2008 through 2012) with no more than 67 whales struck in any year (up to 15 unused strikes may be carried over each year). As the strikes may be carried over and at the end of the 2010 harvest 15 strikes that were not used were available for carry-forward. The combined strike quota for 2011 is 82 (67 plus the 15) (Federal Register 2011b). An agreement between the U.S. and the Russian Federation gives the Russian natives no more than 7 of these strikes and Alaskan Natives may use no more than 75 strikes (Federal Register 2011b). In Alaska the strikes are allocated among 11 Alaska Eskimo communities that harvest bowhead whales which include: Kaktovik, Nuiqsut, Barrow, Wainwright, Point Hope, Kivalina, Gambell, Savoonga, Wales, Little Diomede and Point Lay became the eleventh AEWC member in 2008 (Suydam et al. 2008). Figure 3.3-6 describes the efficiency of the bowhead subsistence harvest in Alaska from 1973 to 2007 (Suydam et al. 2007). Figure 3.3-7 describes the number of bowheads landed, and struck by subsistence hunters in the U.S., Canada, and Russia from 1974 to 2006.

Data from four communities on the Chukchi Sea from 1982 through 2005 was compiled by BOEM (formerly MMS [2007a]) from various sources for Lease Sale 193 and depicts the annual bowhead whale subsistence harvest of Barrow, Wainwright, Point Hope and Kivalina and is described in Table 3.3-8.

**Table 3.3-8 Bowhead Subsistence Harvest for Barrow, Wainwright, Point Hope and Point Lay from 1982 to 1985.**

| Year | Barrow | Wainwright | Point Hope | Kivalina |
|---|---|---|---|---|
| 1982 | 0 | 2 | 1 | 0 |
| 1983 | 2 | 2 | 1 | 0 |
| 1984 | 4 | 2 | 2 | 1 |
| 1985 | 5 | 2 | 1 | 0 |
| 1986 | 8 | 3 | 2 | 0 |
| 1987 | 7 | 4 | 5 | 1 |
| 1988 | 11 | 4 | 5 | 0 |
| 1989 | 10 | 2 | 0 | 0 |
| 1990 | 11 | 5 | 3 | 0 |
| 1991 | 12 | 4 | 6 | 1 |
| 1992 | 22 | 0 | 2 | 1 |
| 1993 | 23 | 5 | 2 | 0 |
| 1994 | 16 | 4 | 5 | 2 |
| 1995 | 19 | 5 | 1 | 1 |
| 1996 | 24 | 3 | 3 | 0 |
| 1997 | 30 | 3 | 4 | 0 |
| 1998 | 25 | 3 | 3 | 0 |
| 1999 | 24 | 5 | 2 | 0 |
| 2000 | 18 | 5 | 3 | 0 |
| 2004 | 27 | 6 | 4 | 0 |

| Year | Barrow | Wainwright | Point Hope | Kivalina |
|---|---|---|---|---|
| 2002 | 22 | 1 | 0 | 0 |
| 2003 | 16 | 5 | 4 | 0 |
| 2004 | 21 | 4 | 3 | 0 |
| 2005 | 29 | 3 | 7 | 0 |

**Source:** MMS 2007a.

Note: Suydam et al. (2005) indicates that 4 whales were landed at Wainwright during the 2005 subsistence harvest which would result in the total harvest of 38 whales for the years 1997 through 2006 (See Table 3.3-9 below).

Summary information for the number of bowhead whales landed between 1997 and 2006 complied from NMFS (2008) is described in Table 3.3-9. Additional harvest data is provided in Table 3.3-10 for the years 2005 to 2010. During the 2010 harvest, 43 whales were landed and 28 were lost for a total of 71 strikes (Brower 2011). In the fall of 2010 the community of Wainwright landed a whale for the first time since 1974 and possible 50 years (Suydam and George 2004 in Suydam et al. 2010, Brower 2010). More recently in order to meet allotted quotas whaling crews from Wainwright, Point Hope and Point Lay have all been conducting fall hunts as changing sea ice conditions have been more dangerous in the spring (Comstock 2011).

**Table 3.3-9 Number of Bowhead whales landed 1997 to 2006.**

| | Gambell | Savoonga | Wales | Little Diomede | Kivalina | Point Hope | Wainwright | Barrow | Nuiqsut | Kaktovik | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Landed | 14 | 25 | 2 | 2 | 0 | 30 | 38 | 234 | 33 | 32 | 410 |
| Annual Average | 1.4 | 2.5 | 0.2 | 0.2 | 0 | 3 | 3.8 | 23.4 | 3.3 | 3.2 | 41 |

**Source:** Compiled by data provided by the AEWC and NSB for NMFS 2008b

**Table 3.3-10 Summary of bowhead whales landed, struck and lost, and total struck 2005 to 2010.**

| Village | Landed | Struck and Lost | Total Struck |
|---|---|---|---|
| **2005** | | | |
| Kaktovik | 3 | 0 | 3 |
| Nuiqsut | 1 | 0 | 1 |
| Barrow | 29 | 7 | 36 |
| Wainwright | 4 | 1 | 5 |
| Point Hope | 7 | 3 | 10 |
| **2006** | | | |
| Kaktovik | 3 | 2 | 5 |
| Nuiqsut | 4 | 0 | 4 |

| Village | Landed | Struck and Lost | Total Struck |
|---|---|---|---|
| Barrow | 22 | 5 | 27 |
| Wainwright | 2 | 0 | 2 |
| **2007** | | | |
| Kaktovik | 3 | - | 3 |
| Nuiqsut | 3 | 1 | 4 |
| Barrow | 20 | 12 | 32 |
| Wainwright | 4 | 1 | 5 |
| Point Hope | 3 | 6 | 9 |
| **2008** | | | |
| Kaktovik | 3 | - | 3 |
| Nuiqsut | 4 | - | 4 |
| Barrow | 21 | 9 | 30 |
| Wainwright | 2 | - | 2 |
| Point Hope | 2 | 3 | 5 |
| **2009** | | | |
| Kaktovik | 3 | 1 | 4 |
| Nuiqsut | 2 | 1 | 3 |
| Barrow | 19 | 3 | 22 |
| Wainwright | 1 | - | 1 |
| Point Lay | 1 | - | 1 |
| Point Hope | 1 | - | 1 |
| **2010** | | | |
| Kaktovik | 3 | - | 3 |
| Nuiqsut | 4 | - | 4 |
| Barrow | 22 | 15 | 37 |
| Wainwright | 3 | 2 | 5 |
| Point Hope | 2 | 7 | 9 |

**Source:** Suydam et al. 2005, 2006, 2007, 2008, 2009 and 2010
**Note:** Summarized in these references by the authors from data provided by AECW to NSB.

Barrow, Wainwright and Point Lay are the only communities within the EIS project area that hunt bowhead whales in the spring and fall. Kivalina, Wainwright, Point Hope, and (beginning recently in 2009) Point Lay hunt bowhead whales during the spring season. Kivalina and Kotzebue residents join bowhead whaling crews out of Point Hope.. The communities of Kaktovik and Nuiqsut bowhead whale only during the fall season, although some Nuiqsut hunters join Barrow whaling crews during the spring whaling season (NSB 1998, Alaska Consultants Inc. and S.R. Braund and Assocs. 1984). Bowhead whale harvest areas for Kaktovik, Nuiqsut and Barrow have been extensively mapped by S.R. Braund and Associates (2010). Bowhead whale subsistence harvest areas for the Beaufort and Chukchi seas are provided on Figures 3.3-20 and 3.3-21. Harvest areas for the recently resumed bowhead whale hunt near Point Lay are unavailable and are not depicted on Figure 3.3-21. Descriptions of the bowhead whale hunts and their management are provided in NMFS (2008b) and are incorporated by reference. There are also many reports on subsistence patterns available from BOEM at http://www.alaska.boemre.gov/index.htm.

## Beluga Whale

Beluga whales (*Delphinapterus leucas*) are distributed throughout seasonally ice-covered Arctic and subarctic waters of the Northern Hemisphere (Gurevich 1980), and some stocks are closely associated with open leads and polynyas (nonlinear openings in the sea ice) in ice-covered regions of the Beaufort and Chukchi seas. Depending on season and region, beluga whales may occur in both offshore and coastal Alaskan waters. Mapping data is limited regarding harvest areas of the Beaufort Sea for beluga whales. Harvest areas where mapping data is available in the Chukchi Sea are described on Figure 3.3-23.

The Alaska Beluga Whale Committee monitors the subsistence harvest of beluga whales by Alaska Native hunters. There are five stocks of beluga whales in Alaska, namely the Cook Inlet, Bristol Bay, eastern Bering Sea, Kotzebue Sound, and Beaufort Sea stocks. The harvest by all Alaska Native communities is approximately 300 to 350 belugas a year. The Beaufort Sea stock harvest averages approximately 25 to 26 belugas a year. In the eastern Chukchi Seas (Kotzebue Sound, Point Lay and Wainwright) the harvest averages 95 animals per year and then further south in the eastern Bearing Sea (Norton Sound, Yukon and Kuskokwim Delta) the harvest averages about 180 per year and Bristol Bay harvests average approximately 20 per year (Suydam 2011).

## Seals

Harvest areas for seals are described on Figures 3.3-24 and 3.3-25

### *Spotted Seal*

Spotted seals (*Phoca largha*) are distributed along the continental shelf of the Beaufort, Chukchi, Bering, and Okhotsk Seas south to the northern Yellow Sea and western Sea of Japan (Shaughnessy and Fay 1977). As of August 2000, the subsistence harvest database indicated that the estimated number of spotted seals harvested for subsistence use per year was 5,265 animals (Allen and Angliss 2010).

### *Bearded Seal*

Bearded seals (*Erignathus barbatus*) are circumpolar in their distribution, extending from the Arctic Ocean south to Hokkaido in the western Pacific. In Alaskan waters, bearded seals occur on the continental shelves of the Bering, Beaufort, and Chukchi seas (Burns 1981, Johnson et al. 1966, Ognev 1935 in NMFS 2008b). Bearded seals are an important species for Alaskan subsistence hunters, with estimated annual harvests of 6,788 (Allen and Angliss 2010).

### *Ringed Seal*

In the Beaufort and Chukchi seas, ringed seals (*Phoca hispida*) haul out in highest densities in shorefast ice during the May-June molting season, immediately following the March-April pupping season (Johnson et al. 1966; Burns and Harbo 1972; Frost et al. 1988, 1997, 1998, 1999 in NMFS 2008b). Ringed seals are an important species for Alaska Native subsistence hunters. The most recent annual subsistence harvest in Alaska is estimated to be 9,567 (Allen and Angliss 2010).

### *Ribbon Seal*

Ribbon seals (*Histriophoca fasciata*) may migrate north to the Chukchi Sea during the summer (Kelly 1988). Ribbon seals are taken by Alaska Native subsistence hunters, primarily from communities in the vicinity of the Bering Strait and to a lesser extent at communities along the Chukchi Sea coast (Kelly 1988). The more recent annual subsistence harvest in Alaska is estimated to be 193 (Allen and Angliss 2010).

## Walrus

Walrus (*Odobenus rosmarus*) are harvested at higher levels in the Chukchi Sea communities than in the Beaufort Sea communities. The current size and trend of the Pacific walrus population is unknown. Subsistence harvest mortality levels are estimated at 5,789 animals per year (Allen and Angliss 2010). When harvested walrus meat may be eaten and its ivory used in the manufacture of traditional arts and crafts. Harvest areas are described on Figures 3.3-22 and 3.3-23.

## Polar Bear

Polar bears (*Ursus maritimus*) are harvested primarily during the winter months on ocean ice and along ocean leads. The 1995-2000 mean U.S. harvest from the Beaufort Sea stock was 32.2 animals per year (NMFS 2008b). A management agreement that allocates harvest between Canadian Inuit and Alaskan Iñupiat of the North Slope has been in place since 1998. Polar bear fur is used to manufacture cold-weather gear such as boots, mitts, and coats. These sewn items are bartered, sold, and given as gifts to relatives and friends. Harvest areas for the Chukchi Sea are described on Figure 3.3-25.

## Fish

Both marine and anadromous fish inhabit coastal Arctic waters. Marine fish include Arctic cod, saffron cod, two-horn and four-horn sculpins, Canadian eelpout, Arctic flounder, capelin, Pacific herring, Pacific sand lance, and snailfish. Migratory (anadromous) fish common to the Arctic environment include Arctic cisco, least cisco, Bering cisco, rainbow smelt, humpback whitefish, broad whitefish, Dolly Varden char, and sheefish. Although uncommon in the North Slope region, salmon are present in Arctic waters and used for subsistence. Subsistence fisheries for pink and chum salmon occur in the Colville and Itillik rivers and at Elson Lagoon near Barrow (Carothers 2010). In general, fish species include Pacific salmon (chum and pink), whitefish, Arctic char, Arctic grayling, burbot, lake trout, northern pike, capelin, rainbow smelt, Arctic cod, tomcod, and flounder. Harvest areas are described on Figures 3.3-26 and 3.3-27.

## Waterfowl

Migratory birds and their eggs are an important food source. Species harvested vary be region but generally include black brants, long-tailed ducks (oldsquaw), eiders, snow geese, Canada geese, and pintail ducks, although other birds, such as loons, may be occasionally harvested. Eider and long-tailed ducks are the most hunted ducks, while brant and Canada geese are the primary goose species. Ptarmigan can be taken all year in some communities. Since waterfowl is a highly preferred food, it is shared extensively within the community. Birds are often given to relatives, friends, and community elders. While most birds are eaten fresh, usually in soup, some are stored for the winter. Birds are often served for special occasions and holiday feasts such as Nalukataq and Thanksgiving. Harvest areas are described on Figures 3.3-26 and 3.3-27.

## Caribou

Caribou *(Rangifer tarandus)* are the main land mammals hunted for subsistence harvest by the Beaufort Sea and Chukchi Sea coastal communities. In some of the communities, caribou are the primary source of protein and are available year round. Other terrestrial mammals used for subsistence can include moose, brown bear, Dall sheep, musk ox, Arctic fox, red fox, porcupine, ground squirrel, wolverine, weasel, wolf, and marmot. Harvest areas are described on Figures 3.3-26 and 3.3-27.

### 3.3.2.4 Community Subsistence Harvest Patterns – Seasons and Use Areas

This section describes annual subsistence cycles and harvest use areas by community. The timing of subsistence harvests is depicted in Tables 3.3-11 through 3.3-18 for the communities of Kaktovik, Nuiqsut, Barrow, Wainwright, Point Lay, Point Hope, Kivalina, and Kotzebue.

Subsistence harvest patterns are seasonal, responding to biological cycles, the proximity of resources, environmental conditions, and ease of travel. These patterns have a long historical basis and have been modified with the establishment of permanent settlements. It is important to note that the seasonal movement of subsistence resources to hunting sites and camps involves travel over and use of the extensive areas around each of the communities. Each community relies on specific subsistence resources to varying degrees, depending on their abundance, seasonal distribution, and proximity to the community. Many studies have been conducted to identify traditional subsistence use areas and are incorporated by reference throughout this section. They include studies by: NSB 1979; Pederson 1979; MMS 2007a, 2007b, 2007c; MMS 2008; Galginaitis 2009; Braund and Kruse 2009; EDAW-AECOM 2007; and Braund 2010. Seasonal descriptions of harvest are reported from the NSB's Coastal Management Plan (2007) and the NAB's Coastal Management Plan (2006). Extensive marine and terrestrial subsistence map efforts were conducted by Stephen R. Braund & Associates (2010) for the communities of Kaktovik, Nuiqsut, and Barrow in an effort to develop a GIS system that depicts regional subsistence patterns and measuring changes in these patterns over time.

Subsistence harvests tend to occur within traditional use areas, for which hunters have accumulated detailed knowledge of the physical geography of landscape and waters, the social geography of place names and the associated stories, and the wildlife ecology of likely animal distributions by seasons and under varying weather conditions. Hunters have a repertoire of effective harvest strategies to draw upon as they hunt throughout these traditional harvest areas. For example, bowhead subsistence whaling occurs in U.S. waters primarily during the spring and autumn migrations as the bowhead whales move north and east through near shore leads in the spring, and then west and south as ice forms in the autumn (Figures 3.3-19 through 3.3-21). The bowhead migration patterns are conducive to spring harvests for the Chukchi Sea communities, while Barrow's (and now Wainwright's) location provides for successful spring and fall hunts, the communities of Nuiqsut and Kaktovik on the Beaufort Sea participate in the fall hunt (NMFS 2008b).

## Beaufort Sea Communities

### *Kaktovik*

The subsistence patterns of Kaktovik are influenced not only by the seasonality of the resources but by the community's geographical position and periodic access limitations. Along this portion of the Beaufort Sea coast there is shorefast ice for at least 10 months of the year due to the currents. During the winter, marine mammals such as seals and walrus are not as numerous in the Beaufort Sea as in the Chukchi Sea, and they are not present as long in the summer. Some species such as walrus rarely occur near Kaktovik. Belugas are harvested opportunistically during the bowhead hunt. The majority of summer activities are coastal oriented, as Kaktovik lacks direct access to a navigable river because the waters are too shallow for boating. Hunters will go out along the coast for seals throughout the year.

Kaktovik has winter access to resources such as Dall sheep in the Brooks Range and to the Porcupine and Central Arctic caribou herds. Caribou hunting also occurs along the coast from June through September. These two resources make up for the lessened availability of marine mammals. Kaktovik's primary subsistence resources are caribou, sheep, bowhead whale, fish, and waterfowl, with seal, polar bear, and furbearers also being important. Main subsistence areas include a summer coastal zone extending from Foggy Island to Demarcation Bay and inland areas, such as along the Hula Hula River and into the Brooks Range, used when snow cover permits access by snowmachine (NSB 2007)

**Winter:** Sheep and caribou hunting declines during December due to the lack of daylight. Some limited trapping occurs and wolves and wolverines are taken in the mountains. Foxes are trapped along the coast, and polar bears are hunted near the community. During late January hunters begin returning to the mountains with trips becoming more frequent in March with increasing daylight. Winter fishing reported at the Hula Hula camps occurs during late February to April. Some caribou remain on the coast and are taken in late winter; and moose may be taken if they are needed and available (NSB 2007). Some sheep

hunting may also be done in late winter. Lake trout are taken at places in the mountains, and ling cod can be obtained along inland portions of rivers (Wentworth 1979).

**Spring:** The long daylight hours of April and May and sufficient snow cover are good conditions for snow machine travel. Fishing at favored locations on the Hula Hula and other rivers continues until early April. Sheep might be taken until May (NSB 2007). Furbearer hunting continues until then also. Ground squirrels and marmots are hunted from early April when they come out of their holes. Often, the last trips to the mountains for the season are used to hunt them. Ptarmigan, though hunted all year, are most easily taken when they congregate in large flocks in the spring. Upon returning from the mountains, the first migratory waterfowl are taken along the coast in late spring/early summer, especially at traditional sites like Nuvuaq where seals, caribou, fox, and fish can be taken in various seasons (Wentworth 1979).

**Summer:** Waterfowl arrive as soon as there is open water. Tent camps are then set up in the Camden Bay area. As the season progresses and snow machine travel diminishes, hunting is done closer to the community, such as on the mainland or the historic area of Arey Island. Eggs are gathered on several of the barrier islands. Seals may also be taken, particularly for the oil and hides, but are hunted less than they were previously when they were needed for dog food. Towards the end of June, subsistence activities can come to a standstill as there is no snow for snow machine travel, and the frozen waters prohibit boat travel. Later, summer use areas are confined mainly to coastal and river delta regions due to shallow water. Griffin Point is a primary summer subsistence area; caribou, seals, and fish are taken there by people who may stay there for up to two months (Wentworth 1979).

In early July, boat travel is possible, and nets are set in Kaktovik Lagoon and other sites from Camden Bay to Jago Spit for Arctic char, which are harvested until August. Cisco and pink salmon are caught in the nets later in the summer; and, occasionally, beluga whales are taken. Beluga whales usually are harvested in August through November, incidental to the bowhead harvest. Caribou season occurs in about July, and they are taken along the coast and especially along the lower seven miles of the Canning River, where boating is possible (NSB 2007). A particularly good caribou hunting area has been identified at Konganevik Point. Grayling and whitefish are taken in the Canning Delta, which is one of the most important fishing areas for Kaktovik.

**Fall:** In late August, bowhead migration begins as the whales move westward, and crews may travel 20 miles out to sea at the beginning of the season, though later in the season, the whales migrate closer to shore and can be taken nearer the community during early September(Huntington and Quakenbush 2009). Kaktovik whalers have noticed patterns in the size of the whales during their migration and speculate that the larger whales are further offshore (more than 20 miles [32.2 km]) than they usually hunt (Huntington and Quakenbush 2009). Whaling may continue for several weeks, and butchering and transporting the whale can take another week. Peak sealing occurs during the whaling season. After whaling and freeze-up, inland travel is possible, and trips are frequently made along the Hula Hula River and into the mountains. Various camps along the Hula Hula are good spots for ice fishing for grayling and Dolly Varden/ char and provide a base of operations for caribou and sheep hunting in late October/early November. Kongakut River fishing sites produce Dolly Varden/char. Grayling fishing is done in nearly all the major rivers and especially along the Canning, where whitefish and ling cod are also taken, and along the Kuparuk (Jacobson 1979).

Many studies document the customary and traditional use of subsistence resources by Kaktovik residents. These studies are herein incorporated by reference: Brower and Hepa 2000; Caufield and Pedersen 1981; Chance 1966; Chance 1997; Coffing and Pedersen 1985; Craig 1987; George and Fuller 1997; ADFG 2000; Haynes and Pedersen 1989; Impact Assessment, Inc. 1990; Jacobson and Wentworth 1982; MMS 2003; MMS 2001; MMS 1998; MMS 1996b; MMS 1990; MMS 1986; MMS 1983; MMS 1998; MMS 1996;; MMS 1986;; Nielson 1977; NSB 1979; Oldham n.d.; Patterson 1974; Pedersen 1995; Pedersen 1990; Pedersen 1984; Pedersen 1979; Pedersen and Linn 2005; Pedersen and Coffing 1984; Pedersen and

Coffing 1985; Pedersen et al. 1991; Pedersen et al. 2000; Huntington and Quakenbush 2009; Wentworth 1979.

**Table 3.3-11 Kaktovik Seasonal Subsistence Cycle**

| Subsistence Resource | Inupiaq Name | Winter | | | Spring | | Summer | | Fall | | | Winter | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| **Bowhead whale** | **Agviq** | | | | | | | | ■ | ■ | ■ | | |
| **Beluga whale** | **Quilalugaq** | | | | | | | | ■ | ■ | ■ | | |
| **Bearded, ringed and spotted seals** | **Ugruk, Qasigiaq, Qaigulik** | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| **Walrus** | **Aiviq** | | | | | | ■ | ■ | | | | | |
| **Polar Bear** | **Nanuq** | ■ | ■ | ■ | ■ | ■ | ■ | | | ■ | ■ | ■ | ■ |
| **Birds/eggs** | **Mannik (eggs)** | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| **Caribou** | **Tuttu** | ■ | ■ | ■ | ■ | ■ | | | | | | | |
| **Moose** | **Tuttuvak** | ■ | ■ | ■ | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | ■ |
| **Brown Bear** | **Aklaq** | | | | | ■ | ■ | | | | | | |
| **Furbearer Hunt/trap** | ***** | ■ | ■ | ■ | ■ | | | | | | ■ | ■ | ■ |
| **Small mammals** | ***** | | | | ■ | ■ | ■ | ■ | ■ | | | | |
| **Sheep** | **Imnaiq** | ■ | ■ | ■ | ■ | | | | | ■ | ■ | ■ | ■ |
| **Freshwater fish** | ***** | ■ | ■ | ■ | ■ | ■ | ■ | | ■ | ■ | ■ | ■ | ■ |
| **Marine fish** | ***** | | | | | | | ■ | ■ | ■ | ■ | ■ | |

**Source:** NSB 1979, MMS 2007a and 2007c, MMS 2008, Braund and Kruse 2009, Braund, 2010 *many Inupiaq names for these resources

### *Nuiqsut*

Marine mammals harvested by Nuiqsut hunters include bowhead whales, beluga whales, bearded seals, ringed seals, spotted seals, and polar bears. Bowhead whales are hunted from Cross Island.. The barrier island and Thetis Island are also reported as important seal hunting areas:

> *Thetis Island is one of the most important areas for seal hunt during -- when you have access to go out to the ocean or you have access closer to the shore. Once that ice goes out, it goes out, it doesn't come back. And we depend on these islands for subsistence.* – Nuiqsut Public Scoping Meeting March 11, 2010.

Nuiqsut hunters report caribou and moose as their most important subsistence land mammals, but also harvest wolf, wolverine, and fox. Fish harvests include Arctic cisco, whitefish, least cisco, grayling, humpback whitefish, burbot, northern pike, pink salmon, and Arctic char. The general area of terrestrial subsistence activities extends from the community east to the Sagavanirktok River, south to the middle Colville, west to Teshekpuk Lake, and along the coast to Pitt Point to the mouth of the Canning River.

Hunters also join Barrow hunts for sea mammals and occasionally go to Kaktovik and Wainwright (NSB 2007).

**Winter:** Activities slow down during the coldest and darkest part of winter. Trapping for foxes and hunting of wolves and wolverines are accomplished during this season. Caribou and moose have traditionally been taken during winter. Seals are hunted on sea ice when open leads appear. As weather and light improve, trapping, caribou hunting, and fishing for cod, grayling, and lake trout increase (NSB 2007).

**Spring:** Spring whaling on the coast draws some men to Barrow to participate as crew members or whaling captains. No spring whaling occurs from Nuiqsut or Cross Island. Seals are taken on the sea ice during April and May. Furbearer hunting in the foothills and on the coastal plain is an important activity as the daylight and weather improves and continues until the snow is gone in May. Grayling, cod, and lake trout are taken with hook and line during the warmer weather. Long snow machine trips may be taken to Barrow or Kaktovik or even farther to visit friends and relatives before the snow melts and some caribou may be taken in conjunction with these trips (NSB 2007).

**Summer:** In the summer, ringed and spotted seals are hunted near the Colville River as far south as Ocean Point (EDAW-AECOM 2009). Following breakup in early summer, whitefish are taken in nets in the Colville River when the water clears in June. As this season progresses, fishing is conducted farther up river and on Fish Creek. Waterfowl begin to appear and are taken periodically until their fall migration. In late summer, char and salmon begin running up the Colville River, followed by spotted seals. Some coastal fishing occurs for whitefish and cisco. Children set traps for ground squirrels and fish for grayling with nets and rod/reel. Caribou hunting then becomes the primary activity in late summer (NSB 2007).

**Fall:** Caribou hunting, fishing, and bowhead whaling are the most important subsistence activities that occur in the fall. Bowhead whaling begins in mid-September along the coast as far east as the Canning River. The base for fall whaling is Cross Island which is 90 to 100 miles from the community by boat (EDAW-AECOM 2009). As indicated by Nuiqsut whalers:

> *Thetis Island, on to Cross Island and beyond Cross Island to Camden Bay. Those are our very important areas for feeding, resting for the bowhead whales while they're migrating west during fall time.* – March 11, 2010 Nuiqsut Scoping Meeting.

Seals are also hunted near the Colville Delta and along the coast from Cape Halkett to Foggy Island (EDAW-AECOM 2009). Caribou migrate south from their respective calving grounds, though some remain in the area throughout the winter near Fish Creek. Moose are a newer species to the region and are becoming an important resource, especially during times of restricted hunting of caribou and are taken along the middle Colville River. Fishing for cisco and whitefish is done with nets before freeze-up in the rivers and continues after freeze-up at fish camps on the Colville and Fish Creek. Grayling and ling cod are taken through the ice in later fall. Berries are picked during fishing and hunting trips, and sometimes driftwood and coal are collected. Seals, ducks, caribou, and sometimes polar bear are taken concurrent with bowhead whaling activites (NSB 2007).

Whaling activities of Nuiqsut have been extensively studied in cooperation with participating whaling captains for more than a decade. BOEM (and previously MMS) has conducted long-term environmental monitoring around the Northstar development, which is near the Nuiqsut subsistence-whaling area at Cross Island. As part of this monitoring effort, BOEM conducted a multiple-year collaborative project with Nuiqsut whalers that describes present-day subsistence whaling practices at Cross Island to verify any changes to whaling due to weather, ice conditions, or oil and gas activities. The project findings were summarized during the 2005 MMS Information Transfer Meeting (MMS 2005) and specifically through Galginaitis (various studies through 2009). These observations and narrative annual reports were performed in participation with whaling captains from Nuiqsut that depict geospatial information from the

sharing of GPS data. This data reflects the extensive use of the area for bowhead hunts from whaling camps at Cross Island (specifically see Galginaitis 2009).

The customary and traditional use of subsistence resources by Nuiqsut residents and the effects of oil development is documented in many studies, which are herein incorporated by reference: ADFG 2000; ADF&G 2003; Brower and Opie 1998; Brown 1979; Burns 1990; Craig 1987; Galginaitis and Funk 2005; Galginaitis et al. 1984; George and Fuller 1997; George and Nageak 1986; George and Kovalsky 1986; Hall 1983; Hoffman et al. 1978; Impact Assessment, Inc. 1990; Kruse 1982; Kruse et al. 1982; Kruse et al. 1981; Moulton and Field 1988; MMS 2003; MMS 2001; MMS 1998; MMS 1996a and 1996b; MMS 1990; MMS 1986; MMS 1983; Nielson 1977; NSB 2003; NSB 1979; NSB 1978; NSB 1975; Patterson 1974; Pedersen 2001; Pedersen 1995; Pedersen 1988; Pedersen 1986; Pedersen 1979; Pedersen et al. 2000; USACE 1997; U.S. Department of the Interior 1998.

**Table 3.3-12 Nuiqsut Seasonal Subsistence Cycle**

| Subsistence Resource | Inupiaq Name | Winter | | | Spring | | Summer | | Fall | | | Winter | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| **Bowhead whale** | **Agviq** | | | | | | | | ■ | ■ | ■ | | |
| **Beluga whale** | **Quilalugaq** | | | | | | | | ■ | ■ | ■ | | |
| **Bearded, ringed and spotted seals** | **Ugruk, Qasigiaq, Qaigulik** | | | ■ | ■ | ■ | | | ■ | ■ | ■ | | ■ |
| **Walrus** | **Aiviq** | | | | | | ■ | ■ | | | | | |
| **Polar Bear** | **Nanuq** | ■ | ■ | ■ | | | | | | | | ■ | ■ |
| **Birds/eggs** | **Mannik (eggs)** | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| **Caribou** | **Tuttu** | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| **Moose** | **Tuttuvak** | | | | | | | | ■ | ■ | ■ | | |
| **Brown Bear** | **Aklaq** | | | | | | | ■ | ■ | ■ | ■ | | |
| **Furbearer Hunt/trap** | * | ■ | ■ | ■ | ■ | ■ | ■ | | | | | ■ | ■ |
| **Small mammals** | * | | | | | ■ | ■ | ■ | ■ | ■ | ■ | | |
| **Freshwater fish** | * | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| **Berries/roots/ plants** | * | | | | | | ■ | ■ | ■ | ■ | | | |

**Source:** NSB 1979, MMS 2007a and 2007c, MMS 2008, Braund and Kruse 2009, Braund, 2010 * many Inupiaq names for these resources

### *Barrow*

Barrow is the only community in the EIS project area that hunts bowhead whales in the spring and fall. Hunters in Barrow harvest bowhead whale, ringed and bearded seal, and walrus as they migrate north along the Chukchi Sea towards the Beaufort Sea. In the fall, Barrow whalers hunt bowhead whales as they migrate south. Birds, such as eider ducks and geese, are also present in great numbers during their migrations to key nesting grounds on the North Slope (Braund 2010). Caribou migrate across the tundra

throughout the year and are available to hunters primarily during the summer and fall while they migrate to the coastal areas and along rivers to escape the heat and insects. Barrow residents harvest fish including: broad whitefish; Arctic grayling; tomcod; and burbot in local rivers and lakes and in Elson Lagoon. Other subsistence resources include moose, ptarmigan, and furbearing animals, such as wolf and wolverine (Braund 2010).

Boats are used for travel in the open water season and in open water leads. Outboard motors and all-terrain vehicles now enable hunters to travel much farther in a day than in the past. Aircraft are used by some to access fish camps or special hunting areas far from the community. Barrow hunters use the sea-ice/ocean environment at all times of the year, in the areas ranging from Peard Bay to Pitt Point for marine mammals, waterfowl, and fox. Spring whaling is based from camps on the ice shelf northwest of the community. The coastal zone is used for hunting ducks, seals, and walrus, fishing (spring/summer), and, in the fall, for whaling (especially at Pigniq). The coast is also used for collecting eggs, driftwood, and occasionally plants and invertebrates, also for picnics and camping. Inland areas are used in pursuit of caribou, fish, and fur-bearers (Schneider et al. 1980).

**Winter:** During the coldest and darkest of the winter months, subsistence activities progressively decrease. Sealing occurs on the west side of Barrow, and polar bears are harvested if they are encountered along the coast. Polar bear are hunted during the fall and winter – October to June – in the same areas where walrus are hunted from west of Barrow southwestward to Peard Bay. Inland travel is lessened with river and lake fishing ceasing by midwinter. Light trapping occurs, but the hunting of furbearers is conducted by use of snow machine. Trap lines are set on nearshore pack ice off Barrow and inland about one hour from the community. Trap lines are extended much farther in all directions from Barrow when the weather warms beginning in late winter (March). The historic site of Pulayaaq on the Meade River is used for trapping in late winter and for taking waterfowl in the spring, as well as for summer fishing and hunting. Nearby, Pulayatchiaq is also noted as a current and historical area for trapping and spring waterfowl. Some trap lines extend for a hundred miles with many loops and follow the rivers, ridges, or other easily traversed features. Furbearer hunting by snow machine is also done when people are out hunting caribou or trapping. Foxes are trapped or shot incidental to other hunting trips. The local demand for wolf and wolverine far exceeds the supply (NSB 2007).

Midwinter is also a time for socializing and celebrations at which subsistence foods, particularly bowhead whale, play an important role. As winter progresses and daylight hours lengthen, subsistence activities and travel increases. Trap lines are extended, and caribou hunting becomes of increased importance as food supplies become generally low. Sealing and polar bear hunting continue along the coast in each direction from Barrow. In late winter, preparations begin throughout the community for spring whaling (NPR-A Task Force 1978, Schneider et al. 1980).

**Spring:** The spring bowhead hunt occurs west and east of Point Barrow (Braund 2010). Barrow residents have reported hunting bowhead whales almost as far as Smith Bay to the east and as far as Skull Cliff to the west where there is an area of overlap with Wainwright whaling areas (Braund 2010). The location of Barrow allows access for whalers from April to June in offshore leads from historic areas such as Nuvuk. Spring whaling areas depend on the location of the open lead. Huntington and Quakenbush (2009) reported that whalers have noticed an increase in the numbers of bowheads over the last few decades and that changes in ice in conditions and have influenced the spring migration pattern near Barrow with fewer whales migrating next to the edge of the shorefast ice and fewer seen southwest of Barrow.

The spring hunt for beluga whale occurs from April to June in the spring leads between Point Barrow and Skull Cliff. Later in the spring, whalers in Barrow hunt belugas in open water around the barrier islands off Elson Lagoon.

With the increase of daylight hours, other subsistence activities increase, and migratory animals return to the coast. Ducks, some walrus, and bearded seals may become available offshore west and north of Point

Barrow in April. Trapping ends at about this time, though furbearer hunting continues at places, such as Qaviarat on the Meade River (where geese can be taken later on), and Kalayauk, which is also noted for its geese and ducks. While caribou may be hunted, whaling takes precedence unless the quota is met early, in which case all of the above resources are then pursued (NSB 2007). Ptarmigan are available year round but are taken in greater numbers in the spring when they flock. By June, when spring whaling is over, seal and duck hunting camps are set up along the coast southwest to Peard Bay. One especially popular camp is at the historic site of Pigniq, north of Barrow (NSB 2007).

**Summer:** In late spring/early summer, gathering of coastal and inland birds including eggs commences. When the rivers become free of ice, nets are set at fish camps for harvest of whitefish, char, and salmon. When the shore ice retreats in about early July, boat travel becomes more frequent, and trips are taken to Wainwright, Nuiqsut, Beechey Point, and inland fish camps, such as Qaviarat, where other year round activities take place as well. As the ice recedes, ringed sealing decreases though bearded and harbor seals become more common in abundance. Bearded seal hunting is a communal effort, and hunts are conducted west of Barrow or from Pigniq (NSB 2007).

After the shore ice breaks up, walrus are also hunted cooperatively. Barrow residents harvest walrus for their meat, hides, and ivory tusks. The walrus supplies food and material for clothing and arts and crafts. Residents hunt walrus in early summer to early fall, June to September, from west of Barrow southwestward to Peard Bay. Barrow residents hunt seals for their meat, oil, and skins. The meat and oil serve as dietary supplements. Seal skin is used in clothing, as wells as for boats.

Coastal fishing with nets for salmon, and char occurs at traditional sites along Elson Lagoon and west of Point Barrow, where tending nets may be combined with duck and marine mammal hunting. Whitefish and grayling are taken with gill nets during mid to late summer. Inland fishing becomes intensified. Payugvik, on the Meade River, is a noted traditional site used for more than a hundred years as a summer and winter fishing spot. The area is a common rest stop for people traveling the trail between Barrow and the community of Atqasuk further inland.

In conjunction with other activities on the coast and at inland lakes and rivers, berries and plants are collected when in season. The major fish effort for the Barrow area takes place at inland sites. Sealing and walrus hunting begins to decrease in late summer. Caribou skins are considered to be in prime condition in late summer when the main hunting effort begins. The majority of caribou hunting occurs by boat during the summer and fall months along the coast and inland along various rivers; whereas caribou are taken as needed throughout the winter months (Braund 2010). A few grizzly bears are taken if the opportunity presents, usually while conducting other subsistence activities along rivers. Duck hunting can continue into September as the southward migration begins, especially at Pigniq where some fishing is also done (Schneider et al. 1980).

**Fall:** Intensive caribou hunting, fishing, and whaling occur during the fall. Barrow residents have reported that fall hunting areas depend on the location of the migrating whales, weather, and ice conditions, and hunters generally indicated that the primary fall hunting area is east or northeast of Cape Simpson on Smith Bay (Braund 2010). Fall bowhead whaling occurs from August to October in an area that extends 16 km (10 mi) west of Barrow to 48 km (30 mi) north of Barrow, and southeast 48 km (30 mi) off Cooper Island with an eastern boundary on the east side of Dease Inlet. Occasionally, bowhead whale hunting may extend east as far as Smith Bay and Cape Halkett or Harrison Bay. In a 2009 study (Braund 2010), respondents noted that the whaling captains set the timing of the fall hunt with some hunters preferring to hunt in October after the larger whales have migrated through.

Caribou are still numerous near Barrow in September. Inland fishing is considered to be most productive in the fall, and this activity increases especially at such historic places as Iviksuk on the Inaru River and Nauyalik on the Meade, where a landing strip provides easy access for the community. As during the summer months, fishing is often combined with caribou hunting and berry picking and later with furbearer hunting. Permanent (cabins) and temporary camps are set up at favorite spots to conduct these

subsistence activities for extended periods of time. Food storage is another function of these camps, as ice cellars store excess food which can be transported to the community later. They are not, however, as commonly used today as in the past. The camps are like small tent cities, especially after freeze-up, and are heavily used on weekends. Distant camps as far away as Teshekpuk Lake are used by Barrow residents, either because their past history includes personal familiarity or because nearer camps may be overcrowded (NSB 2007).

During the fall, coastal areas such as Pigniq continue to produce ducks while they are available, and seals and walrus may also still be available. When the ice begins to form on inland waters, fishing continues for whitefish, grayling, and burbot with nets and by jigging (NSB 2007). Ringed seals will begin to appear on the coast. Moose, which have recently extended their range northward, can sometimes be available in the Colville drainage, but the number taken by Barrow residents is considered low.

**Table 3.3-13 Barrow Seasonal Subsistence Cycle**

| Subsistence Resource | Inupiaq Name | Winter | | | Spring | | Summer | | Fall | | | Winter | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| **Bowhead whale** | **Agviq** | | | | ■ | ■ | ■ | | ■ | ■ | ■ | | |
| **Beluga whale** | **Quilalugaq** | | | | | | | | | | | | |
| **Bearded, ringed and spotted seals** | **Ugruk, Qasigiaq, Qaigulik** | ■ | | | ■ | ■ | ■ | ■ | | | | ■ | ■ |
| **Walrus** | **Aiviq** | | | | | | ■ | ■ | ■ | | | | |
| **Polar Bear** | **Nanuq** | ■ | ■ | ■ | ■ | ■ | | | | | ■ | ■ | ■ |
| **Birds/eggs** | **Mannik (eggs)** | | | | | ■ | ■ | ■ | ■ | ■ | ■ | | |
| **Caribou** | **Tuttu** | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| **Moose** | **Tuttuvak** | | | | | | | | ■ | ■ | | | |
| **Brown Bear** | **Aklaq** | | | | | ■ | ■ | ■ | ■ | ■ | | | |
| **Furbearer Hunt/trap** | ***** | ■ | ■ | ■ | | | | | | | | ■ | ■ |
| **Freshwater and marine fish** | ***** | | ■ | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| **Berries/roots/plants** | ***** | | | | | ■ | ■ | ■ | ■ | ■ | | | |

**Source:** Braund 2003, MMS 2007a and 2007c, MMS 2008, Braund and Kruse 2009, Braund 2010 * many Inupiaq names for these resources

## Chukchi Sea Communities

### *Wainwright*

Wainwright is situated close to several different environments, each of which provides the community with diverse wildlife resources for subsistence harvest. Bowheads, belugas, walrus, and seals are taken from the ocean/sea ice environments. The lagoon system inside of the barrier islands provides habitat for waterfowl, seals, and other marine mammals. Subsistence hunts for bowhead whales occur in the spring and fall. Beluga whales comprise a main portion of the subsistence economy of Wainwright (NSB 2007).

Beluga subsistence hunters conduct annual hunts for cultural and nutritional reasons, and, in Wainwright, up to forty belugas per year are harvested (Willie Goodwin - ABWC 2007). Seals are also harvested, with bearded seal being the most sought after species, and ringed seal is not considered as important. Bearded seals are considered a mainstay subsistence resource and are prized for their fat and meat. Bearded seals are harvested from spring through fall. Smaller bearded seals are preferred for their meat, and the larger ones are considered best for rendering oil (MMS 2008). The Kuk River is an area where fish and other predators attracted to them are taken. The Kuk River estuary provides habitat for fish, especially smelt. Terrestrial resources such as caribou, furbearers, plants/berries, bear, and ptarmigan are also harvested. Subsistence activities are concentrated along coastal areas from Point Franklin to Icy Cape and inland along the Kuk and Utukok river drainages. The sea and sea/ice environments are used for many miles out from the shore. Avid hunters may extend their operations to the Meade and Colville rivers or along the coast to Point Lay and Peard Bay (Ivie and Schneider 1979) overlapping with subsistence user areas of other communities.

**Winter:** Wainwright residents hunt polar bear for their meat and pelts. Polar bear subsistence hunts occur in the fall and winter around Icy Cape, at the headland from Point Belcher to Point Franklin, and at Seahorse Island. In the winter, furbearers are taken during late winter when there is increased daylight and weather improves. Fox are harvested along major rivers and at coastal sites, while wolf and wolverine are trapped or shot on the coast or at inland locations. Throughout the winter, ringed seals are taken along leads in the ice. Caribou and polar bear may occasionally also be taken. Wainwright is noted throughout the North Slope for its smelt, and much fishing is done in January through March in the Kuk Lagoon.

**Spring:** Whaling is the most important subsistence activity in spring. Bowhead whaling occurs beginning in April, and these whales are taken in open leads in the offshore ice as they pass close to shore near Point Belcher and Icy Cape. More recently is has been reported that bowheads are appearing in early April and sometimes even in March, with movements being determined by ice conditions (Quakenbush and Huntington 2010). Wainwright residents will travel up the coast as far as Peard Bay to hunt bowheads in the spring. Whaling camps are sometimes located 10 to 15 mi (16 to 24 km) from shore (MMS 2009b). Hunters report that the bowhead whales reach the Wainwright area approximately a week after passing Point Hope (Quakenbush and Huntington, 2010). The beluga whale hunt takes place in the spring lead system from April to June. The beluga whales arrive about the same time as bowheads. Belugas are hunted from the ice along leads or driven into inlets in summer and harvested. Belugas are hunted from late June through mid-July and sometimes later into the summer. Walrus and harbor and bearded seals also may be taken but are more commonly hunted in summer; ringed seals, however, are taken during the spring. Migratory waterfowl harvest occurs along the coast and along rivers beginning in May. Squirrels and marmots are sometimes harvested in conjunction with furbearer hunting trips inland toward the mountains.

**Summer:** Bearded seals are hunted in early summer southwest of the community, and spotted seals, which migrate south in fall, are harvested in late summer when they will float after being shot. Walrus become prevalent during July and August and are taken from drifting ice floes near Wainwright and along the coast to Peard Bay. From August to September, Wainwright residents may hunt walrus at local haul-outs, with the main area being from Milliktagvik north to Point Franklin. Icy Cape is a known walrus haulout location (NSB 2007).

Subsistence activities occur on the coast and at rivers as overland tundra travel becomes more difficult in summer. Families occupy traditional camping sites along the coastline for sealing, waterfowl hunting, and other activities up until the midsummer, and then fishing activities intensify. Waterfowl are harvested in early summer until nesting and some egg collecting occurs along Kasegaluk Lagoon or Seahorse Island (NSB 2007).

Caribou migrate to the coast during summer and are harvested from Icy Cape to Peard Bay beginning in late August and into the fall. Berries are collected during the late summer near the community and along the Kuk River. Fishing is a major subsistence activity that occurs all year, and, during midsummer, nets are set up in front of the community for salmon, trout, and whitefish. Fishing activities then move to streams and rivers as the migratory fish work their way upstream (NSB 2007).

**Fall:** Fishing and caribou hunting are the main subsistence harvest activities in the fall. Caribou skins are considered the best at this time of year, and they are hunted on the coast from Icy Cape to Peard Bay and along major rivers (NSB 2007). Migratory waterfowl are also harvested at areas including Icy Cape and Point Belcher. While caribou is not a coastal resource, access is closely tied to the waterways as they travel along the drainages and beaches, and the waterways provide an avenue for transportation for locating the caribou and hauling the harvest home. Wainwright residents recently resumed a fall bowhead hunt and landed a whale in the fall of 2010 for the first time since 1974 and possible 50 years (Suydam et al. 2010, Brower 2010).

Fall fishing occurs at camps for up to two months along the Kuk, Ivisaruk, and Avalik rivers, often in combination with other hunting and berry-picking expeditions (Nelson 1981). After freeze-up in the fall, travel becomes easier overland, and additional fishing trips are made to Utukok River camps. Sometimes people use charter airplanes to reach these camps. Sites on the Kuk River are used after freeze-up with access by snow machines. When the shorefast ice begins to form in the late fall, polar bears are taken when they come to the coast to feed on sea mammal carcasses. The meat is popular for winter holiday feasts. Coal is collected in late summer and fall along the Kuk River and coastal beaches after heavy storms (NSB 2007).

The customary and traditional use of subsistence resources is documented in many studies that are herein incorporated by reference, including: Bane 1966; Braund 2003; Braund 2003; Braund 1993; Braund 1989; Burns 1990; Chance 1966; Craig 1987; George and Fuller 1997; ADFG 2000; Ivie and Schneider 1988; Jorgensen 1990; Kassam and Wainwright Traditional Council 2001; Lutton 1985; Nelson 1981; Nelson 1969; NSB 2002; NSB 1979; Patterson 1974; Pedersen 1979. A particularly important collaborative effort to document traditional use areas and potential impacts of oil and gas development is found in Wainwright Traditional Council and the Nature Conservancy, n.d. [est 2007].

### *Point Lay*

Beluga whales comprise a main portion of the subsistence economy of Point Lay. The beluga subsistence hunters of this community conduct annual hunts for cultural and nutritional reasons, and, in Point Lay, hunters will harvest approximately 30 to 50 belugas each year (Willie Goodwin – in MMS 2008). Frost and Suydam (2010) estimated that up to sixty percent of the eastern Chukchi Sea harvest occurred at Point Lay and noted that the hunt usually occurs in very shallow water, less than two meters near the town. Point Lay hunts belugas from late June through mid-July. It is estimated that up to two-thirds of the annual subsistence production by weight is beluga whale (ADFG 2011) with the majority of the harvest being taken in one or two cooperative hunts in the early summer. Point Lay hunters take belugas near the community, usually herding them from the south to the shallows inside Kasegaluk Lagoon. Hunters are most familiar with belugas in the area between Omalik Lagoon and Point Lay, although they also have hunted belugas as far north of the community as Icy Cape (Huntington et al. 1999).

There are several overlapping areas of subsistence usage between the communities of Point Lay and Wainwright such as in the Beaufort and Raven basins up the Kukpowruk River where hunters from both communities harvest furbearers. Icy Cape is another area that each community uses for hunting waterfowl. Caribou hunting areas in the western Brooks Range in the southeast corner of the NPR-A are used by Point Lay and Wainwright hunters (NSB 2007). In March and April, both communities may hunt for wolf and wolverine in the Amatusuk Hills. A seasonal description of current subsistence activities of Point Lay follows.

**Table 3.3-14 Wainwright Seasonal Subsistence Cycle**

| Subsistence Resource | Inupiaq Name | Winter | | | Spring | | Summer | | Fall | | | Winter | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| **Bowhead whale** | **Agviq** | | | | | ■ | ■ | ■ | ■ | | | | |
| **Beluga whale** | **Quilalugaq** | | | | | ■ | ■ | | | | | | |
| **Bearded, ringed and spotted seals** | **Ugruk, Qasigiaq, Qaigulik** | ■ | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| **Walrus** | **Aiviq** | | | | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| **Polar Bear** | **Nanuq** | ■ | ■ | | | | | | | | ■ | ■ | ■ |
| **Birds/eggs** | **Mannik (eggs)** | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | |
| **Caribou** | **Tuttu** | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| **Furbearer Hunt/trap** | * | ■ | ■ | ■ | | | | | | | | ■ | ■ |
| **Freshwater and marine fish** | * | ■ | ■ | ■ | | | | ■ | ■ | ■ | ■ | ■ | ■ |
| **Berries/roots/ plants** | * | | | | | | | ■ | ■ | ■ | | | |

**Source:** Kassam 2001 in MMS 2008, Braund 2009 * many Inupiaq names for these resources

**Winter:** Some ice fishing continues in early winter, and occasional caribou hunting trips are taken. Trapping occurs throughout the winter primarily at coastal areas, though winter storms may prevent the checking of traps at regular intervals. Wolf, wolverine, and caribou hunting may be combined in areas towards the mountains. Coastal traps are often set next to washed up marine mammal carcasses which attract fox and wolverine. Polar bears are also taken at these trapping sites as they are attracted because of the bait or foxes. Polar bears are not as actively hunted as in former years. Some sealing is attempted. In late winter, some people travel to other communities to participate in the bowhead whaling activities (NPR-A Task Force 1978, Schneider and Bennett 1979 in NSB 2007).

**Spring:** During the spring, Point Lay residents gather eggs and hunt terrestrial mammals and marine mammals. Migratory waterfowl and eggs are harvested during May and June at coastal sites and along inland rivers. Large quantities of eggs are harvested at specific areas, such as the islands in Kasegaluk Lagoon north of the community and along the barrier islands. Ground squirrels are harvested by the community and hoary marmots are hunted in the Amatusuk Hills. Ringed and bearded seals are available year-round. Ringed and bearded seals are hunted 20 mi (32 km) and 30 mi (48 km) north of Point Lay, respectively, with bearded seals concentrated in the Solivik Island area and up to three miles north off the island (NSB 2007, MMS 2009b). Bearded seals are also hunted from south of Point Lay to the southern end of Kasegaluk Lagoon. Snow machines are used to hunt caribou as they move toward the coast for the summer or in the Amatusuk and Kiklupiklak hills (Schneider and Bennett 1979 in NSB, 2007). While

Point Lay hunts mostly beluga whales, in the spring of 2009, a bowhead whale was landed for the first time since 1937 and in May 2011 a whaling crew again landed a bowhead whale (Arctic Sounder 2011).

**Summer:** Many different subsistence activities occur during the summer, and boats are used for access to subsistence resources. In early June, the open lead allows for sealing, and later the annual walrus hunt occurs near Icy Cape. As the sea ice retreats in June, the walrus migrate north past Point Lay, and the community conducts their annual hunt. Walrus are hunted from June to August – depending on favorable ice conditions – along the entire length of Kasegaluk Lagoon, south of Icy Cape, and as far as 20 mi (32 km) offshore (NSB 2007, MMS 2009b).

Beluga whales are harvested from the middle of June to the middle of July. The hunting area is concentrated in Naokak and Kukpowruk Passes south of Point Lay. Hunters use boats to herd the whales into the shallow waters of Kasegaluk Lagoon where the belugas are harvested. If the July beluga hunt is unsuccessful, Point Lay hunters may travel as far north as Utukok Pass and as far south as Cape Beaufort in search of beluga whales. Like the walrus hunt, all available hunters participate. Boats are used to herd whales into shallow water where they can easily be retrieved after being stuck. Occasionally, belugas can be taken in August as well. Data from satellite tagging and aerial surveys in the eastern Chukchi Sea indicate that belugas make extensive use of the coastal waters within 50 miles of the coast in June and July, and more than 1,000 belugas have been observed at Kukpowruk, Akunik, and Utukok passes along Kasegaluk Lagoon during these months (Willie Goodwin – ABWC in MMS 2008; Suydam et al. 2000).

Caribou are taken along the coast and around Icy Cape, and waterfowl and eggs continue to be taken in early summer. Fishing using gill nets occurs near river mouths (except Kokolik), at ocean passes, in Kasegaluk Lagoon, and at Sitkik Point. The season lasts from early July to late September. The nets are moved about 15 miles up the Kukpowruk River in September for grayling fishing. A variety of salmon, whitefish, flounder, smelt, herring, bullhead, and an occasional char are taken. A majority of residents of the community are engaged in fishing during the summer months (NSB 2007). Berries and other edible plants are collected along the coast, inland along rivers and near the historic site of Cully. As fall approaches, preparations are made for ice fishing. Snow machines are taken by boat up the Kukpowruk River and left to be used after freeze-up (Schneider and Bennett 1979 in NSB 2007).

**Fall:** Point Lay residents hunt for polar bears from September to April along the coast with the hunting area rarely extending more than two miles offshore. The fall migration of waterfowl attracts hunters to the area near Icy Cape. Caribou hunting is actively pursued from late August to October at inland locations. Whole families will engage in fall grayling fishing up the Kukpowruk River, even after the school year has begun. Nets are used until freeze-up, when hook and line methods are then used for ice fishing at traditional ice fishing sites. Berry picking is combined with fishing trips, and coal is sometimes brought back to the community after freeze-up by snow machine from the mine on the Kukpowruk. Residents hunt moose, which is considered a new species to the area. Spotted seals are hunted in early fall when they are fat and do not sink (Schneider and Bennett 1979 in NSB 2007). Point Lay has been recently conducting fall hunts as changing sea ice conditions have been more dangerous in the spring (Comstock 2011).

### *Point Hope*

During much of the year, certain species, including seals and caribou, are present, as well as smaller mammals and ptarmigan. A discussion follows of the seasonal description of subsistence use and harvest areas for Point Hope.

**Winter:** Winter lasts in this area from approximately November to March and April. During this time, inland travel is most accessible. Trips are taken to Cape Lisburne and Kivalina in conjunction with caribou and furbearer hunting. Sealing and caribou hunting are the major resources for subsistence foods during winter, and sea ice fishing for cod contributes to the diet of residents in January (NSB 2007). Cod

fishing is done with hook and line through the ice. Trapping sites are set up along the coast north and south of the community, especially around sea mammal carcasses to attract Arctic fox and wolverine.

**Table 3.3-15 Point Lay Seasonal Subsistence Cycle**

| Subsistence Resource | Inupiaq Name | Winter | | | Spring | | Summer | | Fall | | | Winter | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| **Bowhead whale** | **Agviq** | | | | | | | | ■ | ■ | ■ | | |
| **Beluga whale** | **Quilalugaq** | | | | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| **Bearded, ringed seals** | **Ugruk, Qasigiaq,** | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| **Spotted seal** | **Qaigulik** | | | | | | ■ | ■ | ■ | ■ | ■ | ■ | |
| **Walrus** | **Aiviq** | | | | | ■ | ■ | ■ | ■ | ■ | | | |
| **Polar Bear** | **Nanuq** | ■ | ■ | ■ | ■ | | | | | | | | |
| **Waterfowl** | ***** | | | | ■ | ■ | ■ | ■ | ■ | ■ | | | |
| **Eggs** | **Mannik** | | | | | ■ | ■ | ■ | ■ | | | | |
| **Ptarmigan** | **Aqargiq** | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| **Caribou** | **Tuttu** | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| **Furbearer Hunt/trap** | ***** | ■ | ■ | ■ | ■ | | | | | ■ | ■ | ■ | ■ |
| **Freshwater and marine fish** | ***** | | | | | ■ | ■ | ■ | ■ | ■ | ■ | | |
| **Berries/roots/plants** | ***** | | | | | | ■ | ■ | ■ | ■ | | | |
| **Marine invertebrates** | ***** | | | | | | ■ | ■ | ■ | ■ | | | |
| **Salmon** | ***** | | | | | | ■ | ■ | | | | | |
| **Moose** | **Tuttuvak** | | | | | | | ■ | | | | | |

**Source:** Pedersen 1979 in MMS 2008 * many Inupiaq names for these resources

Sealing sites along the south coast are used most frequently, but north coast sites are used if ice and wind conditions permit (Lowenstein 1980). Polar bears are more abundant in late winter. Point Hope residents hunt polar bear for their meat and their fur. Primary polar bear hunting takes place from January to April and occasionally from October to January (MMS 2007c). Residents hunt these mammals in the area south of the point, as far out as 16 km (10 mi) from shore. The winter area of subsistence usage is more extensive than at any other season, ranging from Cape Lisburne to the ice pack well beyond Cape Thompson to inland regions encompassing nearly all the Kukpuk and Ipewik river drainage (Foote and Williamson 1966).

**Spring:** Migration patterns of subsistence resources (mainly the bowhead whale migration) influence the harvest, which occurs in the spring. Whaling occurs from the time the offshore leads form in the ice in late March or early April until June. Bowhead whales are hunted from March to June from whaling camps along the ice edge south and southeast of Point Hope. The pack-ice lead is rarely more than 10 to

11 km (6 to 7 mi) offshore (MMS 2007c). Seals, some walrus, beluga whales, and polar bears are taken if the bowhead whales are not present. The main sealing season begins along the south shores of the peninsula after whaling has concluded. Belugas are usually taken from late March through June. Seals and walrus follow the receding ice pack and are not commonly available at Point Hope during the summer months. Walrus are also hunted in south shore leads and by boat as the old ice breaks up (NSB 1979). Hunters harvest walrus from May to July along the southern shore from Point Hope to Akoviknak Lagoon.

Early migratory birds passing through the area are also harvested. The area of subsistence activities includes extensive sea ice usage along the north coast and around Point Hope north toward Cape Thompson. Inland areas along the Kukpuk and Ipewik rivers also are utilized (Foote and Williamson 1966).

**Summer:** Open water by late June allows for boat travel. Some bearded and harbor sealing may occur in late spring/early summer (Pedersen 1971). Beluga whaling also occurs again in July, and some may be taken with nets from the beach (Burch 1981). The second beluga hunt occurs later in the summer from July to August. During this second hunt, Point Hope residents hunt beluga whales in the open water near the southern shore of Point Hope close to the beaches, as well as north of Point Hope as far as Cape Dyer (MMS 2007c).

Bird nesting sites at Cape Thompson and Cape Lisburne are visited by boat to collect eggs and harvest birds (Maclean 1971 in NSB 2007). Marine fishing for char and salmon is conducted with beach seines and nets along the north and south shores, and lagoons yield whitefish. Caribou are also harvested at several places inland along the coast, including the Kukpuk River area or towards the Pitmegea River (Lowenstein 1980). Salmon and grayling are caught at the mouth of the Kukpuk River and at other fishing areas along the river. Berries and edible plants are collected and, if not used immediately, are stored in oil or frozen.

**Fall:** Subsistence activities in the fall are conducted from about mid-September to early November and are characterized by intensive fishing along the Kukpuk River. About three fourths of the total fish harvest is obtained in the fall (Pedersen 1971). Fishing is combined with caribou and moose hunting up to the mouth of the Ipewik River. Gill nets and hook and line are used for fishing before freeze up and afterwards through holes in the ice. Grayling, char, whitefish, and Dolly Varden are harvested. Cod are harvested in the fall when storms throw them up on the beaches (Lowenstein 1980). Caribou are hunted along the Kukpuk River and at coastal and inland areas around Cape Thompson. Migratory waterfowl are harvested again in the fall. As the sea ice forms, seals begin to reappear, and some are hunted by boat while residents collect driftwood. Sealing becomes more intense as the ice thickens. In early November, the trapping season begins. The area of greatest fall subsistence usage extends from the south shore inland to an area beyond the Kukpuk River and part of the north coast. Point Hope has recently been conducting fall hunts to meet their allocated quota and provide for their community as changing sea ice conditions have been more dangerous in the spring hunt (Comstock 2011).

### *Kivalina*

Kivalina residents use a continuous offshore area that extends from Cape Krusenstern to Cape Thompson with use areas also extending to Point Hope and then inland to the DeLong Mountains and Noatak River (Braund 2008, Magdanz et al. 2010). Some use areas also occur near Kotzebue, Cape Lisburne, Point Lay and Selawik. Areas with the highest overlapping use were located directly west of the community in the Chukchi Sea for marine mammal harvests and also in the lowland areas to the east of the community, including the Kivalina and Wulik rivers for caribou, furbearers, fish, berries, and other resources (NAB 2006). In 2007, residents reported subsistence use areas extending along the coast from Cape Thompson towards Cape Krusenstern and inland from Rabbit Creek into the Delong Mountains (Braund 2008). Surveys conducted in 2007 reported that subsistence activities of Kivalina residents (and the nearby

inland community of Noatak) occur over more than a 25,000 sq km area and can range more than 150 km (93 mi) from home (Magdanz et al. 2010).

**Table 3.3-16 Point Hope Seasonal Subsistence Cycle**

| Subsistence Resource | Inupiaq Name | Winter | | | Spring | | Summer | | Fall | | | Winter | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| **Bowhead whale** | **Agviq** | | | | ■ | ■ | ■ | | | | | | |
| **Beluga whale** | **Quilalugaq** | | | | ■ | ■ | ■ | | | | | | |
| **Bearded, ringed and spotted seals** | **Ugruk, Qasigiaq, Qaigulik** | ■ | ■ | ■ | ■ | ■ | ■ | | | | | ■ | ■ |
| **Walrus** | **Aiviq** | | | | | ■ | ■ | | | | | | |
| **Waterfowl** | * | | | | ■ | ■ | ■ | ■ | ■ | | ■ | ■ | |
| **Bird eggs** | **Mannik** | | | | | | | ■ | ■ | | ■ | ■ | |
| **Caribou** | **Tuttu** | | ■ | ■ | | | | ■ | ■ | ■ | ■ | ■ | |
| **Furbearer Hunt/trap** | * | ■ | | | | | | | | | | | ■ |
| **Freshwater fish** | * | | | | | | | | | | ■ | ■ | |
| **Crab** | * | | | ■ | ■ | | | | | | | | |
| **Marine Fish** | * | | | | | | ■ | ■ | ■ | | | | |
| **Berries/roots/plants** | * | | | | | | | ■ | ■ | ■ | | | |

**Source:** Pedersen 1977 in MMS 2008 * many Inupiaq names for these resources

Marine mammals are hunted by residents between Cape Thompson and Sheshalik Spit (NAB 2006). Seal and walrus use areas extend farther out into the Chukchi Sea, while beluga and polar bear subsistence use areas are located closer along the coastline. Areas where land mammals are harvested, including caribou, bear, and furbearers, occur over an expansive inland area from Cape Thompson in the north to Cape Krusenstern in the south and inland into the Noatak National Preserve and DeLong Mountains (EPA 2009). Moose hunting is focused along the coast and nearby rivers, and sheep hunting was reported around several inland mountains. Use areas for fishing occur along the Kivalina and Wulik rivers, in lagoons south of the community, in the waters near Sheshalik, and in Selawik Lake. Bird hunting and egg gathering occurs along the coast and along the Wulik and Kivalina rivers. Harvests of vegetation, including berries, plants, and wood, are reported as located along the Kivalina and Wulik rivers and on the coast from south of Chariot (an area between Cape Thompson and Cape Seppings) to Sheshalik (EPA 2009).

**Winter:** Kivalina Lagoon is a subsistence use area that provides overwintering habitat for fish and serves as a migration pathway for anadromous fish bound for the Wulik and Kivalina Rivers (NAB 2006). The occurrence of marine mammals within the Kivalina Lagoon area is closely associated with the presence of shorefast ice along the coast during the winter and the recurring polynyas between Kivalina and Point Hope (NAB 2006). During the winter, ringed seals and bearded seals are harvested. Beluga whales may occur in the open leads along the coast as early as January and February due to the presence of a

persistent polynya. Caribou winter use areas where subsistence harvest occurs are along the north Kivalina coast and the Upper Kivalina River and its tributary streams.

**Spring:** During the spring and summer, Cape Krusenstern is an important use area for residents of Kivalina, Noatak, and Kotzebue when spring sealing takes place in the open leads (NAB 2006). The north Kivalina coast is an important resource use area where waterfowl hunting occurs during the spring and later in the fall. The north Kivalina coastline is used for hunting ringed seal and bearded seal during the spring, for beluga whales during spring and summer, bowhead whales during the spring, and walrus during spring and summer (NAB 2006). Spotted seals may haul out here as well. Polar bears are hunted in the spring during years of abundance along the north Kivalina coast.

**Summer:** During the summer, the camps are established near Cape Krusenstern to harvest berries and plants. Whitefish (least cisco, Bering cisco and humpback whitefish) are harvested in Cape Krusenstern Lagoon (NAB 2006). Herring have also been reported to spawn in the lagoon and are harvested. The north Kivalina coast is another important resource use area where berry picking occurs in the summer. Dolly Varden, salmon, and whitefish are harvested in this area as well during this season. During the summer, spotted seals are present on barrier island beaches, and harvest occurs along the north Kivalina coastline. The Upper Kivalina River and its tributary streams are used for fishing and hunting. During the summer months, Dolly Varden, chum salmon, and whitefish are harvested.

**Fall:** The Cape Krusenstern area is used by waterfowl during fall migration. Species present may include brant, Canada geese, northern pintail, tundra swan, and oldsquaw. Waterfowl hunting also occurs during the fall along the North Kivalina coast. The Upper Kivalina River and its tributary streams are use areas for moose hunting during the fall (NAB 2006).

Subsistence use seasonal patterns and cycles have been extensively studied as a result of its location to Red Dog Mine and Red Dog's associated DeLong Mountain Terminal. These studies include work by: Braund and Burnham (1983), and Schroeder et al. (1987) which described and documented Kivalina's pre-mine subsistence use areas for varying time periods. Extensive pre and post mine subsistence map efforts were conducted by Stephen R. Braund & Associates (2008) and are found in Appendix D of the Red Dog Supplemental EIS prepared for the EPA in 2009 (Braund and Associates 2009).

### *Kotzebue*

Seasonal and subsistence use areas for Kotzebue overlap with the use areas of neighboring communities of Kivalina, Noatak, Kiana, Noorvik, and Buckland (Magdanz et al. 2010). Mapping data is lacking regarding specific harvest areas for this community. A discussion of the seasonal harvest activities of Kotzebue and specific harvest areas follows.

**Winter:** The Kobuk/Selawik Lakes are used year round for subsistence activities by residents of several communities mainly for sheefish hooking. The Kobuk River Delta is an important year-round subsistence use area (NAB 2006). Uses in the winter include sheefish hooking through holes in the ice during the winter and early spring. Trapping is primarily a winter activity, where muskrat are trapped for their fur and harvested as food. The area between the North Fork and the Omar is especially important for trapping in the winter. The lower North Fork River and all of the Omar River drainage provide important wintering habitat for moose in the region. During some years, this area receives heavy use by wintering caribou which are then harvested (NAB 2006).

**Spring:** Sisoalik Spit is an important spring and summer subsistence site for residents of several of the nearby NAB communities. Subsistence camps are established each year to harvest resources, which include ringed seal, beluga, fish, and berries. Waterfowl hunting occurs in Paul's Slough and throughout the delta area. The Sisoalik Spit area is heavily used from June to freezeup (usually in mid-September) for waterfowl hunting (NAB 2006). The lagoons in the Sisoalik Spit area provide important spring feeding and staging for waterfowl, particularly brant, and waterfowl hunting and egg gathering occurs in this area. The Kobuk/Selawik Lakes are used year around for subsistence activities by residents of

several communities. During the spring-summer season, sheefish hooking and sealing are the primary activities. Goose hunting occurs on Selawik Lake. The Kobuk River Delta is another important year-

**Table 3.3-17 Kivalina Seasonal Subsistence Cycle**

| Subsistence Resource | Inupiaq Name | Winter | | | Spring | | Summer | | Fall | | | Winter | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| **Bowhead whale** | **Agviq** | | | | | ■ | | | | | | | |
| **Beluga whale** | **Quilalugaq** | | | | | ■ | ■ | | | | | | |
| **Bearded, ringed and some spotted seals** | **Ugruk, Qasigiaq, Qaigulik** | ■ | ■ | ■ | ■ | ■ | ■ | | | | | ■ | ■ |
| **Walrus** | **Aiviq** | | | | | | ■ | ■ | | | | | |
| **Caribou** | **Tuttu** | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| **Waterfowl** | ***** | | | | ■ | ■ | | | | | | | |
| **Ptarmigan** | **Aqargiq** | ■ | ■ | ■ | ■ | | | | ■ | ■ | ■ | ■ | ■ |
| **Fish - Grayling** | ***** | ■ | ■ | ■ | | | | | | | | ■ | ■ |
| **Fish – Char or Dolly Varden** | ***** | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| **Fish (whitefish, burbot)** | **Aanaakliq (whitefish)** | | | | | ■ | ■ | ■ | ■ | ■ | ■ | | |
| **Salmon, cod** | **Iqalugaq (cod)** | | | | | | ■ | ■ | ■ | ■ | | | |

**Source:** MMS 2008 * many Inupiaq names for these resources

round subsistence use area. Uses here include waterfowl hunting, sheefish fishing, and trapping. Waterfowl hunting occurs in both the spring and fall. The valleys of the Omar and North Forks Rivers provide north/south migration corridors for caribou moving to calving and summering areas in the spring and returning to winter range in the fall (NAB 2006).

Eschscholtz Bay spring-summer uses include beluga whaling (Morseth 1997), seal hunting, egg gathering, and berry picking (NAB 2006). The Elephant Point/Choris Peninsula area is the site of summer subsistence camps along Eschscholtz Bay where spring-summer uses include beluga whaling, seal hunting, egg gathering, and berry picking (NAB 2006). Beluga whale hunting involves residents of many communities, who set up hunting camps at Elephant Point. Whale hunting lasts from two to three weeks and peaks in mid-June.

**Summer:** Much of the commercial fishing in Kotzebue Sound takes place from summer camps in the Sisoalik Spit Area. Salmon are harvested in the Kobuk Lake in July and August. The entire Kobuk River chum salmon population passes through the Kobuk Delta twice: once as adults on their upstream migration (during July and August) and again as out migrating fry (in June and July). Dolly Varden also migrate in and out of the Kobuk River and are harvested. At Elephant Point, berry picking takes place from August through mid-September (NAB 2006). During the summer, salmon and Dolly Varden are harvested in the North Fork Squirrel and Omar rivers. Important summer use areas for waterfowl are present in the wetlands adjacent to the lower reaches of the Omar and North Fork Rivers. Chum salmon

spawning areas are present in the Omar River upstream from its confluence with the Squirrel River. At Elephant Point and along the Choris Peninsula, berry picking takes place from mid-August through mid-September. At Eschscholtz Bay, spotted seal are present throughout the summer as they feed on smelt and herring in the bay and use the shores for hauling out at Chamisso Island and Elephant Point (NAB 2006).

**Fall:** Waterfowl hunting occurs in fall in the Kobuk River Delta and near the Omar River during the fall. Berry picking takes place from mid-August through mid-September in the Eschscholtz Bay area (NAB 2006).

#### 3.3.2.5 Community Subsistence Harvest Rates

This section summarizes subsistence harvest rates, including quantities produced and the rates of participation in subsistence activities. The importance of subsistence harvests can be shown through the comprehensive household surveys conducted from 1986 through 2007 and reported in the ADFG Subsistence Division subsistence harvest database. Table 3.3-19 (Rates of Participation in Subsistence Activities – All Resources) describes rates of participation of communities within the EIS project area. Data included in this table were gathered from ADF&G's Community Subsistence Harvest Records and reflect years where the most comprehensive resource inventory was completed. Complete data are not available for each community.

Participation on the harvesting and sharing of subsistence foods goes beyond the family and the community. There is an extensive network of exchange that occurs between communities of the Beaufort and Chukchi seas and further to relatives in larger towns such as Anchorage and Fairbanks. For instance, the shares of bowhead whale that each crew member receives after whaling are involved in a secondary redistribution among local relatives and those in other communities. Social and cultural identity is strengthened by serving subsistence foods at home and at feasts and sharing subsistence foods, particularly with elders. The foods that are exchanged strengthen family and regional ties.

Some subsistence foods are exchanged between communities, each noted for its special resources. Point Hope and Barrow are the major suppliers of bowhead whale, with Point Lay contributing beluga whale. Kaktovik is recognized for its sheep and Wainwright its smelt. Nuiqsut is noted for its whitefish and pelts (NSB 2007). As noted by Bill Tracey at the Point Lay February 22, 2010 public scoping meeting for this EIS:

> *It has to do with sharing. If Point Lay catches a beluga whale, that beluga whale is shared with people as far away as Anchorage, Kotzebue, Nuiqsut, it just goes all over the place. So if we get 30 belugas, I wouldn't be surprised if that showed up in 30 villages. So when something affects Point Lay, little old Point Lay in the middle of north nowhere, it's felt in Anchorage in some way, in some fashion. So yes, if there is something big that happens offshore at Point Lay and it contaminates, say, our lagoon system, we're not catching the belugas anymore, people in the whole state of Alaska are going to feel that.*

Kin-based groups form the basis for most harvest and distribution activities. Spring bowhead whaling remains the dominant activity for expressing culturally relevant values of cooperation and sharing in the communities of Point Hope, Wainwright, and Barrow. The nature of the hunt, the size of the whale, and severe weather conditions encountered require cooperation of nearly everyone in the community for success (Worl 1980). Before the season begins, the equipment must be prepared and checked, ice cellars prepared, and the bearded seal skins necessary for covering the whaling boat obtained and sewn by the women (NSB 2007). More recently freezers are being used for storage of subsistence foods (EDAW-AECOM 2007).

## Table 3.3-18 Kotzebue Seasonal Subsistence Cycle

| Subsistence Resource | Inupiaq Name | Winter | | | Spring | | Summer | | Fall | | | Winter | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| **Beluga whale** | **Quilalugaq** | | | | | | | ■ | ■ | | | | |
| **Bearded seal** | **Ugruk** | | | | | | ■ | ■ | | | ■ | | |
| **Ringed Seal** | **Natchiq** | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | ■ | ■ | ■ |
| **Spotted seals** | **Qasigiaq** | | | | | | | | | | ■ | | |
| **Furbearers (hare, fox, lynx, wolf)** | * | ■ | ■ | ■ | ■ | ■ | | | | | | ■ | ■ |
| **Caribou** | **Tuttu** | | ■ | ■ | ■ | | | | | ■ | ■ | | |
| **Moose** | **Tuttuvak** | | | | | | | | ■ | ■ | | | |
| **Waterfowl** | * | | | | | ■ | ■ | | | ■ | | | |
| **Eggs** | **Mannik** | | | | | | ■ | ■ | | | | | |
| **Ptarmigan** | * | ■ | ■ | ■ | ■ | | | | | | | ■ | ■ |
| **Fish – Sheefish Grayling** | * | ■ | ■ | ■ | ■ | ■ | | | | | | ■ | ■ |
| **Fish – Char or Dolly Varden** | * | | | | | | ■ | ■ | | ■ | ■ | | |
| **Fish - whitefish** | **Aanaakliq** | | | | | | ■ | ■ | | ■ | ■ | ■ | |
| **Fish – Smelt** | * | | | | | | ■ | ■ | | | | | |
| **Fish - burbot** | * | | | ■ | ■ | | | | | | | | |
| **Fish - Saffron cod** | * | | | | | | | | | | ■ | ■ | |
| **Fish - Herring** | * | | | | | ■ | | | | | | | |
| **Dall Sheep** | **Imnaiq** | | | ■ | ■ | | | | | ■ | ■ | | |
| **Brown Bear** | **Aklaq** | | | | ■ | | | | | ■ | ■ | | |
| **Salmon** | * | | | | | | | | ■ | ■ | | | |
| **Berries/roots/ plants** | * | | | | | | ■ | ■ | ■ | ■ | | | |

**Source:** Georgette and Loon 1993. * many Inupiaq names for these resources

**Table 3.3-19 Rates of Participation in Subsistence Activities – All Resources**

| Community | Percentage (%) of Households | | | | | |
|---|---|---|---|---|---|---|
| | Using | Trying to Harvest | Harvesting | Receiving | Giving | Average pounds harvested per household – all resources |
| **Kaktovik (1992)** | 95.7 | 89.4 | 89.4 | 91.5 | 83 | 2,713 |
| **Nuiqsut (1993)** | 100 | 93.5 | 90.3 | 98.4 | 91.9 | 2,943.1 |
| **Barrow (1989)** | - | - | 61 | - | - | 930.73 |
| **Wainwright (1989)** | - | - | 66 | - | - | 2,954.46 |
| **Point Lay (1987)** | 100 | 83.1 | 83.1 | 100 | 88.7 | 2,495.83 |
| **Point Hope (1992)** | - | - | - | - | - | 2,182 |
| **Kivalina (2007)** | 100 | 95.2 | 95.2 | 100 | 90.5 | 3,152 |
| **Kotzebue (1986)** | 100 | 78.4 | 78.4 | 96.3 | 71.6 | 1,395.14 |

**Source:** ADFG 1986, 1988, 1989; NSB 1993, 2007 accessed on April 28, 2011; MMS 2008; Braund and Kruse 2009

## Beaufort Sea Communities

### *Kaktovik*

ADF&G (2011) estimated that in 1992 the approximate per capita consumption of subsistence food for Kaktovik was 886 pounds. Approximately 93 percent of the Iñupiat households in Kaktovik participate in the local subsistence economy, while approximately 80 percent of other residents use wild resources obtained from hunting, fishing, or gathering. In 2003, 68 percent of all Kaktovik residents reported that half or more of their diet consisted of local subsistence resources (Shepro et al. 2003).

Levels of harvest change from year to year, depending on species population dynamics, weather, and hunting conditions, among other factors. However, subsistence users adapt. For example, when fewer whales (or smaller whales) are harvested, it is likely that the lower percentage for these species is offset by increases in the use of other resources (EDAW-AECOM 2007). Kaktovik subsistence harvest data is described in Table 3.3-20.

### Table 3.3-20 Kaktovik Subsistence Harvest Data

| Kaktovik Subsistence Harvest Data (by weight) ADFG (1992) | |
|---|---|
| **Resource** | **Percentage (%) of Harvest** |
| Bowhead Whale | 64 |
| Fish | 13 |
| Caribou | 11 |
| Birds | 1 |
| Other | 11 |
| **Kaktovik Mean Per Capita Subsistence Harvest (lbs per person), ADFG (1992)** | |
| Salmon | 1 |
| Fish | 118 |
| Land Mammals | 150 |
| Marine Mammals | 599 |
| Birds and Eggs | 17 |
| Shellfish | 0 |
| Plants | 1 |
| All Resources | 886 |
| **Kaktovik Subsistence Harvest Summary, ADFG (1992)** | |
| Estimated Pounds Harvested | 170,940.00 |
| Mean Household Pounds | 2,713.33 |
| Harvested Per Capita Pounds Harvested | 885.60 |

**Source:** ADFG 2011

Between the 1998 and 2003 surveys, there have been some changes in household consumption of subsistence resources (Shepro et al. 2003). The percentage of households who used very little local foods increased, while the number of households that identified the "more than half" category decreased. The percentage of households that were heavily reliant on subsistence resources (those who consumed all or nearly all of their food from local resources) increased from 35 percent in 1998 to approximately 41 percent in 2003 (Shepro et al. 2003).

### Table 3.3-21 Kaktovik's Usage of Local Subsistence Resources in 1998 and 2003

| Amount | Households 2003 | Percentage (%) 2003 | Households 1998 | Percentage (%) 1998 |
|---|---|---|---|---|
| **None** | 0 | 0 | 1 | 2 |
| **Very little** | 8 | 15 | 1 | 2 |
| **Less than half** | 9 | 17 | 8 | 13 |
| **Half** | 11 | 20 | 11 | 18 |
| **More than half** | 4 | 7 | 18 | 30 |
| **Nearly all** | 13 | 24 | 12 | 20 |
| **All** | 9 | 17 | 9 | 1 |
| **Total** | **54** | **100** | **60** | **100** |

**Source:** Shepro et al. 2003

The average expenditure for the 49 households who reported subsistence expenditures was $4,788; the community spent approximately 10 percent of its total income on subsistence activities (Shepro et al. 2003). This includes expenses such as fuel, ammunition, and other supplies needed to participate in subsistence activities.

### *Nuiqsut*

ADF&G (2011) estimated that in 1993 the approximate per capita consumption of subsistence food for Nuiqsut was 742 pounds. Fish (mainly freshwater white fish), terrestrial mammals (caribou and moose), and marine mammals (whales and seals) are harvested in roughly the same amounts (EDAW-AECOM 2007). Other resources harvested in lesser amounts include furbearers and birds. There is no "average" year so that in some years one of the resource components may comprise much more than a third of the actual subsistence resource use (especially in years when few or no whales are taken) (Galginaitis 1990 in EDAW-AECOM 2007).

**Table 3.3-22 Nuiqsut Subsistence Harvest Data**

| Nuiqsut Subsistence Harvest (by weight), ADFG (1993) | |
|---|---|
| **Resource** | **Percentage (%) of Harvest** |
| Bowhead Whale | 29 |
| Fish | 34 |
| Caribou | 30 |
| Birds | 2 |
| Other | 5 |
| **Nuiqsut Subsistence Harvest Summary, ADFG (1993)** | |
| Estimated Pounds Harvested | 267,818.00 |
| Mean Household Pounds | 2,943.05 |
| Harvested Per Capita Pounds Harvested | 741.75 |

**Source:** ADFG 2011a

Approximately 81 percent of the households in Nuiqsut participate in the local subsistence economy; the participation rate for Iñupiat residents was recorded at approximately 95 percent (Shepro et al. 2003). Another study of subsistence practices in Nuiqsut (Brower and Opie 1997 in NSB 2005) indicated that of 259 harvest instances, 226 (87 percent) resulted in sharing with others. Sharing harvest resources is known to be one of the most important traditions in the local subsistence lifestyle. The subsistence lifestyle remains a primary cultural choice for Native households. In 2003, approximately 63 percent of local residents said that half or more of their diet consisted of local subsistence resources (Shepro et al. 2003). Table 3.3-23 describes usage of local subsistence resources for Nuiqsut.

**Table 3.3-23 Nuiqsut Usage of Local Subsistence Resources in 1998 and 2003**

| Amount | Householder 1998 | Percentage (%) 1998 | Householder 2003 | Percentage (%) 2003 |
|---|---|---|---|---|
| **None** | 0 | 0 | 0 | 0 |
| **Very little** | 8 | 13 | 14 | 18 |
| **Less than half** | 9 | 14 | 16 | 20 |
| **Half** | 20 | 31 | 18 | 23 |
| **More than half** | 15 | 23 | 14 | 18 |
| **Nearly all** | 7 | 11 | 13 | 17 |
| **All** | 5 | 8 | 4 | 5 |
| **Total** | **64** | **100** | **79** | **100** |

**Source:** Shepro et al. 2003

The average expenditure for the 50 households who reported subsistence expenditures was over $6,700. Together, these 50 households spent approximately $335,000 on subsistence in 2003, representing about 20 percent of the gross incomes of these families (Shepro et al. 2003).

### *Barrow*

A 2003 survey found that 91 percent of Iñupiat households participated in the local subsistence economy, and 66 percent of the households indicated that half or more of their diet consisted of local subsistence resources (Circumpolar Research Associates 2004 in EDAW-AECOM 2007). In contrast, two-thirds of Barrow's non-Iñupiat households do not use wild resources obtained from hunting, fishing, or gathering. This is likely a result of the high non-Iñupiat population in Barrow and a reason for the lower harvest of subsistence resources on a per capita and per household basis in comparison to Nuiqsut and Kaktovik rates (EDAW-AECOM 2007).

In 1992, from subsistence fish and wildlife harvests in Barrow, 349 pounds per capita of wild resources were harvested (BLM 2005 in EDAW-AECOM 2007). Marine mammals composed approximately 55 percent of the total resources harvested, and land mammals composed 30 percent of the total. In 1992, the total harvest of marine mammals (bowhead whale, walrus, and ringed and bearded seals) accounted for approximately 72 percent of the total village harvest of all species, and bowhead whale provided the single greatest contribution of food to the community at 54 percent of the total harvest. Land mammals (caribou, moose, and Dall sheep) contributed approximately 19 percent of Barrow's total harvest in 1992, and caribou was the principal terrestrial resource (17 percent of the total harvest). Close to half (45 percent) of Barrow households participated in caribou hunting in 1992; caribou is one of the most consistently eaten subsistence resources in Barrow. In 1992, fish constituted approximately seven percent of the total harvest in Barrow, and broad whitefish was the most important fish resource (four percent of the total harvest). Birds, such as eiders and geese, contributed less than two percent of the total harvest by weight; however, participation in bird hunting was high (EDAW-AECOM 2007). ADF&G harvest data for Barrow from 1989 is described in Table 3.3-24.

**Table 3.3-24 Barrow Subsistence Harvest Data - 1989**

| Barrow Per Capita Subsistence Harvest (per capita pounds), ADFG (1989) | |
|---|---|
| Salmon | 4.06 |
| Fish | 35.22 |
| Land Mammals | 71.18 |
| Marine Mammals | 168.5 |
| Birds and Eggs | 9.76 |
| Plants | 0.44 |
| **Barrow Harvest Summary, ADFG (1989)** | |
| Estimated Pounds Harvested by community – all resources | 872,092 |
| Average pounds per household - all resources | 930.73 |
| Harvested Per Capita Pounds | 289.16 |

**Source:** ADFG 2011

The average expenditure for the 492 households who reported subsistence expenditures was $3,787, while the median expenditure was $925. Fifty-nine percent of the households that were interviewed reported spending less than $2,000 per year on subsistence (Shepro et al. 2003).

Many studies document the customary and traditional use of subsistence resources by Barrow residents including: ADFG 2000; BOEM 2011b, 2011c and 2011d; Braund 1993; Braund 1989; Chance 1966; Craig 1987; EDAW-AECOM, 2007; George and Fuller 1997; George et al. 1993; Hess 1999; MMS 2003; MMS 2001; MMS 1998; MMS 1996a and 1996b; MMS 1990; MMS 1986; MMS 1983; MMS 2006b and 2006c, MMS 2007a and 2007c; MMS 2008; MMS 2009a and 2009b Nielson 1977; NSB 2002; NSB 1979; Patterson 1974; Pedersen 1979; Pedersen et al. 1979; Philo et al. 1994; Sonnenfeld 1956; SRB&A 2010; and Wolfe et al. 1986.

## Chukchi Sea Communities

### *Wainwright*

Wainwright subsistence users have opportunities for hunting terrestrial, riverine, and marine species, including bowhead whales, though they tend to harvest mostly from the ocean (Fuller and George 1997). Their data indicate that Wainwright residents primarily utilize marine mammals, caribou, and fish in terms of pounds per person harvested. Other resources are also harvested but at lower rates.

**Table 3.3-25 Wainwright Subsistence Harvest Data, 1989**

| Resource | Estimated Number | Estimated pounds | Average pounds | Per Capita pounds |
|---|---|---|---|---|
| **All Resources** | - | 351,581 | 2,954.46 | 751.24 |
| **Fish** | 64,567 | 17,385.00 | 146.09 | 37.15 |
| **Salmon** | 180 | 1,044.00 | 8.77 | 2.23 |
| **Non-Salmon Fish** | 64,387 | 16,341.00 | 137.32 | 34.92 |
| **Land Mammals** | 760 | 83,389.00 | 700.75 | 178.18 |
| **Large land mammals** | 713 | 83,387.00 | 700.73 | 178.18 |
| **Small land mammals** | 47 | 2.00 | 0.02 | 0.00 |
| **Marine mammals** | - | 243,594.00 | 2,047.01 | 520.50 |
| **Natures and eggs** | 2,735 | 7,211.00 | 60.60 | 15.41 |

**Source:** ADFG 2011

Approximately 92 percent of the households in Wainwright participate in the local subsistence economy; the participation rate for Iñupiat residents was recorded at approximately 99 percent (Shepro et al. 2003). In 2003, approximately 73 percent of all Wainwright residents said that half or more of their diet consisted of local subsistence resources, while 83 percent of Iñupiat residents were heavily reliant on subsistence resources (half or more of their diet comes from local foods) (Shepro et al. 2003).

The average household expenditure for subsistence activities in Wainwright in 2002 was $4,504, and the median expenditure was $2,500 (Shepro et al. 2003). Subsistence expenses include items such as fuel, ammunition, and other supplies needed to participate in subsistence activities.

**Table 3.3-26 Wainwright Household Use of Subsistence Resources by Ethnicity**

| Level of Use | 1998 Total | Iñupiat in 2003 | Other in 2003 | Total in 2003 |
|---|---|---|---|---|
| **None** | 0 | 1 | 8 | 9 |
| **Very little** | 12 | 5 | 6 | 11 |
| **Less than half** | 29 | 12 | 1 | 13 |
| **Half** | 32 | 30 | 1 | 31 |
| **More than half** | 16 | 22 | 0 | 22 |
| **Nearly all** | 29 | 30 | 1 | 31 |
| **All** | 4 | 5 | 0 | 5 |
| **Total** | **122** | **105** | **17** | **122** |

**Source:** Shepro et al. 2003 (authors noted that results were only of those households responding to the survey)

### *Point Lay*

Caribou, fish, and beluga whale comprise the most significant subsistence resources of Point Lay residents. The reestablished bowhead hunt was successful in 2009 though poor ice conditions in 2010 prevented Point Lay hunters from striking a whale (ADN 2009, AEWC 2011). Seals and walrus are not as intensively used as in the past due to the reduction in dog teams and the present adequate supply of caribou. Other resources are also utilized by the community but at lower harvest levels in terms of pounds per person.

**Table 3.3-27 Point Lay Subsistence Harvest Data, 1987**

| Resource | Estimated Number | Estimated pounds | Average pounds | Per Capita pounds |
|---|---|---|---|---|
| **All Resources** | - | 107,321.00 | 2,495.83 | 890.11 |
| **Fish** | 2,807 | 2,983.00 | 69.38 | 24.74 |
| **Salmon** | 147 | 425.00 | 9.88 | 3.52 |
| **Non-Salmon Fish** | 2,660 | 2,559.00 | 59.50 | 21.22 |
| **Land Mammals** | 458 | 21,426.00 | 498.27 | 177.71 |
| **Large land mammals** | 167 | 21,309.00 | 495.56 | 176.74 |
| **Small land mammals** | 292 | 117.00 | 2.72 | 0.97 |
| **Marine mammals** | - | 76,853.00 | 1787.27 | 637.41 |
| **Birds and eggs** | 3,531 | 5,836.00 | 135.73 | 48.40 |
| **Plants** | - | 223.00 | 5.19 | 1.85 |

**Source:** ADFG 2011

Approximately 77 percent of the households in Point Lay participate in the local subsistence economy (Shepro et al. 2003). Of those households, 75 percent are heavily reliant on subsistence resources, where half or more of household diets consisted of local resources.

**Table 3.3-28 Point Lay Usage of Local Subsistence Resources in 1998 and 2003**

| Amount | Households 1998 | Percentage (%) 1998 | Households 2003 | Percentage (%) 2003 |
|---|---|---|---|---|
| **None** | 2 | 4.50 | 2 | 4.5 |
| **Very little** | 4 | 9.10 | 7 | 15.90 |
| **Less than half** | 5 | 11.40 | 2 | 4.50 |
| **Half** | 9 | 20.50 | 11 | 25.00 |
| **More than half** | 14 | 31.80 | 6 | 13.60 |
| **Nearly all** | 4 | 9.10 | 8 | 18.20 |
| **All** | 6 | 13.60 | 8 | 18.20 |
| **Total** | **44** | **100** | **44** | **100** |

**Source:** Shepro et al. 2003 – Authors noted that results include only households participating in the census survey and responding to the question "How much of the meat, fish and birds you and your household ate came from local food sources (fishing and hunting)?"

Thirty percent of the Point Lay households spent less than $500 on subsistence activities. Approximately 40 percent of the households spent $3,100 to $9,500 on subsistence activities (Shepro et al. 2003). Many sources document the customary and traditional use of subsistence resources by residents of this community, and are hereby incorporated by reference: Ahmaogak 1989; Alaska Consultants 1983; Alaska Consultants 1983; Bockstoce et al. 1979; Braund et al. 1988; MMS 2001; MMS 2009; NSB 1979; Suydam et al. n.d.; Suydam et al. 1994; and Worl 1980.

### *Point Hope*

At Point Hope, marine mammals comprised over three-quarters of the harvest by weight (77 percent), including belugas, bowheads, walrus and seals (Fuller and George 1997). Caribou have historically been, and remain, an important subsistence resource for the community; in the 1997 study, caribou were the only non-marine mammal species in the top five species harvested for the year (NSB 2005).

**Table 3.3-29 Main Subsistence Resources Harvested at Point Hope, 1992**

| Resource | Edible Pounds Harvested | Number Harvested | Pounds per household | Pounds per capita | Percent (%) of Total Harvest |
|---|---|---|---|---|---|
| **Beluga whale** | 137,172 | 98 | 879 | 196 | 40.3 |
| **Walrus** | 55,797 | 72 | 358 | 80 | 16.4 |
| **Bearded seal** | 28,242 | 160 | 181 | 40 | 8.3 |
| **Caribou** | 26,303 | 225 | 169 | 38 | 7.7 |
| **Bowhead whale** | 23,365 | 3 | 150 | 33 | 6.9 |

**Source:** Fuller and George 1997

In 2003, approximately two-thirds of all Point Hope residents said that half or more of their diet consisted of local subsistence resources, while three-quarters of all Iñupiat residents were heavily reliant on subsistence resources (half or more of their diet comes from local foods) (Shepro et al. 2003). Approximately 93 percent of the households in Point Hope participate in the local subsistence economy; the participation rate for Iñupiat residents was recorded at approximately 99 percent (Shepro et al. 2003).

Nearly half of Point Hope residents (47.5 percent) spent less than $1,200 on subsistence activities; however 15 percent of residents spent between $9,600 and $20,000 (Shepro et al. 2003). Customary and traditional use of subsistence resources is documented in many sources that are incorporated into this document by reference: ADFG 2000; Foote and Williamson 1966; Foote and Williamson 1961; George and Fuller 1997; Heller 1966; Lowenstein 1980; NSB 1979; Patterson 1974; Pedersen 1979; and Pedersen 1971.

**Table 3.3-30 Point Hope Usage of Local Subsistence Resources in 1998 and 2003**

| Amount | Households 1998 | Percentage (%) 1998 | Households 2003 | Percentage (%) 2003 |
|---|---|---|---|---|
| **None** | 4 | 2.9 | 10 | 7.0 |
| **Very little** | 11 | 8.2 | 16 | 11.3 |
| **Less than half** | 23 | 17.2 | 23 | 16.2 |
| **Half** | 34 | 25.4 | 28 | 19.7 |
| **More than half** | 34 | 25.4 | 30 | 21.1 |
| **Nearly all** | 19 | 14.2 | 15 | 10.6 |
| **All** | 9 | 6.7 | 20 | 14.1 |
| **Total** | **134** | **100** | **142** | **100** |

**Source:** Shepro et al. 2003 Authors noted that results include only those households responding to the census survey, and the query about the amount of subsistence harvested by the household.

### *Kivalina*

Subsistence harvest data for Kivalina, from 1992 and 2007, show 100 percent of households using subsistence resources during each year with 761 per capita pounds of subsistence resources in 1992 and 594 per capita pounds in 2007 (Braund 2008). The main species harvested tend to be Dolly Varden char, bearded seal, and caribou. Kivalina's harvest numbers have been extensively studied by Braund (2008) who noted that Kivalina's recent harvests, compared to pre-mine harvest levels, appear to have steadily decreased from 1,838 usable pounds per person in 1959–1960 to 594 pounds in 2007. This was attributed to less harvest needed to feed to dogs with the shift from sled-dogs to snowmachines as the primary mode of transportation. While Kivalina did not harvest a bowhead during 2004, data from that period indicate that rates of receiving from other communities were high at 64 percent of households receiving bowhead (Braund 2008).

**Table 3.3-31 Kivalina Estimated Harvest by Resources, 2007**

| Resource | Total Pounds | Mean Households pounds | Per Capita pounds | Percent (%) of Total Harvest |
|---|---|---|---|---|
| **All resources** | 255,344 | 3,152 | 594 | 100 |
| **Caribou** | 36,458 | 450 | 85 | 14.3 |
| **Moose** | 2,075 | 26 | 5 | 0.8 |
| **Other large land mammals** | 201 | 2 | 0 | 0.1 |
| **Bowhead** | 0 | 0 | 0 | 0.0 |
| **Beluga** | 21,890 | 270 | 51 | 8.6 |
| **Bearded seal** | 96,188 | 1,188 | 224 | 37.7 |
| **Other seals** | 5,830 | 72 | 14 | 2.3 |
| **Walrus** | 1,350 | 17 | 3 | 0.5 |

| Resource | Total Pounds | Mean Households pounds | Per Capita pounds | Percent (%) of Total Harvest |
|---|---|---|---|---|
| **Furbearers – small land mammals** | 39 | 0 | 0 | 0.0 |
| **Waterfowl** | 3,319 | 41 | 8 | 1.3 |
| **Eggs** | 839 | 10 | 2 | 0.3 |
| **Upland birds** | 233 | 3 | 1 | 0.1 |
| **Dolly Varden char** | 67,739 | 836 | 158 | 26.5 |
| **Other non-salmon fish** | 7,596 | 94 | 18 | 3.0 |
| **Salmon** | 3,445 | 43 | 8 | 1.3 |
| **Berries** | 7,398 | 91 | 17 | 2.9 |
| **Plants** | 654 | 8 | 2 | 0.3 |

**Source:** Braund 2008

### *Kotzebue*

The three main harvested species included caribou, sheefish, and bearded seal (Braund 2008, Magdanz et al. 2010). Other major harvested species include chum salmon, moose, spotted seal, and Dolly Varden char. In 1991, 99 percent of Kotzebue households reported using at least one resource, and at least 90 percent used caribou, berries, and salmon (Braund 2008). The composition of subsistence harvests in Kotzebue is considered to have remained relatively steady, with caribou, bearded seal, and sheefish among the top harvested species before and after the development and operation of nearby Red Dog Mine. The exception noted is the harvest of beluga whales as declines in amounts harvested have fallen since 1990 (Braund 2008). The composition of the subsistence harvests of Kotzebue are similar to comprehensive subsistence harvest information from seven nearby communities (based on 97 surveys) in the Kotzebue Sound area where caribou comprises 30 percent of the subsistence foods harvested (Magdanz et al. 2010).

**Table 3.3-32 Kotzebue Estimated Harvest by Resources, 2004**

| Resource | Percent of Households Harvesting | Total Pounds | Mean Households pounds | Percent of Total Harvest |
|---|---|---|---|---|
| **All resources** | - | 1,022,847 | 3,237 | 100% |
| **Caribou** | 76 | 260,459 | 743 | 25.5% |
| **Moose** | 22 | 51,215 | 135 | 5.0% |
| **Other large land mammals** | - | 472 | 4 | 0% |
| **Beluga** | 5 | 7,960 | 74 | 0.8% |
| **Bearded seal** | 40 | 204,272 | 638 | 20.0% |
| **Other seals** | - | 31,113 | 106 | 3.0% |
| **Walrus** | 3 | 12,320 | 114 | 1.2% |
| **Polar bear** | 1 | 0 | 0 | 0.0% |
| **Waterfowl** | - | 12,864 | 33 | 1.3% |
| **Eggs** | - | 605 | 2 | 0.1% |
| **Dolly Varden char** | 56 | 18,287 | 45 | 1.8% |
| **Other non-salmon fish** | 63 | 245,352 | 799 | 24.0% |
| **Salmon** | 68 | 164,689 | 499 | 16.1% |

**Source:** Braund 2008

### 3.3.2.6 Influence of Climate Change on Subsistence Resources and Uses

While the potential impacts of climate change on subsistence resources and harvests are impossible to predict, Arctic residents have observed some trends that are anticipated to continue. Changes that have been observed in the Arctic by residents include: changes in thickness of sea-ice; increased snowfall; drier summers and falls; forest decline; reduced river and lake ice; permafrost degradation; increased storms and coastal erosion; cooling in the Labrador Sea (associated with increased sea-ice melt); and ozone depletion (MMS 2008).

The communities of the Beaufort and Chukchi seas have voiced increasing concern about the potential for adverse effects on subsistence harvest patterns and subsistence resources from habitat and alterations due to the effects of global climate change. Indigenous peoples have settled in particular locations because of their proximity to important subsistence resources and dependable sources of water, shelter, and fuel. As voiced by Edna Ahmaogk at the March 9, 2010 public scoping meeting in Wainwright for this EIS:

> *[T]here is nowhere else in the world where people are still living as lively as we are, subsistence-wise, and we're not exploiting our natural resources as in most countries. You know, we're doing it for our living. And I don't want to lose that.*

MMS (2008) described how the indigenous communities and their traditional subsistence practices will be stressed to the extent that the following observed changes continue:

- villages and settlements are threatened by sea-ice melt, permafrost loss, and sea-level rise;
- traditional hunting locations are altered;
- traditional storage practices are altered due to melting in ice cellars;
- subsistence travel and access difficulties increase on land and on water; and
- resource patterns shift and their seasonal availability changes.

Changes in sea ice could have dramatic effects on sea mammal-migration routes which could impact the harvest patterns of coastal subsistence communities and increase the danger of hunting on sea ice (Callaway et al. 1999, Bielawski 1997).

Subsistence hunters have already noted such changes:

> *We realize the ecosystem we are in is very healthy and productive. However, the access, due to changing patterns in ice and weather, has affected our ability to access resources. The changes aren't all bad, because in 1990 Savoonga and Gambell started harvesting bowheads in the dead of winter. As a consequence, 40 percent of our harvests are now occurring in winter (November/December timeframe). We have begun to take steps to conduct spring whaling activities earlier so we can adjust to the changes that are now occurring in migration patterns of marine mammals, specifically the bowhead whales.* - George Noongwook, AEWC Vice Chair and representing Savoonga/St Lawrence March 2011 - Open Water Meeting, Anchorage, AK.

In addition changes in ice conditions have influenced the spring bowhead hunt in the Chukchi sea communities. Due to worsening ice conditions that are considered to be too dangerous and difficult for captains and their crews during the spring season whaling crews from Wainwright, Point Hope and Point Lay have recently been conducting fall hunts to provide for their communities and meet allotted quotas (Comstock 2011).

Social organization is underlain by subsistence in the communities of the Beaufort and Chukchi seas. Disruption of the subsistence cycle by climate change could also change the way social groups are organized and affect rates of harvest and sharing. Widespread changes in patterns of subsistence harvest, particularly serious declines in productivity, would likely result in stresses within a community or between communities.

Populations of subsistence resources of marine and terrestrial animals could be particularly vulnerable to changes in sea ice, snow cover, and changes in habitat and food sources brought on by climate change. The thawing of permafrost and sea-ice melting will continue to threaten and change important subsistence habitats and species. The reduction of sea ice would result in the loss of habitat for marine mammals, including polar bear, ringed and bearded seals, walrus, and beluga whales.

Every community in the Arctic potentially is affected by the anticipated climactic shift (MMS 2008). It is likely that the reduction, regulation, and/or loss of subsistence resources would have severe effects on the way of life for residents of coastal communities in the Beaufort and Chukchi seas who depend on subsistence resources. Shore erosion in communities such as Shishmaref, Kivalina, Wainwright, Barrow, Kaktovik, the Yukon-Kuskokwim Delta in Alaska, and in Tuktoyaktuk at the mouth of the Mackenzie River in Canada has become increasingly severe in recent years, as sea-ice formation occurs later, allowing wave action from storms to cause greater damage to the shoreline and change the usage pattern of local and regional subsistence use areas (MMS 2008).

## 3.3.3 Public Health

### 3.3.3.1 Introduction

This section presents an overview of public health in the areas that comprise the affected environment for this EIS. As described below, the affected environment for public health consists of the eight communities in the NSB and one community of the NAB whose residents may be affected by the proposed oil and gas offshore exploration activities in the Beaufort and Chukchi seas.

The description of health conditions presented in this section is considerably broader than what has, until recently, typically been included in EISs to describe the health of affected populations. This wider scope is driven by two reasons. The first reason relates to changing expectations for what constitutes a sufficient examination of human health within the regulatory process. North Slope residents, the NSB municipality, the Alaska Inter-Tribal Council, the Iñupiat Community of the Arctic Slope, the EPA, and the National Research Council (NRC) have all advocated strongly for the inclusion of a more systematic and broad-based appraisal of human health concerns in planning processes and the BLM on the national level is reassessing public health analysis in planning (MMS 2008, NRC 2003b).

The second reason has to do with data availability. Data have only recently become available that allow the health of the affected environment to be described explicitly; previously, most relevant health indicators were available only at the state level, for all rural Alaska populations, or for all Alaska Natives as a group.

In depicting health conditions in the affected environment, this section begins with a description of biomedical health outcomes—rates of disease, injury, and other indicators of ill health—and follows with a description of health determinants—the environmental and social conditions that cause or contribute to biomedical health outcomes. By including both health conditions and health determinants, this section attempts to elucidate the specific pathways through which public health may be affected, as well as the outcomes that may result.

The main health conditions that burden the population in the affected environment are the same ones that are seen elsewhere in Alaska and the U.S.: cancer; heart disease; respiratory diseases and intentional and unintentional injury; overweight/obesity; and diabetes. Overall, the rates of these conditions are parallel to that seen elsewhere in Alaska, although the rates of some conditions are higher in the affected environment.

These diseases and health conditions are multifactorial – that is, they arise from a complex combination of factors that affect populations and the individuals within them. These factors include individual behaviors, environmental conditions, institutional supports, and social and economic circumstances.

What is important to note in the context of this EIS is that the factors that are most relevant for disease generation in this population are not necessarily the same as those that apply to populations elsewhere. The unique physical, cultural, and social environments of northern Alaska determine the level of health of the population and of individuals. The health determinants described in this section—such as income and employment and subsistence participation and diet—play a critical role in supporting or undermining the health of the population.

### 3.3.3.2 Data Sources

Although the data presented in this section derive from a large number of sources, there are three sources in particular that are important to note and that have been used extensively throughout this section. The first of these is the Public Health section of the Affected Environment chapter of the Northeast NPR-A Final Supplemental Integrated Activity Plan/Environmental Impact Statement (IAP/EIS), authored by Dr. Aaron Wernham (BLM 2008a).

The second source of note is a report that is currently being prepared by Dr. Jana McAninch on behalf of the NSB Department of Health and Social Services (McAninch 2010). This report is a comprehensive compilation and analysis of health data pertaining to the communities of the NSB. The report provides extensive information on health, including analyses by age, sex, location and trends over time. The information in McAninch's report derives from the 2010 NSB census health module (described below) and also from previously published information about health conditions and outcomes in the NSB and across Alaska. The report is expected to be published in the summer of 2012, and has been cited heavily throughout this section. Wherever there are data presented that are relevant to the NSB without another reference cited, the information originates from this report.

The third key source of information is the 2010 NSB Economic Profile and Census (Circumpolar Research Associates 2010). The census results are also cited extensively in this section, particularly in the tables. Because the methodology of a census or survey influences the results, some relevant information about the census has been provided by Circumpolar Research Associates, the organization that developed and administered the census.

> *The 2010 NSB Census is the fourth in a series of local household surveys undertaken by the NSB to enumerate the local population for each community and examine topics such as employment, subsistence participation, income, housing characteristics, Iñupiaq language proficiency, and residents' attitudes on a variety of topics. Previous censuses were conducted in 1992, 1998, and 2003, although the instrument and survey design have been modified somewhat over that period.*
>
> *After mapping all the occupied structures in each community the 2010 NSB census takers conducted face-to-face interviews, attempting to reach every household in each NSB community. Sampling proportions ranged from 65 percent in Barrow to nearly 90 percent in some of the smaller communities. The total potential households for each community were determined by analyzing utility (primarily electricity) hookup data provided by the Borough. Given such high sampling fractions and absent any reasonable expectation of sampling bias this survey provides an extremely representative picture of the population. Standard errors of the proportion range from 1.9 percent to 7.5 percent depending on the community. For the North Slope Borough as a whole with 1,604 households interviewed out of total of 2,271 the standard error is 1.4 percent.*
>
> *For each household, an attempt was made to interview the adult who identified themselves as the "household head," a household member who was available and likely to have the greatest familiarity with household economics, health of household members, level of subsistence participation, etc. The respondents, or "household heads" were asked all the questions as they pertained to themselves and then a smaller subset of questions as they pertained to all other household members, acting as a proxy. Household heads participating in the census were 48 percent male and 52 percent female.*

*Household heads participating in the census were 69 percent Iñupiat, 19 percent Caucasian, and 12 percent of other ethnic groups* (Circumpolar Research Associates 2011).

Two last points are important to note about the data presented in this section. First, the population of the affected communities is relatively small, and when de-aggregated into individual villages, it is smaller still. Small populations mean small numbers of cases on an annual basis, with potentially large fluctuations from year to year. For example, two cases of cancer one year and three cases of cancer the next may appear as a 50 percent increase, although the difference between two and three is unlikely to be statistically significant. For this reason, rates of uncommon diseases or health conditions in the affected environment must be interpreted with caution.

Second, the tables often contain data that have been obtained from different sources. In this case, the original questions or methods used to obtain the data may vary between sources, and thus comparisons between these data sets should be made cautiously.

#### 3.3.3.3 Study Area and Population Demographics

The affected environment for the Public Health section of this EIS comprises the communities whose residents may be affected by social or environmental changes that result from the proposed oil and gas offshore exploration activities in the Beaufort and Chukchi seas. This includes the communities of Kaktovik, Nuiqsut, Anaktuvuk Pass, Atqasuk, Barrow, Wainwright, Point Lay, Point Hope, and Kivalina. Anaktuvuk Pass and Atqasuk are not on the coast of either the Beaufort or Chukchi seas and are not included in the affected environment of many other sections of this EIS. However, residents of these two communities use the seas for subsistence activities, a key health determinant, and therefore these communities are included in the affected environment for public health. Kotzebue is not included in this assessment as there are no proposed offshore exploration activities occurring in this area.

The population of the communities in the affected environment is described in Table 3.3-33 below. There is one larger community: Barrow, but the majority of communities are small, with populations fewer than 1,000 residents. The majority of residents in all communities (roughly 90 percent except in Barrow) are Iñupiat or Alaska Natives. The population is very young, with the median age between 20 and 25 years old and children comprising 34 percent of the population in the NSB. This age structure influences the health conditions likely to be observed in the affected environment, since younger populations are more likely to experience higher rates of infectious diseases, injuries, and some mental illnesses. Older populations, in contrast, tend to exhibit higher rates of chronic disease such as heart disease, diabetes, arthritis, and cancer.

**Table 3.3-33 Population Demographics in Affected Environment Communities**

| Community | Population size | Percent (%) Iñupiat/Alaska Natives | Median Age | Proportion of residents over the age of 65 | Proportion of residents under the age of 18 |
|---|---|---|---|---|---|
| **North Slope Borough (NSB) Communities** | | | | | |
| **Anaktuvuk Pass** | 346 | 88 | 25.7 | 4% | 36% |
| **Atqasuk** | 250 | 91 | 26.3 | 6% | 39% |
| **Barrow** | 4,429 | 61 | 28.8 | 5% | 32% |
| **Kaktovik** | 286 | 88 | 32.1 | 10% | 30% |
| **Nuiqsut** | 416 | 92 | 23.8 | 6% | 31% |
| **Point Hope** | 764 | 91 | 21.8 | 8% | 37% |
| **Point Lay** | 260 | 86 | 20.8 | 5% | 40% |
| **Wainwright** | 556 | 94 | 24.5 | 8% | 35% |
| **Northwest Arctic Borough (NAB) Community** | | | | | |
| **Kivalina** | 388 | 97 | 20.8 | n/a | n/a |

Data: NSB 2011a, ADCCED 2010, Advameg, Inc. 2009. Note that these data are derived from the 2000 and 2003 census.

The focus of the analysis of impacts in Chapter 4 will consider the entire affected environment to the degree to which effects are predicted for each community. In this chapter, current health conditions are described more intensively for the eight communities of the NSB than for Kivalina in the NAB. This is primarily because more specific and fine-grained data about health conditions exists for the NSB communities, as described in Section 3.3.3.2 (Data Sources). However, Kivalina shares many common features with the NSB communities, including many lifestyle, environmental, social, economic, and cultural conditions that determine health outcomes, such as reliance on subsistence resources, including the Western Arctic Caribou Herd, remote location, small population comprised mainly of Iñupiat people, limited infrastructure, housing type, and availability and limited economic opportunities. In addition, many of the health outcome indicators described in this chapter indicate that biophysical health outcome measures are likely to be similar for the populations in NSB and NAB communities. As a result, the impact pathways between proposed alternatives and human health outcomes are likely to be similar for NSB communities and Kivalina, as are the effects that will be experienced. The additional fine-grain of detail available for NSB communities therefore provides an extra source of information that will help in the analysis of impacts; but the lack of this same level of detail for Kivalina will not preclude a full assessment of impacts for that location.

### 3.3.3.4 Biomedical Health Outcomes

This section presents an overview of biomedical health outcomes and diseases experienced by the population in the affected environment. Biomedical health refers to illnesses, diseases, injuries, and other health states experienced by individuals.

#### General Health Indicators

General health indicators provide a picture of the overall health status of the population. The health indicators presented in this section reflect important measures of population health and wellness that can be compared across time and across different regions to understand how the health of one population compares with the health of others.

## Table 3.3-34 General Health Indicators in the NSB

| | Anaktuvuk Pass | Atqasuk | Barrow | Kaktovik | Nuiqsut | Point Hope | Point Lay | Wainwright | All NSB | All Alaska |
|---|---|---|---|---|---|---|---|---|---|---|
| **Reported health status, adults** | | | | | | | | | | |
| "Very good" or "excellent" general health | 32% | 21% | 53% | 38% | 39% | 36% | 52% | 35% | 46% | 56%[a] |
| "Fair" to "Poor" general health | 4% | 34% | 13% | 19% | 22% | 21% | 10% | 21% | 16% | 14%[a] |
| **Reported health status, children** | | | | | | | | | | |
| "Very good" or "excellent" general health | 41% | 38% | 68% | 66% | 55% | 66% | 70% | 54% | 63% | 89%[b] |
| "Fair" to "Poor" general health | 4% | 9% | 4% | 10% | 16% | 7% | 1% | 7% | 6% | |

Source: [a] CDC 2008 [b] CAHMI 2007
Source: Circumpolar Research Associates 2010,

## Table 3.3-35 Leading Causes of Death in the EIS Project Area

| | North Slope Borough 2006-2008 | | | Northwest Arctic Borough 1999-2003 | | | Alaska 2006-2008 | |
|---|---|---|---|---|---|---|---|---|
| | Rank | Number of Deaths | Rate (age-adjusted) | Rank | Number of Deaths | Rate (age-adjusted) | Rank | Rate (age-adjusted) |
| **Cancer** | 2 | 29 | 272.9 | 1 | 39 | 347.8 | 1 | 181.3 |
| **Heart Disease** | 1 | 26 | 274.8 | 2 | 28 | 321.3 | 2 | 154.8 |
| **Unintentional injuries** | 4 | 17 | 125.2 | 3 | 38 | 133.6 | 3 | 54.8 |
| **Chronic Lower Respiratory Diseases** | 3 | 10 | 144.3 | n/a | n/a | n/a | 5 | 42.5 |
| **Suicide** | 5 | 10 | 53.3 | 4 | 30 | 79.5 | 6 | 22.7 |

Notes: Rates are per 100,000 persons, age-adjusted to U.S. year 2000 standard population. Ranks are based on age-adjusted rates.
Source: State of Alaska Department of Health and Social Services 2008, AN Epicenter 2008

As can be seen from the data in Table 3.3-34, residents of the NSB report lower rates of excellent/very good health and higher rates of fair/poor health than residents of Alaska as a whole, both for children and for adults, with considerable diversity among the different NSB communities. Self-rated health is one of the strongest, most consistent predictors of illness, premature death, health care utilization, and hospitalization (Idler and Benyamini 1997). The observation that NSB residents experience poorer overall health than other Alaskan residents is supported by data that show the NSB ranking 17$^{th}$ out of 22 Alaskan census areas for overall health outcomes, based on a combination of standard health indicators (MATCH 2010).

Life expectancy and mortality are also commonly used to evaluate and compare the health of populations. Between 1999 and 2008, the life expectancy at birth for a resident of the NSB was estimated as 71.9 years, approximately four years shorter than for Alaskans overall (75.6 years), although the estimate was similar to that for Alaska Natives statewide (State of Alaska Department of Health and Social Services

2008). However, rates of adult and infant mortality have declined in the NSB over the past three decades, representing overall health improvements in the area.

Since the early 1990s, the leading causes of death in the NSB have been fairly constant. Cancer is the leading cause of death in both the NSB and across Alaska, followed by heart disease and respiratory disease (Table 3.3-35). In the NAB, the leading causes of death in Alaska Natives, which make up 97 percent of the population are cancer, heart disease, and unintentional injuries (Table 3.3-35) (AN Epicenter 2008). Rates of death for all leading causes of death are much higher in the affected environment than in the State of Alaska.

## Chronic Diseases

**Table 3.3-36 Chronic Disease in the NSB**

| | All NSB | All Alaska |
|---|---|---|
| **Proportion of adults who report a health professional diagnosis of:** | | |
| High blood Pressure | 20% | 26%[a] |
| Heart disease | 5% | 3%[b] |
| Thyroid problems | 4% | 9% (U.S.)[c] |
| **In the past 12 months, percent who experienced:** | | |
| Chronic breathing problems (adults) | 8% | 10%[d] |
| Chronic breathing problems (children under 18) | 5% | 5-6%[d] |
| Daily pain or arthritis that limits activities or requires prescription pain medicine | 21% | 22%[a] |

Notes:
[a] CDC 2009
[b] CDC 2008 (Heart disease: Alaska estimate includes only diagnoses of angina, heart attack, coronary heart disease. NSB estimate may include other types of heart disease such as congestive heart failure, heart rhythm problems, or valvular heart disease)
[c] Melzer 2010
[d] Based on CDC 2004, Gessner and Utermohle 2006, CAHMI 2007
Source: Circumpolar Research Associates 2010, with the exception of those noted here

Important chronic diseases in the affected environment include chronic respiratory disease, cancer, and cardiovascular conditions. The leading causes of self-reported health problems among Iñupiat adults (over age 16) participating in a 2004 survey were high blood pressure (reported in 29 percent of respondents), arthritis/rheumatism (21 percent), asthma (21 percent), stomach problems or intestinal ulcers (15 percent), chronic bronchitis, emphysema, or shortness of breath (12 percent), and heart problems (9 percent) (Poppel et al. 2007).

Chronic lower respiratory disease (CLRD) is one of the most frequently cited health concerns among community members in the NSB and has been the fifth leading cause of death in the Borough for most years since 1990. Mortality rates from CLRD in the NSB remain almost twice statewide rates and nearly three times the mortality rate for the U.S. (130 per 100,000 residents compared with 45 per 100,000) (Day et al. 2006). Approximately eight percent of NSB adults and five percent of NSB children report having chronic breathing problems (Table 3.3-36). These values are slightly lower than state or national rates; however, the difference is not statistically significant. Asthma rates are fairly evenly distributed amongst Alaska residents with no differences seen between urban and rural or Native and non-Native populations (McAninch 2010). A number of environmental factors are known to trigger or exacerbate asthma and CLRD symptoms, including exposure to tobacco smoke, exhaust from heating sources and nearby

vehicles, and outdoor and indoor air quality. Arctic residents are particularly vulnerable to indoor air pollution due to tightly sealed houses and poor ventilation, as well as prolonged time spent indoors (Gordian 2004). High rates of smoking in the NSB may be a primary cause of high respiratory disease rates. However, because there are no available data on local fine particulate concentrations, hazardous air pollutants, indoor air quality, and little data on intra-regional variation in other EPA-criteria pollutants, it is not possible to estimate the possible contribution of environmental factors to chronic respiratory disease in the area (NRC 2003b).

Cancer is the leading cause of death across Alaska, among Alaska Natives, and in the NSB, and it is understandably a major community health concern in many areas. Between 1996 and 2007 there were a total of 225 cases of cancer reported in the NSB (McAninch 2010). This corresponds to an age-adjusted annual incidence rate of 491.7 cancers per 100,000 population, compared with 482.9 for all of Alaska and 468.5 for the U.S. Because the numbers of cancers in the NSB are small, there is the potential for a large margin of error, and a great deal of year-to-year variation, and therefore the differences between the NSB and Alaska/the U.S. are not statistically significant.

The most common cancers in the NSB are lung/bronchus, colon/rectum, prostate, and breast. These are also the most common four cancers across the state and the U.S., and it is likely that this trend is the same in Kivalina. Age-adjusted rates of lung and colorectal cancers in the NSB for the years 1996 to 2007 are approximately double the national rates; however, rates of prostate and breast cancers are close to half the national rate. For other cancer sites, the number of cases across the NSB is so small that it is difficult to compare the rates with those in other jurisdictions.

While many people in the NSB, like people in many other places, are concerned about environmental contamination as a possible contributor to cancers, there is no easy way to determine whether or to what extent environmental factors play a role. What is known is that tobacco smoking is currently a large contributor to cancers in the NSB and among Alaska Natives and circumpolar Inuit and directly contributes to high rates of lung cancer and overall cancer mortality.

Cardiovascular disease has been a leading cause of death in the U.S. for many decades and is currently the second leading cause of death in Alaska. The amount, or prevalence, of cardiovascular disease has been increasing in the NSB, but death from cardiovascular disease has been decreasing, which has frequently been attributed to improvements in medical intervention. Smoking, excess weight, and diabetes, all of which have been increasing in the NSB, are risk factors for cardiovascular disease. Rates for heart disease in the NSB are slightly higher than the state average (Table 3.3-36).

Arthritis refers to a number of separate conditions affecting joints, bones, and supporting tissue. Rates of arthritis in the NSB are around 21 percent (Table 3.3-36), which is very similar to the national average.

Diabetes is another chronic disease of great importance in the NSB due to its association with dietary factors and is discussed below in the section titled Nutritional Outcomes.

## Infectious Diseases

Infectious diseases disproportionately impact Alaska Natives, illustrated by higher incidence rates and higher rates of hospitalization than non-Natives (Holman et al. 2001). The main infectious diseases that are often impacted by resource development are sexually transmitted infections (STIs) and infectious respiratory diseases, including tuberculosis (TB).

The reported rates of the STIs chlamydia, gonorrhea, and hepatitis C have increased since mandatory reporting began in 1996. Gonorrhea increased dramatically in 2007 with 59 new cases reported in the NSB, compared with between six and 30 cases per year for the six years prior (Cecere 2008). For all three of these infections, incidence rates are substantially higher in the NSB than the Alaska average; however, the trend of increasing incidence parallels similar trends seen in the state and across the nation (McAninch 2010, NCSTDD 2005). Higher rates prevail among all Alaska Natives compared with non-

Natives; STI rates between two and six times higher have been reported for chlamydia, gonorrhea, syphilis, and hepatitis for Alaska Natives statewide, compared to non-Alaska Natives (NCSTDD 2005). There have been no new reported cases of Human Immunodeficiency Virus (HIV) in the NSB since 1995 (McAninch 2010).

Infectious respiratory diseases are common and include lower respiratory tract infections (LRIs), such as pneumonia and respiratory syncytial virus, and upper respiratory tract infections (URIs), such as colds, flus, and the common complication of ear infections. URIs account for almost one-third of visits with assessments in the NSB (Golnick 2009) and contribute to days missed at work/school, increased health care costs, and can sometimes lead to more serious health problems. LRIs can be very serious; in 2006 to 2007, an outbreak of respiratory syncytial virus occurred on the North Slope, resulting in the hospitalization of 53 infants and young children in Barrow. Twenty-eight children required transport to Anchorage for intensive care (McAninch 2010).

TB is another infectious disease of great public importance, particularly given the devastation wrought by TB in rural Alaska half a century ago. There has been an average of less than one new case a year reported in the NSB over the past 25 years; however, the state of Alaska is hoping to reduce this rate even further (Pearson 2002).

A disease of concern among Alaska Natives is *Helicobacter pylori* (*H. pylori*) infection. *H. pylori* is commonly found in conditions with inadequate sanitation and causes chronic inflammation of the stomach and small intestine, and may be associated in Alaska Natives with iron deficiency and anemia among children (DiGirolamo et al. 2007, Baggett et al. 2006) and possibly with stomach cancer among adults. Unusually high rates of *H. pylori* have been found among Alaska Natives. Based on a sample of approximately 2,000 stored blood samples taken between 1980 and 1986, rates of *H. pylori* infection were estimated to be about 75 percent among Alaska Natives (Parkinson 2000). While the reasons for these high rates are not clear, the strain of the bacteria is unusually resistant to treatment (Centers for Disease Control 2011).

Few parasitic diseases have been reported in the literature as presenting a significant medical problem in Alaska. The parasitic diseases most likely to cause problems in humans in the area are giardia, brucellosis, and trichinella. However, concern has been raised that changing of the landscape, water supply, and subsistence food practices (including food harvesting, preparation and storage) caused by climate change, development activities, or other causes, could cause an increase in the rates of parasitic diseases experienced by humans (Brubaker et al. 2011).

## Nutritional Outcomes

Diet and nutrition play an important part in health. Healthy diets prevent disease and are important to maintain at community and individual levels. Native populations in Alaska and elsewhere have experienced marked changes in disease patterns stemming from the rapid transition from a healthy subsistence diet to a more Western diet and lifestyle, resulting in drastic increases in obesity, diabetes, and other chronic diseases (Kuhnlein and Receveur 1996).

**Table 3.3-37 Nutritional Outcomes Among Adults in the NSB**

| | Anaktuvuk Pass | Atqasuk | Barrow | Kaktovik | Nuiqsut | Point Hope | Point Lay | Wainwright | All NSB | All Alaska |
|---|---|---|---|---|---|---|---|---|---|---|
| Diabetes | | | | | | | | | 6% | 6%[a] |
| Overweight (BMI 25-29.9 kg/m$^2$, based on self-reported height and weight)[2] | | | | | | | | | 33% | 37%[a] |
| Obese (BMI 30 kg/m$^2$ or higher, based on self-reported height and weight)[2] | | | | | | | | | 39% | 28%[a] |
| Percent of households that found it difficult to get the foods they needed to eat healthy meals in the past year | 57% | 59% | 28% | 40% | 38% | 36% | 51% | 46% | 35% | |
| Percent with household members who at times did not have enough to eat | 40% | 20% | 14% | 19% | 25% | 24% | 22% | 30% | 19% | |

Notes: [a] CDC 2009
Source: Circumpolar Research Associates 2010, with the exception of that noted here

**Table 3.3-38 Nutritional Outcomes Across Alaska**

| Indicator | All Alaska | American Indian / Alaska Native | All Rural Alaska |
|---|---|---|---|
| Proportion of Alaskan adults with pre-diabetes or borderline diabetes | 8.1% (95% confidence interval: 7.0% - 9.4%) | 10.1% (95% confidence interval: 7.4% -13.6%) | 6.5% (95% confidence interval: 4.9% - 8.6%) |
| Proportion of Alaskan adults with non-gestational diabetes | 6.7% (95% confidence interval: 5.7% - 7.8%) | 8.2% (95% confidence interval: 5.7% - 11.6%) | 5.7% (95% confidence interval: 3.9% - 8.1%) |

Source: Parnell et al. 2008

Overweight, obesity, and diabetes present significant health burdens to NSB (Parnell et al. 2008). This constellation of disorders is linked with increased risk of developing a number of other chronic health problems, including high blood pressure, heart disease, arthritis, certain cancers, and some types of respiratory problems.

As shown in Table 3.3-37, in 2006 to 2008 the NSB had substantially higher estimated adult obesity rates than the Alaska average, with almost two-thirds of residents self-reporting as overweight or obese. One-half of children in the NSB are overweight or obese, making rates of childhood obesity in the NSB well above the state average for Alaska. Between 1990 and 2005, the prevalence of diabetes in the Barrow service unit increased by roughly 130 percent, or by nearly three times the overall U.S. rate (ANMC 2010). Across all of Alaska, rates of overweight individuals are similar in Natives compared to non-Natives, although rates of obesity are significantly higher in Alaska Natives (38.1 percent vs. 26.1 percent) (Parnell et al. 2008).

Rates of diabetes among adults in the NSB vary substantially depending on the data source. The NSB census data show rates very similar to those of adults across Alaska, and this similarity has also been found in the Behavioral Risk Factor Surveillance Survey telephone survey data (Tables 3.3-37 and 3.3-38). However, the Alaska Native Medical Center's diabetes program that maintains a statewide diabetes registry found the age-adjusted diabetes prevalence for the Barrow service area to be the second lowest in the state, estimated at only 2.8 percent (ANMC 2010). As has been happening across the country and state, rates of diabetes have risen rapidly in the NSB over the last several decades. Between 1985 and 2005, the crude prevalence of diabetes seen in the Barrow service unit approximately doubled (McAninch 2010).

Food insecurity and a change away from subsistence food sources may contribute to the risk for obesity and the associated chronic illness for residents in the NSB. Food insecurity refers to an inability to secure sufficient healthy food for a family. Those facing food insecurity tend to consume cheaper, high-calorie food with low nutrient value (ADPH 2005, Bersamin et al. 2006, Bersamin and Luick 2007, Bersamin et al. 2008). This is often because processed or packaged foods are cheaper and more readily available in rural/remote areas than fruits and vegetables, often because of their longer shelf life. Rates of food insecurity are high in the NSB with 19 to 40 percent of households reporting not having enough food to eat at times (Table 3.3-37). Food availability from subsistence foods is discussed further in Section 3.3.2.5, Community Subsistence Harvest Rates.

## Injuries

Injuries are an important health outcome that can lead to lost worker productivity and income, increased health care costs over the short and long term, disability, and even death (McAninch 2010). Injuries not only impact those involved; caregivers and family members can also experience mental anguish and decreased quality of life. In Alaska, injuries account for a large proportion of premature death, particularly in children and within Native populations (McAninch 2010).

**Table 3.3-39 Leading Causes of Injury Hospitalization for Alaska Natives in the EIS Project Area, 1991-2003 (rate per 10,000)**

| Injury Type | North Slope | Northwest Arctic | All Alaska Natives |
|---|---|---|---|
| **Falls** | 39.9 | 34.8 | 38.7 |
| **Suicide attempt** | 24.2 | 34.8 | 20.4 |
| **Assault** | 19.7 | 21.8 | 18.5 |
| **Snow machine** | 15.1 | 21.2 | 7.7 |
| **All-terrain vehicle** | 14.6 | 14.1 | 6.1 |
| **Motor vehicle** | 11.2 | 4.6 | 13.7 |
| **All unintentional injury** | 119.4 | 115.4 | 99.8 |

Source: ANTHC 2008; n/a – data not available

**Table 3.3-40 Leading Causes of Injury Death for Alaska Natives in the EIS Project Area, 1999-2005 (age-adjusted rate per 100,000)**

| Injury Type | North Slope Borough | Northwest Arctic Borough | All Alaska Natives | All U.S. |
|---|---|---|---|---|
| **Suicide** | 61.3* | 81 | 37.9 | 10.7 |
| **Drowning** | n/a | 37.1* | n/a | n/a |
| **Off road vehicle** | n/a | 33.3* | n/a | n/a |
| **All unintentional injury** | 106.8 | 132.4 | 101.8 | 36.3 |
| **Total injury** | 188.1 | 243.9 | 154.9 | 54.8 |

Source: ANTHC 2008; Note: *fewer than 20 cases reported, interpret rate with caution; n/a – data not available

In the NSB, injury (which includes unintentional injuries, suicide, assault, and homicide) is the second leading cause of death, as well as the second leading reason for hospitalization, and disproportionately impacts younger populations (NRC 2003b). The Alaska Trauma Registry reports that the NSB has the highest rates of hospitalizations due to injuries in the state (141 per 100,000 residents), over double the state average (NRC 2003b). Hospitalization rates due to different types of injuries are presented in Table 3.3-39 for Alaska Natives in the NSB and the NAB. Overall, hospitalization rates are comparable across Alaska Natives in the NSB and NAB. High risk-taking behavior, much of which is associated with alcohol consumption, is thought to contribute to many injuries. The unique social and physical environments in Alaska's north also contribute to high injury rates in this area. Unusual ice patterns, resulting from changes to the climate are also making ice travel more dangerous (Brubaker et al. 2011). The number and severity of injuries may be substantially underreported, due to a lack of hospital facilities in the communities and limited hospital beds in Barrow, which results in many injuries being treated as outpatient visits rather than hospitalizations.

Death due to injury also disproportionately affects Alaska Natives compared to other population groups. Injury is the leading cause of death amongst Alaska Natives (ANTHC 2008). The rate of mortality for unintentional injury is approximately 3.5 times higher for Alaska Natives than U.S. Caucasians (Day et al. 2006). Table 3.3-40 depicts these trends for suicide, drowning, off road vehicles, all unintentional injuries and total injury for Alaska Natives and compares the rates to those in the U.S. Rates of death due to injury in the affected area for Alaska Natives are many times more the rates than for the general U.S. population.

## Social Pathologies and Mental Health

Social and psychological problems, including alcohol and drug problems, unintentional and intentional injury and suicide (a high percentage of which are associated with alcohol use), depression, anxiety, and assault and domestic violence, are now highly prevalent on the North Slope (as they are in many rural Alaska Native and Arctic Inuit villages in Canada and Greenland) and cause a disproportionate burden of suffering and mortality for these communities (MMS 2008). These problems rarely occur in isolation, but usually arise in the context of specific sociocultural and physical environments that shape human behavior. Research in circumpolar Inuit societies suggests that social pathology and related health problems, which are common across the Arctic, relate directly to the rapid sociocultural changes that have occurred over the same time period (Bjerregaard et al. 2005, Curtis et al. 2005, Goldsmith et al. 2004).

**Table 3.3-41 Social Pathologies in the NSB**

| | All NSB | All Alaska |
|---|---|---|
| In the past 12 months, felt a household member had been hurt by drugs or alcohol[1] | 30% | n/a |
| In the past 12 months, felt the health of their community had been hurt by drugs or alcohol | | |
| Often | 57% | n/a |
| Sometimes | 35% | n/a |

Notes: [1] Includes all head of households (survey respondents)
Source: Circumpolar Research Associates 2010

**Table 3.3-42 Mental Health Across Alaska**

| Indicator | All Alaska | American Indian / Alaska Native | All Rural Alaska |
|---|---|---|---|
| Proportion of Alaskan adults with current moderate-to-severe depression | 7.6% (95% confidence interval: 5.9% - 9.7%) | 9% (95% confidence interval: 6% - 15%) | 8% (95% confidence interval: 5% - 11%) |

Source: Parnell et al. 2008

Alcohol and drug misuse, which usually comprise a significant component of and contributor to social pathologies. As shown in Table 3.3-41, a large proportion of NSB residents feel that their families and communities have been hurt by drug or alcohol use.

In 2006 to 2008, suicide was the fourth leading cause of death in the NSB. Since 1990, age-adjusted suicide mortality rates in the NSB have averaged twice the statewide average and four times the national average, with a rate of 52.9 suicides per 100,000 population between 2004 and 2006 (AIPC et al. 2006). Alaska Natives are at particular risk of suicide, comprising 39 percent of all suicides in the state (AIPC et al. 2006). This trend is also apparent in youth; 13.8 percent of Alaska Native high school students reported having had attempted suicide in the previous 12 months compared to 6.4 percent of white high school students (McAninch 2010). Overall, true suicide rates are thought to be higher than the rates reported, as a significant percentage of accidental injury deaths are thought to be due to suicidal risk-taking behavior (McAninch 2010).

Mental health is a critical part of overall health. The Survey of Living Conditions in the Arctic estimated that six percent of adult Iñupiat in the NSB were likely suffering from depression (Poppel et al. 2007). This figure appears similar to statewide estimates for Alaskan adults, although the figures are not directly comparable due to differences in survey methodology. Rates of depression for Alaska Natives are reported as being slightly higher than the state average (Table 3.3-42). However, underreporting of mental health problems is common, especially in some Native populations (McAninch 2010). Other societal factors, such as high rates of domestic violence and suicide mentioned above, as well as high rates of child maltreatment, indicate that mental health status in the NSB might be worse than what these statistics imply (McAninch 2010). In both the NSB and in other populations, depression and anxiety are often higher among youth than adults.

Rates of assault and domestic and sexual violence in Alaska are consistently among the highest in the nation. The NSB is no exception to this trend. The U.S. Department of Health and Social Services

reported that between 2000 and 2003 rates of rape and assault in the NSB were 8 to 15 times greater than the national average (NRC 2003b). During 2004 to 2006, 29 percent of adult respondents reported having been hit, hurt, or threatened by an intimate partner sometime in their lifetime. Although this figure is not markedly different than the state average of 22 percent, it is still concerningly high (CDC 2006). Within the NSB, there can be considerable variation among communities; in Barrow in 2003, rates of reported domestic violence were six times higher than reported in the rest of the state (ANDVSA 2004). Across the state, Alaska Natives suffer disproportionately higher rates of domestic violence than non-Alaska Natives (Rivera 2010).

## Maternal and Child Health

Indicators of maternal and child health provide insight into overall health status and social wellbeing at a societal level, since they are highly sensitive to changing social and environmental conditions. The infant mortality rate for the NSB was reported as 9.2 per 1,000 live births between 1998 and 2007. Although this rate has been steadily declining in the NSB since 1977, this rate is still higher than the state rate of approximately 6.5 deaths per 1,000 live births and is above the state target of 4.5 per 1,000 live births (Pearson 2002). However, the NSB has the lowest 10-year average infant mortality rate of all the northern, southwest, and interior rural Alaskan regions (ABVS 2007).

Child mortality among all Alaska Natives is higher than among Alaska non-Natives, and this health disparity has persisted over many years. Between 2003 and 2005, child mortality among children ages 1 to 4 was 103.4 per 100,000 population in Alaska Native children vs. 23.7 per 100,000 for non-Native children (Schoellhorn et al. 2008). The proportion of deaths due to unintentional injuries among all Alaska Natives increases from young children to adolescents to teenagers. While homicide is the second leading cause of death in children aged 0 to 9, suicide becomes the second leading cause of death for youth and teens (Schoellhorn et al. 2008).

Mortality is not the only indicator of child health. Of particular relevance to the NSB is tooth decay, a health issue that is predominant in Native populations across the country. Rates of untreated tooth decay in Alaska Native and American Indian children have been two to five times the rates for non-Native children (IHS 1999, Riedy 2010), and high intakes of sugar-sweetened beverages appear to be a causative factor. As discussed earlier in the section titled Nutritional Outcomes, diabetes and obesity also greatly impact youth of the NSB and represent serious public health concerns.

## Health Disparities

Although population-level health data are usually presented in a way that aggregates individual experience and shows the "average" experience of health, it is important to note that significant health disparities exist among individuals, and also among subsets of the population. While some people and some groups will always be healthier than others, systematic health disparities—also termed *health inequities*—generally arise along predictable lines. Groups that experience some areas of disadvantage, such as economic disadvantage, environmental injustice, or social dysfunction, are usually those that experience health disparities.

In Alaska, these health inequities can generally be found when looking at differences between rural and urban populations, and among racial and socioeconomic groups. Alaska Natives, people living in rural areas, and the poor are generally worse off in terms of almost all measurable health outcomes.

Examples of health disparities between Alaska Natives and non-Natives can be seen in a large number of health outcome indicators. In the year 2000, the life expectancy for Alaska Natives was 69.5 years, lagging the life expectancy of 76.5 years for the general U.S. population (Parkinson 2006). Rates of unintentional injury are higher in Natives, as is cancer mortality, social pathologies (including suicide, homicide, family and intimate partner violence), smoking-related illness such as lung cancer, and CLRD (Day et al. 2006, Lanier et al. 2006). Indicators of maternal and child health are also worse for this group.

Disparities are neither fixed nor uniform. While patterns may be observed in the population at large, the health of individuals within any group will vary widely. And regardless of disparities, many disadvantaged groups in Alaska have seen substantial improvements across a wide range of health indicators over the last several decades.

### 3.3.3.5 Health Determinants

To a large extent, health is determined by where we live, the state of our environment, our income and education levels, our jobs, and our relationships with friends, family, and the larger community. These critical factors are often called *health determinants* (or determinants of health) because of their roles in shaping health in individuals and communities. Some health determinants are under the direct control of individuals, for example, the choice to use alcohol or to smoke, to eat healthy foods, or to use snow machines or four-wheeler helmets. Other health determinants are more closely tied to the physical environment (e.g. air and water quality; subsistence resources); activities under the control of governments (public utilities, land use, access to alcohol and tobacco); working conditions (jobs, income); or the social environment (social, emotional, and religious supports).

The biomedical health outcomes described in Section 3.3.3.4 share the fact that rates of disease incidence, prevalence, and mortality are driven in large part by these determinants, although other factors, such as genetic factors, also play a role. The effects of individual health determinants on disease rates often persist even after controlling for standard risk factors such as smoking rates, cholesterol and blood pressure levels, and overall poverty.

The following sections describe a number of health determinants that are relevant for the affected population and to potential development that may stem from the proposed oil and gas offshore exploration activities in the Beaufort and Chukchi seas.

Table 3.3-43 shows where there is an evidence-based interaction between the health determinants presented below and the biomedical health outcomes presented above, especially those that may be applicable for the affected population (Driscoll 2009).

**Table 3.3-43 Interaction Between Health Determinants and Health Outcomes in the EIS Project Area**

| | Chronic diseases | Infectious diseases | Nutritional outcomes | Injuries | Social pathologies and mental health | Maternal and child health |
|---|---|---|---|---|---|---|
| **Income and employment** | X | X | X | X | X | X |
| **Subsistence participation and diet** | X | X | X | X | X | |
| **Health care services and emergency preparedness** | X | X | X | X | X | X |
| **Alcohol and drug misuse** | X | X | | X | X | X |
| **Culture and language** | | | X | | X | |
| **Environmental contamination** | X | | X | | X | X |
| **Climate change** | | X | X | X | | |

Source: Driscoll 2009

## Income and Employment

The economy is one of the fundamental drivers of population health and wellness. A large body of research has explored the links to health of both societal-level economic structure (such as disparity) and individual-level wealth (such as income and job satisfaction). At its most basic, income provides the ability for individuals to meet their core needs: shelter; food; clothing; and other necessities. However, the health benefits of a "good job" go far beyond bare necessity. Work that provides an identity, social networks, a sense of worth and opportunities for personal growth can drive health outcomes, such as longevity, reductions in chronic disease, and a greater sense of well-being (Doyle et al. 2005). At the same time, workplace hazards—for example, from physical risks through chemical exposures—can be a significant source of ill-health in a community.

The EIS project area, like most of rural Alaska, faces fluctuating employment markets with limited job opportunities and chronic levels of unemployment and underemployment. Iñupiat residents have identified the lack of good jobs as a priority issue (Poppel et al. 2007). Importantly, residents state that they would prefer to participate in a combination of wage-based and traditional subsistence activities (Poppel et al. 2007).

Poverty has a devastating negative impact on health, particularly for children, due to its association with chronic stress, poor nutrition, increased exposure to crime and victimization, fewer opportunities, and problems with access to health care. From 2001 to 2008, the NSB estimated rates of residents living below the poverty level were above state levels (Circumpolar Research Associates 2010) despite the oil and gas development that occurred during this time. Poverty may disproportionately affect the Iñupiat population, which has substantially lower median household incomes than non-Iñupiat NSB residents (Circumpolar Research Associates 2010).

Economic indicators for NSB communities are discussed extensively in Section 3.3.2, Socioeconomics.

## Subsistence Participation and Diet

**Table 3.3-44 Food and Nutrition in the NSB**

| | Anaktuvuk Pass | Atqasuk | Barrow | Kaktovik | Nuiqsut | Point Hope | Point Lay | Wainwright | All NSB |
|---|---|---|---|---|---|---|---|---|---|
| Times last year when household found it difficult to get the foods they needed to eat healthy meals[1] | 57% | 59% | 28% | 40% | 38% | 36% | 51% | 46% | 35% |
| If yes, because not able to get enough subsistence foods | 71% | 34% | 34% | 44% | 53% | 59% | 48% | 36% | 43% |
| If yes, because not able to get enough store foods | 80% | 100% | 90% | 88% | 87% | 86% | 96% | 95% | 90% |
| Households that get at least half of their meals from subsistence sources | 67% | 58% | 44% | 67% | 67% | 64% | 61% | 67% | 54% |

Notes: [1]Includes all head of households (survey respondents)
Source: Circumpolar Research Associates 2010

Diets in the NSB include both traditional, or subsistence foods, and non-traditional, or store foods. Traditional diets are associated with numerous health benefits and reduced risk of many chronic diseases including diabetes, high blood pressure, high cholesterol, heart disease, stroke, arthritis, depression, and some cancers (Reynolds et al. 2006; Murphy et al. 1995; Adler et al. 1994, 1996; Ebbesson et al. 1999, Bjerregaard et al. 2004).

While evidence of dietary habits in the NSB is limited, subsistence sources are an important food source to NSB residents. Subsistence foods include fish, seal, walrus, beluga and bowhead whale from the Beaufort and Chukchi seas, as well as land-based animals and certain migratory birds and eggs. In the 2010 NSB census, 54 percent of households indicated that they get at least half of their meals from subsistence sources. Data from the 2003 NSB census show that virtually all Iñupiat households reported relying on subsistence resources to some extent and that subsistence foods make up a large proportion of healthy meals (Table 3.3-44) (Circumpolar Research Associates 2010). The NSB also has among the highest per capita harvests of subsistence food in Alaska (McAninch 2010).

Seventy-two percent of adults in the NAB reported participating in hunting, fishing, and harvesting for subsistence (Poppel et al. 2007). The most important sea animals for residents of Kivalina include the bearded seal, beluga and bowhead whale and Arctic char (Brubaker et al. 2011). Income opportunities do not appear to substantially affect participation in subsistence activities: in agreement with previous literature (Poppel et al. 2007), even household heads with full-time employment relied heavily on traditional food sources (McAninch 2010).

Section 3.3.2 (Subsistence Resources and Uses) contains detailed information regarding subsistence harvest patterns of the Iñupiat communities in the affected environment. The section describes the cultural importance of subsistence activities to the Iñupiat, emphasizing its role in economic and nutritional outcomes and in maintaining cultural identity. Data are also provided on the community levels of subsistence harvesting by species. It is noted in this discussion that marine mammal harvest contributes a high percentage of subsistence foods in the communities that make up the affected environment. Additional subsistence activities include harvesting of fish and waterfowl.

Research and anecdotal evidence from the NSB and surrounding areas suggest a trend away from subsistence food sources, particularly in younger people (Ballew and Tzilkowski 2006). Two recent studies in Alaska found greater consumption of traditional foods by elders and more nontraditional foods by younger people (Nobmann et al. 2005, Bersamin and Luick 2007). The NSB communities are similar to many other Arctic communities in this respect: people across the circumpolar regions are increasingly replacing traditional subsistence foods, which are associated with numerous health benefits, with store-bought foods that are often high in sugar, calories, and unhealthy types of fat. NSB residents are also consuming high levels of sodas and other sugared beverages (Circumpolar Research Associates 2010).

A common explanation for the trend away from subsistence food sources has been residents' concern over the quality of traditional foods. Many people believe subsistence foods are contaminated (Poppel et al. 2007). The issue of contamination is complex, and the potential for harm due to ingestion of contaminants has not been definitively answered. Nonetheless, the perception of contamination (regardless of whether or not any "real" contamination exists) may lead people to avoid healthy traditional foods and rely more heavily on store-bought foods, with resulting health consequences. Other reasons that have been cited for choosing store-bought foods over traditional foods included not having anyone to hunt for the family and lack of transportation and/or time or traditional knowledge to hunt and gather (Ballew et al. 2004).

A limited availability and variety of store-bought food is particularly prevalent in rural Alaska due to small community sizes, high costs, and limited transportation. This results in a domination of foods that have a longer shelf-life, which tend to be high in fat, salt, and calories.

## Health Care Services

### Table 3.3-45 Health Insurance in the NSB

| | All NSB | All Alaska |
|---|---|---|
| Have health insurance, including IHS eligibility | 97% | 82%[a] |
| Have health insurance, other than IHS eligibility | 64% | |

Notes: Includes all head of households (survey respondents)
[a] CDC 2009
Source: Circumpolar Research Associates 2010, with the exception of that noted here

### Table 3.3-46 Health Insurance across Alaska

| Indicator | All Alaska | American Indian / Alaska Native | All Rural Alaska |
|---|---|---|---|
| Proportion of Alaskan adults with health care coverage | 83.2% (95% confidence interval: 81.4% - 84.8%) | 84.3% (95% confidence interval: 80.9% - 87.2%) | 78.9% (95% confidence interval: 75.4% - 82.0%) |

Source: Parnell et al. 2008

Health care resources play a specific role in prevention—and a widespread role in treatment—of disease and illness. The adequacy of health care resources is dependent on both universality of access and availability of resources. The provision of health care services may be limited, especially in rural areas, by the unavailability of health care providers. Rural areas often have problems with both recruitment and retention of medical personnel, and some areas are chronically understaffed and underserved. Access to specialist care (and some of the allied health professions, such as mental or nutritional health) is also quite limited in rural areas, unless the patient travels to a major population center.

Provision of health care in the NSB is the joint responsibility of the NSB and the Arctic Slope Native Association (ASNA). Other than Barrow, all NSB communities of the NSB maintain a clinic that is staffed by Community Health Aide/Practitioners. None of these communities have a physician or physician's assistant in residence. Barrow houses the Samuel Simmonds Memorial Hospital, a 14-bed hospital with an outpatient unit that consists of a six-room clinic and a two-bed emergency room (ASNA 2010). The hospital in Barrow offers an ambulatory care clinic, dental and eye clinics, pharmacy, and a specialty clinic. Barrow acts as the tertiary care center for the NSB communities, with cases referred to Fairbanks or Anchorage if they cannot be taken in Barrow. Barrow also offers outpatient behavioral or mental health services. A wellness center in Barrow houses both NSB and ASNA services. NSB services include a public health nurse, an eye clinic, and an allied health program, while the ASNA has a "Screening for Life" program that includes screening for STIs and, breast and colon cancers.

Health services in and near the NAB are provided through the Maniilaq Association, which is responsible for the provision of extensive health, tribal, and social services to residents of rural Northwest Alaska. Kotzebue houses the Maniilaq Health Center, a primary health care facility that offers an emergency room, an ambulatory care clinic, dental and eye care clinics, a pharmacy, a specialty clinic, and an inpatient wing with 24 beds. In Kivalina, the Community Health Aide/Practitioner program operates a village clinic staffed by two to four Health Aides. The clinic is supported by electronic access to the

Maniilaq Health Center in Kotzebue. Several times a year, specialized doctors, dentists, and eye doctors make regularly scheduled visits to the clinic to provide specialized care not usually offered in the area (Maniilaq Association 2010).

Alaska Native Health Service provides health insurance to all Alaska Natives, and over 97 percent of adult NSB residents have health insurance compared to 82 percent of adults statewide (Table 3.3-45). Rural Alaskans also have lower rates of insurance coverage than the overall population, although the rates remain high (Table 4.4-43). While insurance coverage is very good, access to services is severely inhibited by the remote location of the communities and severity of the climate. The costs and inconvenience of travel necessary for many services is cited as a barrier (McAninch 2010). People may have to travel by airplane to the nearest hospital. Bad weather can lengthen the time it takes to get to the hospital or back home from the hospital. Another barrier is the fragmentation of services and complications resulting from the coordination of multiple parties in different locations to provide care. Finally, most of the communities suffer from chronic health care workforce shortages and turnover, to the extent that the U.S. Health Resources and Services Administration characterize the NSB and the NAB as medically underserved and health professional shortage areas.

The Alaska Native Tribal Health Consortium has supported the development of telehealth technologies to support health-related communications in Alaska, through the Alaska Federal Health Care Access Network. Although NSB Health and Community Health Aides/Practitioners have been trained in using telehealth, challenges in staff turnover at the Samuel Simmons Memorial Hospital have prevented its full implementation.

Emergency medical services are also considered a part of health care services in the affected community. The NSB maintains a centralized headquarters to coordinate the provision of fire, rescue, and emergency medical services and oversees nine fire rescue stations, all of which house, at a minimum, an ambulance, engine, and tanker to provide Emergency Medical Services (EMS) response and fire protection to the community (NSB 2011b). Following considerable investment by the Borough, an estimated 94 percent of NSB households have modern water and sewer service as of 2008, compared with an average of 76 percent for Tribal Health Regions statewide (AN EpiCenter 2009, Circumpolar Research Associates 2010, McAninch 2010). The *Healthy Alaskans 2010* target is for 98 percent of households across the state to have modern water and sewer service. The cost and complexity of maintaining and repairing expensive water and sewer systems in the NSB are ongoing concerns.

The NAB maintains a number of public services designed to protect public safety, including a fire department and fire prevention programs for all communities, a search and rescue department, an emergency management department, a public safety program, and shelter cabins. The borough has drafted a 5-year safety plan that will strengthen public services in all communities, and is in the process of revising their Emergency Preparedness Plan (NAB 2010).

## Alcohol and Drug Misuse

**Table 3.3-47 Alcohol Misuse Across Alaska**

| Indicator | All Alaska | American Indian / Alaska Native | All Rural Alaska |
|---|---|---|---|
| Binge drinking: Proportion of males having 5 or more drinks or females having 4 or more drinks on at least one occasion in the past 30 days. | 15.1% (95% confidence interval: 13.6% - 16.7%) | 18.3% (95% confidence interval: 14.8% - 22.4%) | 14.4% (95% confidence interval: 12.1% - 17.0%) |
| Excessive drinking: Proportion of males having more than 2 drinks per day or females having more than 1 drink per day in the past 30 days. | 6.2% (95% confidence interval: 5.1% - 7.5%) | 5.8% (95% confidence interval: 3.5% - 9.2%) | 5.1% (95% confidence interval: 3.6% - 7.2%) |

Source: CDC 2008

Alcohol abuse is linked to chronic disease, interpersonal violence, injuries, disintegration of family structure and well-being, and adverse home environments for children. Within the NSB, alcohol is involved in an estimated 40 percent of snow machine-related injury hospitalizations, 70 percent of assault injuries, 57 percent of suicide attempts, and 45 percent of motor vehicle-related injury hospitalizations. Many incidents of interpersonal violence or injury in particular are associated with "binge," or episodic, heavy drinking.

In the NSB, the sale and importation of alcohol is prohibited in all communities but Barrow, which prohibits the sale but not the importation of alcohol. Restrictive alcohol policies in rural Alaskan communities are associated with decreased incidence of alcohol-related injuries and other health problems (Chiu et al. 1997, Landon et al. 1997), and the NSB's laws appear to be moderately effective: binge drinking and prenatal drinking in the NSB seem to have decreased since the 1990s. Currently, there does not appear to be a significant difference in self-reported periodic heavy, or "binge," alcohol consumption compared to the state of Alaska or the nation. In 2005 to 2007 the rate of binge drinking among adults in the NSB was estimated at 17 percent (McAninch 2010), similar to the rates shown in Table 3.3-47. In 2005, the rate of self-reported consumption of any alcohol among NSB high school students was significantly lower than the national average, and self-reported binge drinking among NSB high school students was not significantly different from state or national estimates.

In the NAB, a 2010 vote allowed the selling of liquor in the community of Kotzebue via a city-run package store and distribution center.

## Culture and Language

Culture and ethnicity are important determinants of health, as they influence almost all aspects of how we live. Culture and language provide the framework in which we understand and interpret our surroundings and provide a set of "ready-made" choices about lifestyle and behavior (e.g. eating and physical activity patterns, use of tobacco, risk-taking behavior, interaction with health care alternatives, etc.).

The NSB has made several efforts towards strengthening culture and language among the Iñupiat peoples. The school curriculum in the NSB now includes Alaska Native culture, history, and language (Circumpolar Research Associates 2010), and language ability among NSB Iñupiat compares very well to neighboring regions of Bering Straits and the NAB. The NAB has a Rosetta Stone Language program in place for the Northwest Iñupiaq language, and the NSB is finalizing plans for its own Iñupiat Eskimo Rosetta Stone Language program.

However, there are several threats to culture and language in the NSB. Younger residents do not have the fluency of older residents with Iñupiaq language (Circumpolar Research Associates 2010; et al. 2007).

Subsistence foods—believed by many Iñupiat and other Alaska Natives to be the very foundation of health and well-being—are increasingly viewed as threatened in terms of both availability and potential contamination, and this may impact participation in subsistence activities and food sharing social networks (McAninch 2010).

## Environmental Contamination

Residents of the NSB are quite concerned about environmental contamination, particularly as it relates to contamination of subsistence food sources. In a recent survey, 44 percent of Iñupiat village residents reported concern that fish and animals may be unsafe to eat (Poppel et al. 2007).

Environmental contaminants have the potential to affect human health in a number of ways. First, exposure to contaminants via inhalation, ingestion, or absorption may induce adverse health effects, depending on a number of factors, including the nature of the contaminant, the amount of exposure, and the sensitivity of the person who comes in contact with the contaminant.

Aside from actual exposure to environmental contamination, the *perception* of exposure to contamination is also linked with known health consequences. Perception of contamination may result in stress and anxiety about the safety of subsistence foods and avoidance of subsistence food sources (CEAA 2010, Joyce 2008, Loring et al. 2010), with potential changes in nutrition-related diseases as a result. It is important to note that these health results arise regardless of whether or not there is any "real" contamination at a level that could induce toxicologic effects in humans; the effects are linked to the perception of contamination, rather than to measured levels.

The issue of exposure to environmental contaminants is contentious, and few data exist to support or deny resident concerns regarding degradation of environmental quality and local health impacts. In general, the field of public health addresses this concern through efforts to control exposure to environmental contaminants, rather than through responding to specific increases in disease rates related to a known exposure. Other sections of this chapter, including those related to air quality (Section 3.1.5), water quality (Section 3.1.7), and environmental contaminants and ecological processes (Section 3.1.8) discuss some of the media through which humans could be exposed to contamination.

## Public Health and Climate Change

Rural Arctic communities are particularly vulnerable to the health effects of climate change, and global warming is increasingly becoming recognized as a determinant of health in the Arctic (ICIA 2005). Changing weather and ice patterns have the potential to affect a wide range of health-related outcomes. Climate change may affect both subsistence food availability and storage and may increase risks associated with subsistence activities, which in turn may lead to dietary and cultural change. Climate change can also affect water, sanitation, housing, transportation infrastructure, cultural continuity, community stress levels, the spread of infection, and even the types of diseases and infections to which the population is susceptible (ACIA 2004, Brubaker et al. 2010, Brubaker et al. 2011).

Communities in the NSB are already experiencing some effects of climate change: erosion problems; thawing ice cellars; less reliable ice conditions; and subsequent higher risk to hunters and spring whalers. Several communities south of the Brooks Range (Kivalina, Shishmaref, and Newtok) are actively planning to relocate due to climate-induced erosion problems. Climate change will likely result in rapidly changing physical environment and health conditions for this population in the coming years.

## Other Determinants of Health

The health determinants discussed above are thought to be relevant for the assessment of public health impacts potentially resulting from offshore oil and gas exploration activities in the Beaufort and Chukchi seas. There are, however, other health determinants that impact upon population health in the affected population. These include education, smoking, physical activity, and motor vehicle safety. Although

each of these determinants plays an important role in determining the health of the population in the affected area, they are not discussed because of their irrelevance to the proposed activities.

#### 3.3.3.6 Summary

The population in the affected area is experiencing health trends similar to that of the rest of Alaska and the U.S.; however, health outcomes in the affected area tend to be worse off, especially for health outcomes like diabetes, obesity, respiratory illness, and injury. The health determinants that play a role in altering the impacts of these health outcomes comprise of those similar to all populations, as well as ones unique to the environment and culture in northern Alaska. A consideration of this local health data and accepted determinants of health will allow for recognition of important risks associated with a project and the eventual development of effective mitigation strategies.

### 3.3.4 Cultural Resources

#### 3.3.4.1 Introduction

Cultural resources include archaeological sites and historic structures and features that are protected under the National Historic Preservation Act of 1966, as amended. Cultural resources also include traditional cultural properties (TCPs) that are important to a community's practices and beliefs and that maintain a community's cultural identity. Cultural resources that meet the eligibility criteria for listing on the National Register of Historic Places (NRHP) are considered significant resources and, when present, must be taken into consideration during the planning of federal projects. Federal agencies also are required to consider the effects of their actions on sites, areas, and other resources (e.g., plants) that are of religious significance to Native Americans and Alaska Natives, as established under the American Indian Religious Freedom Act. Native American and Alaska Native graves, burial grounds, and associated funerary objects are protected by the Native American Graves Protection and Repatriation Act.

Pursuant to Section 106 of the National Historic Preservation Act (*16 U.S.C. 470f*), and its implementing regulations (36 CFR 800), the alternative identified in this EIS may have the potential to cause effects to offshore prehistoric and historic resources, including submerged prehistoric sites and historic shipwrecks, as well as onshore prehistoric and historic resources, including camps, village sites, artifact scatters, historic structures, and World War II and Cold War era facilities. Offshore impacts may be incurred throughout the project area in conjunction with seismic testing activities. Onshore impacts would be restricted to areas of shore-based activities, including Prudhoe Bay, Barrow, Wainwright, and Nome.

#### 3.3.4.2 Cultural Setting

The northwestern American Arctic, extending from Nome, Alaska, to the Mackenzie River delta in Canada, includes the lands occupied in the twentieth century by the western Inuit. Archaeologically, this area is noted for its important role in the development of early American Arctic cultures and, more recently, the development of Arctic Eskimo culture. While the prehistory of the region is not well understood, over 1,200 archaeological sites have been recorded in the Alaska Heritage Resource (AHRS) files of the Alaska Office of History and Archaeology. As currently interpreted, regional prehistory has been divided into five periods that reflect significant changes in culture and habitat: full-time tundra hunting, from earlier than 11,000 years ago to about 8,000 years ago; adaptation to taiga-tundra hunting and fishing, from 8,000 to 4,200 years ago; development of seasonal and year-round coastal hunting and fishing, from 4,200 to 1,500 years ago; prehistoric Eskimo culture, from 1,500 years ago to 1778; and historic Eskimo culture, from 1778 to the present (Anderson 1984). There is abundant evidence of human presence in North America soon after 11,500 years ago, while at least one site, Monte Verde, in Chile, gives secure evidence of a still-earlier presence. This site, and its distance from the presumed Beringian entryway to North America, indicates people arrived in the New World at least 12,500 years ago (Meltzer 2009:192. Two finds were reported in early 2011 that support the early presence of humans in North

America. One of these is a child cremation associated with the remains of a semi-subterranean house in central Alaska, dated to 11,500 years ago (AAAS 2011). The second is an even older site located in central Texas, where a pre-Clovis archaeological assemblage has been identified and dated to between 13,200 and 15,500 years ago (Waters et al. 2011). Closer to the area in question are the Broken Mammoth site on the Tanana River in central Alaska, dated to 11,800 years ago; the Mesa Site on Alaska's North Slope, dated to near 12,000 years ago; and the Nenana Complex sites of the Nenana and Tanana river valleys of interior Alaska (Meltzer 2009:190, 217, 304-305; West 1996: 537-549). Evidence from these and other sites in interior and coastal North America and elsewhere have led some archaeologists to postulate alternative models to the traditional Bering land bridge explanation of the populating of North America, including coastal migration with later inland movement and settlement (Dixon 1999:243-256).

The earliest well-documented archaeological tradition in the northwestern Arctic, representative of the tundra-hunting era, is the American Paleo-Arctic tradition, identified from the coast of the Arctic Ocean to both shores of the Bering Strait, south along the Alaska coast to the Alaska Peninsula, as well as into interior areas. Sites of this tradition are known for containing wedge-shaped microblade cores, microblades, blades and blade cores, bifacial cores, and slotted antler arrows with microblades. These sites are known to be located in both coastal and interior regions and extend from western Alaska to the northern Yukon Territory; providing a well-defined indication of a Pleistocene population migrating south from Alaska (Anderson 1984:81-82; Meltzer 2009:193-194).

By 8,000 years ago, as a result of the post-Pleistocene warming trend and the melting of glacial ice, sea level had risen to between 25 and 40 feet below its present height and for the most part, the Arctic coastline was within one mile of its current position. Archaeological cultures of this time, identified as part of the Northern Archaic Tradition, begin to resemble those of the North American boreal woodlands. Diagnostic artifacts include side-notched projectile points and half-rounded lithic artifacts worked on both surfaces, (semilunar bifaces), bifacial knives, end scrapers, notched pebbles, microblades, and cobble choppers. The oldest site of this tradition is the Tuktu site in Anaktuvuk Pass, in the Brooks Range. In addition to open camps, sites from this tradition include semi-subterranean houses and stone-lined tent rings; the latter two types are known from sites both on the North Slope and in the Brooks Range (Anderson 1984). Anderson (1984:82) proposes that beginning about 6,000 years ago, the North Alaskan cultures shifted from a nearly exclusive land-based, hunting subsistence-base to taiga-tundra hunting and fishing.

Between 4,500 and 4,200 years ago, as sea levels stabilized, evidence for coastal habitation in the Arctic becomes plentiful. Sites of this era reflect the characteristics of the Arctic Small Tool tradition, known for the presence of small, finely flaked stone tools. Fist discovered at Cape Denbigh in 1948, sites of this tradition have been identified throughout the coastline. Artifacts include wide microblades, microblade cores, tiny end and side blades used as weapon insets, tanged end scrapers, semilunar bifacial knives, flaked burins, unifacially flaked knives, and notched stones, probably used for net weights. Coastal sites were occupied during the late spring and summer, while late summer, fall, and winter sites were located near tundra lakes, elevated lookout points in the Brooks Range, and in the woodlands, especially along the Kobuk River. Faunal remains at sites are almost exclusively caribou with some evidence of fish, while coastal sites contain seal and caribou (Anderson 1984:82-84).

By about 1,500 years ago, Prehistoric Eskimo cultural phases emerged along the north coast of Alaska, reflecting a substantial change from the preceding cultures. These ancestral Iñupiat or Iñupiaq cultures resulted either from movement of people from Siberia or the transfer of new sea mammal hunting technology. In either case, there were significant changes in the material culture, especially related to food acquisition and processing (Anderson 1984:90-93). The Birnirk cultural phase, documented at the Point Barrow type site, indicates a return to whale hunting after a 500-year hiatus. Their primary food supply included seals, fish, caribou, and birds hunted with a variety of hunting implements. Material used to make artifacts include ground slate, chipped stone, antler, bone, ivory, clay, wood, and baleen.

The Western Thule phase developed out of the Birnirk phase along the north coast of Alaska between 1,000 and 750 years ago. Western Thule material culture appears to be an elaborate combination of Birnirk artifacts with specialized tools with whale, caribou, and seal hunting being the major subsistence activities. Houses were similar to Birnirk, with large settlements developed around the group sizes required for whale hunting. However, settlement size also decreased in response to declining whale populations in the Kotzebue area. Current archaeological evidence suggests that there is an apparent gap in large, year-round coastal settlements between Point Barrow and the Mackenzie Delta. However, several archaeological excavations at many sites and contemporary Eskimo villages indicate continuous occupation from the late-prehistoric culture. During the early Western Thule phase, groups expanded both onto the North Slope and into the Brooks Range. Sites that date from late in this phase and that have Athabascan Indian artifacts have been documented in the central and eastern Brooks Range and on the North Slope (Anderson 1984:91-93).

The late prehistory and history of the coastal region focuses primarily on the Iñupiat of the North Slope who continued to have settlements based on hunting and gathering seasonal rounds. They relied heavily on fish and sea mammals, as well as caribou and smaller terrestrial animals. In the nineteenth century, a series of "battles" and famines took place in the Interior, which caused population shifts leading anthropologists to suggest that the current ethnic boundaries may have fluctuated. While direct contact with Euroamericans may not have occurred until the mid-nineteenth century, the Iñupiat Eskimo established trade routes to exchange goods along the coast and into the Interior for at least 100 years prior. Trade goods found at historic Eskimo sites include glass beads, metal knife blades, and brass fittings from trade muskets (Anderson 1984:93).

Vitus Bering explored the coastal areas of Alaska in 1741; within a short time, Russian fur hunters began to exploit the rich sea otter grounds along the Aleutian chain. In 1778, Captain James Cook arrived in southern Alaska where, at Cook Inlet, Tanainas came to his ship to exchange furs and fish for iron. Cook noted that at this time, a few European goods were already in the possession of the Indians. At this time, while southern Alaska Indians and Eskimos were eager to trade with Europeans visiting in ships, attempts at settlement were opposed. As a result, with the exception of the Aleuts, Alaska's inhabitants remained relatively free of European influence (VanStone 1984:149,152).

The historic period of the northwestern Arctic begins with direct encounters between the Iñupiat with European explorers along the north and northwestern coasts of Alaska. By 1762, Russian fur hunters had reached Kodiak Island, well to the south of the current area of interest. The Russian fur traders soon established a post on the island, which was destined to become one of the major headquarters of the Russian-American Company. Within 20 years, additional posts were established on the Kenai Peninsula and at Sitka, and several native groups were drawn more actively into the fur trade (VanStone 1984:150-153).

European exploration quickly expanded to the north along the Alaska coastline, most notably with the voyages of Captain James Cook, who explored the area between Bristol Bay and Icy Cape between 1776 and 1780. By 1850, commercial whaling ships began to frequent the waters of the Arctic Ocean in large numbers every summer, trading in large quantities with northern Eskimos. From the 1850s to the 1920s, commercial Euroamerican whaling activities often included an Iñupiat labor force. Many impacts to traditional lifeways, the economy, and material culture occurred as a result of commercial whaling (VanStone 1984:155-156).Whaling persisted until the baleen market collapsed after 1916 (Spencer 1984:278-281). Foreign diseases decimated Native populations and caused major demographic and traditional territorial shifts. Direct contact with Euroamerican missionaries, who arrived in Barrow in 1890, also led to changes in traditional religious practices and resulted in the acceptance of Christianity by many Native Alaskans. Other Euroamerican commercial interests attracted northern Native societies into the larger Western economic sphere. Domestic reindeer, introduced at Wainwright and Barrow, developed into large herds up to about 1915, but a reduction of meat and hide markets in the early 1930s led to the demise of caribou herding among the North Slope settlements (VanStone 1984:156-157). Also,

the fur industry sought Arctic fox pelts, providing a brief economic boost for some Natives trappers for nearly a decade after World War I. With prolonged contact, Euroamerican trade goods entered the Native material culture realm as local populations traded for them or earned them in exchange for monetary wages. As commercial whaling and trading expanded, contact caused the disruption and eventual demise of long established Native trade networks as the Iñupiat sought western goods. By the 1920s, mass-produced items produced in the U.S. substantially replaced items of Native manufacture. Archaeological remains of Native historic activities associated with seasonal subsistence activities, and Euroamerican trade goods lay among sod house ruins and tent rings that can be found along the coast and inland to the foothills and valleys of the Brooks Range (Spencer 1984:278-281).

## Beaufort Sea

### *Offshore Prehistoric Resources*

The presence of offshore prehistoric resources is difficult to assess. Approximately 19,000 years ago, at the height of the late Wisconsinan glacial advance, sea level was approximately 120 meters lower than at present. During this time, large expanses of what is now the outer continental shelf were exposed as dry land (MMS 2007c). The exact elevation of past sea levels in relation to present sea level varies geographically, depending primarily on the location of the area in relation to the major glacial ice masses. In the northwestern Arctic region of Alaska, relict fluvial channels and shoreline features evident at the seafloor suggest that sea level was probably between 50 and 60 m lower than present at about 12,000 B.P. (years before present). As a result, a conservative estimate of 60 m below present is used for relative sea level at this time, a date by which current research indicates prehistoric human populations were almost certainly present in the area (MMS 2007c; Dixon et al. 1986.). The location of the 12,000 B.P. shoreline is roughly approximated by the 60-m bathymetric contour. The continental shelf shoreward of this contour would have potential for prehistoric sites dating later than about 12,000 B.P. Seismic-survey and borehole data that have been collected in the Beaufort Sea indicate areas of well-preserved Holocene sedimentary sequences and landforms that have potential for containing prehistoric archaeological deposits (MMS 2007c). In some areas of the Beaufort Sea, available remote-sensing data indicate little evidence of ice gouging at the seafloor and areas of well-preserved landforms, such as river channels with levees and terraces just below the seafloor. Although these features have not been directly dated, their stratigraphic position indicates that they are most likely Holocene in age. The presence of these preserved landforms just beneath the seafloor indicates that there also is potential for preservation of prehistoric archaeological sites that may occur in association with the landforms. The potential for the occurrence of archaeological resources in the Beaufort Sea seaward of the barrier islands, however, is probably much lower than for those areas landward of the barrier islands and in areas protected by floating, landfast ice during the winter (MMS 2007c).

### *Offshore Historic Resources*

Much like prehistoric resources, offshore historic resources are likely to be present in the project area, but are equally difficult to identify or quantify. Available documentation indicates that between 1851 and 1934, at least 34 shipwrecks occurred within a few miles of Barrow; another 13 wrecks occurred to the west and east of Barrow in the waters of the Beaufort and Chukchi seas. No surveys of these shipwrecks have been made; therefore, no exact locations are known. If intact remains are present, these wrecks would be valuable finds, providing significant information on the historic whaling industry (MMS 2007c).

### *Onshore Prehistoric and Historic Resources*

The coast of the Beaufort Sea suffers from active erosion, damaging or destroying important coastal cultural resources. Of the more than 1,200 North Slope prehistoric sites, very few are located in the coastal region (AHRS files). As noted above, onshore resources that may be subject to impact from the current undertaking would likely be limited to those in the vicinity of Barrow and Prudhoe Bay, where

land-based activities may occur. AHRS records on file with the Alaska Office of History and Archaeology indicate that as many as 16 prehistoric and historic resources have been included within a two-mile radius of Barrow. These include three historic Iñupiat village sites; prehistoric camp sites and burial locations; a late nineteenth century whaler's refuge facility, World War II and Cold War era Navy, Air Force, and Army facilities; and one paleontological resource location. Fewer resources have been documented in the vicinity of Prudhoe Bay. Four of these have been recorded within a two-mile radius of Prudhoe Bay, including one prehistoric camp site, two historic camp sites, and the site of the original discovery well.

## Chukchi Sea

### *Offshore Prehistoric Resources*

The potential for the presence of offshore prehistoric resources in the Chukchi Sea area is similar to that of the Beaufort Sea. Analyses of shallow geologic cores obtained by the U.S. Geological Survey in the northeastern Chukchi Sea indicate the presence of well-preserved coastal plain sedimentary sequences of Holocene age just beneath the seafloor. Radiocarbon dates on in situ freshwater peat contained within these deposits indicate that relative sea level in the Chukchi Sea area would have been approximately 50 m below present at 11,300 B.P. The location of the 11,300-B.P. shoreline is roughly approximated by the 50-m bathymetric contour. The continental shelf shoreward of this contour would have potential for prehistoric sites dating subsequent to approximately 11,300 B.P. The presence of preserved nonmarine Holocene sedimentary sequences in the Chukchi Sea indicates that there also is potential for preservation of prehistoric archaeological sites. Even in some areas of intense ice gouging, such as off Icy Cape, the Holocene sediments are thick enough that any archaeological sites that occurred in the underlying Late Pleistocene deposits would be below the depth affected by ice gouging (MMS 2007c:; Dixon et al. 1986).

### *Offshore Historic Resources*

Like the Beaufort Sea, shipwrecks were a relatively common occurrence on the Chukchi Sea, and remains of these incidents may very well be present. At Point Belcher near Wainwright, 30 ships were frozen in the ice in September 1871; 13 others were lost in other incidents off Icy Cape and Point Franklin. Another seven wrecks are known to have occurred off Cape Lisburne and Point Hope. From 1865-1876, 76 whaling vessels were lost because of ice and also because of raids by the Confederate battleship *Shenandoah*, which was sent to the Pacific with the goal of destroying the Union whaling fleet. The *Shenandoah* burned 21 whaling ships near the Bering Strait during the Civil War. The possibility exists that some of these shipwrecks have not been completely destroyed by ice and storms. This likelihood is reinforced by the 2010 discovery by Parks Canada archaeologists of the HMS Investigator, a British ship abandoned in the ice in 1853 along the northern coast of Banks Island in Canada's western Arctic during a search for the Northwest Passage. This shipwreck is remarkably well-preserved, standing upright in approximately 11 meters of water (AIA 2011). The likelihood for good preservation has been determined particularly high around Point Franklin, Point Belcher, and Point Hope (MMS 2007c).

### *Onshore Prehistoric and Historic Resources*

Onshore archaeological resources near the Chukchi Sea coast receive less damage from the eroding shoreline than those on the Beaufort Sea coast, which is subjected to more slumping because of water action and permafrost. As a consequence, archaeological resources have been recorded in greater numbers in the Chukchi Sea area, and unknown resources are more likely to be present. There are 200-300 known archaeological sites in the Hope Basin area, and the area around Point Hope is especially rich in archaeological resources. Many of the known sites are of Kukmiut and Iñupiat tradition and include villages, graves, whaling camps, and fishing/hunting camps (MMS 2007c).

Alaska Heritage Resource Survey (AHRS) records indicate that at least 18 historic and prehistoric sites have been documented within a two-mile radius of Wainwright. These include at least two historic Iñupiat village sites; several prehistoric camp sites; the possible remains of a settlement established by

Roald Amundsen during his polar exploration efforts of 1925; partial remains of the 1871 whaling fleet, discussed above, scattered over 30 miles of shoreline; and Cold War era communication facilities.

Twenty-four resources are documented in the AHRS files within a two-mile radius of Nome. These include the remains of an historic Eskimo village and a historic fishing camp, but are largely dominated by historic structures related to the community of Nome; World War II facilities are also present.

## 3.3.5 Land and Water Ownership, Use and Management

The United States government is the sole owner of the Beaufort Sea and the Chukchi Sea Outer Continental Shelf lands, the energy (conventional and renewable) and mineral reasources are managed by the BOEM, but living and non-living resources are managed by other federal agencies, including NMFS and USFWS. However, the adjacent nearshore and onshore areas reflect multiple owners, including the federal government, state government, borough government, Alaska Native corporations and Alaska Native allottees (the Bureau of Indian Affairs holds in trust many of the lands owned by Alaska Native allottees). With the exception of the tidelands offshore of the ANWR (Shalowitz and Reed 2000), the State of Alaska owns all tidelands and submerged lands along the coast out to 3 nautical miles (nmi), which includes three miles out from barrier islands that are owned by the State of Alaska. Lands bordering the coast are within the NSB, and the NAB, and most lands within these boroughs are held by a few major landowners. The predominant landowner within the NSB is the federal government, which owns the ANWR, managed by the USFWS, and the National Petroleum Reserve—Alaska, managed by the Bureau of Land Management (BLM). Other major landholders include the State of Alaska, Alaska Native village corporations, and the Arctic Slope Regional Corporation. Along the coast within the NAB lies the Cape Krusenstern National Monument, managed by the National Park Service (NAB 2004). See Figure 3.3-28 for general ownership patterns on the North Slope of Alaska near the Beaufort and Chukchi seas.

### 3.3.5.1 Land and Water Ownership

**Federal Ownership**

***Federal Waters***

Beyond the 3-mile limit owned by the state, the United States has sovereign rights and control over the living and non-living natural resources of the seabed, subsoil and the waters above them out to 200 nautical miles from the point of average low tide (normal baseline) or to the international maritime boundary (Office of the Press Secretary 1983, NOAA n.d.).

***Federal Lands***

The federal government owns the land in the ANWR, containing about 30,135 square miles, the National NPR-A, containing about 3,906 square miles, Alaska Maritime National Wildlife Refuge, containing about 7,656 square miles, and most of the Cape Krusenstern National Monument, containing about 1,016 square miles, all of which abut the coastline of the Beaufort or Chukchi seas.

**State Ownership**

***State Waters***

With the exceptions of federal lands described above and some privately owned tidelands, the state owns the surface and subsurface estate of all tide and submerged lands along the coastline, as well the bed of navigable waters within its boundaries. Tidelands include the land between mean (average) high and mean low tide. Submerged lands are seaward of mean low tide to three miles offshore. The state's claim of title for submerged lands is based on the "Equal Footing" Doctrine, the Submerged Lands Act of 1953,

and the Alaska Statehood Act of 1958. The Submerged Lands Act of 1953 held such lands in trust for the state and title was transferred at statehood in 1959.

### *State Lands*

The State owns the majority of the land located between ANWR and the NPR-A containing the Prudhoe Bay onshore oil fields, as well as various parcels near the coast of the Chukchi Sea from the western boundary of the NPR-A to just south of Point Hope.

### *State Selections*

When Alaska gained statehood in 1959, the state was authorized to select about 104 million acres of federal land, to be chosen from lands that were unreserved and unappropriated for any purpose, claimed, or withdrawn. Although the Statehood Act provided for the State of Alaska to select lands, in some instances, certain selections have not been transferred and remain in federal ownership due to legal considerations, conflicting Native selections or similar reasons. In the project area, most of these State selected, but unconveyed, lands are located in the Point Hope area.

## Native Ownership

### *Corporation Lands*

In 1971, Congress passed the Alaska Native Claims Settlement Act (ANCSA). The act settled Alaska Native land claims with a grant of 44 million acres and payment of $1 billion. It also provided for village and regional corporations to manage that land and money. Part of the reason for this land grant was to help provide a long-term economic base for the corporations. Corporations were to select mainly from tracts the federal government withdrew near villages, but when there was not enough available land there, they could also choose from other unreserved federal land (UAA 2000). The EIS project area has several of these sections. There are large tracts around the communities of Kaktovik, Nuiqsut, Barrow, Wainwright, Point Lay and Point Hope, as well as scattered pieces along the North Slope.

In Alaska, ownership of land is often characterized by a "split estate" interest, in which rights to the surface estate are separate from the subsurface estate. Surface owners receive title and rights include the use of soil, timber, and lands beneath non-navigable waters. Subsurface owners receive title to rock, gravel, and sand as well as oil, gas, and minerals. Village corporations, established by the ANCSA, generally receive title to the surface estate for their land entitlement. The corresponding subsurface estate is typically conveyed to the ANCSA regional corporation.

ANCSA village corporation surface estate lands are generally selected and conveyed in the vicinity of their home communities. However, ANCSA Regional corporation subsurface estate may also be located in areas away from existing communities.

### *Corporation Selections*

Although ANCSA provided for Native land selections, in some instances, certain selections have not been transferred and remain in federal ownership due to legal considerations, conflicting State selections, incomplete land surveys or similar reasons

## Native Allotments

In 1906, the Native Allotment Act was passed, whereby Natives could apply for up to 160 acres, if they could demonstrate use and occupancy of the land for a minimum of five years. The Native Allotment Act was replaced in 1971 with the passage of ANSCA; however, ANSCA allowed those applications pending before the U.S. Department of the Interior to continue through processing. The lands under application by a Native Allotment applicant are under the management of a federal and sometimes state agency until the lands are conveyed to the Native allotee. BLM issues upon conveyance a certificate of title to the Native allotee which lands are held in trust by the Bureau of Indian Affairs (BIA). In some instances, the

BIA has authorized federally recognized tribal governments to act as their administrative representative for Native allottees. Several Native allotments occur along the Beaufort and Chukchi Sea coasts. There are a few that dot the border of the ANWR outside of Kaktovik and continue along the coast in the Prudhoe Bay area, and are scattered throughout the NPRA. The allotments run along the coast between Cape Lisburne and Point Hope, and all through the Point Hope region.

**Borough and Other Municipal Lands**

Under the Alaska Statehood Act, municipal governments are entitled to select lands from the State of Alaska. In the project area, the NSB and the NAB have selected lands from the State. The NSB's municipal land entitlement is 89,850 acres. Lands conveyed to date are primarily in the vicinity of communities, and some parcels in the Prudhoe Bay/ Deadhorse and Cape Simpson areas. The ability to select and receive conveyance of the Borough's remaining entitlement has been delayed (URS 2005).

The NAB is also entitled to select lands from the State of Alaska, but completion of selection and receipt of its total conveyance has been also been delayed. Borough-owned lands along the Chukchi Sea coast are likely to be limited to village areas.

The incorporated villages within both Boroughs also retain title to municipal lands, generally located in the vicinity of the communities. Villages are entitled to select land from ANCSA village corporations under Section 14 (c) 3 of the act; however, many villages have not completed their selections.

### 3.3.5.2 Land and Water Use

Land use has many definitions and methods of classification. For this EIS, land use concerns the physical ways in which land is used and modified for different human purposes (UN 1993). The classifications below are based on the nationally standardized scheme by Anderson et al 1976, and the Michigan Resource Information System (MIRIS).

#### *Recreation*

This classification refers to the use of land in an outdoor setting for purposes of rest, sport or relaxation. In the context of this EIS, recreation activities are closely related to enjoyment of the natural environment (MIRIS). Recreation occurs at generally low levels of use in the EIS project area. Key recreational activities include wildlife viewing and flightseeing. Recreation is discussed in detail in Section 3.3.8.

#### *Subsistence*

Subsistence, which refers to harvest activities involving hunting, fishing, trapping, and gathering as a way of life, is a wide-spread land use throughout the EIS project area. Further details are discussed in Section 3.3.2.

#### *Industrial*

Industrial areas include a broad spectrum of facilities, from heavy manufacturing plants to a loading device or storage shed (Anderson et al 1976). Most major industrial uses in the EIS project area are related oil and gas activities and occur in Barrow, and Deadhorse/Prudhoe Bay. In these areas, industrial uses are supported by docks, airstrips, warehouses, roads, pipelines, and other essential infrastructure and facilities.

#### *Residential*

This classification refers to land uses that serve as a place of permanent residence (MIRIS). Residential land use occurs in small communities throughout the project area. The communities that would be most proximate to proposed offshore oil and gas exploration and seismic activities are adjacent to the Beaufort and Chukchi seas and include Kaktovik; Prudhoe Bay/Deadhorse; Nuiqsut; Barrow; Wainwright; Point

Lay; Point Hope; Kivalina; Kotzebue; and Nome. Section 3.31 discusses population and classification of these communities.

### *Mining*

Mining involves the use of land for mineral extraction purposes using both surface and subsurface methods. Red Dog Mine is the biggest source of mineral extraction in the EIS project area. Located east of the village of Kivalina, it is the second largest zinc mine in the world, and the fourth largest lead mine. Red Dog Mine covers over 2,000 acres and also includes supporting land uses such as an airstrip, a road to the coast, a dock and dock facilities (Tetra Tech 2009).

Exploration activities are occurring in the Western Arctic coal deposits, between Point Lay and Point Hope, but no mine yet exists (Szumigala et al 2009).

### *Protected Natural Areas*

This classification applies to lands that are set aside in their natural state for the purpose of ecological preservation. In the EIS project area, this includes ANWR, particularly the wilderness and 1002 areas discussed below, Alaska Maritime National Wildlife Refuge, and Kasegaluk Lagoon/Ledyard Bay Critical Habitat Unit.

### *Transportation*

Land used for transportation systems can be considered a supporting component of other uses, such as industrial facilities. However, since it can influence the land uses around it; it is considered as its own, separate classification (Anderson et al 1976). In the context of this EIS, Transportation land uses includes the Dalton Highway, industry road systems within the general Prudhoe Bay/Kuparuk filed area, aircraft and shipping infrastructure, and the road to Red Dog Mine.

### *Commercial*

Commercial areas are those used predominantly for the sale of products and services (Anderson 1976). There is only a small amount of land devoted to commercial use in the EIS project area mostly centered within Prudhoe Bay and the communities within the project area.

## 3.3.5.3 Land and Water Management

### Federal Lands Management

### *Arctic National Wildlife Refuge*

The ANWR, managed by the USFWS, was established in 1960 and expanded in 1980 to nearly 20 million acres as part of the ANILCA. The area contains three Wild rivers and the largest designation of Wilderness areas in the National Wildlife Refuge System (USFWS 2000b). The refuge has five management categories: Intensive, Moderate, Minimal, Wild River, and Wilderness. Due to controversy over management of the coastal plain, Section 1002 of the Alaska National Interests Lands Conservation Act established a 1.5 million acre Coastal Plain Resource Assessment Area to develop a baseline study to quantify the extent of oil & gas resources and to characterize important biological resources in that portion of ANWR. This area, referred to as the “1002 Area” is the northernmost section of the refuge adjacent to the Beaufort Sea. The United States Geological Survey estimates the total quantity of technically recoverable oil from the 1002 Area to be between 4.3 and 11.8 billion barrels (USGS 1998), however, at this time, oil extraction is not permitted. The 1002 Area is currently managed as a “Minimal management” area, which is directed at maintaining the existing condition of the areas that have high wildlife and fish values. Activities such as subsistence practices, outfitting, float planes and motor boats, and oil and gas studies are permitted under this management category (USFWS, 1998). Currently, the

USFWS is updating the Comprehensive Conservation Plan for the ANWR, with a final revised plan expected to be released during the summer of 2012 (USFWS 2011a).

### *National Petroleum Reserve—Alaska*

The NPR-A is 9.4 million acres in north-central Alaska managed by the BLM. The reserve was established in 1923 to provide oil for military purposes, and transferred to the Department of the Interior in 1977 to meet the economic needs of oil for the rest of the nation. The reserve is divided into three Planning Areas: the Northeast, Northwest, and the South. Both the Northeast and the Northwest Planning Areas include large stretches of coastline off the Beaufort and Chukchi seas (BLM 2005). In the Northwest Planning Area, site-specific restrictions are implemented on all oil/gas related operations within the boundaries of the NPR-A to protect important natural resources such as water quality, vegetation, wetlands, fish/wildlife habitat cultural and paleontological resources subsistence uses and access, scenic and recreation values (BLM 2003). In the Northeast Planning Area, an Integrated Activity Plan outlined land allocations for immediate oil and gas leasing, adopted performance-based stipulations on operating procedures, and detailed required studies and monitoring (BLM 2008a)..

### *Alaska Maritime National Wildlife Refuge*

The Alaska Maritime National Wildlife Refuge is managed by the United State Fish and Wildlife Service and contains approximately 4.9 million acres of Alaska coastland and islands. The refuge was created by ANILCA in 1980, consolidating 11 preexisting refuges, adding 1.9 million acres of new land, and combining the majority of Alaska's seabird habitat within a single refuge. The refuge is divided into five distinct geographic units: the Chukchi Sea Unit, the Bering Sea Unit, the Aleutian Islands Unit, the Alaska Peninsula Unit, and the Gulf of Alaska Unit. The refuge encompasses approximately 3,000 headlands, islands, inlets, and pinnacle rocks, used by 80 percent of Alaska’s seabird population, about 40 million nesting seabirds. The Chukchi Sea Unit is included in the project area and covers nearly 300,000 acres, 4 percent of the total refuge. It does not extend to the entire coastline, but is made up of non-contiguous areas of offshore public lands on islands, islets, rocks, reefs and spires. There are a few larger land groupings such as at Cape Thomson (USFWS 1988).

A Comprehensive Conservation Plan and Wilderness Review for the Alaska Maritime National Wildlife Refuge was adopted in 1988 that designated areas according to their resources and values, outlined programs for conserving fish and wildlife resource values, and specified uses compatible with the major purposes of the Refuge. The refuge has four management categories: Intensive Management, Moderate Management, Minimal Management, and Designated Wilderness. 99 percent of the Chukchi Sea Unit is managed with Minimal Management, which is directed at protecting existing fish and wildlife populations. Management activities focus on biological monitoring, eradication of introduced predators/rodents, and research and regulation. Oil and gas leasing is not permitted (UWFWS 1988).

### *Cape Krusenstern National Monument*

Cape Krusenstern National Monument was designated pursuant to ANILCA and contains approximately 660,000 acres. The National Park Service manages the monument; the main policies are to protect archeological sites in the area and protect the habitat for wildlife and subsistence resources. The monument is a coastal plain stretching along 70 miles of the Chukchi Sea shoreline, and archeological sites dating back 5,000 years can be found in the beach ridges (NPS 2011).

## State Lands Management

### *Area Plans*

The State of Alaska prepares land management plans called Area Plans to govern the use of state lands. Area Plans describe intended uses of state lands. Specifically, the plan contains management guidelines and classifications for specific management units. The document identifies what land should be retained by the state and what land may be sold or granted to municipalities through the municipal entitlement

process. Area plans can open and close areas to mineral entry and can recommend legislative designations (for example, parks). The Northwest Area Plan was completed in 1989, and contains 10,000,000 acres of land. It includes lands on the Seward Peninsula, in the NAB and in the western segment of the NSB. An Area Plan has not been prepared for the North Slope Region, which contains 12,252,000 acres of land.

### *Oil and Gas Lease Sales*

The State leases lands and waters for resource development, including oil and gas, minerals, and timber. Annually, ADNR prepares and presents a 5-year program of proposed oil and gas lease sales to the legislature. Currently, Division of Oil and Gas conducts competitive annual areawide lease sales, offering for lease all available state acreage within five areas (North Slope, Beaufort Sea, Cook Inlet, North Slope Foothills, and Alaska Peninsula). The lease sale area is divided into tracts, and interested parties that qualify may bid on one or more tracts. Since the first lease sale in 1964, the State has held 56 onshore and offshore oil and gas lease sales on the North Slope involving Beaufort Sea and North Slope acreage (ADNR 2009).

## Municipal Lands Management

### *Community and Borough Planning*

Boroughs and cities vested with land use authority in the State of Alaska are required to prepare a comprehensive plan, which is intended as a long-range vision of possible future development. Generally the planning process involves community members, public officials, planning committees, and any relevant stakeholders. Comprehensive plans do not provide enforcement power. Instead, they are intended as a tool for policy makers to consult in making land development decisions (URS 2005). There are two boroughs that have jurisdictional boundaries along the Beaufort and Chukchi seas. The NSB spans 89,000 square miles across the top of Alaska from the Canadian border to Point Hope and from the Brooks Range to the Arctic Ocean. The NAB comprises approximately 39,000 square miles in the northwest of the state, on the coast of the Chukchi Sea and south of the NSB. Both boroughs have comprehensive plans discussed below and contain eight coastal communities of predominantly Iñupiat populations: Kaktovik, Nuiqsut, Barrow, Wainwright, Point Lay, Point Hope in the NSB and Kivalina, and Kotzebue in the NAB. With the exception of Kotzebue, these communities have no comprehensive plan in place, although the NSB is working with Kaktovik, Nuiqsut, Barrow, Wainwright, Point Lay, and Point Hope to develop village plans that are either in process or planned to begin in 2011.

### *North Slope Borough Comprehensive Plan and Title 19*

In 2005 the NSB Assembly adopted a comprehensive plan to aid the long-range growth and development of the Borough. The vision and goals outlined in the plan helped guide the Borough Assembly when updating and writing ordinances for the region, particularly Title 19, which outlines land use regulations for the Borough and is considered part of the Comprehensive Plan (URS 2005).

Title 19 describes Borough management practices through nine different zoning districts, with four being the most relevant for offshore activities. Barrow Industrial and Storage districts are characterized by terminals, loading docks, storage sheds and airports and are intended to provide uses that support aviation, shipping and other transit. Resource Development Districts (RDDs) are intended to accommodate large-scale resource extraction and related activities, while balancing protection of subsistence resources. Existing RDDs include Badami, Duck Island, Prudhoe Bay, Mine Point, and Kuparuk River. RDDs are generally focused along the north coast of the Borough and the Beaufort Sea, centered on Prudhoe Bay. Transportation Corridor districts are established to accommodate linear transportation facilities such as pipelines and roads. The most significant corridor is the Dalton Highway and Trans-Alaska Pipeline System that runs from Prudhoe Bay to the NSB's southern border (NSB 1990). Communities are zoned as Village Districts, aimed at maintaining traditional values and lifestyle. With the exception of Barrow, there are no further zoning regulations within the Village Districts. Title 19 also outlines policies

pertaining to villages, economic development, offshore development, coastal management (reflecting the enforceable policies of the 1988 Coastal Management Program), and transportation corridors. The policies are meant to guide development and uses within the North Slope Borough while protecting the subsistence resources and cultural resources (NSB 1990).

### *Northwest Arctic Borough Comprehensive Plan and Title 9*

The NAB Assembly approved a comprehensive plan in 1993 that addresses land use controls and planning and zoning issues in the borough. At the time of the plan, permits were the primary means of land control. Permits allowed the borough to control land and water use, materials, timber, minerals, certain activities, and lease sales. The comprehensive plan has strategies for the NAB to use in determining land selections under ANCSA, and deciding on land use controls for the development and adoption of zoning ordinances. It details land management strategies, involving zoning, platting, and methods of village planning.

The plan divides the borough into six zoning districts. Subsistence Conservation Districts, General Conservation Districts, and Commercial Recreation Conservation Districts would make up most of the borough land and be oriented towards conservation of habitat, renewable resources and subsistence protection. In addition, the Subsistence Conservation Districts would prohibit development that would negatively affect subsistence resources, the General Conservation Districts would accommodate resource development on a limited scale and encompass undeveloped areas outside the boundaries of other districts, and the Commercial Recreation Conservation Districts would accommodate commercial recreation as long as it is consistent with the conservation of wildlife habitat and other resources, and effects on subsistence could be mitigated. Village Districts would be the boundaries of villages in the borough and reinforce lifestyles and values. Resource Development Districts would accommodate major resource development, most notably Red Dog Mine. The Transportation Corridor District would allow control over location and development of transportation corridors, such as roads, railroads, and pipelines, and supporting transportation facilities (NAB 1993).. Title 9 of the Borough code contains the Zoning Ordinance.

## Federal Waters Management

Federal jurisdiction of the coastal waters extends from the three-mile limit, which is under state jurisdiction, to 200 nmi from the point of average low tide. The first 12 nmi from the coast are managed as territorial seas, within which the United States holds complete sovereignty yet ships or aircraft of any country can have the right of transit and innocent passage (64 FR 173 1988). 24 nmi from the coast are managed as the contiguous zone, where the United States has the right to exercise control to prevent or punish infringement of its customs, fiscal, immigration, or sanitary laws (64 FR 173 1999). 200 nmi from the normal baseline is the Exclusive Economic Zone, within which the United States has sovereignty over the mineral deposits and living resources (Office of the Press Secretary 1983).

In the wake of the Deepwater Horizon oil spill in the Gulf of Mexico in April 2010, the President issued an Executive Order (EO) in July 2010 adopting the Final Recommendations of the Interagency Ocean Policy Task Force for management of federal waters off the coasts of the U.S. and the Great Lakes. The EO established a national policy to ensure protection, maintenance and restoration of the health of coastal and ocean ecosystems (Office of the Press Secretary 2010). The policies outlined in the EOseek to ensure that the oceans, coasts and the Great Lakes are healthy and resilient, as well as safe and productive (CEQ 2010b).

In general, the management practices used by BOEM, Alaska OCS Region, rely on federal laws and regulations to govern the waters in federal jurisdiction. These acts and executive orders designate appropriate uses for the waters, while at the same time ensuring the protection of the human, marine, and coastal environments. The OCS Lands Act gives the U.S. Department of the Interior responsibility to manage the offshore energy (conventional and renewable) and minerals resources, which includes the

leasing, exploration, development, and production of those resources on the federal OCS. Other acts that heavily influence management of the federal waters are the National Environmental Policy Act, the Marine Mammal Protection Act, the Magnuson-Stevens Fishery Conservation and Management Act, the Endangered Species Act, the Clean Air Act, the Clean Water Act the Oil Pollution Act, and the Coastal Zone Management Act.

**State Waters Management**

Waters owned by the State of Alaska were subject to the Alaska Coastal Management Program (ACMP) until 2011. The ACMP included statewide standards and coastal district enforceable policies that balance development and the protection of natural resources within the coastal zone. Oil and gas leases within the 3-mile limit are sold by the Alaska Department of Natural Resources, Division of Oil and Gas and were in that category (ADNR 2011, ADNR 2005). As a result of the ACMP expiration, oil and gas lease sales are not expected to adhere to a coastal management program.

## 3.3.6 Coastal Zone Management

The State of Alaska operated the federally-approved ACMP from 1979 to 2011 as a voluntary state partner in the National Coastal Management Program. In 2011, the state legislature failed to pass legislation required to extend the ACMP. By operation of Alaska State law (Alaska Statutes 44.66.020 and 44.66.030), this meant that the Alaska Coastal Management Program officially expired on July 1, 2011, resulting in a withdrawal from participation in the National Coastal Management Program. Consequently, the CZMA federal consistency provision, Section 307, no longer applies in Alaska and Alaska is no longer eligible for CZMA grants under Sections 306, 306A, 308, 309 or 310. Because a federally approved coastal management program must be administered by a state agency, reinstatement of the program would require approval by the state legislature. Information about the expired ACMP is available on the ADNR website (http://www.alaskacoast.state.ak.us/ ) until June 30, 2012

## 3.3.7 Transportation

### 3.3.7.1 Air Transportation Systems

**Kaktovik**

Air travel provides the only system for year round access to Kaktovik. The airport at Kaktovik is on Barter Island, which is owned by the U.S. Air Force and operated by the NSB. The length of the runway is 4,820 ft. It is serviced daily by ERA Alaska (formerly Frontier Flying Service) (ADCCED 2011b). Chartered aircraft also use this airport.

**Nuiqsut**

Air travel provides the only transportation system for year round access to Nuiqsut. The 4,343 ft long by 90 ft wide gravel airstrip is owned and operated by the NSB. This airport is serviced by ERA Alaska (ADCCED 2011b). The airport is equipped with a rotating beacon, approach lights, high-intensity runway lights, and visual-approach slope-indicator systems; though the runway is unattended and unmonitored (BLM 2003). Daily flights carry passengers, cargo, and mail, and commercial flights connect Nuiqsut to Barrow and Deadhorse. Chartered and private aircraft also use the airport on a regular basis.

**Prudhoe Bay/Deadhorse**

There are three major airstrips in the Prudhoe Bay/Kuparuk area--the state-owned and operated Deadhorse airport and the privately owned and operated Prudhoe Bay and Kuparuk airstrips. The airport at Deadhorse services the oil and gas facilities on the North Slope in the Prudhoe Bay area. The airport located at Deadhorse is the primary means of public transportation to the North Slope industrial areas.

The state-owned asphalt and gravel airstrip at Deadhorse is 6,500 ft long by 150 ft wide, and a state-owned heliport is located at Prudhoe Bay. The Deadhorse airport is served daily by a variety of aircraft and can accommodate Boeing 737 sized jet aircraft. The airport has a small passenger terminal, hangars, storage warehouses, and equipment for freight handling. It accommodates mostly oil company and support company personnel passengers (BLM 2003). Commercial cargo service is also provided into Deadhorse and to satellite oil field airstrips. Alaska Airlines, ERA Alaska, and private charters service this airport. There are no services beyond Deadhorse (ADCCED 2011b).

### Barrow

The state-owned Wiley Post-Will Rogers Memorial Airport serves as the regional transportation center for the NSB. This airport has a 7100 ft long by 150 ft wide asphalt runway. Jet service is regularly provided on a daily basis. This airport is serviced by commercial air carriers including: Alaska Airlines and ERA Alaska (ADCCED 2011b). Freight arrives by air cargo year-round. This airport is the transportation hub for villages on the North Slope. Alaska Airlines provides regularly scheduled jet passenger flights into Barrow from Anchorage and Fairbanks and other air carriers offer shuttle service from Barrow to various North Slope communities. The Barrow airstrip is accessible year round with use constraints involving severe weather, an occasionally obstructed runway, and migratory waterfowl that may be in the area during spring and fall. Airport facilities include two large hangars, storage warehouses, and equipment for freight handling. Barrow airport has the ability to provide medical evacuation service to larger communities in Alaska and, as a result, could be used as a medevac location for offshore exploration activities for emergencies.

### Wainwright

Wainwright's only year-round access is by air travel. The 4,494 ft long by 90 ft wide gravel airstrip is owned and operated by the NSB and is the primary airstrip. A 3,000 ft long by 100 ft wide gravel airstrip exists at the old Wainwright Air Station. This airport is serviced daily by commercial and chartered service by ERA Alaska (ADCCED 2011b). Freight arrives by cargo plane. Wainwright’s airport could be used as a base for offshore exploration activities in the Chukchi Sea given its proximity to active lease exploration programs. It is equipped with a rotating beacon, approach lights, high-intensity runway lights, and visual-approach systems.

### Point Lay

A public 4,500 ft long by 100 ft wide gravel airstrip, owned by the U.S. Air Force is Point Lay's only year-round access. ERA Alaska provides daily commercial airline service to this community (ADCCED 2011b). Freight arrives by air cargo year-round. Federal government chartered aircraft also use this airport on a limited basis.

### Point Hope

The state-owned 4,000 ft long by 75 ft wide paved airstrip provides Point Hope's only year-round access. Bering Air, ERA Alaska (daily), Grant Aviation (by charter), and Tanana Air Service (by charter) provide service to this community (ADCCED 2011b). Freight arrives by air cargo year-round. Federal government chartered aircraft also use this airport on a limited basis.

### Kivalina

The primary means of transportation into this community is by plane which lands on the state-owned 3,000 ft long by 60 ft wide gravel airstrip. Daily flights are available from Kotzebue (ADCCED 2011b). Bering Air, ERA Alaska (daily), Grant Aviation (by charter), and Tanana Air Service (by charter) fly to this community (ADCCED 2011b).

**Kotzebue**

Air transportation is the primary means of year-round transportation. The state-owned Ralph Wien Memorial Airport supports daily jet service to Anchorage and several air taxis to the region's villages. This community has a 5,900 ft long by 150 ft wide main paved runway and 3,876 ft long by 90 ft wide crosswind gravel runway. A seaplane base is also operated by the state in Kotzebue. This airport is serviced daily and throughout the week by the following carriers: Alaska Airlines; Baker Aviation; Bering Air; ERA Alaska; Grant Aviation (by charter); and Tanana Air Service (by charter) (ADCCED 2011b).

**Other Aircraft Traffic**

USCG aircraft presence in the Arctic region has expanded in recent years. The USCG "Arctic Domain Awareness Flights" in the Beaufort and Chukchi seas region use HC-130 Hercules aircraft to support operations and exploration and promote an understanding of the region. These types of flights provide the USCG with opportunities to test their personnel and equipment capabilities, survey sea ice, and monitor vessel traffic. The NSB's Search and Rescue Department provides aircraft (helicopter and jet) and trained personnel for airborne response, medevac, search and rescue, and support to the NSB communities.

Scientific surveys are conducted by aircraft along the coastlines of the Beaufort and Chukchi seas predominately during a portion of the open water season. For instance, BWASP aerial surveys have been conducted by fixed wing aircraft in the region annually since 1979. The Chukchi Sea Planning Area (CSPA) was surveyed often during the open water seasons between 1979 and 1991 by contractors under contract to BOEM. The COMIDA surveys began in 2008 for the CSPA; this program is now *"part of the Aerial Surveys of Arctic Marine Mammals project, which is funded by BOEMRE and coordinated through NMML"* (NMFS 211). Oil and gas industry support aircraft (usually helicopters) are more frequent in the summer months in areas of active exploration and production. Small private aircraft and charters are also associated with recreational hunting activities along both coastlines and inland.

### 3.3.7.2 Marine Transportation Systems

**Community Vessel Traffic**

Marine transportation in the region is dominated by freight deliveries but also includes relatively small inboard and outboard-engine watercraft used by villagers and less frequently by scientific research vessels. Marine transportation provides an economical means of transporting heavy machinery and other cargo with a low value-to-weight ratio (BLM 2003). Marine shipments along the Beaufort and Chukchi coasts are limited to a seasonal window between late July and early September, when the Arctic coast is ice free.

During the open water period, local skiffs are used for hunting and for transportation between villages and camps. Barge resupply operations for the coastal communities occur during the months of July, August, and September when the Arctic pack ice traditionally recedes and a navigable lead forms along the Alaskan coast. Tugs with barges are the main vessel types used to resupply the communities along the coastline during the ice free months with dry goods, fuel, raw building materials, and other commodities that cannot be flown in on aircraft. Tug and barge operations generally consist of a tug towing several barges. There is no major maritime industrial infrastructure or port in the Beaufort or Chukchi seas that supports transporting goods between major ports. There are small port facilities on the North Slope ranging from shallow-draft docks with causeway/road connections to Prudhoe Bay to beach-landing areas in the local communities. As there is no deep water port, cargo ships and oceangoing barges are typically offloaded to shallow-draft or medium-draft ships for lightering to shore.

## Industrial traffic

Tugs and barges are used as sealift operations for transporting large building units, drill rigs, and modules used in the oil and gas development on the North Slope and travel occurs mainly along the nearshore waters of the coast during the open water season. Sealifts have decreased over the last several years (two to three per year or less) as onshore production has declined in the oil fields, and less exploration and development has occurred onshore (MMS 2008). Oil spill response vessels are used in the marine areas near Prudhoe Bay and existing oil and gas infrastructure during the open water season to practice effective response strategies.

Along the Beaufort Sea coast at Prudhoe Bay, there are three dockheads for unloading barges, one at East Dock and two at West Dock. A 1,100-ft long causeway connects East Dock to a no-longer-used 100- by 270-ft long wharf constructed from grounded barges (BLM 2003). West Dock, a 13,100-ft long by 40-ft wide, solid-fill, and gravel causeway runs along the northwestern shore of Prudhoe Bay east of Point McIntyre. There are two unloading facilities off the gravel causeway at West Dock. One facility is 4,500 ft from shore and has a draft of 4 to 6 ft. The second facility is about 8,000 ft from shore and has a draft of 8 to 10 ft. On the Chukchi Sea, the DeLong Mountain Terminal south of Kivalina is the only port facility that can accommodate large vessel traffic, and it is used to ship processed ore from Red Dog Mine.

The closest developed port facilities to the Beaufort and Chukchi seas are located at Nome and include docks that industrial vessels use for fueling and supplies. The City Dock on the causeway is equipped with marine headers to handle the community's bulk cargo and fuel deliveries. The City Dock is approximately 200 ft in length with a depth of 22.5 ft. The West Gold Dock is 190 ft in length with a depth of 22.5 ft. The West Gold Dock handles nearly all of the exported rock/gravel for the Nome region and is the primary location to load/unload heavy equipment. There is also a small boat harbor at Nome which offers protected mooring for recreational and fishing vessels alongside two floating docks. Smaller cargo vessels and landing crafts load village freight and fuel at the east, west and south inner harbor sheet pile docks, east beach landing, and west barge ramp for delivery in the region (City of Nome 2011b).

Potential offshore development in the Beaufort and Chukchi seas would increase the numbers of support and supply ships transiting the region. The service vessels to support offshore oil and gas exploration activities can be categorized as supply, crew, and utility vessels (seismic and icebreaking). Each of these types of vessels produces noise, discharges, and air emissions (MMS 2008). Exploratory drilling programs would be expected to use several support vessels, including spill response vessels.

## Large Vessel Traffic

The Bering Strait, with a width of 50 nautical miles between Alaska and Russia, is considered the entrance to the Arctic Ocean. It is also considered a choke point for marine traffic in and out of the Arctic Ocean from the Pacific. With lessening of sea ice and increased open water periods, the Northern Sea Route along the northern coast of Siberia and the Northwest Passage along the northern coast of North America have become more viable maritime options for commercial transportation. Vessel traffic through the Bering Strait is in a rapid state of growth, which is likely to continue as the period of open water continues to lengthen. Growth in all sectors of Arctic marine traffic is expected to occur, including bulk natural resource shipments, scientific exploration, fishing, military activities, and tourism (Arctic Council 2004 and 2009, Brigham and Ellis 2004, U.S. Arctic Commission 2010, US Navy Arctic Roadmap 2009). In 2010, there were approximately 325 transits through the Bering Strait, in comparison to approximately 275 in 2009 and about 245 in 2008 (Colvin 2011).

Shipping in the Arctic, including the Beaufort and Chukchi seas, is focused on the transport of regional community goods, and the shipment of natural resources out of the Arctic to world markets (Arctic Council 2009). For instance, Red Dog Mine is one of the world's largest producers of zinc and lead and must carefully plan bulk ore shipments to occur before the fall ice forms. Approximately 25 large

commercial ships (bulk carriers) annually sail north through the Bering Strait region (in the ice-free season) to the DeLong Mountain Terminal. Large bulk carriers, *Panamax* and *Handymax* which range in size up to 65,000 tons, visit Red Dog Mine in Alaska during this open water season (Arctic Council 2009).

The USCG is responsible for maritime safety, security, and stewardship, and its mission applies to U.S. Arctic waters as well. Search and rescue missions by the USCG mainly occur in the Gulf of Alaska and the Bering Sea. However, with increased open water in the Arctic and increased vessel traffic, the USCG has expanded its missions in the Beaufort and Chukchi seas and sent assets into the region in several ways (USGC 2009). In recent years during the open water months, summer operations called Arctic Crossroads have been conducted in an effort to integrate local knowledge of the region with military expertise to meet the challenges of Arctic operations. This operation involves USCG, U.S. Air Force, Army National Guard, Air National Guard, and U.S. Public Health Services personnel. This program aims to build Arctic domain awareness, involves cutter operations (including icebreaking, buoy tenders and cutters), deployments to villages, community engagement, and search and rescue exercises. The USCG cutter *Hamilton* entered Arctic waters for the first time in 2009 to conduct search and rescue drills. Use of cutters in the Arctic is considered a challenge as the hulls of these vessels are not ice reinforced. The USCG has indicated that the current infrastructure and small boats and short range helicopters are not effective for long distance search and rescue operations in the Arctic and limit response capabilities for emergencies and response to potential oil spills.

The only USCG icebreaker currently available to operate in the Arctic is the *Healy*. The USCG icebreaker *Polar Sea* is scheduled to be decommissioned in 2011, and the USCG *Polar Star* icebreaker is currently in the process of being reactivated for service but is not expected to be commissioned again until 2013 (Colvin 2011, USCG 2010). Polar region ice breaking activities by the USCG are performed as part of scientific and national security activities, including joint scientific, search and rescue exercises. The USCG seasonally has small boat operations off Point Barrow and Prudhoe Bay. The University of Alaska, Fairbanks expects to have an icebreaker – the *R/V Sikuliaq* - a research vessel suited for work in the Arctic region available by 2013 to 2014 (UAF 2011).

A key finding of the Arctic Climate Impacts Assessment was that reductions in seas ice will likely lead to increase in marine transportation and access to resources and development (Ellis 2007, Arctic Council 2009, U.S. Arctic Commission 2010). In 2004, the bulk transport of commodities, including oil gas and minerals such as ore, were a large portion of the total of Arctic vessel traffic (Arctic Council 2009). The types of vessels now entering the Bering Strait have changed and now includes tugs, Arctic research vessels, oil and gas related vessels, cruise ships, government vessels, adventurers (12 in 2009 and 17 in 2010), and government vessels (Colvin 2011). As the open water season increases, as predicted by climate change, it is likely that ships related to a spectrum of uses could eventually be found in the EIS project area, including fishing, hard minerals/mining, science and exploration, tourism, and offshore oil and gas development (Colvin 2011).

The USCG has initiated a Port Access Routing Study to increase safety of vessel traffic that transit the Bering Straits (Colvin 2011). Eventually vessel fairways (also called safe vessel routes) could be established and listed on nautical charts with International Maritime Organization approval. The need for this action was spurred in part by the sharp increase of vessels entering the Bering Strait from 2008 to 2010. Navigation aids are currently limited in the Beaufort and Chukchi seas, as is the ability of the USGS to respond to maritime emergencies. Needs for enhancing Arctic marine safety, protecting Arctic people and their environment, and building marine infrastructure, were identified as important issues in 2009 (Brigham and Sfraga 2009). Hydrographic surveys have provided the available charting information for limited areas along the northern coast of Alaska (Arctic Council 2009). The expansion of charting_knowledge for the currently used routes in the Arctic was identified as important for development of alternative courses when ice conditions are hazardous, for entry to points of refuge for vessels and to support the expected expansion of access to natural resources (Arctic Council 2009). The

Arctic Regional Hydrographic Commission was established in 2010 with representatives from the U.S, Canada, Denmark, Norway and Russia to develop nautical charts that will improve the safety of mariners transiting the Arctic (NOAA 2010). NOAA's Office of Coastal Survey and the U.S. Naval Oceanographic Office charting efforts are intended to provide additional hydrographic survey data that would be used to support safe navigation in the Arctic.

Cruise ships and ecotourism vessels are a new presence in U.S. Arctic waters. In 2009, two passenger vessels cruised through the Northwest Passage, stopping in the communities of Nome, Point Hope, and Barrow. The majority of cruise ships and adventurer ships recently present in Arctic waters are not purpose-built for Arctic operations and are built for voyaging in open water in lower latitudes and warmer climates and are not ice reinforced (Colvin 2011). Arctic marine tourism poses a risk, as there is no infrastructure in local communities to respond to emergencies. At present commercial fishing vessels in the Bering Sea/Aleutian Island fleets do not enter the Chukchi Sea due to fishing moratoriums in this area. However, changing fishing grounds could bring commercial vessels and fleets northward from the Bering Sea into the Arctic Ocean. In that event, changes to current fishery management plans would be required under the Magnuson-Stevens Fishery Conservation and Management Act.

#### 3.3.7.3 Increased Aircraft and Vessel Traffic Concerns

The increase in the length of the open water season and increase in offshore oil and gas exploration is leading to an increase in aircraft and vessel traffic along the coastlines. This is viewed as a disruption to marine species by indigenous people and first nations whose culture and way of life are based on subsistence harvests. With regard to presence of increased air traffic, hunters have noticed:

- *We have a lot of air traffic, not just from the oil companies but from tourist stuff going on. Hunters traveling along the coast, too, so we were having to deal with that on top of the helicopters and stuff doing their routes to Point Thompson already. They're flying in the same migration -- or the times as the migration of the caribou and stuff, and I'd just really hate to see more of it happen because I think it's going to -- the cumulative impact is going to have a great negative impact on our community.* – Carla Sims Kayotuk at Kaktovik Scoping Meeting, March 12, 2010
- *They're [airplanes and oil planes] flying all over now around here, and it's impacting us. And more of the things that's happening now, it's impacting us. And we're a subsistence hunters. And I don't want to see more of that. It's our garden.* – Marie Rexford, Kaktovik Scoping Meeting, March 12, 2010
- *These are our only times during the summer [on calm days] that we have access to hunting caribou that go down to the coast. If activity, support activity, such as aircraft or helicopters or other support activities are near the coast -- and we have many people that can make oral statements that during the summer when they're getting close to caribou, either a small plane or helicopter show up and drive the caribou further inland.* – Fenton Rexford, Native Village of Kaktovik, March 12, 2010

Subsistence hunters have also expressed concern about the impacts of vessel traffic and increased ship presence on the animals and on their hunting practices. Oil spills from marine vessels are one of the largest concerns, as are air emissions impacts as well. The accidental release of oil or toxic chemicals can be considered one of the most serious threats to Arctic ecosystems as a result of shipping and increased large vessel marine transportation. The Arctic Council (2009) noted "*potential conflicts between increased ship traffic and indigenous marine resource use in the Bering Strait region include but are not limited to an increased amount of:*

- *Ambient and underwater ship noise;*
- *Ship strikes on large marine mammals;*

- *Potential for collision between coastal and offshore large ship traffic and small open boats using marine resources; and*
- *Pollution affecting the availability and quality of offshore, coastal and beachcast marine resources, due in part, but not limited to lack of navigational and rescue infrastructure in an extremely challenging physical and marine environment; concern for infrastructure to secure a large vessel in distress; concern for infrastructure to assess and respond to an oil and/or chemical spill."*

Concerns regarding the increase in vessel traffic and the relationship between vessel traffic and marine subsistence harvests have been expressed by scientists and residents of the Beaufort and Chukchi communities:

- *What we're expressing now is that on exploration (indiscernible) the barges do interfere and every year we have barges from Outside, coming from Canada going to Prudhoe or Barrow or even from another way around, coming from down through Barrow and get to Prudhoe. What we are facing is that it's pretty hard for us to hunt whales nowadays because all the whales that we've been trying to catch are all spooked and pretty hard to catch and never had any whales last year because of early migration or the whales were not in their migration route. That's the barge activities, that absolute reason.* - Eli Napageak, Nuiqsut Government to Government Meeting, March 11, 2010.
- *We had spotted that whale inside the barrier island and went between it. I don't know where -- the boats come from Prudhoe heading to Badami. And then we see that barge – that whale right in between the barges and the whaling. We never see that whale again and what -- which it was disrupted there.* - Eli Napageak, Nuiqsut Government to Government Meeting, March 11, 2010.
- *I was going east to my crew, almost -- there was just hundreds of whales just constantly passing by and the last one I saw that was in front of me, it was a calf and then the mother came up, put her arm around the calf and then they went down. And then that barge came by about five minutes later, five, ten minutes later, and then there was no whales for like 15 miles to my whaling crew. And so barge activity does divert a lot of whales, our whales we were hunting in the Beaufort Sea and Camden Bay.* – Thomas Napageak, Mayor of Nuiqsut and Whaling Captain, Nuiqsut Government to Government Meeting, March 11, 2010.
- *What concerns me here from the AEWC and from different whaling association – shipping is a concern, fishing industry is another and encroachment moving north into our hunting areas. These are the other two potential threats that are out there.* - Harry Brower at Open Water Meeting 2011, Anchorage, AK.
- *We've been able to tag quite a few belugas in Point Lay over the years and we've learned they use a huge amount of the ocean. We need to keep this in mind as we think about what is happening in the Chukchi Sea with vessels, drill ships and seismic in June and July. If there is a bunch of activity out there before Point Lay hunts, there is a potential to disrupt the movement of the belugas.* - Robert Suydam - 2011 ABWC Subsistence Harvest Updates at Open Water Meeting 2011, Anchorage, AK.
- *I'm [Caleb Pungowiyi] also concerned about the cumulative impacts that other activities will have on our subsistence resources. Not only the exploration activities, but other activities associated with that activity. Support vessels, aircraft, vessels going back and forth to restock and provide support to the activity. We also see some potential increased vessel traffic if the area opens up for international commercial ship traffic for shipping between the European countries and the Asian countries through the Arctic Ocean, especially through the northern route or*

*through the northwest passage.* – Caleb Pungowiyi, Kotzebue Scoping Meeting, February, 18, 2010.

- *The impact we are seeing is on our spring hunt. The transporters are ramming the ice and you could see when the belugas were coming. Every time the marine lines are trying to push the ice out of the way, the belugas head back east. We are feeling it. When we are trying to harvest, they are trying to get to Red Dog early. We try to stop it and we get a call from Shishmaref saying they are being disturbed.* - George (unable to hear), Manilliq, Kotzebue at Open Water Meeting 2011, Anchorage, AK.

## 3.3.8 Recreation and Tourism

Recreation and tourism occur at generally low levels of use in the EIS project area. The affected environment for recreation and tourism will be described by setting and activities. It is important to distinguish between recreation and subsistence uses. The vast majority of fishing, hunting, and boating that occurs in the project area are *subsistence*-based, managed completely apart from recreation-based activities, with separate rights and privileges (see Section 3.3.2, Subsistence for further discussion). This section discusses only recreation-based activities, a small portion of the total of human uses in the area.

### 3.3.8.1 Setting

The EIS project area is a vast Arctic region, with a great deal of opportunities for recreation. The undeveloped setting is conducive to recreation activities such as wildlife viewing and photography, sailing, float boating, hiking/backpacking, camping, fishing, hunting, and winter sports (BLM 2008b). The remoteness of the area, even by Alaska standards, and the vast areas of undeveloped landscape can offer recreationists experiences unlike anywhere else. Possible areas for recreation include the Beaufort and Chukchi seas, Arctic National Wildlife Refuge, the NPR-A, Alaska Maritime National Wildlife Refuge (AMNWR), Cape Krusenstern National Monument, lands managed by the State of Alaska, and communities along the North Slope. However, the area has few facilities to support recreation and tourism and is difficult and costly to access. Most of the North Slope areas are underused for recreation and have the potential to support much more in the future (BLM 2008b).

The EIS project area is described via three recreation settings: offshore, onshore, and coastal communities. The offshore setting is away from the coast of the Beaufort and Chukchi seas. There are presently no facilities located in the offshore setting; marine vessels and aircraft transit the area, but the setting is largely undeveloped and offers abundant opportunities for solitude. The nearshore environment (within three miles of land) contains facilities related to oil and gas development and production in the Beaufort Sea, as well as docks and other industrial support facilities (NSB 2005). While facilities have been located for many years in the vicinity of Prudhoe Bay and Barrow, there are also facilities dispersed across the nearshore environment between Kaktovik and Barrow. A few facilities (not directly related to oil and gas activities) also exist in the nearshore environment of the Chukchi Sea, with larger facilities generally located in the larger communities such as Kotzebue (The City of Kotzebue 2000). While facilities exist in the nearshore environment setting, there are many opportunities for recreation in an undeveloped setting.

The landscape in the vicinity of the coastal communities is typically vast reaches of tundra, with ponds, small drainages, or the rivers running out into the seas. Recreation activities in the project area often are based from the coastal communities that have facilities and services to support recreation or tourism activities, such as flight services and accommodations. Several of the communities have limited facilities to accommodate tourism activities or a more developed range of recreation activities. A small private lodge exists in Kaktovik, which also offers flight services, wildlife viewing, and other services (Waldo Arms Hotel 2006); Barrow and Kotzebue are larger hub communities in the region, and each hosts hotels and several firms that offer wildlife viewing and sightseeing activities (City of Barrow 2011, The City of

Kotzebue 2000). Recreation activities in the coastal communities may occur in a rural setting, within sight and sound of structures and human activities. The communities may also serve as a gateway to backcountry recreation opportunities, which would occur in undeveloped settings.

### 3.3.8.2 Activities

Low levels of recreation activities are estimated to occur in the project area. As mentioned above, the vast majority of hunting, fishing, and boating in the area are subsistence-based and rarely considered as recreation or pleasure. While estimated to occur at very low levels, local and non-local residents engage in recreation activities in the project area, including the offshore environment, nearshore environment, as well as in the vicinity of the coastal communities evaluated in this document.

There is very little information available on recreation and tourism in the project area, particularly in the offshore environment. No agency tracks dispersed recreation in the offshore environment. The State of Alaska and the NSB manage activities in the nearshore environment, but there is little recreation use data compiled for this area. Federal agencies, including the BLM and the USFWS, as well as the State of Alaska and the NSB manage activities on lands in the vicinity of the project area. Management policies and searches for guides and outfitters that operate in the area provide the basis for this summary analysis.

#### Offshore

Offshore recreation activities in the project area generally require the use of large boats, including sail boats, cruise ships, and other large motorized vessels. Wildlife viewing by boat is also a featured recreation activity in the area. There are a number of whale watching tours and wildlife viewing/photographing boats available for charter along the Beaufort and Chukchi seas, primarily out of Barrow, Kaktovik, and Kotzebue. A limited number of flight services also offer wildlife viewing opportunities (Alaska PhotoGraphics 2011, Arctic Air Guides 2009, Kaktovik Arctic Tours 2010).

Residents in the NSB also have observed an increase in yachts or personal pleasure boats traversing the project area. Opportunities exist for expeditions to the North Pole that would traverse through the EIS project area.

#### Nearshore

In the nearshore environment, many recreation activities are supported by small, personal watercraft, both motorized and non-motorized. This type of recreation is usually residents of the coastal communities, because access is difficult and costly, particularly for transporting watercraft. Beachcombing, wildlife viewing, and photography are also common activities in the nearshore environment. Guided trips or flight seeing, based from the coastal communities, typically serve non-local residents (NSB 2005).

#### Coastal Communities

The communities along the coast are hundreds of miles apart with vast stretches of federal and state lands in between. Access to the undeveloped areas is difficult and costly. As a result, much of the recreation occurs around the coastal communities, where some infrastructure exists, such as airports, hotels, and guide services. Several options for commercial flightseeing are available out of Kaktovik, Barrow, and Kotzebue. Charter boats are available in towns for wildlife viewing and photography. Rafters coming out of the Arctic National Wildlife Refuge may end in Kaktovik. Hiking and backpacking opportunities out of Kaktovik, Barrow, and Kotzebue exist, although there are no specific facilities or services to support these activities, and no designated trails. The aurora borealis also draws visitors, and these tours are often paired with wildlife viewing or other guided activities (Alaska PhotoGraphics 2011. Arctic Air Guides 2009. Kaktovik Arctic Tours 2010).

Guided and unguided sport hunting, fishing, and hiking occur in the vicinity of coastal communities, as well as on state and federal lands. The Alaska Department of Fish and Game permits sport hunting,

trapping, and fishing on the North Slope in Game Management Units 26 and 23, with certain restrictions (ADFG 2010b).

Wildlife is a big draw to the North Slope for tourists; interest in polar bear viewing has increased as the species gets more media attention from the threat of climate change and the recent listing of the species as threatened under the ESA. Several guided tours are available for polar bear viewing from Kaktovik, Prudhoe Bay, and Barrow (Alaska PhotoGraphics 2011).

## 3.3.9 Visual Resources

### 3.3.9.1 Analysis Area

The analysis area for visual resources includes onshore and offshore areas. Onshore areas included native communities located along the shoreline between Kotzebue, on the western shore of the Arctic Coastal Plain (ACP), across the north edge of the ACP to the U.S.-Canadian border. This portion of the analysis area was established to assess views of the EIS project area from these locations. Offshore areas include the Beaufort Sea, located north of the ACP, between Point Barrow and the U.S.-Canadian border, and the Chukchi Sea, located between Point Barrow and Kotzebue. Both the Beaufort and Chukchi seas are located in the Arctic Ocean. The geographic extent of the offshore portion of the analysis area was defined by the boundary of the EIS project area (Figure 1.1).

### 3.3.9.2 Methods

Visual resources of the project area were assessed from onshore and offshore locations, and from the air, using methods adopted from the BLM visual resource inventory methodology (BLM 1986). The goal of the assessment was to establish a scenic quality rating for the EIS project area.

Scenic quality is defined as "a measure of the visual appeal of a tract of land." The highest scenic quality ratings are assigned to landscapes that have the most variety and most harmonious composition in relation to the natural landscape. For the purpose of this assessment, the analysis area was subdivided into four scenic quality rating units (SQRUs) based on changes in physiography, land use, or offshore development. The geographic extent of each SQRU is described as follows:

- *West Beaufort Sea*: On- and offshore portions of the analysis area extending from Point Barrow, east to the border between ANWR and the North Slope Foothills Areawide Oil and Gas Lease Sale Area.
- *East Beaufort Sea*: On- and offshore portions of the analysis area extending from the border between ANWR and the North Slope Foothills Areawide Oil and Gas Lease Sale Area, to the Alaska-Canada border.
- *North Chukchi Sea*: On- and offshore portions of the analysis area extending from Point Barrow, west to the border between the National Petroleum Reserve and the Alaska Maritime National Wildlife Refuge (Chukchi Unit).
- *Southern Chukchi Sea*: On- and offshore portions of the analysis area extending from the border between the National Petroleum Reserve and the Alaska Maritime National Wildlife Refuge (Chukchi Unit), west to Point Hope, and south to Kotzebue.

The visual quality of landforms/water, vegetation, and structure within each SQRU was assessed in terms of texture, color, form, and line. Visual quality within each SQRU was then ranked using seven factors, including: landform; vegetation; water; color; adjacent scenery; scarcity; and cultural modification. Factors were ranked based on an understanding of the visual landscape of the area, and by reviewing photographs of the project area. A final score was then calculated for each SQRU by totally scores for each key factor. Based on these results, each SQRU was assigned a scenic quality rating of A, B, or C.

Visual quality is typically assessed within the framework of three prevailing distance zone: Foreground / Middleground (3 to 5 miles); Background (5 to 15 miles); and Seldom Seen (beyond 15 miles). For the purpose of this analysis, no distance zones were established. The rationale for this decision is twofold: 1) it is assumed that offshore viewers see the analysis area from various locations, and therefore no fixed point can be established; and 2) views of the analysis area from onland locations are generally unobstructed, and therefore could extend to a distance of 15 miles. For both on- and offshore viewers, it is assumed that landscape components are most easily discerned within the foreground / middleground distance zones. During winter months visibility may be limited to areas within one mile, depending on the level of light present in an area.

In addition to quantifying scenic quality, additional qualitative indicators were assessed, including seasonality and motion. Seasonality will influence the visibility within the project area due to lighting and atmospheric conditions. Motion was evaluated to provide a baseline of activity level within the analysis area.

### 3.3.9.3 Regulatory Framework

The analysis area includes inland areas administered by the NPS, the USFWS, the State of Alaska, the NSB and the NAB. Land use and planning documents for all federal and state agencies do not contain management provisions for offshore visual resources. Borough requirements under its Title 19 Land Management Regulations provide guidance to reduce potential effects to visual resources. The guidance is similar to mitigation measures that have been required in local and federal permits for nearshore and offshore development, and that have been included in Records of Decision for NEPA compliance documents.

### 3.3.9.4 Viewer Sensitivity

Viewer sensitivity was assessed for three predominant viewer groups: Native communities; recreators (including Arctic marine tourists); and industrial workers. Viewer groups and their anticipated exposure to the proposed project area are described below.

- *Native Communities*: Native communities include Kaktovik, Nuiqsut, Barrow, Wainwright, Point Lay, Point Hope, Kivalina, and Kotzebue. These communities are situated on or near the coastline and contain views of the offshore portion of the analysis area. Individuals from these communities may also engage in offshore subsistence activities, where they may experience views of the project area.
- *Recreators*: Recreational viewers include land-based user groups located in the Cape Krusenstern National Monument, the Alaska Maritime National Wildlife Refuge and ANWR. Recreators situated near shorelines in these locations experience views of the offshore portion of the project area. Other recreation groups include those accessing the area by boat. Recreators may also experience views of the project area from the air when traveling to/from recreation destinations.
- *Arctic Tourists*: Arctic tourists include individuals traveling through the project area by ship. These individuals may experience views of the project area from the offshore perspective.
- *Industrial Workers*: Industrial workers are primarily situated in Oil and Gas lease areas located on the north shore of the ACP.

Visual sensitivity was determined using criteria provided by the BLM Sensitivity Level Analysis procedure. Sensitivity level rating units (SLRU) coincided with SQRU, and included: 1) the west Beaufort Sea; 2) the east Beaufort Sea; 3) the northeast Chukchi Sea; and 4) the southern Chukchi Sea.

For each SLRU, visual sensitivity was established by evaluating the following factors:

- *Type of Users*: Visual sensitivity is expected to vary with the type of user. For example, recreational sightseers may be highly sensitive to any changes in visual quality, whereas industrial workers who pass through the area on a regular basis may not be as sensitive to change.
- *Amount of Use*: Areas seen and used by large numbers of people are potentially more sensitive. Protection of visual values usually becomes more important as the number of viewers increase.
- *Public Interest*: The visual quality of an area may be of concern to local, state, or national groups. Indicators of this concern are usually expressed in public meetings, letters, newspaper or magazine articles, newsletters, land-use plans, etc. Public controversy created in response to proposed activities that would change the landscape character should also be considered.
- *Adjacent Land Uses*: The interrelationship with land uses in adjacent lands can affect the visual sensitivity of an area. For example, an area within the viewshed of a residential area may be very sensitive, whereas an area surrounded by commercially developed lands may not be visually sensitive.
- *Special Areas*: Management objectives for special areas such as Natural Areas, Wilderness Areas or Wilderness Study Areas, Wild and Scenic Rivers, Scenic Areas, Scenic Roads or Trails, and Areas of Critical Environmental Concern frequently require special consideration for the protection of the visual values. This does not necessarily mean that these areas are scenic, but rather that one of the management objectives may be to preserve the natural landscape setting. The management objectives for these areas may be used as a basis for assigning sensitivity levels.

Native communities, including individuals engaged in subsistence, recreators, and air travelers, were assigned a high visual sensitivity. Industrial workers were assigned a low visual sensitivity. The sensitivity level analysis and determination of visual sensitivity is presented in Table 3.3-48.

**Table 3.3-48 Sensitivity Level Analysis for Viewer Groups Located Within the Visual Resources Analysis Area**

| SLRU[1] | Viewer Location | Public Interest | Adjacent Land Use | Special Areas[3] | Type of User | Amount of Use | Other Factors | Overall Visual Sensitivity |
|---|---|---|---|---|---|---|---|---|
| West Beaufort Sea | Onshore | Moderate | ANWR[2] | N/A | Native community of Nuiqsut (HIGH) | Prolonged; small population (LOW) | Traditional use area (HIGH) | HIGH |
| | | | | | Industrial workers (Oil & Gas) centered on Prudoe Bay and Deadhorse (LOW) | Variable and at specific locations (LOW) | Located in and adjacent to well established industrial nodes | LOW |
| | Offshore | High | N/A | N/A | Individuals engaged in subsistence (HIGH) | Year-round; low numbers (LOW) | Well-established sense of place (HIGH) | HIGH |
| | | | | | Industrial workers (LOW) | Seasonal – low numbers (LOW) | N/A | LOW |
| | | | | | Arctic tourists expecting to see oil & gas activity (LOW) | Seasonal – low numbers (LOW) | N/A | LOW |
| East Beaufort Sea | Onshore | High | N/A | ANWR[2] (HIGH) | Native Community of Kaktovik (HIGH) | Prolonged; small population (LOW) | Traditional use area (HIGH) | |
| | | | | | Recreators located in the ANWR[2] (HIGH) | Seasonal – low numbers (LOW) | N/A | HIGH |
| | Offshore | High | N/A | N/A | Individuals engaged in subsistence (HIGH) | Year-round; low numbers (LOW) | Well-established sense of place (HIGH) | HIGH |
| | | | | | Industrial workers (LOW) | Seasonal – low numbers (LOW) | N/A | LOW |
| | | | | | Arctic tourists expecting more pristine views associated with ANWR[2] (HIGH) | Seasonal – low numbers (LOW) | N/A | HIGH |
| Northeast Chukchi Sea | Onshore | Moderate | AMNWR[4] | N/A | Native Communities of Barrow and Wainwright (HIGH) | Prolonged; small populations (LOW) | Traditional use area (HIGH) | HIGH |
| | | | | | Industrial workers (Oil & Gas) (LOW) | Variable and at specific locations (LOW) | Located in and adjacent to well established industrial nodes | LOW |

| SLRU[1] | Viewer Location | Public Interest | Adjacent Land Use | Special Areas[3] | Type of User | Amount of Use | Other Factors | Overall Visual Sensitivity |
|---|---|---|---|---|---|---|---|---|
| | Offshore | High | N/A | N/A | Individuals engaged in subsistence (HIGH) | Year-round; low numbers (LOW) | Well-established sense of place (HIGH) | HIGH |
| | | | | | Industrial workers (LOW) | Seasonal – low numbers (LOW) | N/A | LOW |
| | | | | | Arctic tourists (HIGH) | Seasonal – low numbers (LOW) | N/A | HIGH |
| South Chukchi Sea | Onshore | High | Noatak National Preserve; Cape Krusenstern National Monument (HIGH) | HIGH | Native communities of Point Lay, Kivalina, and Kotzebue (HIGH) | Prolonged; small population (LOW) | Traditional use area (HIGH) | HIGH |
| | | | | | Recreators located in the AMNWR[4] (HIGH) | Seasonal – low numbers (LOW) | N/A (HIGH) | HIGH |
| | Offshore | High | Cape Krusenstern National Monument (HIGH) | N/A | Individuals engaged in subsistence (HIGH) | Year-round; low numbers (LOW) | Well-established sense of place (HIGH) | HIGH |
| | | | | | Arctic tourists (HIGH) | Seasonal – low numbers (LOW) | N/A | HIGH |
| ALL SLRUs | Onshore / Offshore | High | HIGH | N/A | Air travelers (industrial workers, tourists, researchers / scientists) | Variable; dependent on work rotations and seasonal access | Short viewer duration; variable angle of observation. | HIGH |

Notes:

[1] SLRU = Sensitivity Level Rating Unit, [2] ANWR = Arctic National Wildlife Refuge, [3] N/A – Not Applicable, [4] Alaska Maritime National Wildlife Refuge
Cape Krusenstern National Monument: http://www.nps.gov/cakr/parkmgmt/lawsandpolicies.htm

### 3.3.9.5 Regional Landscape

The EIS project area is located offshore, to the north and west of ACP and Arctic Foothills physiographic province (Arctic Research Consortium 2011). Physiographic provinces represent geographic areas that are classified largely based on homogenous topography within a province. Each province is distinct, and differences across adjacent provinces are readily apparent (Wahrhaftig 1965).

The ACP physiographic province is bounded on the north and the west by the Arctic Ocean and stretches eastward nearly to the international boundary between Alaska and the Yukon Territory, Canada. When viewed from offshore locations, the area is characterized by expansive, flat topography that extends approximately 200 miles south to the Brooks Range. Numerous thaw lakes dot the province, creating a contiguous network of water bodies that extend across the plain between Wainwright and Prudhoe Bay. The predominant vegetation cover is low growing, and the area is devoid of trees and shrubs. Oil and gas development is concentrated in the center of the ACP and appear as isolated developments connected by a network of pipelines and roads. The Dalton Highway, the primary terrestrial route connecting the region to the southern part of the state, extends in a north-south trajectory from Prudhoe Bay. The ANWR occupies the eastern edge of the ACP.

The Arctic Foothills physiographic province consists of a wide swath of rolling hills and plateaus that grades from the coastal plain on the north to the Brooks Range on the south. The east-west extent of the ecoregion stretches from the international boundary between Alaska and the Yukon Territory, Canada, to the Chukchi Sea. The hills and valleys of the region have better defined drainage patterns than those found in the coastal plain to the north and have fewer lakes. The province is underlain by thick permafrost and many ice-related surface features are present. The province is predominantly treeless and is vegetated primarily by mesic graminoid herbaceous communities. The western edge of the Arctic Foothills physiographic province is occupied by the Alaska Maritime National Wildlife Refuge, and Cape Krusenstern National Monument.

### 3.3.9.6 Seasonality

A high degree of seasonality exists within the EIS project area. Winter conditions persist for much of the year, with extensive snowpack between the months of October to June. Nearshore conditions are marked by extensive ice pack (described below). Summers are marked by inland thaws that expose extensive wetlands, rivers, and low-growing vegetation. Periods of darkness and light vary across the year, bracketed by extremes of 24-hour daylight and the mid-winter “day” devoid of direct sunlight. Between extreme periods of light and darkness are long periods characterized by low-angle sunlight and prolonged periods of darkness. Visibility in winter and spring may be obscured by “Arctic haze” that results from the transport of industrial pollutants from Europe and Asia, which can limit visibility during winter and spring months.

### 3.3.9.7 Activity and Viewpoints

Activities within the EIS project area are supported by air, marine vessel, or snowmobile travel. The modes of travel in the project area provide common means of viewing the project area. (For more detailed information on transportation, refer to Section 3.3.7.)

Onshore and offshore portions of the EIS project area are frequently viewed via regularly scheduled air travel on commuter airlines. Occasional unscheduled air travel (fixed wing and helicopter) may provide viewpoints in support of recreation, tourism, scientific research, or oil and gas activity (MMS 2008).

Two forms of vessel traffic provide viewpoints of the offshore environment during the Arctic Ocean open-water season: smaller vessels, or skiffs, used for hunting and between-village transportation, and larger barges that deliver goods to local communities. Tug and barge traffic associated with the onshore

oil development provide viewpoints mainly in nearshore waters along the coast. Offshore, nearshore, and coastal areas may be viewed from marine vessels.

Industrial workers and residents use snowmachines for local travel, with views of onshore and nearshore areas. Snowmachine traffic commonly runs along many of the same routes each year, often following the coastline, major rivers, or industrial support trails (MMS 2008).

### 3.3.9.8 Characteristic Landscape Description

The analysis area is described as a broad panoramic that extends to the edge of the horizon. Views from and toward the analysis area are largely unobstructed, with the exception of isolated oil and gas facilities, including structures and, in onshore locations, associated roads and pipelines. Views from within the project area toward land, though still largely panoramic, include the backdrop of the Brooks Range.

Landscape character elements, including landform/water, vegetation, and cultural modification are described below.

#### Landform/Water

Visual resources within the EIS project area across all units are dominated by characteristics of the Beaufort and Chukchi seas. The visual characters of these waterbodies undergo dramatic changes across seasons, due in large part to the dynamic seasonal cycle of sea ice. Despite the season, views from on-shore portions of the analysis area (i.e. Native communities, recreation areas) and from within the analysis area (i.e. Arctic tourists, individuals engaged in subsistence activities) are marked by the bold horizontal line of the horizon. Views of both seas may be seen from beaches, such as along the East and West Beaufort analysis units, or from seaside cliffs, such as those characterizing the more rugged coastlines of the North and South Chukchi analysis units.

During the fall, winter, and spring seasons, both the Beaufort and Chukchi seas are covered by sea ice. The southern portion of the Chukchi Sea is typically ice-free for one to two months longer than the Beaufort Sea; however a large amount of inter-annual variability in the formation and breakup patterns of sea ice exists in both waterbodies. Sea ice occurs in three distinct forms, landfast ice, stamukhi ice, and pack ice each of which imparts a different appearance (Figures 3.3-8 and 3.3-9). All ice forms appear predominantly white, although variation in color and texture occurs across ice forms, and may change seasonally as ice thins. Ice formation, deformation, and melt processes create variability in appearance, and overall surface roughness (MMS 2008). For further discussion of sea ice forms, refer to Section 3.1.2.

In late spring, leads – or areas of open water between large pieces of ice – form within the pack-ice zone and particularly around the seaward landfast ice edge (MMS 2008) (Figure 3.3-10). Leads may expose large areas of open water along the shoreline, creating contrast in color and texture between sea ice, land, and sea. A distinct pattern of leads occurs in the western and west-central Beaufort Sea exists creating large arc-shaped areas of open water that emanate from Point Barrow and Harrison Bay. These leads separate a region of largely immobile ice in the southeastern Beaufort Sea from the more mobile pack ice in the west. The Chukchi Sea also exhibits large leads along the northern coast. In May through June, open water can extend up to 4 km at the northern end, and up to 100 km at the southern end. Patterns created from leads are most visible from the air, where large areas can be seen (MMS 2008).

After the first openings and ice movement from late May to early June, the areas of open water with few iceflows expand along the coast and away from the shore, and there is a seaward migration of the pack ice (Figures 3.3-11 and 3.3-12). Although the concentration of ice flows generally increases seaward, the movement of the ice is variable, and can change across years. Summer months expose panoramic views of the waters of the Beaufort and Chukchi seas that extend, largely uninterrupted, to the Arctic Sea.

## Vegetation

Vegetation within the analysis area is limited to low-growing herbaceous forbs and shrubs, exposed only during the snow-free summer months (Figure 3.3-13). As vegetation is not present in the offshore portion of the analysis area, the contribution of on-land vegetation serves only as a back drop of views from within the analysis area toward land. When viewed from the sea, on-land vegetation imparts a green, golden, and brown color to the tundra. Because of the short stature of vegetation in the area, predominant lines created by vegetation follow that created by the predominant topography of the area.

## Structures

Structures within the analysis area exist primarily in onshore locations, however offshore development does exist. Structures occur as oil and gas developments (including industrial nodes and associated pipelines, roads, and landing strips), and Native communities. In general, structures related to oil and gas development that are visible from on land and near shore locations are largely confined to the West Beaufort Sea analysis unit. Structures related to oil and gas exploration and possible development in the North Chukchi Sea would potentially be located over 113 km (70 mi) offshore and would not be visible from land locations. The appearance of Native communities across all analysis units is similar, with each characterized by a dense collection of one or two-story residential and commercial structures, limited roads, and a single airstrip. Night time lighting is present in Native communities and areas of industrial development.

***Oil and Gas* --** Large scale oil and gas exploration is a major component of the landscape character of the West Beaufort Sea analysis unit. Oil and gas-related development has occurred in this area since the 1940s, with major onshore development in Prudhoe Bay and offshore exploration in the Beaufort Sea underway by the 1970s. Development and production in the near shore Beaufort Sea began in the early 1980s. Industrial development is primarily situated on the Beaufort Sea. The primary onshore and near-shore (within three miles) activity extends from the Town of Barrow, east to the Badami Unit, and includes discrete industrial facilities connected by a network of roads and pipelines. Oil and gas related development is the most defining landscape characteristic separating the West Beaufort Sea analysis unit from other analysis units. This unit is characterized by ongoing oil and gas activity. Views of the project area from native communities and industrial nodes along the shoreline of this unit would experience views of existing on- and offshore oil and gas activity. Viewers situated along the shoreline of the adjacent East Beaufort analysis unit may also experience views of on- and offshore oil and gas development. Developments may be long-term, such as facilities present in Deadhorse and Prudhoe Bay (Figure 3.3-14), whereas exploration structures will be temporary, such as the Mars Ice Island (Figures 3.3-15 and 3.3-16). Developments appear as compact areas of dense development with distinct vertical lines that contrast color, texture, and reflexivity to varying extents with the surrounding landscape. When viewed from the project area, the low-lying, horizontal lines of roads and pipelines blend with predominant horizontal lines of the landscape; however, when viewed from the air, the broad network of linear roads and pipelines are apparent.

In contrast, because much of the oil and gas activity occurs over 113 km (70 mi) offshore in the Chukchi Sea, these areas are not seen by viewer groups located on-land, and are rarely observed by non-industrial marine travelers.

***Native Communities* --** Native communities vary in size but typically have many of the same types of infrastructure. These structures and facilities include an airstrip, a landfill, and a variety of buildings and dwellings. When viewed from within the project area, communities are generally small in scale compared to the surrounding landscape.

### 3.3.9.9 Scenic Quality Rating

Scenic quality of seven key factors listed below was ranked for summer and winter conditions in each SQRU. Ranking was based on a scale of 0 to 5; however cultural modification also included options for ranking with negative values extending to -4. Mid-range values (i.e. 2 or 4) were permissible if that ranking most accurately portrayed existing conditions. An explanation for rating criteria is provided below (BLM 1986).

- *Landform*: A ranking of 5 is given to areas with high vertical relief as expressed in prominent cliffs, spires, or massive rock outcrops, or severe surface variation or highly eroded formations. A rating of 3 is generally assigned to steep canyons, mesas, buttes, cinder cones, and drumlins; or interesting erosional patterns or variety in size and shape of landforms; or detail features which are interesting though not dominant or exceptional. A rating of 1 is typically assigned to rolling hills, foothills, or flat valley bottoms; or few or no interesting landscape features.
- *Vegetation*: A ranking of 5 is given to areas where a variety of vegetative types are expressed in interesting forms, textures, and patterns. A ranking of 3 is given to areas where some variety of vegetation exists; however only one or two major types are present. Finally, a ranking of 1 is assigned to areas with little or no variety or contrast in vegetation.
- *Water*: A ranking of 5 is given to areas where water is clear and clean appearing, still, or cascading white water, any of which are a dominant factor in the landscape. A ranking of 3 is given to areas where water is flowing, or still, but not dominant in the landscape. Finally, a ranking of 0 is given to areas where water is absent, or present, but not noticeable.
- *Color*: A ranking of 5 is given to areas where rich color combinations, variety or vivid color exist; or where pleasing contrasts in the soil, rock, vegetation, water or snow fields is expressed. A ranking of 3 is given to areas where some intensity or variety in colors and contrast of the soil, rock and vegetation is present, but not a dominant scenic element. A ranking of 1 is given to areas with subtle color variations, contrast, or interest and/or generally mute tones.
- *Adjacent Scenery*: A ranking of 5 is given to areas where adjacent scenery greatly enhances visual quality. A ranking of 3 is given to areas where adjacent scenery moderately enhances visual quality. A ranking of 0 is given to areas where adjacent scenery has little or no influence on overall visual quality.
- *Scarcity*: A rating of 5+ is given to areas that are considered one of a kind; or unusually memorable, or very rare within region. A rating of 3 is given to areas that are distinctive, though somewhat similar to others within the region. A rating of 1 is given to areas that are interesting within its setting, but fairly common within the region.
- *Cultural Modification*: A ranking of 2 is assigned to areas where modifications add favorably to visual variety while promoting visual harmony. A ranking of 0 is given to areas where modifications add little or no visual variety to the area, and introduce no discordant elements. A ranking of -4 is given to areas where modifications add variety but are very discordant and promote strong disharmony.

The ranking of each key factor was added to derive an overall score for the unit. Based on these results, each SQRU was assigned a scenic quality rating of A, B, or C using the following convention:

Score of 19+ = Class A
Score of 12 to 18 = Class B
Score of 11 or less = Class C

Class A Scenery is thus characterized by higher scenic quality then areas classified as Class C.

All units were ranked as having Class A scenery during summer months and Class B scenic quality during the winter months. Results of the scenic quality analysis are presented below (Table 3.3-49).

**Table 3.3-49 Scenic Quality Rating Summary**

| Key Factor | Scenic Quality Sore (Summer / Winter) | | | | Comments |
|---|---|---|---|---|---|
| | East Beaufort Sea Unit | West Beaufort Sea Unit | North Chukchi Sea Unit | South Chukchi Sea Unit | |
| **Landform** | 3 / 3 | 3 / 3 | 4 / 4 | 4 / 4 | Views from the project area are expansive and dramatic. Landforms serve as a backdrop to the project area. Cliffs located along the shoreline of the North and South Chukchi Sea analysis units contribute visual variety in F/M distance zones through abrupt vertical relief. |
| **Vegetation** | 4 /1 | 4 /1 | 4 /1 | 4 /1 | Vegetation viewed from the project area, and serves as a backdrop. Vegetation not visible in winter. During snow-free months, vegetation contributes color and texture to landforms. |
| **Water / Ice** | 5 / 5 | 5 / 5 | 5 / 5 | 5 / 5 | Water is dynamic, striking, and dominant throughout the year. |
| **Color** | 4 / 1 | 4 / 1 | 4 / 1 | 4/ 1 | Great contrast in color exists during summer months. |
| **Adjacent Scenery** | 3 / 0 | 3 / 0 | 3 / 0 | 3 / 0 | The Brooks Range moderately enhances the visual quality of views from the project area. |
| **Scarcity** | 5 / 5 | 5 / 5 | 5 / 5 | 5 / 5 | Waters of the Beaufort and Chukchi seas are distinctive. |
| **Cultural Modification** | 0 /0 | -4 / -3 | 0 /0 | 0 / 0 | Cultural modification most apparent in the West Beaufort Sea Unit, particularly during summer months when activity increases. |
| **Total Score** | 24 / 15 | 20 / 12 | 25 / 16 | 25 / 16 | |
| **Scenic Quality Class** | A / B | A / B | A / B | A / B | |

Notes:
Class A = score of 19+
Class B = score of 12-18
Class C =- Score of 11 or less

## 3.3.10 Environmental Justice

EO 12898 requires federal agencies to identify and address disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on low-income populations and minority communities (1994). Agencies identify early-on when actions may have disproportional adverse environmental or health effects on minority and/or low-income communities in order to screen feasible alternatives (EPA 1998). One of the tools to identify disproportionate effects is "scoping," a public involvement process designed to identify potential areas of concern *before* the analysis of the proposed project proceeds. A detailed description of the scoping process for this project, including government-to-government consultation with Tribes, is included in the Scoping Summary Report (Appendix C).

"Minority community" and "low-income" are defined for the purposes of analyzing the effects of the agencies' actions on potentially affected populations.

- A minority is any individual self-identified as American Indian, Alaska Native, Asian or Pacific Islander, African American, or Hispanic.
- A low-income population is a community or group with a median household income at or below the U.S. Department of Health and Human Services poverty guidelines. Poverty guidelines are an administrative tool that determines financial eligibility for certain programs and are comparable to the poverty thresholds calculated by the U.S. Census Bureau for statistical purposes.
- Disproportionate high and adverse human health or environmental effects are defined when the health effects of an action are significant or above generally accepted norms (e.g. infirmity, illness or death); the risk or rate of hazard exposure is significant and exceeds the rate to the general population; or the population is exposed to cumulative or multiple adverse exposures to environmental hazards.
- Low-income populations and minority communities are defined as any readily identifiable group of minority or low-income persons who live in geographic proximity and their population percentage is meaningfully greater than the low-income/minority population percentage in an appropriate geographic unit of analysis (CEQ 1997).

Impacts to Alaska Native populations may be different from impacts on the general population due to a community's distinct cultural practices (CEQ 1997). EO 12898 recognizes the importance of research, data collection, and analysis, particularly with respect to multiple and cumulative exposures to environmental hazards and/or a disproportionately high adverse impact resulting from a federal action. Environmental justice analysis considers impacts to subsistence resources and harvest practices, sociocultural systems, and public health. Current and historic subsistence practices are described in Section 3.3.2, and Sociocultural systems are addressed in Section 3.3.1. Public Health discussions and analysis can be found in Section 3.3.3. Impacts to these resources are discussed in Chapter 4.

### 3.3.10.1 Definition of the Affected Populations

The area of potential affect includes the coastal communities (including critical staging areas) of the Beaufort and Chukchi seas within the NSB, NAB, and the City of Nome.

### 3.3.10.2 Ethnicity and Race

Each of the affected communities has a majority Iñupiat or Alaska Native population as shown in Table 3.3-50. (This table will be updated with 2010 U.S. Census data when it is released.) The communities of Kaktovik, Nuiqsut, Barrow, Wainwright, Point Lay, Point Hope, Kivalina, Kotzebue, and Nome would be considered a minority community under the definition of EO 12898. Nome residents identified as 49 percent Alaska Native in the U.S. Census, but with the addition of other racial groups, a

total of 68 percent of the city's population identifies as non-White. Additional demographic information and a narrative profile about each community can be found in Section 3.3.1, Socioeconomics.

### 3.3.10.3 Income Distribution and Poverty Status

The U.S. Census defines "income" as cash payments received on a regular basis, not including noncash benefits such as food stamps, health benefits, or subsidized housing (US Census 2011b). The U.S. Census "American Community Survey" estimates, data found in Tables 3.3-50 and 3.3-51, are the best available estimates for household income and individual and family poverty aside from the 2000 Census.

The State Department of Labor and Workforce Development (ADLWD) tracks average per capita personal income for Alaska by region (ADLWD 2010). Statewide it was $44,395 in 2008 compared to $40,673 nationwide. The highest average per capital personal income was NSB ($66,664), while Nome Census Area ($33,254) and NAB ($31,168) were less than the state average.

Per capita income data are available for 2003 in some NSB Communities from the *North Slope Borough Economic Profile and Census Report*, but are not available at the community level elsewhere. In descending order: Nuiqsut $59,907; Kaktovik $59,342; Point Hope $53,835; Point Lay $33,656; Wainwright $28,320; and data was not available for Barrow (Shepro et al. 2003). Per capita income was not estimated for individual communities in the NAB or Nome Census Area, but it will be available soon through the 2010 Census.

The NSB fares better than the state, nation, and other affected regions in the measure of median household income (shown in Table 3.3-51). However, Alaska's higher cost of living pushes the poverty threshold about 125 percent times the U.S. level (DHHS 2011). The poverty threshold for a family of four in Alaska is an annual household income of $27,570 or less (DHHS 2009). Note that definitions of families and households are not the same although they are both included in Table 3.3-51. All three regions have higher rates of households below the poverty threshold than the state and national averages. Looking more closely at ethnic groups below the poverty level, Alaska Native people are disproportionately below the poverty threshold (Table 3.3-52). For example, the City of Kotzebue is 70 percent Alaska Native, so it would be proportionate to have 70 percent of the individuals below the poverty line to be Alaska Native. However, 85 percent of individuals living in poverty in Kotzebue are Alaska Native.

Considering the data displayed by per capita income, median household income, and poverty threshold levels, the communities of Kaktovik, Nuiqsut, Barrow, Wainwright, Point Lay, Point Hope, Kivalina, Kotzebue, and Nome would be considered low-income communities under the definition of EO 12898.

## Table 3.3-50 Community Population, Race, and Ethnicity, 2009 Estimates[a]

| Community | 2009 Estimated Population | Race | | | | | | | | | | | | | | Hispanic or Latino (of any race)[b] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | One Race | | | | | | | | | | | | Two or more Races | | | |
| | | Percent Alaska Native or American Indian | | Percent White | | Asian | | Black or African American | | Native Hawaiian and Other Pacific Islander | | Some other race | | | | | |
| | | # | % | # | % | # | % | # | % | # | % | # | % | # | % | # | % |
| Kaktovik | 260 | 227 | 87% | 6 | 2% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 27 | 10% | 0 | 0 |
| Nuiqsut | 366 | 345 | 94% | 16 | 4% | 0 | 0 | 1 | 0.3% | 0 | 0 | 0 | 0 | 4 | 1% | 0 | 0 |
| Barrow | 4,078 | 2,239 | 55% | 793 | 19% | 495 | 12% | 64 | 2% | 24 | 1% | 43 | 1% | 420 | 10% | 154 | 4% |
| Wainwright | 534 | 503 | 94% | 19 | 4% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 12 | 2% | 0 | 0 |
| Point Lay | 194 | 192 | 99% | 2 | 1% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | | 0 | 0 |
| Point Hope | 875 | 706 | 81% | 42 | 5% | 58 | 7% | 0 | 0 | 6 | 1% | 0 | 0 | 63 | 7% | 0 | 0 |
| North Slope Borough[c] | 6,716 | 4,531 | 67% | 905 | 13% | 558 | 8% | 73 | 1% | 30 | 0.4% | 43 | 1% | 576 | 9% | 154 | 2% |
| Kivalina | 446 | 431 | 97% | 9 | 2% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 1% | 0 | 0 |
| Kotzebue | 3,152 | 2,232 | 71% | 553 | 18% | 74 | 2% | 8 | 0.3% | 0 | 0 | 0 | 0 | 296 | 9% | 31 | 1% |
| Northwest Arctic Borough | 7,430 | 5,986 | 81% | 900 | 12% | 74 | 1% | 8 | 0.1% | 7 | 0.1% | 5 | 0.1% | 450 | 6% | 54 | 1% |
| Nome | 3,604 | 1,759 | 49% | 1,147 | 32% | 23 | 1% | 200 | 6% | 0 | 0 | 15 | 0.4% | 460 | 13% | 19 | 1% |
| Nome Census Area[d] | 9,339 | 6,660 | 71% | 1,733 | 19% | 28 | 0.3% | 200 | 2% | 0 | 0 | 57 | 1% | 661 | 7% | 157 | 2% |
| State of Alaska | 683,142 | 91,939 | 13% | 467,650 | 68% | 31,878 | 5% | 25,161 | 4% | 4,269 | 0.6% | 11,613 | 2% | 50,632 | 7% | 39,661 | 6% |
| United States | 301,461,533 | 2,423,294 | 1% | 224,469,780 | 74% | 13,201,056 | 4% | 37,264,679 | 12% | 447,591 | 0.1% | 16,986,453 | 6% | 6,668,680 | 2% | 45,476,938 | 15% |

Notes:

a) Total Population, American Community Survey 2005-2009 Estimates

b) Hispanic ethnicity is calculated separately from the races of Native American/Alaskan, Asian/Pacific Islander, White, African American, and Two or More. Ethnicity is not included in the totals because it can result in double counting.

c) There is no population estimates for Prudhoe Bay in 2009, but some are expected in the 2010 census.

d) The City of Nome is not within an organized borough, so the regional area is known by its census geographic unit.

## Table 3.3-51 Median Income and Poverty Rates Estimated for 2009[a]

| Geographic Area | Median Household Income[b] | # Households | # Population[c] | # Individuals below poverty | Individual Poverty Rate (%) | # Families[d] | # Families below poverty | Family Poverty Rate (%) |
|---|---|---|---|---|---|---|---|---|
| Kaktovik | $44,375 | 81 | 260 | 27 | 10.4 | 47 | 3 | 6.4 |
| Nuiqsut | $85,156 | 91 | 366 | 2 | 0.5 | 77 | 0 | 0.0 |
| Barrow | $67,411 | 1,340 | 4,026 | 719 | 17.9 | 952 | 150 | 15.8 |
| Wainwright | $68,750 | 147 | 534 | 68 | 12.7 | 121 | 7 | 5.8 |
| Point Lay | $46,875 | 40 | 191 | 32 | 16.8 | 35 | 6 | 17.1 |
| Point Hope | $73,438 | 222 | 860 | 69 | 8.0 | 167 | 8 | 4.8 |
| North Slope Borough | $66,556 | 2,049 | 6,646 | 984 | 14.8 | 1,478 | 188 | 12.7 |
| Kivalina | $59,821 | 79 | 446 | 55 | 12.3 | 65 | 5.01 | 7.7 |
| Kotzebue | $69,306 | 860 | 3,117 | 484 | 15.5 | 615 | 54 | 8.8% |
| Northwest Arctic Borough | $57,885 | 1,738 | 7,392 | 1,421 | 19.2 | 1,327 | 223 | 16.8 |
| Nome | $70,664 | 1,253 | 3,383 | 132 | 3.9 | 687 | 13 | 1.9 |
| Nome Census Area | $55,766 | 2,580 | 8,694 | 2,013 | 23.2 | 1,706 | 326 | 19.1 |
| State of Alaska | $64,635 | 234,779 | 666,059 | 64,038 | 9.6 | 159,319 | 10,993 | 6.9 |
| U.S. | $51,425 | 112 mil | 307 mil | 39.5 mil | 13.5 | 75.1 mil | 7.4 mil | 9.9 |

Notes:

a) US Census, 2005-2009 American Community Survey, 5-Year Estimates

b) Household income in the last 12 months (in 2009 inflation-adjusted dollars)

c) The total population for whom poverty status is determined.

d) The number of families for whom poverty status is determined. Family is defined as 2 or more people living together, related by birth, marriage, or adoption living in the same housing unit. A household consists of all people occupying a housing unit regardless of relationship. http://www.census.gov/hhes/www/income/about/faqs.html

## Table 3.3-52 Poverty Disparity by Race in Project Area

| Geographic Area | # Population for whom poverty status is determined | # Alaska Native in Population | % Population that is Alaska Native | # Individuals below poverty | Alaska Native below poverty | % of people below poverty that are Alaska Native |
|---|---|---|---|---|---|---|
| **Kaktovik** | 260 | 227 | 87 | 27 | 27 | 100 |
| **Nuiqsut** | 366 | 345 | 94 | 2 | 2 | 100 |
| **Barrow** | 4,026 | 2,196 | 55 | 719 | 585 | 81 |
| **Wainwright** | 534 | 503 | 94 | 68 | 65 | 96 |
| **Point Lay** | 191 | 189 | 99 | 32 | 32 | 100 |
| **Point Hope** | 860 | 691 | 80 | 69 | 69 | 100 |
| **North Slope Borough** | 6,646 | 4,470 | 67 | 984 | 838 | 85 |
| **Kivalina** | 446 | 431 | 97 | 55 | 53 | 96 |
| **Kotzebue** | 3,117 | 2,197 | 70 | 484 | 410 | 85 |
| **Northwest Arctic Borough** | 7,392 | 5,948 | 80 | 1,421 | 1,312 | 92 |
| **Nome** | 3,383 | 1,559 | 46 | 132 | 126 | 95 |
| **Nome Census Area** | 8,694 | 6,430 | 74 | 2,013 | 1,973 | 98 |
| **State of Alaska** | 666,059 | 88,847 | 13 | 64,038 | 20,117 | 31 |
| U.S. | 293,507,923 | 2,334,492 | 1 | 39,537,240 | 603,682 | 2 |

Notes:
a) US Census, 2005-2009 American Community Survey, 5-Year Estimates
b) Household income in the last 12 months (in 2009 inflation-adjusted dollars)
c) The total population for whom poverty status is determined.

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