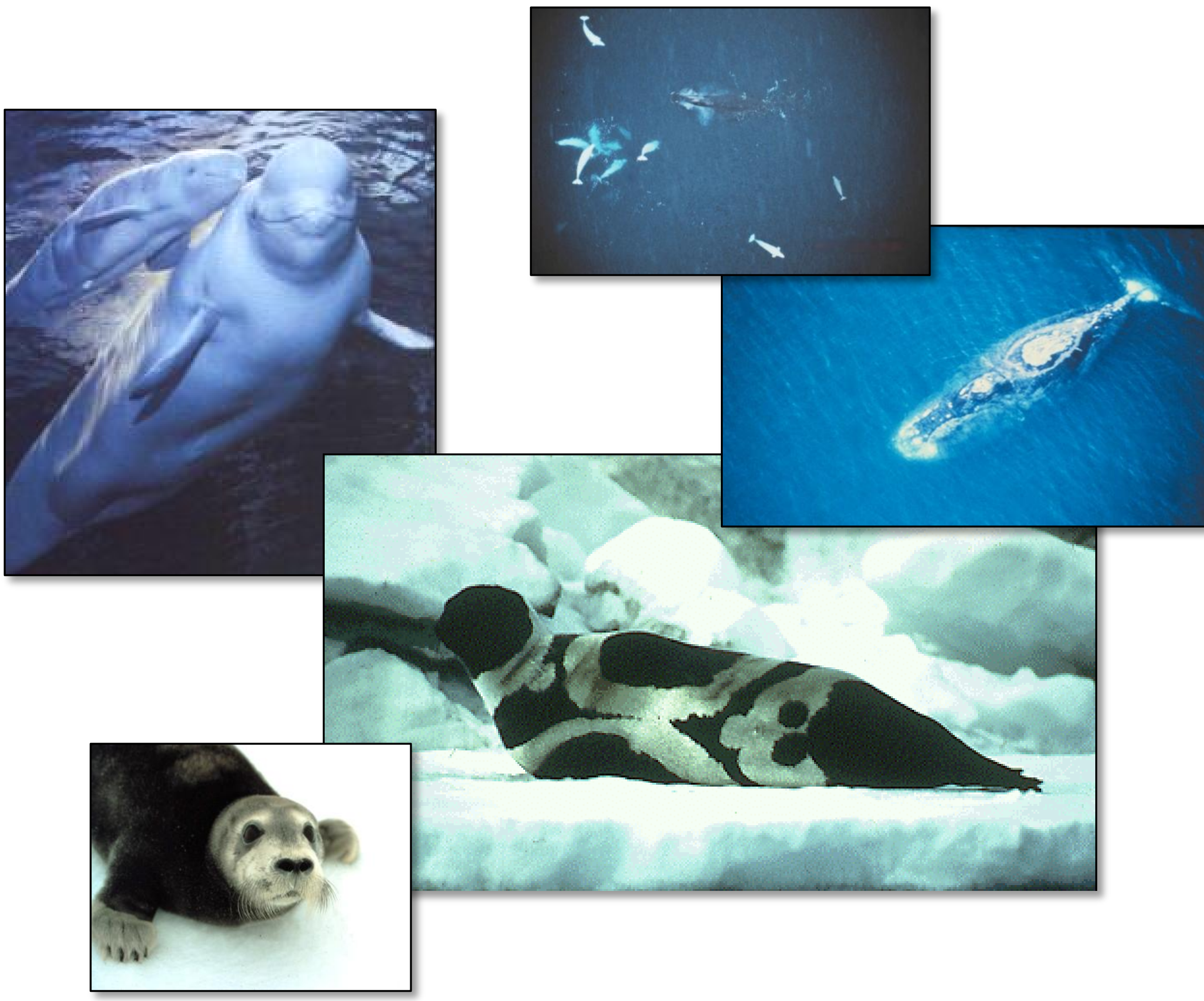
Effects of Oil and Gas Activities in the Arctic Ocean

Final Environmental Impact Statement

Volume 1: Chapters 1-3



October 2016

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

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Prepared by:
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EXECUTIVE SUMMARY

1.0 INTRODUCTION

The U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS) has 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, Alaska. This EIS analyzes a range of management alternatives to assist NMFS in carrying out their statutory responsibilities to authorize or permit these activities. The U.S. Department of the Interior Bureau of Ocean Energy Management (BOEM) participated in the preparation of this EIS as a cooperating agency.

The agency's statutory responsibilities include BOEM's issuance of permits and authorizations under the Outer Continental Shelf Lands Act (OCSLA) for seismic surveys and concurrence on ancillary activities 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 will 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. Minerals 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 2007 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 exploratory drilling, which were not addressed in the 2007 DPEIS. Therefore, MMS and NMFS filed a Notice of Withdrawal of the DPEIS 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 BOEM as a cooperating agency.

On December 30, 2011, NMFS published a Notice of Availability for the *Effects of Oil and Gas Activities in the Arctic Ocean Draft Environmental Impact Statement* in the *Federal Register* (76 FR 82275). The public was afforded 60 days to comment on that document. Consistent with comments on the Draft EIS, NMFS and BOEM determined that the environmental analysis would benefit from the inclusion of an additional alternative for analysis that covers a broader range of potential levels of exploratory drilling, including scenarios in the Beaufort and Chukchi seas that are more reflective of the levels of activity that oil and gas companies have indicated may be pursued in the region within the coming years and that some of the alternatives should be slightly altered from the 2011 Draft EIS. The alternatives are based upon the agencies' analysis of additional information, including the comments and information submitted by stakeholders during the Draft EIS public comment period. For this reason, the agencies determined it appropriate to prepare a Supplemental Draft EIS and allow for an additional public comment period before releasing the Final EIS (FEIS) and Record of Decision (ROD). On January 30, 2013, NMFS published an NOI informing the public of its determination to prepare a Supplemental Draft EIS in the *Federal Register* (78 FR 6303).

NMFS made several substantive changes to this FEIS since publication of the 2013 Supplemental EIS. Portions of the EIS where substantive changes have occurred include:

- Alternatives
  - Based on updated data, modified some of the time/area closures, which have been identified as areas in which activities could be limited in order to protect marine mammals during times when key life functions are being performed (e.g., feeding) and subsistence hunting areas from the effects of exploration activities.
- Mitigation Measures
  - Updated the structure and analysis of the mitigation measures contemplated for inclusion under the alternatives.
  - For each measure, outlined activities to which it applies (e.g., just 2D/3D seismic surveys or just exploratory drilling or all activities), the purpose of the measure, the science, support for reduction of impacts to marine mammals or subsistence availability of marine mammals, the likelihood of effectiveness, the history of implementation of the measure, practicability for applicant implementation, and recommendation for how, and if, to apply the measure in future MMPA ITAs.
  - Added a section outlining the mitigation measures that were considered but are no longer carried forward for inclusion in future MMPA ITAs.
- Baseline Information
  - Using data and literature noted by commenters during the previous public comment period, updated information in the affected environment sections to incorporate newer information (mostly for marine mammals and subsistence activities).
- Impact Analyses
  - Revised the impact criteria and analyses of potential impacts to marine mammals to include additional factors that more closely align with analyses conducted under the MMPA.
  - Included information regarding the final acoustic injury thresholds used by NOAA to determine the level at which injury of marine mammals occurs.
  - NMFS conducted a first-order assessment of chronic and cumulative effects of sound on marine mammals in response to public comments on the DEIS and SEIS and report the initial results as they relate to different scenarios addressed across the EIS Alternatives.

NMFS has made several changes to the document based on public comments received on the 2011 Draft EIS and the 2013 Supplemental Draft EIS. A summary of the comments and our responses to those comments can be found in Appendix A of this FEIS.

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. BOEM and the North Slope Borough (NSB) (a local government entity of the State of Alaska) served as formal cooperating agencies; the Environmental Protection Agency (EPA) served as a consulting agency. NMFS also coordinated with the Alaska Eskimo Whaling Commission (AEWC) pursuant to our co-management agreement under the MMPA on the preparation of this EIS. NMFS invited the U.S. Fish and Wildlife Service (USFWS) to join the effort as a cooperating agency, but they declined the request; however, USFWS participated as a "consulting" agency in the preparation of this FEIS. NMFS also shared preliminary drafts of the FEIS with the State of Alaska for their review.

NMFS has published this EIS to disclose the potential impacts associated with their issuance of ITAs. 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 Outer Continental Shelf Lands Act Requirements:

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

The OCSLA 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 OCSLA 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 OCSLA establishes U.S. Department of Interior authority, delegated to BOEM by regulation, to issue permits for G&G, concur on notices of ancillary activities, and approve exploratory drilling plans for these and related purposes. BOEM's regulations for G&G permits are at 30 CFR Part 551 and for ancillary activities and Exploration Plans are at 30 CFR Part 550. Exploration drilling activities require a permit from BSEE (Application for Permit to Drill under 30 CFR Part 250).

BOEM regulations (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 OCSLA;
- 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;

- disturb archaeological resources; 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 OCSLA.

1.3 Proposed Action and Project Area

The proposed actions of two federal agencies considered in this EIS are:

- 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 concurrence on ancillary activities in the U.S. Beaufort and Chukchi seas, Alaska, by BOEM under the OCSLA.

These federal actions are related, but distinct, actions.

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 spatial scope of this EIS is limited to the Arctic from the border between the U.S. and Canada in the Beaufort Sea to Nome in the Bering Sea. This spatial extent includes the areas where seismic surveys, ancillary activities, and exploratory drilling may occur in the U.S. Arctic, as well as vessel transit routes through the Bering Strait and staging and possible resupply ports.

1.4 Purpose and Need

1.4.1 Purpose

Energy use in the U.S. is expected to continue to increase from present levels through 2040 and beyond (EIA 2015). For example, the U.S. consumption of crude oil and petroleum products has been projected to increase from about 19 million barrels (Mbbl) per day in 2013, to about 19.6 Mbbl per day in 2020, then decline to 19.3 Mbbl per day in 2040 (EIA 2015). Oil and gas reserves in the OCS represent significant sources that currently help meet U.S. energy demands and are expected to continue to do so in the future. The benefits of producing oil and natural gas from the OCS include not only helping to meet this national energy need but also generating money for public use. In this context, the purpose for issuing permits for seismic surveying activities under the OCSLA and issuing authorizations to “take” marine mammals under the MMPA are discussed below.

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 will 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.

NMFS' decision to prepare an EIS should not be construed as an assumption that significant adverse effects would occur from all levels of activities analyzed. Federal agencies may employ the EIS process to aid in their decision-making, whether the contemplated action would have significant effects or not. In this case, the primary reason for preparing an EIS was, that the higher levels of activity predicted by the oil and gas industry to likely occur in the near future could have significant cumulative impacts (we note that predictions of activity levels are likely lower now, in 2016, than they were when the EIS scoping process started in 2010). Based on the industry's prediction of increased activities, NMFS and BOEM wanted to ensure that appropriate NEPA analysis was completed, rather than wait until the first year that anticipated cumulative impacts from industry activities exceed the significance threshold and delay activities while an EIS was written. This EIS was written to prevent permitting delays from causing a future gap in activities.

1.4.2 Need

NMFS expects to receive 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 by providing a comprehensive understanding of deep penetration geophysical surveys, shallow hazards surveys, and exploratory drilling 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 analysis to support the issuance of ITAs for Arctic oil and gas exploration activities. It is the intent of NMFS that the scope of this EIS covers as many actions as possible. However, if necessary, NMFS may need to conduct additional NEPA analysis to support future Arctic MMPA oil and gas permit decisions if such activities fall outside the scope of this EIS. This applies to actions taken under Sections 101(a)(5)(A) and (D) (i.e., issuance of LOAs and IHAs) Please see Chapter 5 (Sections 5.1.2 and 5.1.3) for additional discussions on NEPA compliance related to this EIS.

1.5 Public Input Process

1.5.1 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;
- Occurrence 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 in the 2011 Draft 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

1.5.1 Draft EIS Public Comment Process

The public comment process for the 2011 Draft EIS began on December 30, 2011. After granting a 15-day extension, the comment period ended on February 28, 2012. Public meetings were held in the communities of Barrow, Wainwright, Kotzebue, Kivalina, Point Hope, and Anchorage. Public comments were received verbally and in writing through discussion, testimony, fax, regular mail, and electronic mail.

Of the issues raised during the 2011 Draft EIS public comment process, many were similar to those mentioned above as raised during the scoping process. Those that were most commonly raised include:

- Concerns related to public participation and review process;
- Compliance with NEPA, the MMPA, and other applicable statutes;
- Inadequacy with the range of alternatives;
- Improper dismissal of alternatives;
- Inadequacy of description and analysis of certain physical, biological, and social resources and failure to include newer data; and
- Insufficient analysis and information related to the effectiveness and implementation of mitigation measures.

1.5.2 Supplemental EIS Public Comment Process

The public comment process for the 2013 Supplemental EIS began on March 29, 2013. After granting a 30-day extension, the comment period ended on June 27, 2013. Public meetings were held in the communities of Kotzebue, Barrow, and Anchorage. Public comments were received verbally and in writing through discussion, testimony, fax, regular mail, and electronic mail. The issues raised during public comment on the 2013 Supplemental EIS did not differ from the issues raised during the scoping process and the public comment period for the 2011 Draft EIS.

2.0 ALTERNATIVES

A total of 12 alternatives were initially considered for this FEIS, with the No Action Alternative and five action alternatives carried forward for analysis. The alternatives dismissed and not considered for analysis include: permanent closures of areas, caps on levels of activity and/or noise, duplicative surveys, zero discharge, an alternative that employs adaptive management approaches, activity levels likely to follow a discovery including future lease sales. Some aspects of the dismissed alternatives have been incorporated into the five 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; and
- 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 OCSLA 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. 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 OCSLA.

The six 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 3 Exploration Activity
- **Alternative 5:** Authorization for Level 3 Exploration Activity with Additional Required Time/Area Closures
- **Alternative 6:** Authorization for Level 3 Exploration Activity with Use of Alternative Technologies

Table ES-1 outlines the differences in the alternatives between the 2011 Draft EIS, the 2013 Supplemental Draft EIS, and this FEIS, as well as outlining the differences between the alternatives themselves.

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., ocean-bottom node or cable surveys) or drilling unit (e.g., drillship, jackup rig, SDC) 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 and drilling operations in the Beaufort Sea, support operations would likely occur out of West Dock or Oliktok Dock near Prudhoe Bay. Chukchi Sea surveys and drilling operations could be supported either from Wainwright or Nome. Helicopters stationed at either Barrow (for operations in either the Beaufort Sea or Chukchi Sea), Deadhorse (for operations in the Beaufort Sea), or Wainwright (for operations in the Chukchi 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 Differences in the Alternatives between the December 2011 Draft EIS, the March 2013 SDEIS, and the FEIS

Alternative	2011 Draft EIS	2013 Supplemental Draft EIS	2016 FEIS
Alternative 1 (No Action)	NMFS would not issue ITAs under the MMPA, and BOEM would not issue permits and notices under the OCSLA.	Same as in 2011 Draft EIS	Same as in 2011 Draft EIS and 2013 SDEIS
Alternative 2 (Preferred Alternative)	Considered 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, with up to one of that total number in each done in-ice, if necessary. • Three site clearance and high resolution shallow hazards survey programs in each sea, per year. • One on-ice seismic survey in the Beaufort Sea, per year. • One exploratory drilling program[1] in each sea, per year. Considered inclusion of required standard mitigation measures and additional mitigation measures.	Same as in 2011 Draft EIS	Same as in 2011 Draft EIS and 2013 SDEIS. However, the suite of required standard mitigation measures and additional mitigation measures has been revised based on public comments.
Alternative 3	Considered 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, with up to one of that total number in each done in-ice, if necessary. • Five site clearance and high resolution shallow hazards survey programs in each sea, per year. • One on-ice seismic survey in the Beaufort Sea, per year.	Same as in 2011 Draft EIS	Same as in 2011 Draft EIS and 2013 SDEIS. However, the suite of required standard mitigation measures and additional mitigation measures has been revised based on public comments.

[1] Please see Section 2.4.3 of this FEIS for a discussion of the term “exploratory drilling program.”

Alternative	2011 Draft EIS	2013 Supplemental Draft EIS	2016 FEIS
	• Two exploratory drilling programs in each sea, per year. Considered inclusion of required standard mitigation measures and additional mitigation measures.		
Alternative 4	Considered 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, with up to one of that total number in each done in-ice, if necessary. • Five site clearance and high resolution shallow hazards survey programs in each sea, per year. • One on-ice seismic survey in the Beaufort Sea, per year. • Two exploratory drilling programs in each sea, per year. Considered inclusion of required standard mitigation measures and additional mitigation measures. Considered inclusion of required time/area closures for specific areas important to biological productivity, life history functions for specific species of concern, and subsistence activities. Areas considered were: • Camden Bay; • Barrow Canyon and the Western Beaufort Sea; • Shelf Break of the Beaufort Sea; • Hanna Shoal; and • Kasegaluk Lagoon/Ledyard Bay Critical Habitat Unit.	This alternative differs from Alternative 4 from the 2011 DEIS in the following ways: • Considers up to four exploratory drilling programs in each sea, per year. • It does not consider inclusion of any required time/area closures. Everything else about the alternative remains the same.	This alternative remains the same as the one presented in the 2013 SDEIS with the exception of the changes made to the suite of required standard mitigation measures and additional mitigation measures based on public comments.

<table>
<tr><th>Alternative</th><th>2011 Draft EIS</th><th>2013 Supplemental Draft EIS</th><th>2016 FEIS</th></tr>
<tr><td>Alternative 5</td><td>Considered 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, with up to one of that total number in each done in-ice, if necessary.
Five site clearance and high resolution shallow hazards survey programs in each sea, per year.
One on-ice seismic survey in the Beaufort Sea, per year.
Two exploratory drilling programs in each sea per year
Considered inclusion of required standard mitigation measures and additional mitigation measures.

Considered 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.</td><td>Alternative 5 in this EIS is similar to Alternative 4 from the 2011 Draft EIS with some slight changes:
Increase in the maximum level of exploratory drilling programs from up to two in each sea, per year to up to four in each sea, per year.
Inclusion of required time/area closures. However, there are changes. Camden Bay was removed from the list of required time/area closures that was considered in the 2011 DEIS. The following are the required time/area closures considered in the 2013 SDEIS:
Kaktovik and Cross Island
Barrow Canyon and the Western Beaufort Sea
Shelf Break of the Beaufort Sea
Hanna Shoal
Kasegaluk Lagoon
Ledyard Bay</td><td>This alternative remains the same as the one presented in the 2013 SDEIS. The only changes are the inclusion of one additional required time/area closure: Point Franklin to Barrow and the removal of Hanna Shoal from the list of required time/area closures that was considered in the 2011 DEIS and 2013 SDEIS.

All other aspects of Alternative 5 are the same as Alternative 5 in the 2013 SDEIS with the exception of the changes made to the suite of required standard mitigation measures and additional mitigation measures based on public comments.</td></tr>
</table>

Alternative	2011 Draft EIS	2013 Supplemental Draft EIS	2016 FEIS
Alternative 6	There was no Alternative 6 in this version of the EIS.	Alternative 6 in this EIS is similar to Alternative 5 from the 2011 Draft EIS. The only change is the maximum amount of exploratory drilling activities that could potentially occur under this alternative increases from up to two in each sea, per year to up to four in each sea, per year.	Same as in the 2013 SDEIS with the exception of the changes made to the suite of required standard mitigation measures and additional mitigation measures based on public comments.

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 concur on ancillary activities in the Beaufort and Chukchi seas OCS. Without BOEM authorization, these activities would not occur in federal waters but could occur with state authorization in state waters. In the first case, companies could not proceed, no ITA would be issued, and there would be no impacts on marine mammals or subsistence uses of marine mammals. In the second case, companies could legally operate if they received authorization from the state, but would likely be in violation of the MMPA. If companies proceeded to operate in this area without MMPA authorizations, any takes of marine mammals that occur would violate the MMPA.

2.2 Alternative 2 – Authorization for Level 1 Exploration Activity (Preferred Alternative)

Alternative 2 is defined as the following:

2.2.1 Level of Activity

- Up to **four** 2D/3D seismic surveys in the Beaufort Sea and up to **three** 2D/3D seismic 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 2.7 of this Executive Summary) that are part of every action alternative.
- Including a full analysis of a wide range of Additional Mitigation Measures (described in Section 2.8 of this Executive Summary) 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. 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 three 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 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 surveys in the Beaufort Sea and up to **five** 2D/3D seismic 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 2.7 of this Executive Summary) that are part of every action alternative.
- Including a full analysis of a wide range of Additional Mitigation Measures (described in Section 2.8 of this Executive Summary) 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 3 Exploration Activity

Alternative 4 is defined as the following:

2.4.1 Level of Activity

- Up to **six** 2D/3D seismic surveys in the Beaufort Sea and up to **five** 2D/3D seismic 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 **four** exploratory drilling programs in the Beaufort Sea and up to **four** exploratory drilling programs in the Chukchi Sea per year.

2.4.2 Mitigation

- Including *required* Standard Mitigation Measures (described in Section 2.7 of this Executive Summary) that are part of every action alternative.
- Including a full analysis of a wide range of Additional Mitigation Measures (described in Section 2.8 of this Executive Summary) 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 4 would be the same as those listed for Alternative 2.

2.5 Alternative 5 – Authorization for Level 3 Exploration Activity With Additional Required Time/Area Closures

Alternative 5 is defined as the following:

2.4.1 Level of Activity

- Same level of activity as Alternative 4.

2.4.2 Mitigation

- Including *required* Standard Mitigation Measures (described in Section 2.7 of this Executive Summary) 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.
    - Kaktovik and Cross Island – An area of importance for fall subsistence bowhead whale hunting
        - Bowhead whale subsistence hunting: late August – mid-September
        - Except for emergencies or human/navigation safety, oil and gas exploration operations shall not occur off Kaktovik or Cross Island or the designated buffer zones from August 25 to the close of the fall bowhead whale hunt in Kaktovik and on Cross Island.
    - Barrow Canyon, the Western Beaufort Sea, and the Shelf Break of the Beaufort Sea – An area of high biological productivity; a feeding area for bowhead and beluga whales; fall subsistence bowhead whale hunting area.
        - Bowhead whales: September – October
        - Beluga whales: mid-July – late September

    - 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 25 to the close of the fall bowhead whale hunt in Barrow.

  - Kasegaluk Lagoon – An important habitat for beluga whales (feeding, molting, calving) and spotted seals; subsistence beluga whale hunting area.
    - Beluga whales: June – mid-July
    - Subsistence (Kasegaluk Lagoon beluga whale hunting): mid-June – mid-July
    - Spotted seals: August – October
    - Except for emergencies or human/navigation safety, oil and gas exploration operations shall not occur within Kasegaluk Lagoon or the designated buffer zones from June 1 – July 15.

  - Ledyard Bay – An important habitat for spectacled eiders and the northern edge of important habitat for gray whales
    - Except for emergencies, human/navigation safety, or deployment of scientific devices, 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.

  - Point Franklin to Barrow[2] – The area between Wainwright and Barrow (including Peard Bay). The time period of the closure is to include the bowhead fall hunt off Wainwright. Time area closure from June to September to protect gray whale calf/cow use. Peard Bay has also been noted as an important area of spring and fall migration and staging corridor for waterfowl.
    - Except for emergencies, human/navigation safety, or deployment of scientific devices, oil and gas exploration operations shall not occur within the Point Franklin to Barrow area (including Peard Bay) between June 1 and September 15.
    - To the maximum extent practicable, aircraft supporting oil and gas exploration operations shall avoid operating below 1,500 ft (457 m) over this area between June 1 and September 15.

- Including a full analysis of a wide range of Additional Mitigation Measures (described in Section 2.8 of this Executive Summary) 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, 4 and 6 would not be optional but rather required under Alternative 5.

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

[2] Time area closure for Point Franklin to Barrow was added to Alternative 5 based on review of comments received on the 2013 SDEIS.

2.6 Alternative 6 – Authorization for Level 3 Exploration Activity With Use of Alternative Technologies

Alternative 6 is defined as the following:

2.6.1 Level of Activity

- Same level of activity as Alternative 4.

2.6.2 Mitigation

- Including *required* Standard Mitigation Measures (described in Section 2.7 of this Executive Summary) that are part of every action alternative.
- Including a full analysis of a wide range of Additional Mitigation Measures (described in Section 2.8 of this Executive Summary) 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 6 would be the same as those listed for Alternative 2.

2.7 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. Full descriptions of these measures are contained in Appendix E. Sections 4.5.2.4.16 and 4.5.3.2.3 of the FEIS contain the complete analyses of these standard mitigation measures, including listing the activities associated with these measures and the science behind the measures.

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

  - Establishment and execution of 180 dB shutdown/power down radius for cetaceans and 190 dB shutdown/power down radius for ice seals.
  - 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 icebreakers, as well as on dedicated monitoring vessels.

- All activities must be conducted at least 152 m (500 ft) from any observed ringed seal lair. No energy source may be placed over a ringed seal lair. Operators will use trained seal-lair sniffing dogs or a comparable method to locate the seal structures before initiation of activities.

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

  - 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

  - Specified procedures for changing vessel speed and/or direction to avoid collisions with marine mammals.

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

- 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 August 25.
- Establishment and utilization of Communication Centers in subsistence communities when oil and gas exploration activities and marine mammal subsistence hunts will occur at the same time to address potential interference with marine mammal hunts on a real-time basis throughout the season.
- For exploratory drilling operations in the Beaufort Sea east of Cross Island, no drilling equipment or related vessels used for at-sea oil and gas operations shall be onsite at any offshore drilling location east of Cross Island from August 25 until the close of the bowhead whale hunt in Nuiqsut (Cross Island) and Kaktovik. However, such equipment may remain within the Beaufort Sea in the vicinity of 71 deg. 25 min. N and 146 deg. 4 min. W or at the edge of the Arctic ice pack, whichever is closer to shore.
- No transit of oil and gas exploration vessels into the Chukchi Sea prior to July 1.
- Shutdown of exploration activities in the Beaufort Sea and within 100 miles of the coastline in the Chukchi Sea from Pitt Point on the east side of Smith Bay (~152 deg. 15 min. W) to a location about half way between Barrow and Peard Bay (~157 deg. 20 min. W) from September 15 to the close of the fall bowhead whale hunt in Barrow.

2.8 Additional Mitigation Measures

The mitigation measures (and mitigation monitoring needed to support them) listed below are evaluated in Chapter 4. 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 OCSLA. 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 OCSLA. Full descriptions of these measures are contained in Appendix E. Sections 4.5.2.4.17 and 4.5.3.2.5 contain the complete analyses of these additional mitigation measures, including listing the activities associated with these measures and the science behind the measures.

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

- Prior to conducting the authorized seismic survey or drilling program, the operator shall conduct sound source verification (SSV) tests for their airgun array configurations, drilling units, other acoustic sources, icebreakers engaged in icebreaking, and support vessels in the area in which the survey or drilling program is proposed to occur and report the broadband received levels of 190 dB, 180 dB, 160 dB, and 120 dB radii from the sound sources to the authorizing entity within 10 days of completion of the SSV tests.
- All PSOs shall be provided with and use appropriate ocular equipment in order to detect marine mammals within exclusion zones. This may include the use of night-vision devices (e.g., Forward Looking Infrared [FLIR] imaging devices, 360° thermal imaging devices), Big Eyes, and reticulated and/or laser range finding binoculars.
- Operators shall limit seismic airgun operations in situations of low visibility when the entire exclusion radius cannot be observed (e.g., nighttime or bad weather) and ocular equipment, such as FLIR or 360° thermal imaging devices, are not being used to increase the probability of marine mammal detection. These limitations could mean the cessation of airgun operations entirely, a reduction of the time that operations are conducted in this limited visibility

situation, or a reduction of the number of airguns operating so that the exclusion radius is minimized and entirely visible.

- Seismic operators shall use passive acoustic monitoring systems, in addition to visual monitoring, to detect marine mammals approaching or within the exclusion zone and trigger the shutdown of airguns.
- Enhancement of monitoring protocols and mitigation shutdown zones to minimize impacts in specific biologic situations (for example, but not limited to, expansion of shutdown zone to 120 dB or 160 dB when cow/calf groups and feeding or resting aggregations are detected, respectively).
- PSOs required on all drill ships.
- Operators are required to implement specific procedures for use of the mitigation airgun during seismic activities.

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

- Temporal/spatial limitations to minimize impacts in particular important habitats, including Kaktovik, Cross Island, Barrow Canyon/Western Beaufort Sea, Hanna Shoal, the shelf break of the Beaufort Sea, Point Franklin to Barrow, Kasegaluk Lagoon, and Ledyard Bay.

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

- Specified transit routes of vessels and aircraft involved in oil and gas exploration activities with an associated MMPA ITA to minimize impacts in particular important habitat in areas where marine mammals may occur in high densities.
- 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 prey or habitat.
- Operators are required to recycle drilling muds to the extent practicable based on operational considerations (e.g., whether mud properties have deteriorated to the point where they cannot be used further).

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

- From August 25 until the close of the fall bowhead whale hunts by the communities of Kaktovik and Nuiqsut, 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, except for emergencies or human/navigation safety or for any vessel engaged in transit to or from a coastal community to conduct crew changes or logistical support operations.
- 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 from September 15 until the close of the fall bowhead whale hunt in Barrow.
- All oil and gas industry exploration vessels shall complete operations in time to allow such vessels to complete transit through the Bering Strait to a point south of 59 deg. N no later than November 15.

2.9 Mitigation Measures Considered but Not Carried Forward

The mitigation measures listed here were considered in the DEIS and/or SDEIS as additional mitigation measures. Based on public comments and further analysis, NMFS determined that these measures should not be included in any future MMPA ITAs. The full analysis and explanation is contained in sections 4.5.2.4.18 and 4.5.3.2.7.

- Restriction of 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).
- Separate seismic surveys are prohibited from operating within 145 km (90 mi) of one another.
- Vessel and aircraft avoidance (by 0.8 km [0.5 mi]) of concentrations of groups of ice seals.
- 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 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 north 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 fall 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.

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 positive or negative 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:

<u>Intensity (Magnitude)</u>

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.

<u>Duration</u>

Temporary: Impacts would be intermittent, infrequent, and typically last less than a month.

Interim: Impacts would be frequent or extend for longer time periods (an entire project season).

Long-term: 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 (other than the ESA). The portion of the resource affected fills a distinctive ecosystem role (such as an important subsistence resource) within the locality or the region.

Unique: The affected resource is listed as threatened or endangered (or proposed for listing) under the ESA 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.

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[3]: 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 important and/or 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 6.

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[3] The term negligible in this EIS does not have the same meaning as in the MMPA. The term has different meanings under the two statutes and is being used in two different contexts.

Because most of the alternative technologies associated with Alternative 6 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, 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 over the next several years is not fully known at this time. Therefore, NMFS has determined that additional NEPA analyses would likely be required if applications are received requesting use of 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 3 Exploration Activity	Alternative 5- Authorization for Level 3 Exploration Activity with Additional Required Time/Area Closures	Alternative 6- Authorization for Level 3 Exploration Activity with Use of Alternative Technologies
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 types of impacts as Alternative 2, intensity and extent of the impact would be doubled for exploratory drilling activities, level of impact still minor.	Same as Alternative 4	Same as Alternative 4
Climate	No effect	Impacts cannot be measured on a project-level basis.	Impacts cannot be measured on a project-level basis.	Impacts cannot be measured on a project-level basis.	Same as Alternative 4	Same as Alternative 4
Air Quality	No effect	Negligible to minor impacts due to emissions from survey vessels and from emissions of CO_2e from drilling programs.	Minor impacts due to emissions from survey vessels and from emissions of CO_2e from drilling programs.	Moderate impacts due to emissions from survey vessels and from emissions of CO_2e from drilling programs.	Same as Alternative 4	Same as Alternative 4
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.	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 4	Same as Alternative 4
Water Quality	No effect	Impacts reduced to negligible by mitigation measures.	Impacts reduced to negligible by mitigation measures.	Impacts reduced to negligible by mitigation measures.	Same as Alternative 4	Same as Alternative 4
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.	Minor impacts due to the greater level of activity increasing the potential volume of contaminants introduced to the project area.	Same as Alternative 4	Same as Alternative 4
BIOLOGICAL ENVIRONMENT						
Lower Trophic Levels	No effect	Negligible 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.	Negligible impacts, the increased levels of activity would not generate different types or level of impacts. Introduction of invasive species from ship traffic could cause moderate impacts.	Negligible impacts, the increased levels of activity would not generate different types or level of impacts. 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.
Fish/Essential Fish Habitat	No effect	Minor impacts, small scale and temporary only.	Minor impacts, increased activities would not change the impact level.	Minor impacts, increased activities would not change the impact level.	Minor 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.
Marine and Coastal Birds	No effect	Negligible to minor impacts, depending on species ESA status, from temporary and localized disturbance, injury/mortality, and changes in habitat.	Negligible to minor impacts, depending on the species ESA status, increased activities would not change the impact level.	Moderate impacts from the increased level of activity.	Same as Alternative 4	Same as Alternative 4

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 3 Exploration Activity	Alternative 5- Authorization for Level 3 Exploration Activity with Additional Required Time/Area Closures	Alternative 6- Authorization for Level 3 Exploration Activity with Use of Alternative Technologies
Marine Mammals: Bowhead Whales	No effect	Moderate impacts from noise disturbance or habitat degradation.	Moderate impacts from noise disturbance or habitat degradation.	Moderate to major impacts from noise disturbance or habitat degradation.	Moderate impacts, as the Time/Area closures could reduce adverse impacts in particular times and locations.	Moderate to major impacts. Despite possible localized mitigating capabilities of alternative technologies the impact level would not change.
Marine Mammals: Beluga Whales	No effect	Moderate impacts from noise disturbance or habitat degradation.	Moderate impacts from noise disturbance or habitat degradation.	Moderate impacts from noise disturbance or habitat degradation.	Minor to moderate impacts. The effects on beluga whales would be similar to Alternative 4 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.
Marine Mammals: Other Cetaceans	No effect	Minor impacts from temporary, local disturbance.	Minor to moderate impacts from temporary, local disturbance. Increased activities would not change the impact level.	Minor to moderate impacts from temporary, local disturbance. Increased activities would not change the impact level.	Minor to moderate 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 to moderate 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.
Marine Mammals: Ice Seals	No effect	Minor impacts from temporary localized disturbance.	Minor to moderate impacts from temporary localized disturbance. Increased activities would not change the impact level.	Minor to moderate impacts from temporary localized disturbance. Increased activities would not change the impact level.	Minor impacts, as the time/area closures could reduce potentially adverse effects on seals in those areas.	Minor to moderate 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.
Marine Mammals: Pacific Walrus	No effect	Minor impacts from disturbance, risk of injury or mortality, and changes in habitat in the Chukchi Sea.	Moderate impacts from disturbance, risk of injury or mortality, and changes in habitat in the Chukchi Sea.	Moderate impacts from disturbance, risk of injury or mortality, and changes in habitat in the Chukchi Sea.	Moderate impacts, although time/area closures would reduce potentially adverse effects on walrus in those areas.	Moderate 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.
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 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.
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. 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.
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. 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.
Subsistence	No effect	Negligible to minor impacts from disturbance, depending on the species.	Negligible to moderate impacts from disturbance, depending on the species. 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, depending on the species. 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 minor impacts from disturbance, depending on the species. Impacts would be slightly reduced because of the required time/area closures that would be applied in all circumstances instead of being considered as additional mitigation measures.	Negligible to moderate impacts from disturbance, depending on the species. 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.

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 3 Exploration Activity	Alternative 5- Authorization for Level 3 Exploration Activity with Additional Required Time/Area Closures	Alternative 6- Authorization for Level 3 Exploration Activity with Use of Alternative Technologies
Public Health	No effect	Negligible impacts, both beneficial and adverse, from changes to: • Diet and nutrition • Contamination • Safety • Acculturative stress • Economic impacts • Health care services	Negligible impacts, both beneficial and adverse, from changes to: • Diet and nutrition • Contamination • Safety • Acculturative stress • Economic impacts • Health care services Despite the increased activity, there would be no increase in the impact level.	Negligible impacts, both beneficial and adverse, from changes to: • Diet and nutrition • Contamination • Safety • Acculturative stress • Economic impacts • Health care services Despite the increased activity, there would be no increase in the impact level.	Negligible impacts, both beneficial and adverse. If the time/area closures improve the likelihood of maintaining a strong subsistence harvest, there will also be resulting benefits 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, both beneficial and adverse. 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, and thus the benefits are theoretical. Therefore, the impact rating remains the same. If the alternative technologies are demonstrated to be effective, they would benefit public health.
Cultural Resources	No effect	Negligible impact.	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.
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. 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. Minor impacts to land and water management - as activities increase, the possibility for conflicts with borough offshore development policies goes up as well. Negligible impacts to land and water ownership as no changes in 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. Minor impacts to land and water management - as activities increase, the possibility for conflicts with borough offshore development policies goes up as well. Negligible impacts to land and water ownership as no changes in ownership would occur.	Moderate impacts to land and water use. 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. 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. 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. Minor impacts to land and water management. Negligible impacts to land and water ownership as no changes in ownership would occur.
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.	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.
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. 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.
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.	Moderate impacts from high contrast of drill sites and associated activities.	Moderate impacts from high contrast of drill sites and associated activities.	Moderate impacts from high contrast of drill sites and associated activities.

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 3 Exploration Activity	Alternative 5- Authorization for Level 3 Exploration Activity with Additional Required Time/Area Closures	Alternative 6- Authorization for Level 3 Exploration Activity with Use of Alternative Technologies
Environmental Justice	No effect	Minor adverse impacts from disruption of subsistence activities and potential contamination of subsistence food. Minor beneficial impacts from local employment opportunities.	Minor adverse impacts from disruption of subsistence activities and contamination of subsistence food. Minor beneficial impacts from local employment opportunities.	Minor adverse impacts from disruption of subsistence activities and contamination of subsistence food. 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.

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 that would not necessarily jeopardize the region's ability to meet the federal and State of Alaska air quality standards.

Impacts

- All action alternatives would cause negligible to moderate adverse 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 adverse effects. The impact criteria for acoustics are based on the existence of sound levels that could cause effects.
- All action alternatives would cause moderate adverse impacts to acoustics because they produce underwater sound levels that could exceed ambient noise levels.

- The increased activity under Alternatives 3, 4 5, and 6 would not raise the sound level above the moderate impact level.
- The time/area closures under Alternative 5 do not reduce sound levels but they do reduce the likelihood that exploration activities would occur when marine mammals would be present and consequently reduce the chances of injurious exposures. Moderate adverse 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 6, 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 mostly minor adverse impacts to other marine mammals (other cetaceans, ice seals, Pacific walrus, and polar bear) which are not discussed here. Mechanisms for disturbance would be similar amongst all marine mammal species. 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, and conduct migrations through the Beaufort and Chukchi seas in both the spring and fall. Beluga whales are known to feed in Barrow Canyon, the Shelf Break of the Beaufort Sea, and in Kasegaluk Lagoon.

The primary adverse impact on bowhead and beluga whales resulting from the action alternatives would be from noise exposure. Noise can cause behavioral disturbance and auditory impairment. Disturbance to feeding, resting, or migrating bowhead or beluga whales could cause whales to leave areas of exploration activity and avoid them in the future, effectively reducing their available habitat. 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 moderate (and for some up to major) adverse impacts to bowhead and beluga whales from noise disturbance and habitat degradation.
- The increased activity under Alternative 4 could increase the impact level to major adverse for bowhead whales.
- The time/area closures under Alternative 5 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 in the absence of closures. 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 times and locations, the impact on bowhead whales and beluga whales of oil and gas exploration activities allowed under Alternative 5 would be similar to Alternative 3 and would be considered moderate.

- The use of alternative technologies under Alternative 6 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 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.

3.3 Social Environment

3.3.1 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 Alternatives 2 and 5 would have impacts to subsistence ranging from negligible to moderate adverse depending on the species to be harvested.
- Alternative 5 could reduce adverse impacts in areas where the required time/area closures would occur if they overlapped with subsistence hunting seasons.
- The adverse impact level under Alternative 6 would be reduced if the alternative technologies are successful in reducing disturbance to marine mammals.

3.3.2 Land and Water Ownership, Use, and Management

The lands and waters within the EIS project area is 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 adverse 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 reduce activity levels and affect management plans and would fundamentally change federal, state, and private development rights by preventing exploration for oil and gas resources.

- Impacts to land and water use would be moderate adverse 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 adverse for Alternatives 3 and 4 as the increased activity level may cause conflicts with management plans; minor adverse for Alternative 5 because the time/area restrictions are a change in management; and minor adverse for Alternative 6.
- Impacts to land and water ownership would be negligible for Alternatives 2, 3, 4, 5, and 6 as no changes in ownership would occur.

3.3.3 Visual Resources

Visual resources within the EIS project area are dominated by characteristics of the Beaufort and Chukchi seas. The visual characters of these water bodies 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 impact visual resources by creating visual contrast that may diminish the scenic quality of the area.

Impacts

- All five action alternatives would have short-term, moderate adverse impacts on scenic quality and visual resources.
- Alternatives 3 through 6 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 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; increased 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 adverse effect specific to bowhead whales that still influences population levels because the population is still recovering from depletion caused by commercial whaling.

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

Any of the five action alternatives would have moderate adverse cumulative impacts on visual resources, moderate to major adverse impacts on bowhead whales, and moderate adverse impacts on climate, air quality, lower trophic levels, 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), BOEM Final Secondary SEIS for the Chukchi Sea Oil and Gas Lease Sale 193 (BOEM 2015b), and other publicly available information. For the Beaufort Sea, the discussion and analysis is incorporated from the 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 FEIS identifies Alternative 2 as 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 will use the EIS when issuing ITAs for oil and gas exploration activities. 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 will conduct site-specific NEPA reviews for G&G permit applications. Proposed activities will be reviewed by BOEM to determine whether the activities are covered by the assessment of impacts contained in the Effects of Oil and Gas Activities in the Arctic Ocean FEIS, and may incorporate information and analyses in this EIS by reference (see 40 CFR Part 1506.2).

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 top-level goals:

(a) An increase in our 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.

(b) An increase in our understanding of 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 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).

(c) An increase in our understanding of how individual marine mammals respond (behaviorally or physiologically) to the specific stressors associated with the action (in specific contexts, where possible, i.e., at what distance or received level).

(d) An increase in our understanding of 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).

(e) An increase in our understanding of how the activity affects marine mammal habitat, such as through effects on prey sources or acoustic habitat (e.g., through characterization of longer-term contributions of multiple sound sources to rising ambient noise levels and assessment of the potential chronic effects on marine mammals).

(f) An increase in understanding of the impacts of the activity on marine mammals in combination with the impacts of other anthropogenic activities or natural factors occurring in the region.

(g) An increase in our understanding of the effectiveness of mitigation and monitoring measures.

(h) 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 where the proposed activity may affect the availability of marine mammals for taking for subsistence uses.

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' 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.

From 1994 until 2013, NMFS annually hosted a two-to-three day Open Water Meeting to bring together 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. At these meetings 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.

Prior to 2006, these meetings were small with approximately 15 to 30 participants. The meetings from 2006 through 2013 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. From 2010 through 2016, 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 three to seven scientists to provide an independent scientific review of proposed monitoring plans. During these reviews, NMFS charged the panel members with determining whether or not the monitoring plans, as put forth by the applicants, would accomplish the goals described earlier in this Executive Summary. After the meetings, the panel members provided a final report to NMFS with their recommendations. NMFS reviewed the peer review panel report in the context of the applicants' activities and the requirements of the MMPA and selected those that were appropriate for potential inclusion in the applicant's final monitoring plans. NMFS then worked with the applicants regarding the practicability of including these measures and protocols, and then included the selected measures as requirements in the issued authorizations.

This process has evolved, and will continue to do so, to address strengths and weaknesses identified by reviewers. Utilizing a smaller group chosen from nominated scientists, with affected subsistence hunters available to share information and respond to questions, allows for a true scientific and 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 shared with the applicants and allows NMFS and the applicants to identify ways to improve the plans for current and future actions. Panel members suggested that the time allotted for interaction with the applicants in 2010 and 2011 was too short, so NMFS added additional time for interaction at later peer review panel meetings. Also, at the request of the applicants, beginning in 2012, questions were provided to them in advance so that they could be prepared to discuss specific issues identified by the panel members. Generally, both scientist reviewers and applicants have indicated that this more focused method for peer review of the monitoring plans is more effective than the larger meeting format used in 2006 through 2009. However, it is an iterative process, and NMFS intends to continue modifying the methods as necessary to most effectively solicit input.

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 developed includes:

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

In 2010 and 2011, the independent peer reviewers included in their reports (in addition to specific comments on the applications that they are reviewing) additional recommendations (related to both the goals of monitoring, in addition to methodology) that could potentially be more broadly applied to multiple applicants, both in the present and the future. This sort of comprehensive consideration of multiple monitoring activities across multiple years could facilitate the most effective combined monitoring efforts in the Arctic.

Through continuing discussions at meetings with the peer reviewers, other scientists, Alaska Native hunters, oil companies, regulators, and others, as well as through the development of our Environmental Impact Statement on the Effects of Oil and Gas Activities in the Arctic Ocean, NMFS identified the targeted need to develop a forward-looking MMPA Monitoring Strategy to comprehensively address the monitoring specifically required by Section 101(a)(5) of the MMPA when incidental take authorizations are issued for oil and gas activities in the Arctic, and to help better understand the aggregate impacts of energy development activities. To support this need, in November 2014, NMFS convened a workshop in Anchorage specifically to explore and discuss this goal. The primary goal of the workshop was to identify and begin prioritizing specific key questions that future monitoring can be designed to answer that will fill critical information gaps to best inform future MMPA and ESA analyses and decisions involving marine mammals and their habitats. In addition to and in support of this primary objective, the participants in the workshop reviewed previous monitoring results, discussed effectiveness of existing and emerging monitoring methods, and touched on ways of synergizing across private, Alaska Native hunter, and government efforts to maximize effectiveness of data collection, analysis, and dissemination to support the conservation and protection of marine mammals.

5.2.3 BOEM's Environmental Studies Program

The OCSLA 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. 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 Plan of Cooperation and Conflict Avoidance Agreement

Subsistence communities and the oil and gas industry have worked together to develop documents called Conflict Avoidance Agreements (CAA), which were intended to ensure that there would be "no unmitigable impacts to subsistence uses of marine mammals" resulting from industry activities and generally included (among many other measures) the components identified in the requirements for the POC. The CAA was a binding legal agreement signed by individual companies and the Alaska Eskimo Whaling Commission (AEWC) that put agreed-upon measures in place that would purportedly allow the industry to conduct the indicated activity while ensuring there were no conflicts with the subsistence hunt that would result in unmitigable adverse impacts.

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 found, after conducting an independent analysis, that if a company and the AEWC signed a CAA, then it was possible for a company to conduct their activity without having an unmitigable adverse impact on the bowhead whale subsistence hunt. However, in more recent years, some companies have become reluctant to sign a CAA with the AEWC. Additionally, 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. 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.

POCs are required by NMFS' implementing regulations, and CAAs are not. However, input from the impacted subsistence communities indicates that they have found that the CAA process, through its highly interactive and legally binding aspects, has effectively resulted in the development and implementation of measures that will ensure no unmitigable adverse impact. Alternatively, 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 authorizations, 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.

It is worth noting that both the POC and CAA processes are all about good communication between the appropriate parties, which is absolutely necessary to minimize conflicts between subsistence and industry activities. In support of this, some companies have employed subsistence advisors who serve as the designated seasonal (or longer) contact between a given company and the affected communities and can organize and coordinate timely communication and action to help ensure that the industry activities don't have an unmitigable adverse impact on subsistence uses.

5.3.2 Open-Water Meeting

NMFS held Open Water Meetings from 1994 through 2013. In 2006, the Open Water Meeting evolved into a separate open access stakeholder meeting that was important to help ensure NMFS' understanding, from the affected parties, of the effects of industry activity on the subsistence uses of marine mammals. From 2006 to 2013, the Open Water Meeting included members of industry, Federal, state, and local government officials and scientists, Alaska Native marine mammal commissions, affected Alaska Native hunters and community members, environmental non-governmental organizations, and other interested members of the public. Typically, each year, the industry would present the results of their marine mammal monitoring programs from the previous year and the suite of activities proposed for the upcoming season along with the associated monitoring plans. Native subsistence group representatives (e.g., whaling captains, AEWC members) presented 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 were also presentations regarding ongoing western and traditional science programs conducted in the region.

The Open-Water Meeting is not specifically required by statute or regulation. However, 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, NMFS continued to organize this annual meeting. However, as the meeting continued to grow, it became increasingly difficult for NMFS to accomplish the primary remaining objective of the meeting, which was to solicit input from subsistence users on the impact of industry activities on their hunting, and, after the 2013 meeting, NMFS made a decision to no longer hold the Open Water Meeting.

Therefore, instead of holding the annual Open Water Meeting, NMFS staff will be working with subsistence communities, as well as industry, to determine the best ways to engage, which will likely include attending CAA meetings, Plan of Cooperation processes, Alaska Native Organization meetings and/or other meeting venues where key parties can meet for focused subsistence impact discussions. We believe that this approach will not only be more successful in meeting our objectives but will be a much more effective use of agency resources.

5.4 Adaptive Management

Adaptive Management is a discretionary learning-based management approach to structured decision-making that may be used in conjunction with the NEPA process. Adaptive management considers appropriate adjustments to federal actions (i.e. decisions related to the issuance of permits and authorizations under multiple statutes) and the associated required mitigation, monitoring, and reporting as the outcomes of previous proposed actions and required mitigation and monitoring, as well as new science, are better understood. NMFS and BOEM historically incorporated, and will continue to incorporate in the future, adaptive management principles in the issuance of permits and authorizations and any adaptive adjustments of mitigation and monitoring. The following are some of the specific sources of information upon which adaptive management decisions could be based during the life of this EIS:

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

(2) Stakeholder input received during NMFS attendance at CAA, POC, or ANO meetings, or other meetings specifically targeted to better understand impacts on subsistence uses;

(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 Sound Mapping and Cetacean Mapping in the Arctic and elsewhere;

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

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

(10) Traditional ecological knowledge.

The intent of adaptive management 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. By explicitly laying out this adaptive management framework that identifies the types of information that will be considered and the types of changes that may be considered in order to effect the intent listed above (e.g., those in the Additional Mitigation section or those discussed above in the Monitoring and Reporting Improvement section), it allows for mitigation and monitoring modifications and improvements under the auspices of this EIS, without automatically necessitating a revised NEPA analysis. NMFS will continuously consider adaptive management as the agency executes the ITA program.

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3.0 LIST OF ACRONYMS AND ABBREVIATIONS

1D	One-dimensional
2C	dual component
2D	Two-dimensional
3D	Three-dimensional
4C	multiple/four component
4D	Four-dimensional
AAC	Alaska Administrative Code
ABR	Alaska Biological Research, Inc.
ABWC	Alaska Beluga Whale Committee
ACIA	Arctic Climate Impact Assessment
ACP	Arctic Coastal Plain Physiographic Province
ACMP	Alaska Coastal Management Program
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
AFSC	Alaska Fisheries Science Center
AHRS	Alaska Heritage Resource
AIPC	Alaska Injury Prevention Center
AIMMMS	Automatic Infrared Marine Mammal Mitigation System
AMAP	Arctic Monitoring and Assessment Program
AMNWR	Alaska Maritime National Wildlife Refuge
AN(SW)T	Ambient-Noise (Surface-Wave) Tomography
ANCSA	Alaska Native Claims Settlement Act
ANDVSA	Alaska Network on Domestic Violence and Sexual Assault

ANTHC	Alaska Native Tribal Health Consortium
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
APDES	Alaska Pollutant Discharge Elimination System
APP	Alaska Pipeline Project
AQRV	air quality related values
ARRT	Alaska Regional Response Team
AS	Alaska Statute
ASAMM	Aerial Surveys of Arctic Marine Mammals
ASNA	Arctic Slope Native Association
ASRC	Arctic Slope Regional Corporation
BACT	Best Available Control Technology
bbl	barrels
BIA	biologically important area
BIA	U.S. Bureau of Indian Affairs
BiOp	biological opinion
BLM	U.S. Bureau of Land Management
BOEM	U.S. Bureau of Ocean Energy Management
BOEMRE	U.S. Bureau of Ocean Energy Management, Regulation and Enforcement
BOWFEST	Bowhead Whale Feeding Ecology Study
B.P.	before present
BP	British Petroleum
BPXA	BP Exploration
BSEE	Bureau of Safety and Environmental Enforcement
BWASP	Bowhead Whale Aerial Survey Program
°C	Degrees Celsius

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
CDC	Centers for Disease Control and Prevention
CDS	conical drilling unit
CEAA	Canadian Environmental Assessment Agency
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 Sea
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
Com Centers	Communication and Call Centers
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
CSESP	Chukchi Sea Environmental Study Program
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
DFO	Department of Fisheries and Oceans
DHHS	Department of Health and Human Services
DLI	Daylight Imaging
DMLW	Division of Mining, Land and Water
DO&G	Department of Oil and Gas
DOC	U.S. Department of Commerce
DOSITS	Discovery of Sound in the Sea
DPEIS	Draft Programmatic Environmental Impact Statement
DS	Deep Seismic Survey
DTAGS	Deep-towed Acoustics/Geophysics System
DP	dynamic positioning
DPP	Development and Production Plan
DPS	distinct population segment
DWH	Deepwater Horizon
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
FAA	Federal Aviation Administration
FEIS	Final Environmental Impact Statement
FIRST	Fast Infrared Search and Track
FLIR	Forward Looking Infrared
FM	frequency-modulated
FMP	fishery management plan
FOSC	Federal On-Scene Coordinator
FONSI	Finding of No Significant Impact
FR	Federal Register
FRP	facility response plan
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

GMT	Greater Moose's Tooth
GP	general permit
GPS	Global Positioning System
GTP	gas treatment plant
GWP	global warming potential
HAP	hazardous air pollutants
HF	high-frequency
Hg	elemental mercury
$HgCl_2$	Mercuric chloride
HIV	Human Immunodeficiency Virus
HMW	high molecular weight
HRS	High Resolution Seismic
HyMAS	Hydrocarbon Microtremor Analysis
Hz	Hertz
IAP	Integrated Activity Plan
IB	Icebreaking
ICAS	Iñupiat Community of the Arctic Slope
IFR	Interim Final Rule
IHA	Incidental Harassment Authorization
IMPROVE	Interagency Monitoring of Protected Visual Environments
in	Inch
in^3	Cubic Inch
IPCC	Intergovernmental Panel on Climate Change
IPF	impact producing factors
IRA	Indian Reorganization Act
ISER	Institute for Social and Economic Research
ITA	Incidental Take Authorization
IVI	Industrial Vehicle International
IWC	International Whaling Commission
Kg	kilograms
Kg/L	kilograms per liter

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
LD	lethal dose
L_E	cumulative sound exposure level
L_{eq}	Equivalent sound level
LET	Local Earthquake Tomography
LF	low-frequency
LFC	low-frequency cetaceans
LFS	Low-Frequency Spectroscopy
LME	Large Marine Ecosystem
L_{min}	RMS maximum noise level
L_{min}	RMS minimum noise level
LMW	low molecular weight
LNG	liquefied natural gas
LOA	Letters of Authorization
LOSC	Local On-Scene Coordinator
L_{pk}	peak sound pressure
LRI	lower respiratory tract infections
m	meter
m^2	square meter
MATCH	Mobilizing Action Toward Community Health
MBTA	Migratory Bird Treaty Act
MC	mesoscale cyclone
MF	mid-frequency

MFC	mid-frequency cetaceans
mg/kg	milligrams per kilograms
Mg/L	milligrams per liter
Mg/m^3	Milligrams per cubic meter
MHW	mean high water
mi	mile
min	minute
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
MOA	memorandum of agreement
MODU	Mobile Offshore Drilling Unit
mph	miles per hour
MSD	marine sanitation device
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
MWCS	marine well containment system
myr	million years
myBP	million years before present
µPa	Micro Pascal
$\mu g/m^3$	micrograms of pollutant per cubic meter of air
n.d.	no date
NAAQS	National Ambient Air Quality Standards
NAB	Northwest Arctic Borough
NANA	NANA Regional Corporation
NAO	NOAA Administrative Order
NAO	North Atlantic Oscillation
NCP	National Oil and Hazardous Substances Pollution Contingency Plan

NCSTDD	National Coalition of STD Directors
NEPA	National Environmental Policy Act
Ng/L	nanograms per liter or parts per trillion
NGO	non-governmental organization
NH_3	ammonia
nm	nautical miles
NMFS	National Marine Fisheries Service
NMI	nautical miles
NMM L	National Marine Mammal Laboratory
NO	nitrogen oxide
NO_2	nitrogen dioxide
N_2O	nitrous oxide
NOA	Notice of Availability
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NPFMC	North Pacific Fisheries Management Council
NPR-A	National Petroleum Reserve–Alaska
NRC	National Research Council
NSB	North Slope Borough
NSIDC	National Snow and Ice Data Center
NSR	New Source Review
NTL	Notice to Lessees and Operators
NTU	Nephelometric Turbidity Units
NVDs	Night Vision Devices
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
NWAB	Northwest Arctic Borough

O_3	ozone
OBC	ocean-bottom cable
OBN	ocean-bottom node
OCRM	Office of Ocean and Coastal Resource Management
OCS	outer continental shelf
OCSLA	Outer Continental Shelf Lands Act
ODCE	Ocean Discharge Criteria Evaluation
ODPCP	Oil Discharge Prevention and Contingency Plan
OMB	U.S. Office of Management and Budget
OPA	Oil Pollution Act
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 Vessel
OW	otariid pinnipeds
Pa	Pascals
PAH	polycyclic aromatic hydrocarbon
PAM	passive acoustic monitoring
Pb	lead
PCB	Polychlorinated Biphenyl
PCH	Porcupine Caribou Herd
PCoD	potential consequences of disturbance
PDO	Pacific Decadal Oscillation
PEA	Programmatic Environmental Assessment
PEIS	Programmatic Environmental Impact Statement
PFEIS	Programmatic Final Environmental Impact Statement
PGS	Petroleum Geo-Services
PILT	payment in lieu of tax
PK	peak pressure sound level
$PM_{2.5}$	Particulate matter 2.5 microns in diameter

PM_{10}	Particulate matter 10 microns in diameter
PMC	polar mesoscale cyclone
P	compressional
p/P	Pressure
P_1	Sound having pressure
POC	Plan of Cooperation
PO	Phocid Pinnipeds
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 shift
R/B	respiration to biomass ratio
RDD	Resource Development District
RFFA	reasonably foreseeable future action
RMS	root-mean-square
ROD	Record of Decision
RPSEA	Research Partnership to Secure Energy for America
RRT	regional response team
RSC	reduced sulfur compounds
RUSALCA	Russian-American Long-term Census of the Arctic
S	shear
s	second
SA	Subsistence Advisor
SAR	Search and Rescue
SBI	Shelf Basin Interactions
SBS	Southern Beaufort Sea stock

SCR	Selective catalytic control
SDC	Steel Drilling Caisson
SDEIS	Supplemental Draft Environmental Impact Statement
SEL	sound exposure level
SEL_{cum}	cumulative sound exposure level
SEIS	Supplemental Environmental Impact Statement
SEMS	Safety and Environmental Management System
SFEIS	Supplemental Final EIS
SIL	significant impact level
SMS	safety management systems
SO_2	sulfur dioxide
SOPCs	stressor of potential concern
SOSC	State On-Scene Coordinator
SPL	sound pressure level
SQRU	Scenic Quality Rating Unit
SSV	Sound Source Verification
SLRU	Sensitivity Level Rating Unit
SPCC	Spill Prevention, Control, and Countermeasure
SPLASH	Structure of Populations, Levels of Abundance, and Status of Humpbacks
STI	sexually transmitted infection
TA&R	Technology Assessment & Research
TAPS	Trans-Alaska Pipeline System
TB	tuberculosis
TCH	Teshekpuk Caribou Herd
TCP	Traditional cultural property
TK	Traditional Knowledge
tpy	tons per year
TTS	temporary threshold shift
UC	Unified Command
ULSD	ultra-low sulfur diesel
UN	United Nations

URI	upper respiratory tract infection
U.S.	United States
USACE	U.S. Army Corps of Engineers
U.S.C.	United States Code
USCG	U.S. Coast Guard
USDOI	U.S. Department of the Interior
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
USSCP	U.S Shorebird Conservation Plan
VGP	vessel general permit
VLCC	Very Large Crude Carrier
VLOS	Very Large Oil Spill
VOC	volatile organic compounds
VSP	vertical seismic profiling
WAH	Western Arctic Caribou Herd
WCD	Worst Case Discharge
WRCC	Western Regional Climate Center

1.0 PURPOSE AND NEED

This chapter describes 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 this chapter 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.

This EIS takes a “programmatic” approach, which means that it is designed to be broad in scope so it can address a wide range of related actions or projects. In this way, the EIS can analyze the effects of permitting geological and geophysical operations and ancillary activities and of authorizing the take of marine mammals incidental to geological and geophysical operations, ancillary activities, and exploratory drilling, rather than addressing them one by one. The Council on Environmental Quality (CEQ) regulations encourage the use of programmatic documents to eliminate repetitive discussions of the same issues and to focus on the actual issues ripe for decision at each level of environmental review (40 Code of Federal Regulations [CFR] 1500.4(i); 40 CFR 1502.20; 40 CFR 1508.28).

The National Environmental Policy Act (NEPA) allows an agency to consider environmental impacts and to conduct an environmental analysis at the earliest possible stage. This programmatic EIS will enhance administrative streamlining of the permit and authorization processes described later in this chapter and is meant to eliminate duplication of analysis on an individual permit or authorization basis, per CEQ regulations. No precedent for future actions or decision in principle about future considerations would be made by the decision process and Record of Decision (ROD) related to this EIS. Moreover, this ROD does not constrain future leasing and management decisions to be made by the Bureau of Ocean Energy Management (BOEM). This EIS will be used from the time the ROD is signed until there is scientific evidence that the analysis needs to be updated to address changing conditions or activities (e.g., changes in: marine mammal distribution, abundance, etc., physical environment, and levels and types of oil and gas exploration activities). Additional information regarding agency intentions for future implementation of this EIS and adaptive management processes are discussed in Chapter 5.

NEPA encourages Programmatic NEPA analyses and tiering to reduce or eliminate redundant and duplicative analyses and more effectively address cumulative effects. There are several factors that influence a decision to prepare a programmatic document:

- When an agency has regulatory authority over similar activities in a specific geographic area and affected environment, and these activities can be expected to occur on a regular basis;
- When an agency has jurisdiction over assessing potential cumulative effects over a specific geographic area; and
- When an agency has jurisdiction-wide responsibility for developing and assessing potential program and policy-level mitigation measures.

Furthermore NEPA encourages preparation of programmatic NEPA analyses to meet the following objectives:

- focus on a geographic area subject to similar activities;
- develop scenarios to assess potential effects of different levels of development;
- analyze cumulative effects of multiple future activities;
- develop broad mitigation policies, programs, or plans that would apply to many future projects, the details and location of which are not yet known;

- tier subsequent NEPA compliance documents to simplify and streamline the analysis for a project that implements the program, eliminate repetitive discussions of the same issues and to focus on the actual issues ripe for decision at each level of environmental review;
- incorporate by reference the general discussions in a programmatic document and concentrate individual project compliance solely on the issues specific to the statement subsequently prepared; and
- make project-level NEPA analysis less costly and time consuming.

The analysis in this document improves the ability to assess direct, indirect, and cumulative impacts for oil and gas specific and other reasonably foreseeable future activities on a regional scale. It also facilitates assessment and development of mitigation measures, including periodic review and revision of programmatic policies and best management practices; comprehensive monitoring programs, including metrics for measuring impacts; and protocols for incorporating monitoring and observations and new mitigation measures into standard operating procedures and project-specific best management practices.

1.1 Background

Pursuant to the NEPA, the United States (U.S.) Department of Commerce (DOC), National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS) has prepared this 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, ancillary activities, and exploratory drilling activities) in the U.S. Beaufort and Chukchi seas, Alaska, and the potential impacts of authorizing the take of marine mammals incidental to those activities. The U.S. Department of the Interior (USDOI) BOEM participated in the preparation of this EIS as a cooperating agency.

Department of the Interior – Agency Reorganization

Pursuant to USDOI Secretarial Order No. 3299 (May 19, 2010), the Minerals Management Service (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, in accordance with their 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 the MMS' issuance of permits and authorizations under the Outer Continental Shelf Lands Act (OCSLA) 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 2007 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 the 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. The North Slope Borough (a local governmental entity of the State of Alaska) is also a cooperating agency on the EIS. NMFS invited the U.S. Environmental Protection Agency (EPA) to be a cooperating agency, but the EPA chose to participate as a "consulting" agency on this EIS and has provided input into sections where the EPA has subject matter expertise. NMFS also coordinated with the Alaska Eskimo Whaling Commission (AEWC) pursuant to our co-management agreement under the MMPA on the preparation of this EIS. NMFS invited the U.S. Fish and Wildlife Service (USFWS) to join the effort as a cooperating agency, but they declined the request; however, USFWS participated as a "consulting" agency in the preparation of this Final EIS (FEIS). NMFS also shared preliminary drafts of the FEIS with the State of Alaska for their review.

On December 30, 2011, NMFS published a NOA for the *Effects of Oil and Gas Activities in the Arctic Ocean Draft Environmental Impact Statement* in the *Federal Register* (76 FR 82275). The public was afforded 60 days to comment on that document. Consistent with comments on the Draft EIS (DEIS), NMFS and BOEM determined that the environmental analysis would benefit from the inclusion of additional alternatives for analysis that covered a broader range of potential levels of exploratory drilling, including scenarios in the Beaufort and Chukchi seas that were more reflective of the levels of activity that oil and gas companies have indicated may be pursued in the region within the coming years. The alternatives are based upon the agencies' analysis of additional information, including the comments and information submitted by stakeholders during the DEIS public comment period. For this reason, the agencies determined it appropriate to prepare a Supplemental DEIS (SDEIS) and allow for an additional public comment period before releasing the FEIS and Record of Decision (ROD). On January 30, 2013, NMFS published an NOI informing the public of its determination to prepare a SDEIS in the *Federal Register* (78 FR 6303). Table 1-1 identifies the differences in the alternatives between the December 2011 DEIS , the March 2013 SDEIS, and this FEIS. In addition to the range of alternatives, public comments, newly available scientific information and traditional knowledge have informed changes and additions to other components of the document, including descriptions of the affected environment, analysis of direct, indirect, and cumulative impacts, and the analysis of potential mitigation measures. NMFS has made several changes to the document based on public comments received on the 2011 DEIS and the 2013 SDEIS, and Appendix A addresses responses to all public comments.

This EIS will evaluate the potential effects to the environment from G&G exploration and geotechnical sampling activities in the U.S. Beaufort and Chukchi seas, Alaska, as described in the Table 1-2.

Table 1-1 Differences in the Alternatives between the December 2011 Draft EIS, the March 2013 SDEIS, and the Final EIS

Alternative	2011 Draft EIS	2013 Supplemental Draft EIS	2016 Final EIS
Alternative 1 (No Action)	NMFS would not issue ITAs under the MMPA, and BOEM would not issue permits and notices under the OCSLA.	Same as in 2011 Draft EIS	Same as in 2011 Draft EIS and 2013 SDEIS
Alternative 2 (Preferred Alternative)	Considered 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, with up to one of that total number in each done in-ice, if necessary. • Three site clearance and high resolution shallow hazards survey programs in each sea, per year. • One on-ice seismic survey in the Beaufort Sea, per year. • One exploratory drilling program[1] in each sea, per year. Considered inclusion of required standard mitigation measures and additional mitigation measures.	Same as in 2011 Draft EIS	Same as in 2011 Draft EIS and 2013 SDEIS. However, the suite of required standard mitigation measures and additional mitigation measures has been revised based on public comments.
Alternative 3	Considered 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, with up to one of that total number in each done in-ice, if necessary. • Five site clearance and high resolution shallow hazards survey programs in each sea, per year. • One on-ice seismic survey in the Beaufort Sea, per year.	Same as in 2011 Draft EIS	Same as in 2011 Draft EIS and 2013 SDEIS. However, the suite of required standard mitigation measures and additional mitigation measures has been revised based on public comments.

[1] Please see Section 2.4.3 of this FEIS for a discussion of the term “exploratory drilling program.”

Alternative	2011 Draft EIS	2013 Supplemental Draft EIS	2016 Final EIS
	• Two exploratory drilling programs in each sea, per year. Considered inclusion of required standard mitigation measures and additional mitigation measures.		
Alternative 4	Considered 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, with up to one of that total number in each done in-ice, if necessary. • Five site clearance and high resolution shallow hazards survey programs in each sea, per year. • One on-ice seismic survey in the Beaufort Sea, per year. • Two exploratory drilling programs in each sea, per year. Considered inclusion of required standard mitigation measures and additional mitigation measures. Considered inclusion of required time/area closures for specific areas important to biological productivity, life history functions for specific species of concern, and subsistence activities. Areas considered were: • Camden Bay; • Barrow Canyon and the Western Beaufort Sea; • Shelf Break of the Beaufort Sea; • Hanna Shoal; and • Kasegaluk Lagoon/Ledyard Bay Critical Habitat Unit.	This alternative differs from Alternative 4 from the 2011 DEIS in the following ways: • Considers up to four exploratory drilling programs in each sea, per year. • It does not consider inclusion of any required time/area closures. Everything else about the alternative remains the same.	This alternative remains the same as the one presented in the 2013 SDEIS with the exception of the changes made to the suite of required standard mitigation measures and additional mitigation measures based on public comments.

Alternative	2011 Draft EIS	2013 Supplemental Draft EIS	2016 Final EIS
Alternative 5	Considered 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, with up to one of that total number in each done in-ice, if necessary. • Five site clearance and high resolution shallow hazards survey programs in each sea, per year. • One on-ice seismic survey in the Beaufort Sea, per year. • Two exploratory drilling programs in each sea per year Considered inclusion of required standard mitigation measures and additional mitigation measures. Considered 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.	Alternative 5 in this EIS is similar to Alternative 4 from the 2011 Draft EIS with some slight changes: • Increase in the maximum level of exploratory drilling programs from up to two in each sea, per year to up to four in each sea, per year. • Inclusion of required time/area closures. However, there are changes. Camden Bay was removed from the list of required time/area closures that was considered in the 2011 DEIS. The following are the required time/area closures considered in the 2013 SDEIS: o Kaktovik and Cross Island o Barrow Canyon and the Western Beaufort Sea o Shelf Break of the Beaufort Sea o Hanna Shoal o Kasegaluk Lagoon o Ledyard Bay	This alternative remains the same as the one presented in the 2013 SDEIS. The only changes are the inclusion of one additional required time/area closure: Point Franklin to Barrow and the removal of Hanna Shoal from the list of required time/area closures that was considered in the 2011 DEIS and 2013 SDEIS. All other aspects of Alternative 5 are the same as Alternative 5 in the 2013 SDEIS with the exception of the changes made to the suite of required standard mitigation measures and additional mitigation measures based on public comments.

Alternative	2011 Draft EIS	2013 Supplemental Draft EIS	2016 Final EIS
Alternative 6	There was no Alternative 6 in this version of the EIS.	Alternative 6 in this EIS is similar to Alternative 5 from the 2011 Draft EIS. The only change is the maximum amount of exploratory drilling activities that could potentially occur under this alternative increases from up to two in each sea, per year to up to four in each sea, per year.	Same as in the 2013 SDEIS with the exception of the changes made to the suite of required standard mitigation measures and additional mitigation measures based on public comments.

Table 1-2 Oil, Gas, & Sulphur Exploration Activities Permitting

Regulatory Citation	Permitted Plan or Activity	Survey Examples and/or Purpose	Activity Phase
30 CFR §551.4(a)	Geophysical marine or airborne exploration (gravity, magnetic, electromagnetic, or seismic surveys)	Deep penetration geophysical surveys include open-water, towed streamer 2-dimensional [2D] or 3-dimensional [3D] surveys, in-ice towed streamer 2D or 3D surveys, on-ice 2D or 3D surveys or Ocean-Bottom-Receiver [cable or node] 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.	Exploration occurring pre-lease, off-lease, or on-lease when held by a 3rd party
30 CFR §551.4(b)	Geological and geophysical scientific research (non-commercial investigations conducted in the OCS for scientific and/or research purposes)	G&G Scientific research means any oil, gas, or sulphur related investigation conducted in the OCS for scientific and/or research purposes. Geological, geophysical, and geochemical data and information gathered and analyzed are made available to the public for inspection and production at the earliest practicable time. This does not include commercial geological or geophysical exploration or research. A permit is required to conduct research activities which involve: Using solid or liquid explosives; Drilling a Deep Stratigraphic Test; or Developing data and information for proprietary use or sale. Any other G&G research not requiring a permit requires a Notice to be filed with the BOEM Regional Director.	Exploration occurring pre-lease, off-lease, or on-lease when held by a 3rd party
30 CFR §251.7(b) 30 CFR §551.7(a) 30 CFR §551.7(b)	Geological exploration, including Shallow Test Drilling and Deep Stratigraphic Test Drilling	Pre-lease exploration drilling takes two distinct forms. Shallow Test Drilling is useful for geotechnical investigations necessary for site clearance preliminary to exploration or development activities. These surveys are used to examine the area of potential drill sites for geologic hazards and/or soils and rock sampling for structural and other properties necessary for appropriate siting of platforms, pipelines, and other subsea equipment. Deep Stratigraphic Test Drilling is useful for pre-lease data acquisition in frontier areas where existing geologic information is limited. Deep Stratigraphic Test Drilling is defined as drilling that involves penetration into the sea bottom more than 500 feet (152 meters).	Exploration occurring pre-lease, off-lease, or on-lease when held by a 3rd party

Regulatory Citation	Permitted Plan or Activity	Survey Examples and/or Purpose	Activity Phase
30 CFR §550.201	Exploration Plans	An Exploration Plan (EP) must be submitted before an operator conducts any geological or geophysical exploration activities on a lease or unit, specifically when: It will result in a physical penetration of the seabed greater than 500 feet (152 meters); It will involve the use of explosives; The Regional Director determines that it might have a significant adverse effect on the human, marines, or coastal environment; or The Regional Supervisor, after reviewing a Notice under 30 CFR §550.209, determines that an EP is necessary.	Exploration on-lease or unit
30 CFR §550.207	Ancillary Activities	Before or after an operator submits an EP, they may elect, the regulations may require, or the Regional Supervisor may direct an operator to conduct ancillary activities. These activities include: G&G exploration and development activities; geological and high-resolution geophysical, geotechnical, archaeological, biological, physical oceanographic, meteorological, socioeconomic, or other surveys; or Studies that model potential oil and hazardous substance spills, drilling muds and cuttings discharges, projected air emissions, or potential hydrogen sulfide (H_2S) releases.	Exploration on-lease or unit
30 CFR §250.410	Exploratory Drilling	Any drilling conducted for the purpose of searching for commercial quantities of oil, gas, and sulphur, including the drilling of any additional well needed to delineate any reservoir to enable the lessee to decide whether to proceed with development and production.	Exploration on-lease or unit

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, geotechnical studies, ice gouge surveys, strudel scour surveys, environmental studies, and exploratory drilling.

The 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. 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 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 surveys, and exploratory drilling activities. The analyses aid BOEM and the Bureau of Safety and Environmental Enforcement (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 includes 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. Other statutory responsibilities include 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 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 has further responsibilities under OCSLA and NEPA and will complete a NEPA review prior to holding any lease sale or authorizing any new exploration plans in the Chukchi or Beaufort seas.

NMFS' issuance of ITAs for the take of marine mammals is a federal action for which environmental review is required under CEQ regulations. While NEPA does not dictate a substantive outcome for an MMPA ITA, it requires consideration of environmental issues in federal agency planning and decision making and requires an analysis of alternatives and direct, indirect, and cumulative environmental effects of the NMFS action to authorize take under the MMPA. It also calls for the identification and consideration of reasonable mitigation measures to avoid, minimize, off-set or compensate for potential adverse effects. The EIS will assist NMFS in performing NEPA evaluations for MMPA ITAs for the take of marine mammals incidental to conducting 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 that require some additional site-specific analysis or incorporate relevant sections by reference if other NEPA documents are required. NMFS also intends to utilize information and analysis from this EIS to inform agency analyses and decisions pursuant to its ESA and EFH consultation responsibilities. BOEM intends to conduct site-specific NEPA analyses that either tier from this EIS or incorporate this EIS by reference. Sections 5.1.2 and 5.1.3 of this document provide additional detail regarding NMFS and BOEM NEPA compliance for these proposed actions.

Based on activity levels and MMPA ITA requests over the last several years, NMFS is able to prepare this programmatic EIS based on reasonably foreseeable forthcoming applications for incidental take associated with oil and gas exploration activities in the Beaufort and Chukchi seas. This EIS will enhance administrative streamlining of the MMPA process and is meant to eliminate duplication of analysis on an individual MMPA ITA basis, per CEQ regulations. Additionally, this EIS analyzes a large range of activities (larger than any authorized to date in a single year) and concern has been expressed that those larger levels of activity may exceed NEPA significance thresholds. Therefore, NMFS has also prepared this EIS to determine the level of significance and ensure adequate NEPA coverage of this larger suite of activities for which MMPA take coverage may be requested.

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

The MMPA prohibits the unauthorized "take" of marine mammals by any person or vessel within the waters of the U.S., to include the U.S. Beaufort and Chukchi seas (16 United States Code [U.S.C.] § 1372 (102)(a)). Sections 101(a)(5)(A) and (D) of the MMPA (16 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. For example, a disruption of marine mammal migratory behavior, feeding, or nursing activities, perhaps resulting in cessation of the activity or separation of cow/calf pairs, would constitute an incidental taking. 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 described in this EIS 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 OCSLA, 43 U.S.C. § 1331 *et seq.* prescribes a four stage process for development of OCS federal oil and gas resources: (1) a five-year oil and gas leasing program; (2) lease sales; (3) ancillary activities and exploration; and (4) development and production. Environmental reviews are conducted for each of these stages.

The OCSLA 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 OCSLA 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 OCSLA establishes USDOI authority, delegated to BOEM by regulation, to issue permits for G&G, concur on notices of ancillary activities, and approve exploratory drilling plans for these and related purposes. BOEM's regulations for G&G permits are at 30 CFR Part 551 and for ancillary activities and Exploration Plans are at 30 CFR Part 550. Exploration drilling activities require a permit from BSEE (Application for Permit to Drill under 30 CFR Part 250).

The OCSLA (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) and Applications for Permits to Modify, 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 OCSLA;
- 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;
- disturb archaeological resources; 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 OCSLA. In addition to regulations contained at 30 CFR Part 550, BOEM issues Notices to Lessees and Operators (NTLs). NTLs are formal documents that: provide clarification, description, or interpretation of a regulation or OCS standard; provide guidelines on the implementation of a special lease stipulation or regional requirement; provide a better understanding of the scope and meaning of a regulation by explaining BOEM interpretation of a requirement; or transmit administrative information.

1.1.3 New Requirements for OCS Oil and Gas Exploration and Development Drilling Operations

Following the Deepwater Horizon Event 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 and

BSEE. 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 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 liquid hydrocarbons, including calculations of a worst case discharge scenario. Under the requirements for enhanced drilling safety (NTL 2015-N01, Information Requirements for Exploration Plans, Development and Production Plans, and Development Operations Coordination Documents on the OCS for Worst Case Discharge and Blowout Scenarios), 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 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.

BOEM and BSEE overhauled and continue to proactively reform the offshore regulatory process. Similarly, the oil and gas industry has voluntarily responded with rigorous reform measures, including new and revised industry standards, recommended practices, specifications, and guidelines. BSEE's "Increased Safety Measures for Energy Development on the Outer Continental Shelf" at 30 CFR Part 250 requires that permit applications for drilling projects meet heightened standards for well-design, casing, and cementing. Also, a major aspect of the overhaul was the specific requirement for Professional Engineering certification.

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. BOEM's 2017-2022 OCS Oil and Gas Leasing Program Draft Programmatic EIS describes current regulations and requirements applicable to OCS leasing.

In July 2016, BOEM and BSEE announced final regulations regarding future exploratory drilling activities on the Arctic OCS. The Arctic OCS final rule establishes a holistic regulatory framework that is more stringent than the regulations that govern other OCS locations. Importantly, the final rule only applies to Arctic OCS exploratory drilling activities that use mobile offshore drilling units (MODUs) and related operations during the open-water drilling season (typically late June to early November). The final rule seeks to ensure that operators identify operational risks early on, plan to avoid and/or mitigate those risks, and understand and account for the unique challenges of operating on the Arctic OCS.

1.2 Proposed Action

The proposed actions of the two federal agencies considered in this EIS are:

- The issuance of ITAs under Sections 101(a)(5)(A) and (D) of the MMPA, by NMFS, for the incidental taking of marine mammals during G&G permitted activities, ancillary activities, and exploratory drilling activities in state and federal waters of the U.S. Beaufort and Chukchi seas, Alaska, and
- The authorization of G&G permits and concurrence on ancillary activities in waters in the federal OCS in the U.S. Beaufort and Chukchi seas, Alaska, by BOEM under the OCSLA.

These federal actions are related, but distinct, actions. The spatial scope of this EIS is limited to the Arctic from the border between the U.S. and Canada in the Beaufort Sea to Nome in the Bering Sea. This spatial extent includes the areas where seismic surveys, ancillary activities, and exploratory drilling may occur in the U.S. Arctic, as well as vessel transit routes through the Bering Strait and staging and possible resupply ports.

1.3 Purpose and Need for Action

1.3.1 Purpose

Energy use in the U.S. is expected to continue to increase from present levels through 2040 and beyond (EIA 2015). For example, the U.S. consumption of petroleum and other liquids has been projected to increase from 19.0 million bbl/d in 2013, to 19.6 million bbl/d in 2020, then decline to 19.3 million bbl/d in 2040 (EIA 2015). Oil and gas reserves in the OCS represent significant sources that currently help meet U.S. energy demands and are expected to continue to do so in the future. The benefits of producing oil and natural gas from the OCS include not only helping to meet this national energy need but also generating money for public use.

In 1972, Congress enacted the MMPA, stating the following findings: marine mammals are resources of great international significance; certain species are, or may be at risk of, extinction or depletion as a result of man's activities; marine mammals should not be permitted to diminish beyond the point at which they cease to be significant functioning element of the ecosystem, and; the primary objective of their management should be to maintain the health and stability of marine ecosystems. This is a powerful statement, and clearly speaks to the need to maintain a broad scope that considers species- and ecosystem-level impacts. To serve this broader goal, the MMPA (16 USC 1371, 50 CFR Subpart 1) put a prohibition on the take of marine mammals, with certain exceptions, one of which is the issuance of ITAs. Sections 101(a)(5)(A) and (D) allow 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.

In these contexts, the purpose for issuing authorizations to "take" marine mammals incidental to oil and gas exploration activities under the MMPA is discussed below.

NMFS' decision to prepare an EIS should not be construed as an assumption that significant adverse effects would occur from all levels of activities analyzed. Federal agencies may employ the EIS process to aid in their decision-making, whether the contemplated action would have significant effects or not. In this case, the primary reason for preparing an EIS was, that the higher levels of activity predicted by the oil and gas industry to likely occur in the near future could have significant cumulative impacts (we note that predictions of activity levels are likely lower now, in 2016, than they were when the EIS scoping process was started in 2010). Based on the industry's prediction of increased activities, NMFS and BOEM wanted to ensure that appropriate NEPA analysis was completed, rather than wait until the first year that anticipated cumulative impacts from industry activities exceed the significance threshold and delay activities while an EIS was written. This EIS was written to prevent permitting delays from causing a future gap in activities.

Under the MMPA, the ‘taking’ of marine mammals, incidental or otherwise, without a permit or exemption is prohibited. Among the activities exempt from the MMPA’s moratorium on the take of marine mammals is subsistence hunting of marine mammals by Alaska Natives (Section 101(b)). Among the exceptions allowed to the moratorium on marine mammal takes (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. The MMPA directs the Secretary of Commerce to authorize the take of small numbers of marine mammals 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 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 OCSLA.

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. NMFS could issue ITAs for oil and gas exploration 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, there is the potential that some seismic and exploratory drilling activities may result in the take of marine mammals through sound, permitted 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.

1.3.2 Need

NMFS expects to receive 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 by providing a comprehensive understanding of deep penetration geophysical surveys and exploratory drilling 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 analysis to support the issuance of ITAs for Arctic oil and gas exploration activities. It is the intent of NMFS that the scope of this EIS covers as many actions as possible. However, if necessary, NMFS may need to conduct additional NEPA analysis to support future Arctic MMPA oil and gas permit decisions if such activities fall outside the scope of this EIS. This applies to actions taken under Sections 101(a)(5)(A) and (D) (i.e. issuance of LOAs and IHAs). Please see Chapter 5 (Sections 5.1.2 and 5.1.3) for additional discussions on NEPA compliance related to this EIS.

1.4 Scope of Environmental Analysis

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 in federal waters under the OCSLA for proposed activities.
3. Evaluate a reasonable range 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) 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 OCSLA 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.

The proposed alternatives and reasonably foreseeable scenarios analyzed in this EIS were developed with input from other federal agencies and industry, are based on real world information, and represent reasonably foreseeable levels of oil and gas exploration activity in the U.S. Beaufort and Chukchi seas. Development and production are not part of the scenarios analyzed in this EIS.

There are multiple scenarios under which NMFS can obtain input from the public regarding the agency's issuance of MMPA authorizations (e.g., through monitoring peer review, public comment periods on the proposed authorizations). The history and known strengths and challenges of various scenarios NMFS has used to gain stakeholder and public input 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. Regarding the temporal scope, this EIS will be used from the time the Record of Decision is signed until there is scientific evidence that the analysis needs to be updated to address changing conditions or activities. BOEM will perform separate NEPA analyses on any exploration drilling proposals it may receive for leased tracts in the Beaufort Sea OCS or the Chukchi Sea OCS. Additionally, in 2015, BOEM completed the Lease Sale 193 Second SEIS, which includes a full analysis of potential impacts of all activities associated with OCS oil and gas leasing in the Chukchi Sea.

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. No subsequent scoping efforts occurred.

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

- Concerns regarding the NEPA process;
- impacts to marine mammals and habitats;
- occurrence 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.

Concerns related to the need for a stable domestic energy supply and benefits to the state and nation from oil and gas development were also raised during scoping. These issues were determined to be beyond the scope of the environmental analysis within this EIS and are therefore not discussed further. For more detail on the issues raised during the scoping process, please refer to Appendix C.

Issues and concerns associated with oil and gas related activities in the marine environment have also been documented since the mid-1900s 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. NMFS and BOEM 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 U.S. 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 miles [mi]) offshore. Onshore locations included within the EIS project area include Arctic communities of the Northwest Arctic and North Slope Boroughs: 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 or subsistence use 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 in previous NEPA documents produced by both the NMFS and MMS/BOEM. Summaries of these documents are contained herein. Portions of these NEPA documents are 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 FEIS 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 a Final Programmatic Environmental Assessment (PEA) on the *Arctic Ocean Outer Continental Shelf Seismic Surveys - 2006* (MMS 2006b, 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 OCSLA 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 2006b PEA). On March 30, 2007, the EPA announced the availability for comment of the MMS/NMFS Draft PEIS (MMS 2007c). 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 2007c), 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 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)**. 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 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 an 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 ConocoPhillips Alaska, Inc. in the Chukchi Sea. All leases were obtained in Lease Sale 193 held in February 2008.
- In August 2011, BOEMRE issued an EA and 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 project analyzed in the EA was 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 August 2011, BOEMRE issued the ***Final Supplemental EIS for the Chukchi Sea Planning Area Oil and Gas Lease Sale 193*** (BOEM 2015b). The 2007 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 Lease Sale 193 to BOEMRE to satisfy its obligations under NEPA in accordance with the Court's opinion. 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 October 2011, the Secretary of the Interior signed a ROD that affirmed Lease Sale 193 as held. BOEM completed a Second Supplemental EIS in February 2015 to address the remanded issues and on concerns identified by the Court of Appeals. On March 31, 2015, the USDOI issued a ROD affirming Chukchi Sea OCS Oil and Gas Lease Sale 193.
- In December 2011, BOEM issued an EA and a FONSI for the ***Shell Revised Chukchi Sea Exploration Plan.*** The EA evaluates the potential impacts from proposed exploratory drilling to evaluate oil and gas resources on six of Shell's OCS leases in the Chukchi Sea.
- On December 30, 2011, NMFS published an NOA in the *Federal Register* announcing the availability of the ***Effects of Oil and Gas Activities in the Arctic Ocean Draft EIS*** (76 FR 82275). The public was afforded 60 days to comment on that document. Many of the comments received on the 2011 DEIS have been incorporated into this Final EIS.
- In May 2012, NMFS prepared an EA for the issuance of IHAs to Shell for the take of marine mammals incidental to conducting offshore exploratory drilling programs in the U.S. Beaufort and Chukchi seas. The EA analyzed impacts to marine mammals and their habitats and to the subsistence uses of marine mammals, as well as to other resources in the affected environment. After completion of the EA, NMFS issued two FONSIs for each of the IHAs issued by NMFS.
- In July 2012, BOEM issued the ***Outer Continental Shelf Oil and Gas Leasing Program 2012-2017 Final Programmatic EIS*** (BOEM 2012). The Final PEIS 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.

- In October 2012, BOEM issued an **EA for ION's *Geological and Geophysical Surveys* (OCS EIS/EA BOEM 2012-081)**. 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).
- On March 29, 2013, NMFS published an NOA in the *Federal Register* announcing the availability of the ***Effects of Oil and Gas Activities in the Arctic Ocean Supplemental Draft EIS*** (SDEIS) (78 FR 19212). The public was afforded 90 days to comment on that document. Many of the comments received on the 2013 SDEIS have been incorporated into this FEIS.
- Additional BOEM Alaska OCS NEPA documents can be found at: http://www.boem.gov/About-BOEM/BOEM-Regions/Alaska-Region/Environment/Environmental-Analysis/Environmental-Impact-Statements-and--Major-Environmental-Assessments.aspx.

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 OCSLA 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 EIS 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**. 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 *Federal Register*, 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) 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 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).

As noted earlier in this chapter, NMFS and BOEM determined it was necessary to prepare a SDEIS prior to issuing the FEIS. While not one of the five required steps in the EIS process, NMFS and BOEM determined that the FEIS would benefit from the inclusion of additional alternatives for analysis that covered a broader range of potential levels of exploratory drilling scenarios in the Beaufort and Chukchi Seas than was analyzed in the 2011 DEIS. Additional revisions were made to the document, including the analysis of potential mitigation measures. Based on the nature of the changes to the document from the 2011 DEIS, the agencies determined a SDEIS should be released for public comment. Following the public comment period, the lead agency considered the comments received and prepared this FEIS, which includes responses to comments on the 2011 DEIS and the 2013 SDEIS (see Appendix A).

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

NOAA Administrative Order (NAO) 216-6, May 20, 1999, as preserved by NAO 216-6A, "Compliance with the National Environmental Policy Act, Executive Order 12114, Environmental Effects Abroad of Major Federal Actions; 11988 and 13690, Floodplain Management; and 11990, Protection of Wetlands" 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 of 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 DOI Implementation of the National Environmental Policy Act of 1969

DOI has established procedures (43 CFR Part 46) for the Department and for its constituent bureaus (including BOEM) to use for compliance with NEPA and with CEQ regulations (40 CFR 1500-1508) for implementing the procedural provisions of NEPA. This regulation is intended to supplement and to be used in conjunction with the CEQ regulations.

1.8.4 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 to engage in any such conduct" to species listed as threatened or endangered in 16 U.S.C. § 1532(19). 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 the ESA.

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.

1.8.5 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 adverse 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. If the analysis of a specific proposal indicates the potential for death or serious injury of marine mammals and that potential cannot be negated through the inclusion of mitigation measures, then NMFS would not issue an IHA and would consider issuing regulations and associated LOA, which allow for "take" of marine mammals by serious injury or mortality.

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 purpose of the EIS is to evaluate the potential effects of issuing take of marine mammals incidental to conducting expected types and levels of seismic surveys, ancillary activities, and exploratory drilling activities in both state and federal waters of the U.S. Arctic Ocean. The significance of the effects is evaluated in terms of context and intensity per CEQ's regulations at 40 CFR 1508.27. The analyses in this programmatic EIS and any proposal-specific NEPA documentation (if needed) for an ITA application must support findings of negligible impact on the species or stock(s) and unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses for NMFS to issue an ITA.

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.

1.8.6 Outer Continental Shelf Lands Act

The OCSLA 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 OCSLA, the USDOI is required to manage the leasing, exploration, development, and production of mineral resources on the federal OCS. The OCSLA 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 OCSLA, 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 OCSLA are at 30 CFR Chapters II and V.

This EIS acknowledges and furthers this mandate. BOEM is responsible for implementation of the OCS Program as established by the OCSLA. During development of a 5-year OCS leasing program, the Secretary of the Interior may elect to exclude certain areas from leasing. At the lease sale stage, the Secretary may defer areas from inclusion in a specific proposed lease sale. The time/area locations discussed in this EIS are areas being considered for limitations on specific activities at certain times of the year to mitigate potential adverse effects on marine mammals and the subsistence uses of marine mammals (which is in accordance with Section 101(a)(5) of the MMPA); they are not areas under consideration for exclusion from OCS leasing. Appropriate levels of NEPA analysis will be developed for each specific project that BOEM authorizes or permits.

1.8.7 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 EFH identified under the Magnuson Stevens Fishery Conservation and Management Act (MSFCMA).

1.8.8 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.

On July 1, 2011, the Alaska Coastal Management Program (ACMP) authorities in Alaska Statute (AS) 46.39, AS 46.40, and other uncodified laws relating to the ACMP were automatically repealed. The result of the program's expiration was the withdrawal from participation in the CZMA's National Coastal Management Program. The CZMA federal consistency provision, section 307, no longer applies in Alaska (76 FR 39875, July 7, 2011). As such, coastal zone management will not be carried forward for analysis.

1.8.9 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 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 1990 Amendments transferred the authority to control emissions caused by oil and gas activities on the Alaska OCS, the Atlantic OCS, and the Pacific OCS from the Department of the Interior to the EPA. The Interior maintained jurisdiction only in areas of the Central and Western Gulf of Mexico OCS Region. However, on December 23, 2011, an amendment to the Clean Air Act Section 328 transferred authority for the control of oil and gas-related emissions on the OCS in the area offshore the North Slope Borough of the State of Alaska back to the USDOI through the Consolidated Appropriations Act, 2012 (Public Law 112-74). The other Alaska OCS Planning Areas remain under EPA jurisdiction.

EPA's requirements for air pollution on the OCS differ depending on location. For sources located within 25 miles of a state's seaward boundary, requirements are based on state rules. For sources located beyond 25 miles, federal requirements apply. The state or local air pollution control agency may request delegation from EPA to implement the air pollution control program within 25 miles of a state's seaward boundary on the OCS, including air permitting. The State of Alaska has delegated authority from EPA for onshore sources and sources within three miles, but has not requested delegation for OCS sources. BOEM regulates the air quality impacts of any newly proposed OCS sources associated with proposed exploration plans (or development and production plans). BOEM regulations regarding the control of air emissions are at 30 CFR Part 550. On April 5, 2016, BOEM published a Proposed Rule in the *Federal Register* to amend and update existing regulations in several areas of its jurisdiction, including the Arctic OCS.

1.8.10 Clean Water Act

The Clean Water Act (CWA) has several sections or programs applicable to activities in offshore waters. Section 402 of the CWA authorized EPA to administer the National Pollutant Discharge Elimination System (NPDES) permit program to regulate point source discharges into waters of the U.S.

Section 403 of the CWA requires that EPA conduct an ocean discharge criteria evaluation for discharges to the territorial seas, contiguous zones, and the oceans. The Ocean Discharge Criteria (40 CFR Part 125, Subpart M) set forth specific determinations of unreasonable degradation that must be made before permit issuance. On October 29, 2012, EPA issued two general permits for exploration discharges to the

Beaufort and Chukchi seas, permit numbers AKG-28-2100 and AKG-28-8100, respectively. The general permits authorize discharges from thirteen categories of waste streams, subject to effluent limitations, restrictions, and requirements. The general permits became effective on November 28, 2012, and are effective for five years. The permits require operators to submit Notices of Intent to EPA requesting authorization to discharge at least 120 days prior to commencing discharges. The Alaska Department of Environmental Conservation (ADEC) issued a CWA Section 401 Certification for the Beaufort Sea general permit on October 9, 2012, effective until November 27, 2017.Section 311 of the CWA prohibits the discharges of oil or hazardous substances into or upon the navigable waters of the United States, adjoining shorelines, or into or upon the waters of the contiguous zone, or in connection with activities under the OCSLA or the Deepwater Port Act of 1974, or which may affect natural resources belonging to, appertaining to, or under the exclusive management authority of the U.S. (including resources under the Magnuson-Stevens Fishery Conservation and Management Act of 1976).

The U.S. Coast Guard (USCG) has also promulgated regulations implementing the CWA (33 CFR Part 151).

1.8.11 National Historic Preservation Act of 1966

The National Historic Preservation Act of 1966 (NHPA), specifically Section 106, requires federal agencies to take into account the potential effects of their actions on properties that are listed or are eligible for listing on the National Register of Historic Places (historic properties), and to consult with State Historic Preservation Officers and local governments regarding the effects of federal actions on historic properties. Known historic properties (i.e. archaeological resources) on the Beaufort Sea OCS and Chukchi Sea OCS include historic shipwrecks, sunken aircraft, lighthouses, and prehistoric archaeological sites that have become inundated due to the rise in global sea level since the peak of the last ice age, around 19,000 years ago.

1.8.12 Executive Order 12898: Environmental Justice

Executive Order (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. The effects of the federal action on minority populations are described in Chapter 4.

1.8.13 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 Kotzebue, 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 knowledge and experience can provide with regard to understanding marine mammals and the environment in general. On August 10, 2012, DOI established a policy on Consultation with Alaska Native Claims Settlement Act Corporations. The DOI policy is read in conjunction with the existing DOI policy on Consultation with Indian Tribes.

1.8.14 State of Alaska Administrative Code (Title 18, Chapter 50 – Air Quality Control)

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. Air quality in the project area is also regulated by BOEM. The Consolidated Appropriations Act of 2012, effectively transferred jurisdiction to regulate air emissions associated with oil and gas activities on the Beaufort OCS and the Chukchi Sea OCS from EPA to BOEM.

1.8.15 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 Alaska Native groups specific to species 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.

1.8.16 Migratory Bird Treaty Act

The Migratory Bird Treaty Act (MBTA) of 1918 makes it unlawful to pursue, hunt, take, capture or kill; attempt to take, capture or kill; possess, offer to or sell, barter, purchase, deliver or cause to be shipped, exported, imported, transported, carried or received any migratory bird, part, nest, egg or product, manufactured or not. Many species of migratory birds protected under this act are found in the project area. The effects of the federal action on migratory birds are described in Chapter 4.

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

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. The alternatives carried forward include the No Action alternative (no issuance of geological and geophysical (G&G) permits or concurrence on ancillary activity notices by BOEM under the OCSLA and no marine mammal take authorizations incidental to oil and gas exploration activities issued by NMFS), and five action alternatives that would allow for the issuance of G&G permits and concurrence on ancillary activity notices under the OCSLA and marine mammal ITAs under the MMPA for a range of oil and gas exploration activities. NMFS' consideration of issuance of MMPA ITAs is for activities in both the OCS and State of Alaska waters. However, no G&G permits or ancillary activity notices would be issued by BOEM for exploration activities in state waters under the jurisdiction of the State of Alaska. In addition, the EIS evaluated a number of additional alternatives, associated with permanent closure of areas, caps on levels of activities and noise, reducing duplication of surveys, and zero discharge, but dismissed them from further consideration (Section 2.5).

The two proposed actions considered in this EIS are:

1. BOEM's issuance of G&G permits and ancillary activity notice approvals under the OCSLA, and
2. NMFS' issuance of ITAs under the MMPA for G&G surveys, ancillary activities, and exploratory drilling activities.

2.2 Issues Considered in Developing the Alternatives

The first step in preparing an EIS is publishing a 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 during a 60 day comment period, which 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;

<u>The six alternatives carried forward for consideration in this EIS are:</u>

Alternative 1 – No Action

Alternative 2 – Authorization for Level 1 Activity

Alternative 3 – Authorization for Level 2 Activity

Alternative 4 – Authorization for Level 3 Activity

Alternative 5 – Authorization for Level 3 Activity with Additional Required Time/Area Closures

Alternative 6 – Authorization for Level 3 Activity with Use of Alternative Technologies

- 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 in the EIS project area, 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 communities potentially affected by the proposed action, were notified of the EIS process and invited to participate[1]. The communities were first contacted via letter, dated January 29, 2010; follow-up calls were made, and each Tribal government was visited during the scoping process. The community of Kivalina was added during hearings on the DEIS. The Scoping Comment Analysis Report (CAR) (see Appendix C) includes comments received during the scoping period as a result of government-to-government consultation between NMFS, BOEM, and the Tribal governments.

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

Many of the comments received during the public comment period for the 2011 DEIS and the 2013 SDEIS were similar to issues raised during the public scoping period in early 2010. Issues raised by the public during the 60-day comment period (from December 30, 2011, through February 28, 2012) and the 90–day comment period (from March 29, 2013 to June 27, 2013) include:

- concerns related to public participation and review process;
- compliance with NEPA, the MMPA, and other applicable statutes;
- inadequacy of the range of alternatives;

[1] Tribal governments that were notified included: Native Village of Barrow, Native Village of Point Hope, Native Village of Point Lay, Native Village of Kaktovik, Native Village of Nuiqsut, Wainwright Traditional Council, and the Inupiat Community of the Arctic Slope.

- improper dismissal of alternatives;
- inadequacy of the analysis of cumulative effects;
- concerns regarding the potential for oil spills, their effects, and efficacy of response;
- inadequacy of the description and analysis of impacts on certain physical, biological, and social resources and a failure to include newer data; and
- insufficient analysis and information related to the effectiveness and implementation of mitigation measures.

As noted in Chapter 1, NMFS revised the range of alternatives in the SDEIS, provided additional analysis regarding effectiveness and practicability for implementation of mitigation measures considered in this EIS, and updated baseline descriptions of affected resources and analyses of potential impacts to affected resources with newer literature and data, based on comments received from the public. This FEIS includes, as Appendix A, a CAR that summarizes comments and responses received on the 2011 DEIS and the 2013 SDEIS.

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: ◊ critical feeding and resting grounds near Camden Bay in the mid-Beaufort Sea; ◊ critical feeding grounds in the eastern Alaskan Beaufort Sea and near Barrow Canyon in the western Beaufort Sea; ◊ nearshore areas (within 50 miles of the coast); ◊ 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 ◊ 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: ◊ areas used by the Village of Kaktovik in the eastern Beaufort Sea; ◊ areas around Cross Island used by the Village of Nuiqsut; ◊ areas used by the Village of Barrow in the western Beaufort Sea; ◊ areas used by Wainwright and Point Lay along the Chukchi Sea coast; and Kotzebue Sound (through July 10); and ◊ proposed access routes should be surveyed for ice seal lairs, breathing holes, and resting locales to avoid disturbance of these animals.
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.

Category	Comment
	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: ◊ 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. ◊ 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: ◊ acoustic recorders; ◊ aerial monitoring; ◊ satellite tagging; and ◊ 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: ◊ designating specific shipping lanes; ◊ implementing seasonal restrictions to protect marine mammals during their migration; and ◊ 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: ◊ vibroseis; ◊ extended reach drilling; ◊ zero discharge technology (as implemented in Norway[2]); ◊ gravity, magnetic, and gravity gradiometry data collection; and ◊ low-sulfur fuel.

[2] Norway regulations strictly limit offshore petroleum industry discharges including drilling fluids or muds, drill cuttings, and produced water. Norway first introduced a “zero discharge” goal for petroleum activities in 1996. This goal was later refined to mean zero discharge of environmentally hazardous substances, using Best Available Techniques. Norway’s “zero discharge” goal is not a numeric standard or a discharge level, but is instead a goal based on the precautionary principle and available technology (EPA 2011t).

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. While NMFS has jurisdiction in both state and federal waters, BOEM has jurisdiction only in federal waters. The following permits and authorizations required by BOEM, guide the progression of exploration activities in federal waters. 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 an Ancillary Activity Notice in accordance with 30 CFR 550.207 – 550.210 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. A notice of proposed ancillary activities must be submitted to BOEM, which conducts a technical and environmental review to ensure that the ancillary activities comply with the performance standards listed in 30 CFR Part 550.202(a), (b), (d), and (e). 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 550.211 – 550.235). The EP must include a plan of operations, information on the timing and location(s) of the proposed activity, the affected environment, and the potential effects on the environment. BOEM conducts a technical and environmental review of the proposed EP, as well as a NEPA analysis, and may approve a proposed EP only if the exploration activities described therein comply with the performance standards in 30 CFR Part 550.202.
- **Application for Permit to Drill (APD)** – No drilling may commence without an approved APD. An approved EP, along with all other necessary federal permits, is a prerequisite for APD approval. The authority to review and approve APDs belongs to BSEE in accordance with 30 CFR 250 Subpart D.

The permitting process listed above shows a general progression or sequence of events that occurs during OCS oil and gas leasing and exploration, as companies seek to locate hydrocarbon deposits that could be developed in the future after further evaluation by the agencies. If development and production are proposed at some later point, federal agency decisions regarding those activities will be informed by additional NEPA documents that take into account current conditions and specific project plans. The data and information gathered during OCS activities determine the activities likely to occur in subsequent years.

The following bulleted narrative summarizes how oil and gas prospects on the Beaufort Sea OCS and Chukchi Sea OCS are typically identified, leased, and explored:

- The first step is to search for prospective areas that could contain hydrocarbon accumulations. This is primarily accomplished using deep penetration seismic surveying techniques. Companies conduct 2D or 3D geophysical seismic surveys to identify areas of interest. Deep penetration 2D 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 accumulations. 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 OCSLA, BOEM has the right to copies of any data and information resulting 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 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 the highest 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 clustered over prospects. After obtaining a lease, companies may conduct 3D deep penetration seismic surveys to further define prospects and select proposed drilling locations.
- Prior to submitting an EP and drilling a well, companies are required to conduct ancillary 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 2,400 m x 2,400 m) 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 measurements 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 could 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 and supply 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 support typically associated with operations (Table 2.2).

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 • 1 support vessel • Likely 1 vessel for monitoring
In-ice seismic survey	• 1 source/receiver vessel • 1 icebreaker • Possible 1 support vessel
Ocean-bottom cable surveys	• 2 vessels for cable layout/pickup • 1 recording vessel • 1 to 2 source vessels • 1 to 2 small support vessels
Ocean-bottom node survey	• 1-2 source vessels • 1-3 node deployment vessels • 1 vessel for support monitoring
High-resolution airgun surveys	• 1 source/receiver vessel • Possible 1 vessel for monitoring
High-resolution sonar surveys	• 1 source vessel
On ice vibroseis	• Truck-mounted vibrators over ice • No vessels
Electromagnetic surveys	• 1 receiver/layout/pickup source vessel
Artificial island drilling	• Sea lift or ice road operations to construct islands, transport drilling rigs, and support modules • Drilling on island • Small support vessels • Aircraft for crew changes
Steel-drilling caisson drilling	• Modified very large crude carrier vessel • 2-3 tugs and supply to and from drill site • Aircraft for crew changes
Exploratory Drilling Program from a Drillship or Floating Drilling Unit	• Drillship • 1 or 2 icebreakers • 1 anchor handler • 1 or 2 oil spill response barge and tug • Tank vessel for spill storage • 8-12 support vessels • Aircraft for crew changes
Exploratory Drilling Program from a Jackup rig	• Jackup rig • 1 or 2 icebreakers • 1 or 2 oil spill response barge and tug • Tank vessel for spill storage • 2-3 support vessels • 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) or by the type of survey being conducted (e.g., open-water towed marine streamer, ocean-bottom cable, in-ice towed streamer, over ice). 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, ancillary activity for exploration).

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. The analysis in Chapter 4 of potential impacts of airgun use on the human environment is applicable for all types of surveys.

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. The seismic information would also be used to optimize the location of drilling operations on leases to reduce safety and environmental risks.

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 in the 2011 DEIS 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 meter (m) with most of the energy emitted between 10 and 120 Hertz (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 the target reservoir(s). Individual survey parameters may vary from the descriptions presented here. The vessels conducting these surveys are generally 70 to 120 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 surveys when using smaller vessels, which cannot provide a large enough platform for the total seismic airgun 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 3D 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 cables) 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; however, at present, helicopters are only used for emergency health and safety situations. An additional support vessel may be used to monitor for marine mammals ahead of the survey vessel. For operational purposes, BOEM used to require that all deep penetration seismic surveys maintain a minimum spacing of 24.1 km (15 mi) between source vessels when actively shooting. This was an operational constraint to prevent acoustic interference during data acquisition and has no special biological significance. However, since initiating this EIS, as a result of modern data processing techniques, BOEM has determined that this operational constraint is no longer necessary. NMFS considered other separation distances as a potential mitigation measure. However, the analysis indicated that it is not necessary (see Section 4.5.2.4.18 for the discussion).

2.3.2.3 In-Ice Towed-Streamer 2D/3D 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 currently 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 possibility exists that within the life of this EIS, equipment could be developed to allow towing of multiple streamers in ice covered waters, thus facilitating the ability to conduct 3D surveys in ice. This EIS analyzes effects from both 2D and 3D in-ice towed streamer surveys. This EIS will be used from the time the ROD is signed until there is scientific evidence that the analysis needs to be updated to address changing conditions or activities.

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

Ocean-bottom Cable Seismic Surveys

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 two 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. 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. The source vessel(s) tow the source array perpendicular to the receiver lines and extend past the ends of the receiver lines. During the recording of one patch, nodes from the previous patch are retrieved, recharged, and data downloaded prior to redeployment of the nodes. In addition to airguns, OBNs utilize pingers and transponders to locate receiver nodes. The characteristics of one such pinger system available for use has a transmission source level of 197 dB re 1 µPa at 1 m and operates at frequencies between 35 and 55 kHz. The transponder produces short pulses typically around 187 dB re 1 µPa at 1 m at frequencies also between 35 and 55 kHz.

In Alaska, OBNs in conjunction with land based nodes were 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. This technology has been used in Cook Inlet and in the Beaufort Sea.

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 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 due to the lack of metallic artifacts in the Arctic OCS of Alaska. 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 kilohertz (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 (Dorst 2010; HydroSurveys 2008);
- 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, 2010c; 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

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 either 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. Airguns and airgun arrays similar to those described in the preceding sections are used in VSP operations. However, the arrays are typically smaller than those used in marine deep penetration towed-streamer 3D and 2D surveys. VSP airgun arrays typically range from 450 in^3 to about 800 in^3. Similar to what is described in Section 2.3.2.1, source levels for such arrays range from 238 to 241 dB re 1 µPa at 1 m. 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 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 550.201 – 550.205 and 550.211 -550.235 Subpart B and 30 CFR Part 250 Subpart B, respectively. These regulations and associated NTLs establish and describe 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, which include provisions to ensure safe operations and preservation of the environment. 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 (e.g., 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 2.3). 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, semi-submersibles, or other floating vessels (e.g., *Polar Pioneer*) 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).

Drillship

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.

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 (OSRVs) 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 and crew changes 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.

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 2.4 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.

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. A 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.

The main contributors to the underwater sound levels from jackup rig drilling activities are the use of generators and drilling machinery. 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 than drillships. Marine Acoustics Inc. (MAI) (2012) describes measurements of the Spartan 151 drilling rig operating in Cook Inlet. Results of those measurements indicated the primary sources of underwater sound were produced by the diesel engines, mud pump, ventilation fans (and associated exhaust), and electrical generators. The loudest source levels (from the diesel engines) were estimated at 137 dB re 1 µPa at 1 m (rms) in the 141-178 Hz one-third octave band (MAI 2012). In 2013, ConocoPhillips Alaska submitted an IHA application for exploratory drilling in the Chukchi Sea from a jack-up rig. The application included acoustical modeling. While modeling is not a replacement for geographically specific measurements, it is assumed that the first time a jackup rig is in operation in the U.S. Arctic, detailed measurements will be conducted to determine the acoustic characteristics.

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 CWA Section 402, 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 USFWS and NMFS to ensure that any action it authorizes is not likely to jeopardize the continued existence of any species listed under the ESA, or result in the destruction or adverse modification of critical habitat required by a listed species. The State of Alaska has finalized guidelines for Ocean Discharge Criteria Evaluation (ODCE) for Geotechnical Surveys in State Waters of the Beaufort and Chukchi Seas (ADEC 2015).

On January 29, 2015, the EPA issued a final Geotechnical NPDES General Permit and ODCE for discharges to federal waters of the Beaufort and Chukchi seas (AKG-28-4300). The Geotechnical General Permit authorizes 12 types of wastewater discharges from oil and gas geotechnical surveys and related activities. The Geotechnical General Permit establishes effluent limitations and requirements to ensure the discharges will not cause unreasonable degradation of the marine environment. The Geotechnical General Permit became effective on March 2, 2015, and will expire on March 1, 2020.

On October 29, 2012, EPA issued two general permits for exploration discharges to the Beaufort and Chukchi seas, permit numbers AKG-28-2100 and AKG-28-8100, respectively. The general permits authorize discharges from thirteen categories of waste streams, subject to effluent limitations, restrictions, and requirements. The general permits became effective on November 28, 2012, and are effective for five years. The permits require operators to submit Notices of Intent to EPA requesting authorization to discharge at least 120 days prior to commencing discharges.

For their 2012 exploratory drilling program in the Beaufort Sea, Shell 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. Other than muddy seafloor sediments jetted out from the shallow-driven conductor casing (typically 80-300 feet) with seawater, drilling fluids and cuttings are circulated back to surface and collected for treating and testing, respectively. Used drilling fluids are typically reconditioned and pumped downhole in a closed loop system, being disposed of upon completion of drilling or when the fluid properties can no longer be maintained at appropriate conditions necessary for safe drilling. Rock cuttings waste is tested in accordance with EPA's NPDES permit requirements and is typically disposed overboard if verified within EPA's NPDES limits or collected and barged to shore if deemed contaminated. This EIS will analyze the reduction of those discharge streams as a mitigation measure in all of the action alternatives.

Jurisdiction for control of air emissions from stationary sources on the Arctic OCS (stationary rigs, drillships, and platforms) was the responsibility of the EPA until amendments to the Clean Air Act Section 328 were enacted on December 23, 2011 (Pub. L. 112-74) in the Consolidated Appropriations Act, 2012. The Arctic OCS is defined to include the Beaufort Sea and Chukchi Sea OCS Planning Areas that are adjacent to the North Slope Borough of Alaska. The signing of Pub. L. 112-74 transferred authority for the control of air stationary source emissions on the Arctic OCS from the EPA to BOEM (Consolidated Appropriations Act, 2012). The other Alaska OCS Planning Areas remain under EPA jurisdiction by the authority granted in the Clean Air Act Section 328. However, all actions on the Alaska OCS proposed within three miles of shore remain subject to air quality regulations of the ADEC and may require permitting.

Control of stationary source emissions within the Beaufort and Chukchi seas is now regulated by BOEM and ADEC, depending on the location of the proposed action. For proposed exploration plans or development or production plans located more than three miles offshore on the Arctic OCS, emissions are regulated by BOEM under 30 CFR Part 550 Subpart C (BOEM Subpart C) and by the authority granted in the OCSLA Sec. 5(a)(8). BOEM Alaska OCS Region would conduct an analytical evaluation of the air quality analysis contained in any exploration plan or development or production plan to ensure compliance with BOEM Subpart C. BSEE would be responsible for enforcing any required controls.

Emission of air pollutants, such as nitrogen dioxide (NO_2), sulfur dioxide (SO_2), carbon monoxide (CO), and particulate matter with diameters of less than 10 micrometers and less than 2.5 micrometers (PM_{10}, $PM_{2.5}$) would be required to meet the NAAQS issued by the EPA. The NAAQS specify maximum allowable concentrations for six principal criteria pollutants (EPA 2011b). A project proposed within three miles of shore may be required to obtain a Title V operating permit under Alaska rules depending on the specific source/facility.

2.3.3.6 Oil Spill Contingency and Response Planning

Oil spill contingency and response plans in the Alaska Arctic region are regulated by a combination of both state and federal requirements. The EPA, State of Alaska Department of Environmental Conservation (ADEC), BSEE, and the 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[3]. EPA requires Facility Response Plans (FRPs) and Spill Prevention, Control and Countermeasure (SPCC) plans (40 CFR Part 112) for onshore facilities and facilities in State waters. A FRP demonstrates a facility's preparedness to respond to a worst case oil discharge. Under the 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 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. ADEC’s standards are more stringent than federal standards, as they require response to an oil discharge within 72 hours and require the operator to produce a 15-day scenario in their spill response plan to show that they have adequate resources available on-scene or in the immediate vicinity. 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

[3] The 2011 DEIS contained a standard mitigation measure (listed in Appendix A of the 2011 DEIS as standard measure C4) that would require operators to have a plan in place to minimize the likelihood of an oil spill and outline response protocols in the event of a spill. Operators are required to develop such plans prior to receiving final approval from the appropriate federal and/or state agencies. Because development and approval of such plans is required before activities can be conducted, it is redundant to include development of such a plan in an MMPA ITA, which includes measures that must be carried out during operations. The oil spill contingency and response plans are a required component of the operations at both the planning and execution phases and would therefore already be developed and in place before the point of implementing measures contained in an MMPA ITA.

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. 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. Moreover, spill plans in federal waters need to plan for oil discharges that could affect State waters.

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 these 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 OPA of 1990, Public Law 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 311(d) of the CWA, 33 USC 1321(d) as amended by the OPA, Public Law 101-380.

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), 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 and EPA 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 State of Alaska also participates on the ARRT. 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 North Slope Borough (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).

2.3.4 Local Community Interaction with Industry

Over the years, 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 in conjunction with oil and gas development. Industry interacts with local communities through a local hire program and through community-wide meetings. Local residents may be 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 [MMO] 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.

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 (POCs).

The Open Water Season CAA is a private agreement between members of industry and the 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 a private, third party agreement, mitigating potential adverse impacts to the availability of marine mammals for subsistence uses compliments the requirements of the MMPA. CAAs typically include 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 temporal and spatial measures, CAAs typically provide 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 (i.e., PSOs); conflict resolution procedures; and provisions for rendering emergency assistance to subsistence hunting crews. The mitigation measures contained within CAAs have been developed by particular 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 at 50 CFR 216.104(a)(12) require that operators submit a POC containing mitigation measures to minimize adverse effects on the availability of marine mammals for subsistence uses. NMFS has used measures specific to protecting marine mammals or the availability of marine mammals for subsistence uses developed during the CAA process in previous ITAs.

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

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, a CAA can help 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. It should also be noted that additional local hire can occur in direct support of geophysical and drilling exploration, often through subsidiaries of Alaska Native Corporations.

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 (Weilgart 2010). 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. 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 for subsurface data collection 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. BOEM hosted a workshop in February 2013 titled “Quieting Technologies for Reducing Noise during Seismic Surveying and Pile Driving.” The goal of the workshop was to provide information about emerging technologies with potential utility for seismic exploration.

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	There are currently several next-generation systems under development.	This tool cannot replace all airgun surveys but has the potential to replace airguns for certain geologic prospects in certain environments.
Low-frequency Acoustic Combustion Source (patented) (LACS)	Two LACS systems are under development. However, the first is not fully proven, and the second has not been built. Additional tests of the LACS 4A system must be performed prior to deployment. 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. 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.

2.3.5.1 Marine Vibrators

From the late 1970s to early 2000s, engineering and geophysical companies attempted to develop a marine sound-source alternative capable of emitting a broad band, high amplitude modulating frequency output similar to that produced by land based vibrator trucks (Vibroseis). In 1985, Industrial Vehicle International Inc. (IVI) offered the first commercial marine vibrator. IVI and other marine exploration companies continued to develop marine vibrator systems into the early 2000s. Early field tests of the technology demonstrated its potential viability to produce data volumes equivalent in quality to the standard airgun source array. However, no viable commercial market developed due to the significant expense required to retrofit the marine exploration companies' ships to support marine vibrators. This expense was not offset by reduced operation costs or significantly better data quality compared to an airgun sound source.

In 2012, in response to new regulations resulting from court-derived interpretations of the MMPA and continued pressure by nongovernmental organizations, the Research Partnership to Secure Energy for America (RPSEA) called for a Joint Industry Project to test seismic source alternatives to airguns which would be more environmentally friendly and produce similar data sets for seismic exploration (Duey 2014). Since the RPSEA request, several large exploration companies (BP, Shell, WesternGECO, CGGVEritas etc.) have filed new patents for marine vibrators. These models range in design from mechanical to electromagnetic and may become commercially available in the next few years. However, none have been tested in an Arctic environment.

A marine vibrator consists of an acoustic housing, or shell, similar to that of a common household sound speaker. Within the shell (or speaker) is an oscillator which is driven at various frequencies (sweep) causing the shell to rapidly expand and contract, producing sound waves. The IVI vibrator along with newer patents relies on a hydraulically driven oscillator. Although this works in test environments, the mechanical nature of the oscillator requires frequent downtime for maintenance. In addition, the hydraulic fluid may leak and contaminate the marine environment. Petroleum Geo-Services (PGS) has developed and tested an electromechanical marine vibrator where the oscillator driver is based on electrical coils operating in a magnetic field which pushes spring elements against an external flextensional shell (Houllevigue 2013). PGS uses multiple vibrators in an array to produce high power within the 6-100 Hz range. A third type of oscillator, magnetically driven, is being developed by ETREMA which uses the material Terfenol-D to produce oscillations (ETREMA.com). Terfenol-D is an alloy of Terbium, Dysprosium and Iron, developed by the Naval Surface Warfare Center – Carderock Division, which is capable of converting energy from one form into another. When placed within an oscillating magnetic field, the Terfinol-D stretches and compacts with the oscillations of the induced magnetic field, a property known as magnetostriction. The oscillations within the Terfinol-D push against the acoustic housing producing the sound waves for the source.

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 and Gettrust 2000; Wood et al. 2002) 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 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. These technologies will be further analyzed in site-specific NEPA documents as the development and testing advances.

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 (Reyff 2009; Sexton 2007; Würsig et al. 2000). 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 (Pegg 2005; Weiser 2010).

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).

2.4 Alternatives Considered and Carried Forward in the EIS

The federal actions considered in this EIS are the issuance of G&G permits and concurrence on ancillary activity notices 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. The alternatives considered in this EIS do not constrain BOEM's authority to issue permits and ancillary activity notices but serve as examples of potential future activity levels. 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.

> The absence of an alternative analyzing a higher level of activity than presented here does not limit the number of possible drilling programs. If a higher level of activity is proposed, further NEPA analysis would be developed.

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 affecting 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 OCSLA permitting processes.

The levels are what is reasonably likely in the foreseeable future based on past activity levels and information available regarding future plans by the oil and gas industry. If there is a major discovery in the region, there could be increased interest in and applications for oil and gas activities. This EIS will support project-specific NEPA analysis within the levels of activity presented. If activities exceed the levels analyzed in this EIS, additional and appropriate NEPA analyses would continue to be developed.

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 IHAs 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.

> The alternatives include a range of exploration activities at different activity levels. While these alternatives do not function as "caps," they do serve as the maximum annual level of activities for which NEPA coverage under this EIS exists in a given year.

For planning purposes, NMFS and BOEM can project a reasonable level of exploration activities in the near term based upon current leases, upcoming lease sales, past exploration history, and industry's stated needs for exploring 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 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. 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

This section describes NMFS' review of the mitigation measures and the process for implementation at the individual MMPA ITA stage. Another objective of this EIS is to analyze whether the standard mitigation and monitoring measures stipulated in the past are appropriate for current and reasonably foreseeable MMPA ITAs associated with oil and gas exploration activities and to assess the feasibility and practicability of other mitigation measures that have been suggested during the scoping process and other public comment periods.

The evaluation of measures intended to reduce adverse impacts to marine mammal species and their habitat 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 measures are currently categorized in the action alternatives in three different ways:

1) **Required Standard Mitigation Measures** – These measures, which are required in all five of the action alternatives, are those that NMFS deemed appropriate to *require* in MMPA authorizations based on the analysis contained in this EIS. 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 here *but not required* in all five action alternatives, may or may not be required for future activities depending on the outcome of the project-specific MMPA authorization analyses and processes (or other environmental compliance processes). 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, or new measures considered for the first time here which may not have been required or considered in the past.

3) **Alternatives 5 and 6** – 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 of marine mammals.

In Chapter 4, all of the mitigation measures 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. This analysis, which also includes consideration of public comments received on previous proposed ITAs, the scoping period of this EIS, and on the 2011 DEIS and 2013 SDEIS, is needed in order to better assess the programmatic appropriateness of each measure (i.e., based on the generalized expectations for a given year of projected activities) and to inform decisions of whether the measure should:

a) be considered a Standard Mitigation Measure (i.e., required in every ITA for a given activity type);

b) be included in the Additional Mitigation Measure category, which means that the measure will be considered for inclusion as a requirement through future regulatory or authorization processes during which more specific information is known; or

c) never be required.

All Additional Mitigation Measures identified in this FEIS for a particular activity type will be further evaluated for potential required inclusion for any specific proposed activity through the MMPA process (and potentially other environmental compliance processes). Specific permit application information will be used to determine the degree to which the measure is likely to reduce impacts to marine mammals or subsistence uses of marine mammals. This implementation and evaluation process is outlined in more detail in Chapter 5, but the following are some of the types of more specific information that will be used to make the decision of whether to require a given measure in a given MMPA ITA:

- the timeframe, duration, and location of the proposed activity and the spatio-temporal overlap with marine mammal distribution and subsistence hunts of marine mammals;
- the specific characteristics of the sound sources used in the proposed activity;
- the availability and cost of the resources needed to carry out the measure;
- the timeframe, duration, and locations of other activities expected in the same season; and
- new information related to the likely success of the measure (from reports from previous years).

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. In determining the potential level of activity in each alternative, NMFS and BOEM reviewed the following information: results of recent federal and state lease sales; the timing of the future scheduled lease sales in the 2012-2017 Five

Year Program for the Arctic OCS[4]; and recent industry plans for both seismic surveys, ancillary activities, and exploratory drilling programs in the Beaufort and Chukchi seas. While the five year program was examined in constructing alternatives, the period of analysis in this EIS is not tied to the period in the Five Year Program for the Arctic OCS. The 2017-2022 Proposed Five Year Program for the Arctic OCS was not used in determining the activity levels of the alternatives since it was not available at the time of development of the DEIS and SEIS. NMFS intends to use this EIS from the time the ROD is signed until conditions or activities change that require analysis beyond that contained in this EIS. Additionally, NMFS and BOEM considered the logistical and technological limitations of conducting different levels of exploration activities when developing the potential activity levels for each alternative.

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 (e.g., open-water season only, ice-covered season only), 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. These definitions provide an overview of the components of each type of activity, and there may be slight variations in how a particular activity is conducted from what is outlined in Table 2.4.

In a given G&G permit application or EP, a company may describe a "Program" that utilizes multiple seismic vessels or drilling units simultaneously within a season. However, for the sake of analysis in this EIS (which necessitates a good sense of the spatial and temporal extent of the projected activities), one "program" indicates the use of only one source vessel (or two/three source vessels working in tandem, e.g., OBC surveys) or one drilling unit (e.g., drillship, jackup rig, SDC) at a time, e.g., not surveying multiple sites or drilling multiple wells (with multiple rigs) concurrently. To clarify, "program" is used only to simplify the analysis of impacts; it does not change the way the BOEM issues G&G permits for seismic surveys or applications for permits to drill for exploratory drilling, and it does not limit the number of drilling rigs a single company may employ at one time per sea under an approved EP. Moreover, an individual "program" may require the use of multiple support vessels in addition to the source vessel or drilling unit conducting the actual data acquisition or drilling of the wells, respectively. Those support vessels do not count as separate "programs" as defined for evaluation purposes in this EIS.

> The definition of "program" is used only to simplify the analysis. It does not affect the way the BOEM issues permits for exploratory drilling, nor does it limit the number of drilling rigs a single company may employ at one time, per sea, under an approved Exploration Plan.

Survey vessels and drilling units are generally self-contained, with the crew living aboard the vessel. For surveys and drilling operations in the Beaufort Sea, support operations would likely occur out of West Dock or Oliktok Dock near Prudhoe Bay. Chukchi Sea surveys and drilling operations could be supported either from Wainwright or Nome. Helicopters stationed at either Barrow (for operations in either the Beaufort Sea or Chukchi Sea), Deadhorse (for operations in the Beaufort Sea), or Wainwright (for operations in the Chukchi 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 may 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 often span several seasons of data collection separate from the typical site clearance survey and do not involve the use of airguns but do

[4] These lease sales were subsequently cancelled by DOI in October 2015.

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 Source/ Receiver vessel	• 1 support vessel • 1 vessel for monitoring	• Source array typically consists of one or more sub-arrays of 6-8 airgun sources each • Individual airgun size: 5-1,500 in^3 (0.081-24.58 liter) • 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)	1-2 Source/ Receiver vessels (working in tandem)	• 2 vessels for layout/pickup • 1 recording vessel • 2 small support vessels	• Source array on each vessel typically consists of two sub-arrays of 4 airgun sources each • Individual airgun size: 70-150 in^3 • 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 • 1 support vessel (possibly)	Same as 2D/3D seismic survey and icebreaking	60-90	Late September – December	Approximately 75 line miles (120 km) per day
Site Clearance and High-Resolution Shallow Hazard Surveys	1 Source/ Receiver vessel	• 1-2 vessels for monitoring and/or support operations, as needed	• Four, 10 in^3 (0.16 liter) airguns • Multi-beam echosounders • Sub-bottom profilers • 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 • 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
Artificial island drilling	1 artificial island	• Sea lift or ice road operations to construct islands, transport drilling rigs, and support modules • Drilling on island • Aircraft for crew changes	• Drill rig • Icebreaking	Year round	Year round	U.S Beaufort Sea only on shallow waters to waters less than 15m (49 ft) deep
Caisson-Retained Island	1 floating-structure	• Drilling on floating island • Aircraft for crew changes	• Drill Rig • Icebreaking	Year round	Year round	U.S Beaufort Sea only on shallow waters
Steel-drilling caisson drilling	1 bottom-founded structure	• Modified very large crude carrier vessel • Aircraft for crew changes	• Drill rig • Icebreaking	Year round	Year round	U.S Beaufort Sea only on shallow waters
Exploratory Drilling Program (from a drillship)	1 drillship	• 2 icebreakers • 1 anchor handler • 1 oil spill response barge • 1 oil spill response tug • 1 tank vessel for spill storage • 8-12 support vessels • Aircraft for crew changes	• Drillship • Icebreaking • Minimal airgun usage during VSP	40 days per well (dependent on well depth)	July – October	2-3 wells per season
Exploratory Drilling Program (from a jackup rig)	1 jackup rig	• 2 icebreakers • 2 oil spill response vessels (each with two workboats) • 1 oil spill response tug • 1 tank vessel for spill storage • 3 support vessels • Aircraft for crew changes	• Drill rig • Icebreaking • Minimal airgun usage during VSP	40 days per well (dependent on well depth)	July – October	2-3 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 concur on ancillary activities in the Beaufort and Chukchi seas OCS. Without BOEM authorization, these activities would not occur in federal waters but could occur with state authorization in state waters. In the first case, companies could not proceed, no ITA would be issued, and there would be no impacts on marine mammals or subsistence uses of marine mammals. In the second case, companies could legally operate if they received authorization from the state, but would likely be in violation of the MMPA. If companies proceeded to operate in this area without MMPA authorizations, any takes of marine mammals that occur would violate the MMPA.

2.4.5 Alternative 2 – Authorization for Level 1 Exploration Activity

Alternative 2 and Level 1 exploration activity is defined for analytical purposes as the following:

2.4.5.1 Level of Activity

- Up to **four** 2D/3D seismic surveys in the Beaufort Sea and up to **three** 2D/3D seismic 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. In the Beaufort Sea, the exploratory drilling program could occur in either federal or State waters[5].

2.4.5.2 Mitigation

- Including *required* Standard Mitigation Measures (described in Section 2.4.10) that are part of every action alternative.
- Including a full analysis of a wide range of Additional Mitigation Measures (described in Section 2.4.11) 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, but they may also extend onto floating ice in shallow water and in

[5] There are currently no State of Alaska leases in the Chukchi Sea. Therefore, exploratory drilling programs (in addition to seismic surveys) are not contemplated in State of Alaska waters in the Chukchi Sea in this EIS.

some circumstances, on floating ice in deep water. 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. *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 three years are expected to be concentrated in areas of purchased leases. Exploratory activities in other areas of the U.S. Arctic Ocean may also occur, especially related to any sales in the Arctic OCS proposed in BOEM's 2017-2022 Five-Year OCS Leasing Plan. 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 in the northeast part of the Lease Sale 193 area (see Figure 1.3).

Each exploration project in the Arctic requires extensive commitment of resources and personnel. A suite of vessels are required to conduct an exploratory drilling program, and frequently many of these vessels are located far from the drillship/rig. Recent projects permitted in the Chukchi Sea have required the use of 15-20 support and oil spill response vessels in addition to the drillship itself, including ice management vessels, anchor handler vessels, supply ships, science vessels, oil spill response barges and vessels, and possibly shallow water landing craft. Drilling operations would also be attended by a number of spill response vessels, some that would remain with the drillship and some that would simply be available to respond as needed. In addition to vessel support, each drilling project would require fixed wing air support to transport personnel from the shore base to the nearest regional jet service and helicopter support for multiple weekly runs to rotate crews and transport supplies.

2.4.6 Alternative 3 – Authorization for Level 2 Exploration Activity

Alternative 3 and Level 2 exploration activity is defined for analytical purposes as the following:

2.4.6.1 Level of Activity

- Up to **six** 2D/3D seismic surveys in the Beaufort Sea and up to **five** 2D/3D seismic 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. In the Beaufort Sea, exploratory drilling programs could occur in either federal or State waters.

2.4.6.2 Mitigation

- Including *required* Standard Mitigation Measures (described in Section 2.4.10) that are part of every action alternative.
- Including a full analysis of a wide range of Additional Mitigation Measures (described in Section 2.4.11) 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 3 Exploration Activity[6]

Alternative 4 and Level 3 exploration activity is defined for analytical purposes as the following:

2.4.7.1 Level of Activity

- Up to **six** 2D/3D seismic surveys in the Beaufort Sea and up to **five** 2D/3D seismic 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 **four** exploratory drilling programs in the Beaufort Sea and up to **four** exploratory drilling programs in the Chukchi Sea per year. In the Beaufort Sea, exploratory drilling programs could occur in either federal or State waters.

2.4.7.2 Mitigation

- Including *required* Standard Mitigation Measures (described in Section 2.4.10) that are part of every action alternative.
- Including a full analysis of a wide range of Additional Mitigation Measures (described in Section 2.4.11) 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 4 would be the same as those listed for Alternative 2.

2.4.8 Alternative 5[7] – Authorization for Level 3 Exploration Activity <u>With Additional Required Time/Area Closures</u>

Alternative 5 is defined for analytical purposes as the following:

2.4.8.1 Level of Activity

- Up to **six** 2D/3D seismic surveys in the Beaufort Sea and up to **five** 2D/3D seismic 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.

[6] This alternative was not included in the 2011 DEIS but was added to the 2013 SDEIS.
[7] This alternative was identified as Alternative 4 in the 2011 DEIS and as Alternative 5 in the 2013 SDEIS. Some modifications to the required time/area closures have been made to this alternative since publication of the 2011 DEIS and 2013 SDEIS, as noted below.

- Up to **four** exploratory drilling programs in the Beaufort Sea and up to **four** exploratory drilling programs in the Chukchi Sea per year. In the Beaufort Sea, exploratory drilling programs could occur in either federal or State waters.

2.4.8.2 Mitigation

- Including *required* Standard Mitigation Measures (described in Section 2.4.10) 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[8]. 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. These areas are shown on Figures 3.2-25 and 3.2-26, and are described in detail additional mitigation measures described in Appendix E [9]:
    - Kaktovik and Cross Island[10] – An area of importance for fall subsistence bowhead whale hunting

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[8] We removed Hanna Shoal, which was included in the 2011 DEIS and in a more limited fashion in the 2013 SDEIS. Gray whales were a reason for designating this time/area closure in the 2013 SDEIS. While gray whales were consistently seen feeding in that area in September and October in the late 1980s and early 1990s (Clarke and Moore 2002), gray whale sightings in Hanna Shoal have been very infrequent since aerial surveys recommenced in 2008, and the area probably should not be considered a current gray whale feeding area (Clarke et al. 2012). The two remaining species for why this area was proposed were walrus and bearded seals. Walrus are under the jurisdiction of the USFWS. Therefore, NMFS does not have the authority to include mitigation measures for walrus in any ITAs issued by NMFS. Based on public comments, NMFS reviewed data regarding bearded seals. Tagging data from 2009-2012 indicated that the majority of tagged bearded seals moved close to and along the coast and rarely ventured into the Hanna Shoal area. Therefore, NMFS has removed Hanna Shoal as a required time/area closure from this alternative. However, we retained it in the additional mitigation measure section and will reexamine the designation as more data become available regarding marine mammal use of the area by species for which NMFS has jurisdiction.

[9] In the 2011 DEIS, Camden Bay was included as one of the potential time/area closure locations that would be required under this alternative because of its importance as a feeding area for bowhead whales and important location for subsistence hunters to actively hunt the species. After further review of the most recent data and literature, other areas of the Beaufort Sea, such as the Barrow Canyon and Western Beaufort Sea area (from Point Barrow to Smith Bay) appear to be more important feeding areas for bowhead whales than does the Camden Bay area (Clarke et al. 2011b, 2011c, 2011d). Additionally, hunters from Kaktovik do not venture into Camden Bay to hunt whales but rather stay in close proximity to the community. For these reasons, Camden Bay is no longer considered as a time/area location in this EIS. NMFS' use of the term Camden Bay differs from that of community members on the North Slope. We use the term to define a small area close to shore about 30 miles west of Kaktovik and as labeled on the figures in this EIS. We understand that Native Alaskan hunters use the term to describe a wider area between Cross Island and Kaktovik. However, the locations as now defined here as Kaktovik and Cross Island accurately reflect the areas of importance to subsistence whaling. Additional information on the importance of the various locations for certain biological and life history functions and for subsistence hunts is contained in Chapter 3.

[10] This time/area closure has been added since publication of the 2011 DEIS. The area just east of Kaktovik has been identified as a feeding area for bowhead whales in the fall. Additionally, the waters just off Kaktovik and Cross Island are important fall bowhead whale subsistence hunting areas by the communities of Kaktovik and Nuiqsut. These areas are also sometimes referred to as Camden Bay by Native Alaskan hunters. As explained by hunters from

    - Bowhead whale subsistence hunting: late August – mid-September
    - Except for emergencies or human/navigation safety, oil and gas exploration operations shall not occur off Kaktovik or Cross Island or the designated buffer zones from August 25 to the close of the fall bowhead whale hunt in Kaktovik and on Cross Island.

- Barrow Canyon, the Western Beaufort Sea, and the Shelf Break of the Beaufort Sea – An area of high biological productivity; a feeding area for bowhead and beluga whales; fall subsistence bowhead whale hunting area.
    - Bowhead whales: September – October
    - Beluga whales: mid-July – late September
    - 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 25 to the close of the fall bowhead whale hunt in Barrow.
- Kasegaluk Lagoon – An important habitat for beluga whales (feeding, molting, calving) and spotted seals; subsistence beluga whale hunting area.
    - Beluga whales: June – mid-July
    - Subsistence (Kasegaluk Lagoon beluga whale hunting): mid-June – mid-July
    - Spotted seals: August – October
    - Except for emergencies or human/navigation safety, oil and gas exploration operations shall not occur within Kasegaluk Lagoon or the designated buffer zones from June 1 – July 15.
- Ledyard Bay – An important habitat for spectacled eiders and the northern edge of important habitat for gray whales.
    - Except for emergencies, human/navigation safety, or deployment of scientific devices, 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.
- Point Franklin to Barrow[11] – The area between Wainwright and Barrow (including Peard Bay). The time period of the closure is to include the bowhead fall hunt off Wainwright. Time area closure from June to September to protect gray whale calf/cow use. Peard Bay has also been noted as an important area of spring and fall migration and staging corridor for waterfowl.

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the communities of Nuiqsut and Kaktovik at a meeting with NMFS in September 2013, hunts from Cross Island most commonly occur to the north and northeast of the island, typically no more than 30 miles out, with some hunting activities occurring 20-30 miles to the east of Cross Island. Hunters from Kaktovik tend to conduct hunting activities 15-20 miles to the north and east first, only heading west as a last resort no more than 15-20 miles.

[11] Time area closure for Point Franklin to Barrow was added to Alternative 5 based on review of comments received on the 2013 SDEIS.

  - Except for emergencies, human/navigation safety, or deployment of scientific devices, oil and gas exploration operations shall not occur within the Point Franklin to Barrow area (including Peard Bay) between June 1 and September 15.
  - To the maximum extent practicable, aircraft supporting oil and gas exploration operations shall avoid operating below 1,500 ft (457 m) over this area between June 1 and September 15.
- Including a full analysis of a wide range of Additional Mitigation Measures (described in Section 2.4.11) 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, 4, and 6 would not be optional but rather required under Alternative 5.

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

2.4.9 Alternative 6[12] – Authorization for Level 3 Exploration Activity With Use of Alternative Technologies

Alternative 6 is defined for analytical purposes as the following:

2.4.9.1 Level of Activity

- Up to **six** surveys (utilizing either airguns or an alternative technology, as described in Section 2.3.5 above) 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.
- For exploratory drilling programs, any level up to the maximum contemplated in this EIS (i.e., four in the Beaufort Sea and four in the Chukchi Sea), as the alternative technology only relates to seismic surveys. In the Beaufort Sea, exploratory drilling programs could occur in either federal or state waters.

2.4.9.2 Mitigation

- Including *required* Standard Mitigation Measures (described in Section 2.4.10) that are part of every action alternative.
- Including a full analysis of a wide range of Additional Mitigation Measures (described in Section 2.4.11) 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.

[12] This alternative was identified as Alternative 5 in the 2011 Draft EIS and as Alternative 6 in the 2013 SDEIS.

Assumptions for the analysis of Alternative 6 would be the same as those listed for Alternative 2.

2.4.10 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 for the relevant activity type. Full descriptions of these measures are contained in Appendix E. Sections 4.5.2.4.16 and 4.5.3.2.3 contain the complete analyses of these standard mitigation measures, including listing the activities associated with these measures and the science behind the measures.

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

- Establishment and execution of 180 dB shutdown/power down radius for cetaceans and 190 dB shutdown/power down radius for ice seals.
- Specified ramp-up procedures for airgun arrays.
- Protected Species Observers (formerly referred to as Marine Mammal Observers [MMOs]) required on all seismic source vessels and icebreakers[13], as well as on dedicated monitoring vessels.
- All on-ice activities must be conducted at least 152 m (500 ft) from any observed ringed seal lair. No energy source may be placed over a ringed seal lair. Operators will use trained seal-lair sniffing dogs or a comparable method to locate the seal structures before initiation of activities.

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

- 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

- Specified procedures for changing vessel speed and/or direction to avoid collisions with marine mammals.

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

- 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 August 25.
- Establishment and utilization of Communication Centers in subsistence communities when oil and gas exploration activities and marine mammal subsistence hunts will occur at the same time to address potential interference with marine mammal hunts on a real-time basis throughout the season.
- For exploratory drilling operations in the Beaufort Sea east of Cross Island, no drilling equipment or related vessels used for at-sea oil and gas operations shall be onsite at any offshore drilling location east of Cross Island from August 25 until the close of the bowhead whale hunt in Nuiqsut (Cross Island) and Kaktovik. However, such equipment may remain within the Beaufort

[13] This measure would also be required for VSP surveys, which may occur from some other type of platform.

Sea in the vicinity of 71 deg. 25 min. N and 146 deg. 4 min. W or at the edge of the Arctic ice pack, whichever is closer to shore[14].

- No transit of oil and gas exploration vessels into the Chukchi Sea prior to July 1.
- Shutdown of exploration activities in the Beaufort Sea and within 100 miles of the coastline in the Chukchi Sea from Pitt Point on the east side of Smith Bay (~152 deg. 15 min. W) to a location about half way between Barrow and Peard Bay (~157 deg. 20 min. W) from September 15 to the close of the fall bowhead whale hunt in Barrow.

2.4.11 Additional Mitigation Measures

The mitigation measures (and mitigation monitoring needed to support them) listed below are evaluated in Chapter 4. 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 OCSLA. 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 OCSLA. Full descriptions of these measures are contained in Appendix E. Sections 4.5.2.4.17 and 4.5.3.2.5 contain the complete analyses of these additional mitigation measures, including listing the activities associated with these measures and the science behind the measures.

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

- Prior to conducting the authorized seismic survey or drilling program, the operator shall conduct sound source verification (SSV) tests for their airgun array configurations, drilling units, other acoustic sources, icebreakers engaged in icebreaking, and support vessels in the area in which the survey or drilling program is proposed to occur and report the broadband received levels of 190 dB, 180 dB, 160 dB, and 120 dB radii from the sound sources to the authorizing entity within 10 days of completion of the SSV tests.
- All PSOs shall be provided with and use appropriate ocular equipment in order to detect marine mammals within exclusion zones. This may include the use of night-vision devices (e.g., Forward Looking Infrared [FLIR] imaging devices, 360° thermal imaging devices), Big Eyes, and reticulated and/or laser range finding binoculars.
- Operators shall limit seismic airgun operations in situations of low visibility when the entire exclusion radius cannot be observed (e.g., nighttime or bad weather) and ocular equipment, such as FLIR or 360^{o} thermal imaging devices, are not being used to increase the probability of marine mammal detection. These limitations could mean the cessation of airgun operations entirely, a reduction of the time that operations are conducted in this limited visibility situation, or a reduction of the number of airguns operating so that the exclusion radius is minimized and entirely visible.
- Seismic operators shall use passive acoustic monitoring systems, in addition to visual monitoring, to detect marine mammals approaching or within the exclusion zone and trigger the shutdown of airguns.
- Enhancement of monitoring protocols and mitigation shutdown zones to minimize impacts in specific biologic situations (for example, but not limited to, expansion of shutdown zone to 120

[14] This measure does not apply to the removal of equipment from a temporary artificial exploration island.

dB or 160 dB when cow/calf groups and feeding or resting aggregations are detected, respectively).

- PSOs required on all drill ships.
- Operators are required to implement specific procedures for use of the mitigation airgun during seismic activities.

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

- Temporal/spatial limitations to minimize impacts in particular important habitats, including Kaktovik, Cross Island, Barrow Canyon/Western Beaufort Sea, Hanna Shoal, the shelf break of the Beaufort Sea, Point Franklin to Barrow, Kasegaluk Lagoon, and Ledyard Bay.

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

- Specified transit routes of vessels and aircraft involved in oil and gas exploration activities with an associated MMPA ITA to minimize impacts in particular important habitat in areas where marine mammals may occur in high densities.
- 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 prey or habitat.
- Operators are required to recycle drilling muds to the extent practicable based on operational considerations (e.g., whether mud properties have deteriorated to the point where they cannot be used further).

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

- From August 25 until the close of the fall bowhead whale hunts by the communities of Kaktovik and Nuiqsut, 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, except for emergencies or human/navigation safety or for any vessel engaged in transit to or from a coastal community to conduct crew changes or logistical support operations.
- 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 from September 15 until the close of the fall bowhead whale hunt in Barrow.
- All oil and gas industry exploration vessels shall complete operations in time to allow such vessels to complete transit through the Bering Strait to a point south of 59 deg. N no later than November 15.

2.4.12 Mitigation Measures Considered but Not Carried Forward

The mitigation measures listed here were considered in the DEIS and/or SDEIS as additional mitigation measures. Based on public comments and further analysis, NMFS determined that these measures should not be included in any future MMPA ITAs. The full analysis and explanation is contained in sections 4.5.2.4.18 and 4.5.3.2.7.

- Restriction of 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).
- Separate seismic surveys are prohibited from operating within 145 km (90 mi) of one another.
- Vessel and aircraft avoidance (by 0.8 km [0.5 mi]) of concentrations of groups of ice seals.

- 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 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 north 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 fall 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.

2.4.13 Marine Mammal Monitoring Programs and Reporting Requirements

2.4.13.1 Monitoring Requirements

The MMPA and NMFS' implementing regulations require that an applicant conduct monitoring of marine mammals in the designated activity area. According to 50 CFR § 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 § 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 locate 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 E 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.

2.4.13.2 Reporting Requirements

The following reports are planned to be included as requirements under every ITA and accordingly is a component of all of the action alternatives considered in this EIS; 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. Additional reporting measurements may be required through the MMPA or ESA processes and may be revised from year to year through the adaptive management process, however, at a minimum the report will describe in detail: (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.
- As described in Chapter 5, NMFS plans to engage industry applicants, scientists, and stakeholders in the development of a comprehensive monitoring plan designed to better understand the combined impacts of multiple oil and gas exploration activities in the Arctic. This comprehensive plan may result in monitoring requirements intended to contribute to a broader understanding of industry impacts, beyond those of one activity alone, and may necessitate coordination between multiple companies in a given year to produce an integrated report. NMFS will work with companies through the MMPA process, and any additional requirements of this nature would be coordinated in advance and outlined in individual MMPA authorizations.
- When Field Source Verification is required, the distances to the various isopleths are to be reported to NMFS within 10 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.

- NMFS will make the final reports available to the public on the NMFS Office of Protected Resources website.

In recent years, the Alaska offices of NMFS, BOEM/BSEE, and the USFWS have held weekly monitoring and mitigation meetings while seismic surveys and exploratory drilling activities have been underway. Industry operators attended those meetings on a weekly or bi-weekly basis and provided real-time data on marine mammal observations and any interactions and mitigation measures taken. While not required in the MMPA ITAs, these meetings have proved to be extremely helpful in providing an avenue for immediate feedback to operators, and some changes in location or timing of activities to reduce potential impacts to protected species have been implemented as a result of the meetings. As a result of the usefulness of these meetings, they are likely to continue into the future.

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.

The alternatives carried forward for further evaluation must be reasonable and must meet the purpose and need of the proposal (40 CFR 1502.13), as presented in Section 1.3 of the EIS. Many of the suggested alternatives do not qualify as reasonable alternatives in this EIS because:

- they are out of the scope of the EIS;
- they are suggestions for research;
- they are already addressed as mitigation measures in the EIS; or
- they are predicated on value judgments with which NMFS disagrees and are not practicable.

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 Oil and Gas Leasing Program and later when considering lease sales as described at the leasing stage of the OCSLA. 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.

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, 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.

As noted above, NMFS and BOEM may, and do in the alternatives carried forward, consider temporary restrictions, such as time/area closures (see Alternative 5) 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

<u>Activity Cap</u>

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 under this EIS exists for NMFS' and BOEM's issuance of ITAs and permits or activity notices, respectively, in a given year. If the agencies receive additional requests for authorizations and permits for such activities beyond the level analyzed in this EIS or within the alternative selected in an ensuing Record of Decision, NMFS and BOEM would need to conduct additional NEPA analyses before making a final determination on those requests.

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.

In addition to permitted drilling and development activities, 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 oil and gas exploration activities. NMFS does not authorize the exploration activities, but rather authorizes the take of marine mammals incidental to specified activities. As discussed above, NMFS must consider every application and shall issue the ITA if the requisite findings are made.

Similarly, a commenter recommended that this EIS include an alternative wherein BOEM and NMFS use a phased, adaptive approach for increasing oil and gas activities in the Beaufort and Chukchi seas or issue permits and authorizations in alternating years for each sea (e.g., only issue permits and authorizations for the Beaufort Sea in odd numbered years and only issue permits and authorizations for the Chukchi Sea in even numbered years). The information in the paragraphs immediately above supports our decision not to carry these alternatives forward for consideration (i.e., there are no data to support such a decision, and NMFS must consider every application and shall issue the ITA if the requisite findings are made). Additionally, there are little to no data to support an analysis of such alternatives.

Sound Budget

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.

Sound is a critical component of the physical habitat of every ocean and for many animals that reside in it or travel through it. We know a lot about the purposeful use of sound for communication by marine mammals. For example, bowhead low frequency calls are thought to be used in mating behaviors as well as navigation across long distances. Additionally, there is a growing body of evidence from both land-based and marine organisms illustrating the ecological importance of adventitious sounds: those gathered opportunistically from the surrounding habitat rather than from a purposeful sender (Barber et al. 2010;Radford et al. 2014; Slabbekoorn et al. 2010). These sounds serve to help detect predators, detect prey, navigate, and serve other important purposes. These sounds are often outside of the frequencies of those used to communicate with conspecifics and are utilized at lower levels. Human activities are raising noise levels throughout the oceans, although the Beaufort and Chukchi seas remain relatively quiet to date as compared to many areas of the US EEZ with coastlines that have busy ports, more vessel transit lanes, large urban areas, or military bases. Some marine animals have been shown to be capable of changing the signals they are using to communicate in the presence of noise; however, whether these changes can transfer between generations as well as the long term fitness consequences of these adjustments is unknown. Additionally, higher noise levels reduce marine mammal's (and other marine fauna's) ability to hear the other important ecological cues noted above. In light of these facts, NMFS acknowledges the value of the commenter's recommendation and concurs that an analysis of this sort could add value to our understanding of the broader effects of activities if the necessary components of such an analysis were available and implementable. However, although NMFS is supportive of this sort of approach and is exploring the means to conduct such an analysis in the future, for the reasons below we determined this alternative was not ripe, or appropriate, for pursuing in this EIS.

First, the factors discussed in the "Activity Cap" paragraphs above apply to this recommendation as well. Additionally, inasmuch as a "cap" suggests that a specific sound level must be known in order to avoid exceeding it, there are insufficient data to support a cumulative sound cap as the current understanding of the likely impacts from sound and the ability to quantify those impacts are generally limited to observed responses to *a single sound source*. Existing data support the identification of received levels above which particular species might be expected to respond in a particular manner that NMFS would consider a take (either injury or behavioral harassment), and it is possible, within the context of the area and expected ensonification around one sound source, to use those levels to evaluate the scope of likely effects *in advance* and develop measures intended to minimize impacts or avoid injury. There *are* methods available to quantify the "acoustic space" available to an animal in different circumstances (i.e., the spatial, temporal, and spectral range available to an animal to hear sounds within, based on the animals capabilities and the level of background noise), and these models support the general idea(mostly for overlap in space and time between low frequency sound sources and low-frequency hearing specialists) that the higher the noise level in a given area, the higher the likelihood that it will reduce, to some degree, a marine mammal's ability to communicate with conspecifics or collect other important environmental information. This supports the general goal of reducing noise, which is explored both in mitigation measures and in the alternative technology alternative (i.e., Alternative 6) of this EIS. However, there is no specific information regarding at what level or over what period of time an elevated overall background sound will trigger any specific significant impacts to marine mammal health or fitness, which would make the designation of a sound cap an arbitrary and unsupportable action.

Additionally, the soundscape (and thereby, the "acoustic space" available to any marine mammal) will vary based on bathymetry, the sound speed profile of the water, and where any contributing sources are located in relationship to one another in space and time, which means that it would be very difficult to predict and then designate a "sound cap" in advance with any accuracy in the absence of the specific details of all expected activities, including not only those covered by this EIS (which, themselves, are not spatially and temporally explicit over the life of the EIS), but those over which NMFS has no control, jurisdiction, or knowledge. Last, even if justified, this recommendation would be very difficult (if not impossible) to effectively implement since other entities conducting activities that do not require an MMPA authorization (which would also be contributing to the cumulative sound levels) have no responsibility either to indicate their future plans or report their prior sound production, which would be necessary for the sound budget "accounting." NMFS is currently exploring the development of semi-quantitative methods to help better characterize and assess cumulative acoustic impacts. There are several existing efforts that will help inform this work, including the British Petroleum Cumulative Effects work (in collaboration with multiple partners), the European Union Marine Strategy Framework Directive, NOAA's Cetacean and Sound Mapping Effort, and others. NOAA did not have methods they considered ripe for inclusion in this EIS at the times when new alternative development were an option for this EIS.

Methods for quantifying the chronic and cumulative effects of sound have advanced since NMFS initiated the development of the EIS and since the publication of the 2013 SDEIS. Since publication of the 2013 SDEIS, NMFS conducted a first-order assessment of the chronic and cumulative effects of noise produced by oil and gas exploration activities in the Beaufort and Chukchi seas. Modeling was conducted for a 3.5-month period (July through mid-October) for 10 locations (receiver sites) of biological importance and for six scenarios corresponding to alternatives in this FEIS, including: all three levels of exploration activity (Alternatives 2, 3, and 4) and both with and without proposed time/area closures at each of these activity levels. "Lost listening area" was calculated among scenarios and relative to a baseline ambient noise estimate and considered the hearing sensitivity of low and mid-frequency cetaceans. "Lost communication space" was calculated among scenarios and relative to ambient estimates for a 1/3 octave band representing dominant frequencies of bowhead whale vocalizations. Results are reported as remaining listening area or communication space for a maximum of two depths (5 and 30 m) at each of the 10 locations. As stated previously, though it is clear that higher background noise can limit the ability of marine fauna to detect acoustic cues necessary for critical life functions, data are not available to support absolute thresholds. The analysis conducted in this FEIS allows for relative comparisons of likely chronic and cumulative effects across different alternatives and in different areas, which is informative to this broader programmatic analysis. Of note, NMFS would solicit public input on this novel methodology (such as through the MMPA process) prior to direct application in an MMPA authorization.

In Chapter 4, NMFS considers the combined sound impacts from multiple oil and gas exploration activities and the effects of mitigation measures on these activities. Similarly, in the cumulative impact analysis, NMFS considers the potential sound (and other types of) impacts from other known activities occurring in the EIS project area. This information is analyzed on a qualitative basis and potentially in the development of mitigation or monitoring measures contained in this EIS. Additionally, NMFS and BOEM will consider any applicable available preliminary or final products from the cumulative effects efforts identified above in the EIS, as well as the newer chronic and cumulative assessment noted above, 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 OCSLA 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, for example, in different orientations, using different cable lengths or multi-component sensors. 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 Norway, in cases, implements zero harmful discharge standards. An additional basis for this particular recommendation was a specific voluntary "zero discharge" proposal by one oil and gas operator (i.e., Shell Oil during the 2012 drilling season) to manage five specific waste streams within its lease blocks near Camden Bay in the Beaufort Sea by:

1) collecting sanitary waste, bilge water, ballast water, and domestic waste (i.e., gray water) on the drillship, and subsequently transporting those waste materials for disposal out of the activity area; and

2) collecting and disposing of drilling fluids and drill cuttings after the well casing is set in the top hole and the riser is installed at an offsite location[15].

However, oil and gas exploration activities generate a wide range of waste streams in addition to those associated with the 2012 "zero discharge" proposal put forth by Shell Oil.

The Beaufort and Chukchi NPDES general permits issued by the EPA regulate discharges of drilling fluids and drill 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; and muds, cuttings, and cement at seafloor. The general permits include effluent limitations and monitoring requirements specific to each of the discharges, with additional restrictions for the discharge of drilling fluids and drill cuttings, including no discharge starting on August 25 until fall bowhead whale hunting activities have been completed by the communities of Nuiqsut and Kaktovik in the Beaufort Sea.

[15] During 2012 drilling activities only the tophole was drilled therefore this part of collection did not occur.

The Beaufort and Chukchi general permits also require environmental monitoring programs conducted at each drill site location before, during, and after drilling activities. The general permits also include numerous seasonal and area restrictions.

Under the MMPA, NMFS has the authority to require the implementation of mitigation measures to effect the least practicable adverse impact to marine mammals and their habitat and to ensure that there is no unmitigable adverse impact to the subsistence uses of these species. In this EIS, 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. 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 looks at how the limitation will reduce potential adverse impacts to marine mammals and their habitat or to subsistence uses of marine mammals, the effectiveness of the measure, and the practicability for applicant implementation. This analysis/approach will more effectively support NMFS' purpose and need.

2.5.5 Adaptive Management

Commenters on the DEIS and SDEIS suggested alternatives using adaptive management approaches, such as incorporating the community-based adaptive management approach of the CAA, and a phased, adaptive approach for increasing oil and gas activities. These approaches were considered but eliminated from further analysis because these approaches are already being used. NMFS and BOEM have historically incorporated, and will continue to incorporate in the future, adaptive management principles in the issuance of permits and authorizations and any needed adjustments of mitigation and monitoring. NMFS will continuously consider adaptive management as the agency executes the ITA program and may seek to revise regulations in the future if they no longer are found to reflect the needs of management towards ensuring that takes are no more than negligible and subsistence needs are being properly addressed. This approach is described further Section 5.5 of this EIS.

2.5.6 Activity Level Following Discovery

An alternative was suggested that would describe activity levels likely to follow a discovery including future lease sales and takes into account published Federal Hydrocarbon Resource Assessments, federal and state lease offerings (recent and planned), and industry response foreseeable following a string of exploration success in the planning region over the next 10 years. This alternative was considered but eliminated from further analysis because development and production are beyond the scope of this analysis.

Analysis of potential development and production is not part of the proposed action for the current analysis, which is specifically focused on exploration activities. OCS development and production is addressed in the cumulative analyses as appropriate. Should development and production be proposed in Beaufort Sea or Chukchi Sea OCS, BOEM and NMFS would prepare proposal-specific NEPA documentation.

2.6 Comparison of Impacts

Table 2.6 presents a summary of impacts to all resources from Alternative 1 through Alternative 6. 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 2.5 Summary of Alternatives

Element	Alternative 1 – No Action	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Level of Activity	No ITAs issued; No G&G permits or ancillary activity notices issued	Up to four 2D/3D seismic surveys in the Beaufort Sea (Beaufort) and up to three 2D/3D seismic 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 surveys in the Beaufort and up to five 2D/3D seismic 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	Up to six 2D/3D seismic surveys in the Beaufort and up to five 2D/3D seismic 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	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	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.	Up to four exploratory drilling programs in the Beaufort and up to four exploratory drilling programs in the Chukchi per year.	Same as Alternative 4	Any level up to the maximum contemplated in this EIS, as the technology only relates to seismic surveys
Required Standard 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	Same as Alternative 2
Additional Mitigation Measures	None needed	Full range of those measures described in Section 2.4.11 for consideration as needed.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2
					Additional required time/area closures for: • Kaktovik and Cross Island • Barrow Canyon/ Western Beaufort Sea • Shelf Break of the Beaufort Sea • Kasegaluk Lagoon • Ledyard Bay • Point Franklin to Barrow (Peard Bay)	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.

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 3 Exploration Activity	Alternative 5- Authorization for Level 3 Exploration Activity with Additional Required Time/Area Closures	Alternative 6- Authorization for Level 3 Exploration Activity with Use of Alternative Technologies
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 types of impacts as Alternative 2, intensity and extent of the impact would be doubled for exploratory drilling activities, level of impact still minor.	Same as Alternative 4	Same as Alternative 4
Climate	No effect	Impacts cannot be measured on a project-level basis.	Impacts cannot be measured on a project-level basis.	Impacts cannot be measured on a project-level basis.	Same as Alternative 4	Same as Alternative 4
Air Quality	No effect	Negligible to minor impacts due to emissions from survey vessels and from emissions of CO_2e from drilling programs.	Minor impacts due to emissions from survey vessels and from emissions of CO_2e from drilling programs.	Moderate impacts due to emissions from survey vessels and from emissions of CO_2e from drilling programs.	Same as Alternative 4	Same as Alternative 4
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.	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 4	Same as Alternative 4
Water Quality	No effect	Impacts reduced to negligible by mitigation measures.	Impacts reduced to negligible by mitigation measures.	Impacts reduced to negligible by mitigation measures.	Same as Alternative 4	Same as Alternative 4
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.	Minor impacts due to the greater level of activity increasing the potential volume of contaminants introduced to the project area.	Same as Alternative 4	Same as Alternative 4
BIOLOGICAL ENVIRONMENT						
Lower Trophic Levels	No effect	Negligible 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.	Negligible impacts, the increased levels of activity would not generate different types or level of impacts. Introduction of invasive species from ship traffic could cause moderate impacts.	Negligible impacts, the increased levels of activity would not generate different types or level of impacts. 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.
Fish/Essential Fish Habitat	No effect	Minor impacts, small scale and temporary only.	Minor impacts, increased activities would not change the impact level.	Minor impacts, increased activities would not change the impact level.	Minor 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.
Marine and Coastal Birds	No effect	Negligible to minor impacts, depending on species ESA status, from temporary and localized disturbance, injury/mortality, and changes in habitat.	Negligible to minor impacts, depending on the species ESA status, increased activities would not change the impact level.	Moderate impacts from the increased level of activity.	Same as Alternative 4	Same as Alternative 4

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 3 Exploration Activity	Alternative 5- Authorization for Level 3 Exploration Activity with Additional Required Time/Area Closures	Alternative 6- Authorization for Level 3 Exploration Activity with Use of Alternative Technologies
Marine Mammals: Bowhead Whales	No effect	Moderate impacts from noise disturbance or habitat degradation.	Moderate impacts from noise disturbance or habitat degradation.	Moderate to major impacts from noise disturbance or habitat degradation.	Moderate impacts, as the Time/Area closures could reduce adverse impacts in particular times and locations.	Moderate to major impacts. Despite possible localized mitigating capabilities of alternative technologies the impact level would not change.
Marine Mammals: Beluga Whales	No effect	Moderate impacts from noise disturbance or habitat degradation.	Moderate impacts from noise disturbance or habitat degradation.	Moderate impacts from noise disturbance or habitat degradation.	Minor to moderate impacts. The effects on beluga whales would be similar to Alternative 4 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.
Marine Mammals: Other Cetaceans	No effect	Minor impacts from temporary, local disturbance.	Minor to moderate impacts from temporary, local disturbance. Increased activities would not change the impact level.	Minor to moderate impacts from temporary, local disturbance. Increased activities would not change the impact level.	Minor to moderate 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 to moderate 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.
Marine Mammals: Ice Seals	No effect	Minor impacts from temporary localized disturbance.	Minor to moderate impacts from temporary localized disturbance. Increased activities would not change the impact level.	Minor to moderate impacts from temporary localized disturbance. Increased activities would not change the impact level.	Minor impacts, as the time/area closures could reduce potentially adverse effects on seals in those areas.	Minor to moderate 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.
Marine Mammals: Pacific Walrus	No effect	Minor impacts from disturbance, risk of injury or mortality, and changes in habitat in the Chukchi Sea.	Moderate impacts from disturbance, risk of injury or mortality, and changes in habitat in the Chukchi Sea.	Moderate impacts from disturbance, risk of injury or mortality, and changes in habitat in the Chukchi Sea.	Moderate impacts, although time/area closures would reduce potentially adverse effects on walrus in those areas.	Moderate 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.
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 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.
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. 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.
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. 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.
Subsistence	No effect	Negligible to minor impacts from disturbance, depending on the species.	Negligible to moderate impacts from disturbance, depending on the species. 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, depending on the species. 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 minor impacts from disturbance, depending on the species. Impacts would be slightly reduced because of the required time/area closures that would be applied in all circumstances instead of being considered as additional mitigation measures.	Negligible to moderate impacts from disturbance, depending on the species. 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.

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 3 Exploration Activity	Alternative 5- Authorization for Level 3 Exploration Activity with Additional Required Time/Area Closures	Alternative 6- Authorization for Level 3 Exploration Activity with Use of Alternative Technologies
Public Health	No effect	Negligible impacts, both beneficial and adverse, from changes to: • Diet and nutrition • Contamination • Safety • Acculturative stress • Economic impacts • Health care services	Negligible impacts, both beneficial and adverse, from changes to: • Diet and nutrition • Contamination • Safety • Acculturative stress • Economic impacts • Health care services Despite the increased activity, there would be no increase in the impact level.	Negligible impacts, both beneficial and adverse, from changes to: • Diet and nutrition • Contamination • Safety • Acculturative stress • Economic impacts • Health care services Despite the increased activity, there would be no increase in the impact level.	Negligible impacts, both beneficial and adverse. If the time/area closures improve the likelihood of maintaining a strong subsistence harvest, there will also be resulting benefits 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, both beneficial and adverse. 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, and thus the benefits are theoretical. Therefore, the impact rating remains the same. If the alternative technologies are demonstrated to be effective, they would benefit public health.
Cultural Resources	No effect	Negligible impact.	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.
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. 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. Minor impacts to land and water management - as activities increase, the possibility for conflicts with borough offshore development policies goes up as well. Negligible impacts to land and water ownership as no changes in 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. Minor impacts to land and water management - as activities increase, the possibility for conflicts with borough offshore development policies goes up as well. Negligible impacts to land and water ownership as no changes in ownership would occur.	Moderate impacts to land and water use. 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. 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. 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. Minor impacts to land and water management. Negligible impacts to land and water ownership as no changes in ownership would occur.
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.	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.
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. 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.
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.	Moderate impacts from high contrast of drill sites and associated activities.	Moderate impacts from high contrast of drill sites and associated activities.	Moderate impacts from high contrast of drill sites and associated activities.

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 3 Exploration Activity	Alternative 5- Authorization for Level 3 Exploration Activity with Additional Required Time/Area Closures	Alternative 6- Authorization for Level 3 Exploration Activity with Use of Alternative Technologies
Environmental Justice	No effect	Minor adverse impacts from disruption of subsistence activities and potential contamination of subsistence food. Minor beneficial impacts from local employment opportunities.	Minor adverse impacts from disruption of subsistence activities and contamination of subsistence food. Minor beneficial impacts from local employment opportunities.	Minor adverse impacts from disruption of subsistence activities and contamination of subsistence food. 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.

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 baseline conditions 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. Where pertinent, 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 (Figure 3.1-5). The Beaufort and Chukchi seas are both part 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 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 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) (Greenberg et al. 1981; Weingartner 2008). 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 (Figure 3.1-3).

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). The branch progressing northward from the Central Channel bifurcates as it reaches Hanna Shoal, flowing around both sides of the shoal and dividing into smaller filaments that continue towards Barrow Canyon (Pickart et al. 2016). Mass is conserved in the circulation scheme, with approximately 1 Sverdrup flowing poleward across the Chukchi shelf within these pathways, then exiting Barrow Canyon (Pickart et al. 2016). 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 (Figure 3.1-3) (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 (Figure 3.1-3) (Nikolopoulos et al. 2009; 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 (Pickart et al. 2011; 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 eastward 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 (Nghiem et al. 2014; 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 (Dickins 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 centimeters per second (cm/s) (0.4 kn), but during the landfast ice period (mid-October through June) the mid-water currents are generally less than 10 cm/s (0.2 kn). Tidal currents in the Beaufort Sea shelf area are relatively weak, at less than 3 cm/s (0.06 kn) (Weingartner et al. 2009). Rates of cross-shore flows are also usually small, at less than 3 cm/s (0.06 kn), 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). Seasonal changes in the properties of Chukchi Sea water are established by the annual cycles of sea–ice formation and loss, heating and wind mixing, and transport of waters from Bering Strait (Weingartner et al. 2013). During the open water season, submesoscale density fronts in the Chukchi Sea surface layer play a key role in surface layer restratification, acting in opposition to disorganizing forces, such as wind, that vertically mix the water column (Timmermans and Winsor 2013).

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 Beaufort and Chukchi 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 (Figure 3.1-3) (Pickart and Stossmeister 2008). Recent data suggests an additional slower current flows northward through the Central Channel between Herald and Hanna Shoals (Gong and Pickart 2015).

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

Wind strongly influences current flow and flow variability (Danielson et al. 2014). 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; Weingartner et al. 2011; Woodgate et al. 2005).

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). Summer and fall hydrographic sections in the northeastern Chukchi Sea frequently include 5–20 m thick intrapycnocline lenses or horizontal plumes of warm, moderately salty summer Bering Sea Water flowing northward from Bering Strait. These features occur within the shallow (~20 m depth) pycnocline separating cold, dilute, surface meltwater from near-freezing, salty, winter-formed waters beneath the pycnocline. An idealized numerical model suggests that the features arise from eddies and meanders generated by instability of the surface front separating meltwater from Bering Sea Water (Lu et al. 2015). 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 monthly 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 from local residents 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 & 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 & 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 & 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 kn) (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 (McClelland et al. 2012; 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 (Minerals Management Service [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 (McClelland et al. 2012; Weingartner 2008; Weingartner et al. 2009).

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. Water from the Red Dog Mine, a large zinc hardrock mine, is treated and discharged into tributaries of the Wulik River, which flows into the Chukchi Sea. The mine contact water is treated to remove dissolved metals and other potential pollutants before the water is released to the environment. Many of the potential pollutants removed from the water occur naturally as products of weathering reactions in the local rocks and soils, such that occurs naturally. The treatment of the discharged water has improved the water quality downstream of the mine from pre-mining conditions, so that now the Red Dog Creek supports a population of spawning and rearing Arctic Grayling and Dolly Varden.

3.1.1.6 Sea Ice

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. Sea ice extents are shown in Figures 3.1-4a and 3.1-4b.

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 historically covered 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). Recent modeling suggests that open-water duration in the Alaskan Arctic could expand quickly over the next decades, which will impact regional economic access and potentially alter ecosystems. Yet the northern Alaskan Arctic from January through May will remain sea ice covered into the second half of the century due to normal lack of sunlight (Wang and Overland 2015).

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. 2004a).

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) (Figure 3.1-5). 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. 2004a). 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 (Mahoney et al. 2007a; Weingartner 2008). 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). Idealized numerical simulations of an immobile landfast ice cover that is frictionally coupled to an underice buoyant plume established by river discharge suggest that the frictional coupling between the ice and plume results in an Ekman-like underice boundary layer, a subsurface velocity maximum, and frictional shears that enhance vertical mixing and entrainment (Kasper and Weingartner 2015).

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. 2004a; Eicken et al. 2006).

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).

Because a large fraction of the ices that comprise stamukhi originate from landfast ice, they are predominately formed from freshwater, and so have high mechanical strength. This makes them difficult to break and can impede travel through estuaries and up rivers. Similarly, ice formed in estuaries has a lower salinity than open-ocean sea-ice and has less seasonal variation than sea-ice. As a result of its relatively low salinity, estuarine ice generally has high mechanical strength and lower porosity relative to sea-ice. The Arctic Ocean receives 11 percent of global river discharge but is only 1 percent of the global ocean volume (McClelland et al. 2012). Consequently, riverine inputs and gradients along estuaries are a defining feature of near-shore ice in the Beaufort and Chukchi seas.

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. Gouging is associated with ice keels driven by forces from the associated ice pack. An outer continental shelf (OCS) study commissioned by MMS (2006d) noted that ice gouges occur almost everywhere in the Arctic, from shore to water depths of at least 40 m (131 ft) (Palmer and Niedoroda 2005 as cited in MMS 2006d). Most ice gouges are less than 0.5 m (2 ft) deep, but the deepest gouges exceed 2 m (7 ft) in depth (National Research Council [NRC] 2011). It should be noted, however, that maximum ice gouge depths are not indicative of maximum ice keel penetration depths due to the preferential infill of ice gouges during sediment redistribution events (Barnes and Reimnitz 1979). One 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). Earlier work by Weeks et al. (1983) found no relationship between ice gouge density and water depth in deeper water but reported the presence of relatively fewer gouges along shallower segments in the lagoons situated between Smith Bay in the west to near Camden Bay in the east (Weeks et al. 1983 in MMS 2006d). In contrast, data from 5,329 gouges in the Canadian Beaufort Sea from 1974 to 1990 showed a decreasing density of gouges in deeper water (from about 1.5 gouges/km in about 8 m to about 0.22 gouges/km in 30 m of water) (Chayes et al. 2006 in MMS 2006d). There are a variety of potential explanations for the differences in reported ice gouge density distributions across water depth, but the resolution of such discrepancies is outside the scope of this report. Ice gouges are considered important by pipeline engineers involved in the design and burial of Arctic offshore pipelines (Machemehl and Jo 1989). Because a great amount of force (on the order of 100 meganewtons) is required to cut a deep ice gouge, it is impractical to design a pipeline to withstand such force (Palmer and Niedoroda 2005 as cited in MMS 2006d).

Leads and Polynyas

Polynyas are semi-permanent areas of open water that can be up to thousands of square kilometers in size (Arctic Climate Impact Assessment [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).

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. 2012). The September 2012 minimum ice extent was the second lowest since 1979 (see Figure 2.1 in Perovich et al. 2012). The summers of 2007 to 2012 experienced the six lowest minimums in the satellite record; nine of the ten lowest minimums occurred during the last decade (National Snow and Ice Data Center [NSIDC] 2011b; Perovich et al. 2012). The March 2010 ice extent was four percent lower than the 1979 to 2000 average. A time series (1979 to 2011) of anomalies in March and September monthly sea ice extent 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 13 percent per decade (Perovich et al. 2012; 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 2012 followed by higher values in 2011, 2015, and 2008 respectively (NSIDC 2015). The coverage of multiyear ice in March 2014 increased to 31 percent of the ice cover from the 2013 value of 22 percent. There was a fractional increase in second-year ice, from 8 percent to 14 percent. This increase offset the reduction of first-year ice, which decreased from 78 percent of the pack in 2013 to 69 percent in 2014, indicating that a significant portion of first-year ice remained after the 2013 summer melt. The oldest ice (4 years or more) fraction has also increased, comprising 10.1 percent of the March 2014 ice cover, up from 7.2 percent in 2013. However, there was still much less of the oldest ice in 2014 compared to earlier years such as 1988 (Perovich et al. 2014).

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. 2012). 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. 2004a).

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).

3.1.1.7 Exploration and Production

<u>Petroleum Plays</u>

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 target strata within the Brookian sequence of rocks. Of the remaining five plays, one targets Beaufortian Rift sequence rocks, and another targets Upper Ellesmerian sequence rocks. The remaining three plays target 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 have been mapped using 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 target strata within Brookian sequence rocks, three target strata within Beaufortian Rift sequence rocks, and one targets the Herald Arch thrust structure. Of the remaining 11 plays, one targets strata within Franklinian sequence rocks, two are targeting Endicott Formation rocks, two target Sadlerochit Group rocks, and one targets Lisburne Formation rocks. The five remaining plays target Tertiary age strata within an area where the Chukchi Shelf and Hope Basin converge (MMS 2006a).

The 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).

In 2011, an assessment of undiscovered technically recoverable oil and gas resources of the OCS estimated that the Chukchi Sea contained 4.15 billion barrels of oil and oil-equivalent gas resources, and the Beaufort Sea contained 0.53 billion barrels of oil and oil-equivalent gas resources (BOEM 2011).

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 State of Alaska maintains jurisdiction over waters extending three nautical miles seaward of the baseline from which the breadth of the territorial sea is measured.

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 used for local consumption. Since the 1990s, petroleum accumulations discovered in stratigraphic traps have been developed including the Alpine pool in the Colville River unit that taps sandstones of the Beaufortian sequence. Wells in 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 is in channel sandstones in the Brookian sequence (Houseknecht and Bird 2006). In 2003 and 2004, two new field units with wells testing positive for oil were formed, Oooguruk and Nikaitchuq. In 2008 and 2009, the Greater Mooses Tooth Unit and Bear Tooth Unit were approved in NPR-A.

Since 2006, more than $2.5 billion dollars has been spent by the petroleum industry on 728 Arctic Alaska OCS leases and Alaska OCS contains 31 percent of the United States potential OCS resources, second only to the Gulf of Mexico (BOEM 2011). In 2012, the USGS assessed the potential oil and gas resources in three Arctic Alaska source rocks including the Brookian and Kingak shales and the Shublik Formation. The assessment indicated that the Shublik Formation plays had the highest probability oil and gas resources (Houseknecht 2012).

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 drill sites in the Beaufort Shelf region are presented in Figure 3.1-6 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 six exploratory wells have been drilled to depth on the Chukchi Shelf since the first OCS leases were offered in 1988. The locations of the exploration drill sites in the Chukchi Shelf region are presented in Figure 3.1-6. The wells were drilled between 1989 and 2015, resulting in the discovery of hydrocarbons in four of the wells (Burger 1, Klondike, Crackerjack, and Popcorn). Burger was later determined to be a dry hole.

The Klondike well was drilled to investigate Sadlerochit-equivalent rocks beneath a Jurassic age erosional surface on the east flank of the Chukchi platform. 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 was 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. No reservoir rock was encountered in this well; 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

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.*

3.1.1.8 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 studies that have been conducted within the Beaufort Sea region. 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 two or more years. Onshore in 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. Faults are a major pathway for saline seawater to penetrate the sub-seafloor. Extensive lateral migration in the Tertiary strata is very likely. 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 before present [B.P.]) 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 (Brothers et al. 2012; Frederick and Buffett 2015).

In Pleistocene times (2 my B.P. to 10,000 years B.P.) 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) in the Chukchi Sea, ice gouging 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 et al. (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.

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. 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 active seafloor gas vents have been identified on the Shelf and upper Slope in the Canadian Beaufort Sea (MMS 2003; Paull et al. 2012). Shallow gas was also encountered at about 1,700 feet in the Hammerhead structure drilled in the 1980s (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 (Craig and Sherwood 2004) that could act as conduits for gas migration.

3.1.2 Climate and Meteorology

3.1.2.1 Introduction

This section describes existing climate and meteorology in the area analyzed in this EIS. 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 evaluated in Chapter 4 of this EIS.

3.1.2.2 Regulatory Overview

Council on Environmental Quality Draft NEPA Guidance

On December 18, 2014, the CEQ released revised draft guidance that describes how federal agencies should consider the effects of greenhouse gas emissions and climate change in their NEPA reviews (CEQ 2014). The revised draft guidance supersedes the draft greenhouse gas and climate change guidance released by CEQ in February 2010. The revised draft guidance explains that agencies should consider both the potential effects of a proposed action on climate change, as indicated by its estimated greenhouse gas emissions, and the implications of climate change for the environmental effects of a proposed action. The guidance also emphasizes that agency analyses should be commensurate with projected greenhouse gas emissions and climate impacts, and should employ appropriate quantitative or qualitative analytical methods to ensure useful information is available to inform the public and the decision-making process in distinguishing between alternatives and mitigations. It recommends that agencies consider 25,000 metric tons of carbon dioxide equivalent emissions on an annual basis as a reference point below which a quantitative analysis of greenhouse gas is not recommended unless it is easily accomplished based on available tools and data.

Unlike the 2010 draft guidance (CEQ 2010a), the revised draft guidance applies to all proposed federal agency actions, including land and resource management actions. It reflects CEQ’s consideration of comments received on the 2010 draft guidance in addition to other federal agency and affected stakeholder input. It does not create new or additional regulatory requirements. It instructs agencies on how to address the greenhouse gas emissions from, and the effects of climate change on, their proposed actions within the existing NEPA regulatory framework. CEQ accepted public comment period on the revised draft guidance until March 25, 2015.

Consistent with the CEQ Revised Draft Guidance for Greenhouse Gas Emissions and Climate Change Impacts (2014), this analysis considers the relationships between the proposed project and climate change in the following ways:

- Effects of the Proposed Action on Climate Change —Effects of the proposed action on climate change, as indicated by estimated greenhouse gas emissions, are considered. Estimated greenhouse emissions include both direct and indirect emissions attributable to the proposed action.

- Effects of Climate Change on the Proposed Action—Effects that climate change (e.g., temperature changes) could have on the proposed project are considered, including direct and indirect effects.

Final Mandatory Reporting of Greenhouse Gases Rule

The EPA has issued the Final Mandatory Reporting of Greenhouse Gases Rule (EPA 2011b), which requires reporting of greenhouse gas (GHG) emissions from large sources and suppliers in the United States. Section 3.1.3, Air Quality, provides further background on this rule.

3.1.2.3 Meteorology

The majority of the EIS 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 EIS 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 EIS 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 (Prokein et al. 2011).

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 (Western Regional Climate Center [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 EIS project area as a whole tends 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 EIS 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[1])	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 (°F)	9.8[5]	11.7[6]	10.2[7]	13.6[8]	17.5[9]	21.9[10]
Average Total Precipitation (in)[2]	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[14]	N/A	9.9[6]	12.6[7]	12.8[8]	N/A	32.5[10]

Notes:

N/A = Data not available.
mph = Miles per hour.
in = inches.
°F = degrees Farenheit
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

Sources:

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

3.1.2.4 Climate Change in the Arctic

Climate Change

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 EIS project area, climate patterns and trends within the EIS project area are complex with several contributing factors. 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 Cycle Systems

The Pacific Decadal Oscillation (PDO), the Arctic Oscillation(AO), and the North Atlantic Oscillation (NAO) all represent cyclic patterns of climate variability that are believed to influence the climate patterns and trends of the EIS 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-Cretaceous Period (approximately 120 to 90 million years [myr] 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 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;
- Northward migration of the treeline;
- Ocean Acidification; and
- Arctic Greening

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 2005; ACIA 2010) 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) (4 to 8 in) 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 increased 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).

Black carbon, commonly referred to as soot, also plays a role in short-term climate effects in the Arctic. Black carbon is produced through the burning of carbon-based fuels and affects climate by absorbing incoming and outgoing radiation and decreasing surface albedo when deposited on snow and ice (Hirdman et al. 2009). Unlike GHGs, black carbon is a short-lived pollutant with an atmospheric lifetime of days to weeks (AMAP 2011). Due to its short lifetime, regional climate effects from black carbon are correlated with regional black carbon sources and are noticed more immediately than effects from GHGs. Climate effects from black carbon are especially strong in sensitive areas such as the Arctic, resulting in earlier annual spring melting and sea ice decline (AMAP 2011). Current sources of black carbon in the Arctic are limited and include emissions from boreal forest fires and burning fossil fuels, including those from diesel generators (Hirdman et al. 2009).

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 a recent BOEM-funded study (Mathis and Cross 2014). 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 Beaufort and Chukchi seas, and the interaction of carbonate states with primary productivity.

3.1.2.5 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 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 54.64 million metric tons (MMt) of gross[1] CO_2 equivalent (CO_2e). From 1990 to 2000, GHG emissions from activities in Alaska were estimated to increase by approximately 14 percent which is on par with the national total, which rose by approximately 14 percent over the same period.

The industrial sector, including fuels used in industry as well as emission from the oil, natural gas, and coal industries, contributes the most to Alaska's greenhouse gas emissions, with the transportation sector providing the second most. The residential and commercial sector and electric production are the third and fourth largest emission generators. Industrial processes, agriculture, and waste all contribute minimally to the state's greenhouse gas emissions. Industrial process emissions come from chemical reactions that produce greenhouse gas emissions; for example, cement production directly releases carbon dioxide (ADEC 2015a).

Table 3.1-3 describes Alaska's GHG emissions from anthropogenic sources from 1990 through 2010, and is based on EPA's 2013 State Inventory Tool using modified inputs for Alaska (ADEC 2015b).

[1] Excludes emissions removed due to carbon sequesteration.

Table 3.1-3 Alaska's Greenhouse Gas Emissions (MMT CO_2e), by Sector (ADEC 2015b)

	1990	2000	2005	2006	2007	2008	2009	2010
Electricity Production	3.05	3.62	3.69	3.96	3.74	3.73	3.65	3.51
Coal	0.45	0.78	0.57	0.58	0.58	0.58	0.59	0.56
Natural Gas	1.87	1.89	2.10	2.31	2.19	2.31	2.03	2.12
Petroleum	0.73	0.95	1.02	1.07	0.96	0.84	1.02	0.83
Residential & Commercial	4.36	5.27	4.90	5.35	4.97	5.03	4.68	5.02
Coal	0.77	0.80	0.77	0.86	0.73	0.84	0.80	0.84
Natural Gas	1.80	2.32	1.86	2.09	2.06	2.06	1.95	1.85
Petroleum	1.78	2.14	2.24	2.38	2.16	2.11	1.91	2.30
Wood (CH_4 and N_20)	0.012	0.013	0.019	0.019	0.020	0.020	0.021	0.022
Industrial	24.87	26.33	27.02	23.21	23.36	21.33	21.04	20.26
Coal / Coal Mining	0.026	0.026	0.024	0.025	0.023	0.022	0.034	0.038
Natural Gas / NG Industry.	13.95	18.70	19.13	15.70	15.69	14.28	14.43	14.12
Petroleum / Oil Industry	10.90	7.60	7.86	7.49	7.65	7.02	6.57	6.10
Transportation	11.18	14.31	17.37	17.37	16.35	13.89	11.64	13.36
Aviation	7.21	10.78	13.18	13.09	11.98	9.82	7.75	9.37
Marine	1.59	0.87	1.36	1.48	1.46	1.24	0.98	1.13
On-Road	2.33	2.62	2.75	2.73	2.84	2.77	2.85	2.81
Rail and Other	0.059	0.043	0.082	0.078	0.067	0.058	0.056	0.060
Industrial Processes	1.10	1.17	1.14	0.48	0.47	0.26	0.27	0.29
Ammonia Production	1.050	0.966	0.885	0.216	0.214	0.000	0.000	0.000
Urea Production	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Limestone & Dolomite Use	0.000	0.010	0.007	0.006	0.000	0.000	0.000	0.000
Cement Manufacture	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
ODS Substitutes (HFC, PFC)	0.001	0.169	0.224	0.231	0.232	0.234	0.242	0.264
Soda Ash (CO_2)	0.006	0.006	0.006	0.006	0.006	0.005	0.005	0.005
Electric Power T&D	0.042	0.023	0.023	0.022	0.020	0.021	0.021	0.020
Waste	0.32	0.40	0.45	0.47	0.49	0.50	0.52	0.53
Solid Waste Management	0.27	0.34	0.39	0.40	0.42	0.44	0.45	0.46
Wastewater Management	0.052	0.060	0.065	0.066	0.066	0.067	0.068	0.069
Agriculture	0.05	0.05	0.07	0.07	0.08	0.08	0.09	0.08
Agricultural Soils	0.030	0.026	0.031	0.034	0.038	0.037	0.040	0.033
Enteric Fermentation	0.015	0.019	0.026	0.028	0.029	0.026	0.025	0.025
Manure Management	0.001	0.007	0.009	0.008	0.008	0.014	0.021	0.021
Gross Emissions	44.93	51-16	54.64	50.92	49.45	44.81	41.88	43.04
Emission Sinks	-6.50	-25.20	5.20	-29.04	-26.06	-30.31	-8.15	-22.37
Net Emissions	38.43	25.96	59.84	21.87	23.39	14.50	33.74	20.67
Increase Over 1990	0.00	6.23	9.71	5.99	4.52	-0.12	-3.05	-1.89
Increase Relative to 1990	0%	14%	22%	13%	10%	0%	-7%	-4%

Sources:

[1] National Ambient Air Quality standards (40 CRF 50) as of October 2011

[2]18 AAC 50 as amended April 17, 2015

3.1.3 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 anthropogenic and natural sources. Industrial, residential, transportation-related, and construction emissions are anthropogenic sources; these sources can be either ongoing or temporary. Natural sources include fugitive dust, forest fires, biogenic sources, and volcanic eruptions; these typically contribute only to temporary changes in air quality.

Air quality in the majority of Alaska's Arctic region, including the Beaufort and Chukchi seas, is generally considered good due to sparse indigenous inhabitants. Industrial development, such as that along the Beaufort coast at Prudhoe Bay is located far away from the largest populated areas of Anchorage and 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 are transported to the Arctic, having temporary and usually seasonal effects on visibility; such effects are commonly referred to as regional (or Arctic) haze (ADEC 2011). Regional haze is discussed further under the subheading Other Air Quality Evaluation Criteria in Section 3.1.3.2.

3.1.3.1 EIS Project Area

For purposes of defining existing air quality in the EIS project area, it is convenient to divide the project area into two zones: the state's seaward boundary (0 to 4.8 km [0 to 3 mi]); and beyond the state's seaward boundary (i.e., 4.8 to 322 km [3 to 200 mi] from the coast). These two zones are subject to different air quality regulatory requirements and different ambient air quality background levels. Air pollutant sources located on the Arctic OCS are regulated under the OCS Air Regulations (discussed below). ADEC rules are applicable to offshore areas within Alaska's seaward boundary. In December 2011, Congress returned air pollution regulatory authority for the inner and outer OCS areas off the North Slope from EPA to BOEM.

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 current air pollutant levels. In addition, Kivalina and Nuiqsut are reported to have elevated dust levels (PM_{10}). The other communities in the study area (Point Hope, Point Lay, Wainwright, and Kaktovik [located within 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.

3.1.3.2 Regulatory Framework and Pollutants of Concern

Air Quality Standards

Air quality in Alaska and within Alaska's seaward boundary is regulated by the EPA and ADEC, while air quality on the Arctic OCS is regulated by BOEM (as of December 2011). Alaska Ambient Air Quality Standards apply in the nearshore areas out to twenty-eight miles (territorial waters plus twenty-five miles). 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 land areas adjacent to the Beaufort and Chukchi seas are unclassifiable; according to the EPA's Green Book, this means that the area “cannot be classified on the basis of available information as meeting or not meeting the national primary or secondary ambient air quality standard (EPA 2012e; 2012f)." There are no designated nonattainment areas within or near the EIS project area (ADEC 2011a).

The two main criteria air pollutants affecting Alaska are CO and 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). On the OCS, marine engines cause emissions of NO_2 and particulate matter. Air quality standards for these pollutants, along with the other criteria pollutants, are listed below in Table 3.1-4. Primary standards have been established to protect human health, and secondary standards have been designed to protect property and natural ecosystems from the effects of air pollution.

Table 3.1-4 Federal and State Ambient Air Quality Standards

Pollutant		**Averaging Period**	**National Standards**		**Alaska State Standards[2]**
			Primary[1]	**Secondary[1]**	
Ozone (O_3)		8-hour (2008 Std)	0.07 ppm	0.07 ppm	0.07 ppm
Particulate Matter equal to or less than 2.5 micrometers in diameter ($PM_{2.5}$)	Annual	Annual	12 µg/m^3	15 µg/m^3	
	24-hour	24 Hours	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 (10 mg/m^3)	NA	10 mg/m^3
		1-hour	35 ppm (40 mg/m^3)	NA	40 mg/m^3
Nitrogen Dioxide (NO_2)	Annual	0.053 ppm (100 µg/m^3)	0.053 ppm (100 µg/m^3)	0.053 ppm (100 µg/m^3)	
	1-hour	0.100 ppm	NA	188 µg/m^3	
Sulfur Dioxide (SO_2)	Annual		NA	80 µg/m^3	
	24-hour		NA	365 µg/m^3	
	3-hour	NA	0.5 ppm (1,3001,300 µg/m^3)	1,300 µg/m^{3}1,3001,300 µg/m^3	
	1-hour	75 ppb	NA	196 µg/m^3 (0.075 ppm)	
Reduced Sulfur Compounds (as SO_2)		30-minute average	NA	NA	50 µg/m^3

Pollutant	Averaging Period	National Standards		Alaska State Standards[2]
		Primary[1]	Secondary[1]	
Ammonia (NH_3)	8-hour average	NA	NA	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

Notes:

µm = micrometers (for particulate diameter)
µg/m3 = micrograms of pollutant per cubic meter of air
mg/m3 = milligrams of pollutant per cubic meter of air
ppm = parts per million
NA= not applicable
ppb= parts per billion

Control of Emissions from OCS Sources

Jurisdiction for control of air emissions from stationary sources on the Arctic OCS (stationary rigs, drillship, and platforms) was the responsibility of the EPA until amendments to the Clean Air Act Section 328 were enacted on December 23, 2011 (Public Law 112-74) in the Consolidated Appropriations Act of 2012. The Arctic OCS is defined to include the Beaufort Sea and Chukchi Sea OCS Planning Areas that are adjacent to Alaska's North Slope Borough. The signing of Pubic Law 112-74 returned the authority for the control of air pollutant emissions from stationary sources, except for existing or pending permits, on the Arctic OCS from the EPA to BOEM. The other Alaska OCS Planning Areas remain under EPA jurisdiction by the authority granted in the Clean Air Act Section 328.

Control of Arctic OCS source emissions is now regulated by BOEM. For proposed exploration plans (EPs) located more than three miles offshore on the Arctic OCS, emissions are regulated by the BOEM under 30 CFR Part 550 Subpart C (BOEM Subpart C) and by the authority granted in the OCSLA Sec. 5(a)(8). Under BOEM Subpart C, no air quality permit is required. Rather, the BOEM Alaska OCS Region would be required to review the air quality analysis contained in any EP for compliance with BOEM Subpart C. Emissions projected for a facility proposed for an EP on the Arctic OCS that exceed the exemption thresholds calculated under Subpart C would be required to conduct an air quality impact analysis (dispersion analysis) for comparison to the Significant Impact Levels (SILs), indicating the potential for a significant air quality impact. Control of emission sources on the OCS by BOEM is required only when the source is expected to cause a significant air quality effect on the State of Alaska. Should the analysis demonstrate pollutant concentrations that exceed any SIL, the application of Best Available Control technology (BACT) would be required by BOEM's Regional Supervisor. If the action proposes a permanent facility, additional analysis would be required to show the application of BACT would result in compliance with the maximum allowable increases. Additional controls would be required until the maximum allowable increases are met. An EP must demonstrate compliance with Subpart C before the EP could be deemed submitted by BOEM Alaska Regional Supervisor. Any required application of BACT or other emission controls would be enforced by the Alaska Region of the BSEE.

National Environmental Policy Act (NEPA) Compliance

The air quality assessment required under NEPA is separate and distinct from the requirement to control stationary source emissions under BOEM Subpart C. The air quality analysis conducted for an EA or an EIS under NEPA requires an accounting and disclosure of total project emissions, namely, land, sea, and air emissions, from both temporary and permanent sources of emissions, and from both mobile and stationary sources. The air quality analysis would account for and disclose any project-related emissions that would occur under the EP. The air quality analysis would be required to demonstrate whether or not the proposed EP would cause emissions that would result in pollutant concentrations that would exceed the EPA NAAQS or otherwise cause a significant effect on air quality in the nearest communities onshore.

Other Air Quality Evaluation Criteria

Climate Change and Greenhouse Gases

Climate change is occurring as a direct consequence of global emissions of GHGs. In October 2009, the EPA issued the Mandatory Reporting of Greenhouse Gas Rule, which required reporting of greenhouse gas data and other relevant information from large sources and suppliers in the United States. In general, the Rule is referred to as 40 CFR 98 (part 98). Implementation of Part 98 is referred to as the greenhouse gas reporting program. Facilities that emit 25,000 metric tons or more per year of GHG are required to submit annual reports to the EPA (EPA 2014).

In addition to the reporting rule, the EPA's Tailoring Rule requires sources that emit GHGs in quantities above certain thresholds to include such emissions in prevention of signification deterioration (PSD) and Title V permitting of the clean air act (EPA 2012g).

Regional Haze

Atmospheric visibility is defined by the ability of the human eye to distinguish an object from the surrounding background. Scattering of light by aerosols is the main process limiting visibility in the troposphere (ground level to ~ 10km). Aerosols that have a diameter between 0.01-1µm scatter light most efficiently and therefore have a larger effect on visibility. The greatest reduction in visibility is at high relative humidity when the aerosols swell by uptake of water; this phenomenon is known as haze (Jacobs 1999). Aerosol particles are naturally occurring (biogenic) and include seeds, pollen, spores fragments of plants and animals, sea salt, dust, smoke. They are also generated from anthropogenic sources which include dust from roads, wind erosions of tilled land, biomass burning, fuel combustion, and industrial processes. The global input of particles into the atmosphere from anthropogenic sources is approximately 20 percent of that from natural sources (Wallace and Hobbs 2006). The EPA, in 1980, adopted regulations forcing states to update their SIPs for protection of visibility in Class I areas from one or several distinct sources in 40 CFR 51 Subpart P (40 CFR 51.300 through 40 CFR 51.307).

The Regional Haze Rule (promulgated in 18 AAC 50.300 to 18 AAC 50.309) requires states to develop long-term plans for reducing pollutant emissions that contribute to visibility degradation, and within the plans, to establish goals aimed at improving visibility in Class I areas. In Alaska, two primary sources of haze are long range transport of anthropogenic pollution from northern Europe and Russia and pollutants from Asian deserts and cities (Asian dust). Other sources are biogenic emissions from living organisms, sea salt, and geogenic emissions from volcanoes in Alaska (ADEC 2011).

Alaska has four Class I areas subject to the rule (ADEC 2011d). Denali National Park is the closest Class I area to 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 (29,528 ft). These layers are hundreds to thousands of kilometers wide and 1-3 km (0.6-1.9 mi) thick” (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).

3.1.3.3 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 or unclassifiable 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. The switch to ultra-low sulfur diesel is expected to result in improved air quality, as it would 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 (AECOM 2010; Air Sciences, Inc. 2009; Environ 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 corresponding onshore areas (COAs). Therefore, it is expected that this compiled dataset is reasonably representative for the three air quality zones covered in this EIS (outer OCS, inner OCS, and onshore).

Table 3.1-5 Background Concentrations

Pollutant	Averaging Period	Measured Concentration (µg/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 British Petroleum Exploration (BPX) Liberty and BPX Prudhoe Bay monitoring sites (Environ 2010).
Note:
µg/m^3 = micrograms of pollutant per cubic meter of air

There are limited background concentration data for offshore regions of Alaska; for permitting needs, the data shown in Table 3.1-5 are assumed to represent the most conservative pollutant levels for these regions. Data from an old NPS Interagency Monitoring of Protected Visual Environments (IMPROVE) station on Simeonof 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 (µg/m^3), which is less than half the value shown in Table 3.1-5. Although this monitoring site is remote, the area is subject to dust events and may show particulate levels that are higher than those that would be seen in true offshore locations. It should be noted that this Aleutian island monitoring was performed over 1,287 km (800 mi) from the project area described in this EIS.

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 µg/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 µg/m^3, for the annual and 24-hour periods, respectively (AECOM 2010). This corresponds well with the 98th percentile 24-hour $PM_{2.5}$ concentration (NAAQS reporting standard) at the Simeonof IMPROVE site, which was 9.3 µg/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 good air quality in the area, and show that there is still room for future offshore activities that would not necessarily jeopardize the regions ability to meet the federal and State of Alaska air quality standards.

3.1.4 Acoustics

3.1.4.1 Introduction to Acoustics

Sound Characteristics

Sound is a physical phenomenon consisting of minute vibrations that travel through a medium, such as air or water. When a source vibrates, its forward movement compresses the molecules in the adjacent medium (water or air) and creates a region of higher pressure relative to the ambient pressure in the medium. 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 lower 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 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 $P = 20 \log_{10}[p/p_{\mathrm{ref}}]$. 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 $P_1 = 20 \log[p_1/p_{\mathrm{ref}}]$. Now consider a sound with twice the pressure: $p_2=2p_1$. It has decibel level $P_2 = 20 \log[p_2/p_{\mathrm{ref}}] = 20 \log[2p_1/p_{\mathrm{ref}}] \approx P_1 + 6$ dB.

Sound Metrics

The metrics most commonly used for evaluations of underwater sound effects on marine mammals are peak pressure sound pressure level (0-peak or peak-to-peak), root-mean-square (rms) sound pressure level (SPL), and sound exposure level (SEL). Figure 3.1-8 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 (Madsen 2005; Discovery of Sound in the Sea [DOSITS] 2011b). 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 3.1-9a. 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 3.1-9b 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 3.1-10 shows hearing thresholds for some terrestrial and marine mammals as compared to the hearing threshold for humans. Figures 4.2 and 4.3 illustrate the revised auditory weighting functions for low-frequency, mid-frequency, and high-frequency cetaceans and otariid and phocid pinnipeds, respectively.

O'Neill et al. (2010a, 2010b) provide formulas for calculating underwater levels of impulsive noise used for the purpose of estimating biological impacts, and in particular the peak SPL, the SPL, and the SEL. The peak SPL is the maximum instantaneous sound pressure level attained from one or more pressure pulses (O'Neill et al. 2010). The rms SPL is the square root of mean square pressure level over a specified time window containing the pressure pulse; a common time window for airgun seismic pulses is the interval containing 90 percent of the pulse energy, and the resulting metric is referred to as the 90 percent rms SPL (O'Neill et al. 2010). The SEL is a measure related to 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 for airgun signals (O'Neill et al. 2010).

The evaluation of noise effects on marine wildlife is difficult for several reasons. Sound level thresholds corresponding to injurious effects are difficult to determine without actually causing injuries to animals. The lowest level of injurious effect from noise exposure is damage to hearing organs. Permanent threshold shift (PTS), as opposed to temporary threshold shift (TTS), is considered an auditory injury. Studies to measure the threshold of sound exposure leading to onset of PTS in marine mammals do not involve the actual inducement of PTS. Rather, PTS thresholds have been estimated by measuring thresholds for onset of TTS and extrapolating those thresholds according to the amount of additional exposure required to increase the TTS to a non-recoverable state (Southall et al. 2007). Additionally, knowledge of the frequency sensitivities of different species groups to loud sounds can be incorporated into PTS thresholds using M-Weighted cumulative SELs (see Appendix B). See Finneran (2015) for a summary of marine mammal TTS studies.

Behavioral effects thresholds are likewise difficult to determine due to the highly variable reactions of animals to sound (NRC 2003a). Variability in reactions may occur as a result of individual's hearing ability, sex, age, and the context of the sound exposure. Context can include habitat, current activity of the animal and past exposure experiences. Additionally, the sensation level of a sound, which is the relative received level of a particular sound as compared to the animal's basic hearing threshold at the frequency of that sound, can factor into how an animal may respond to a sound.

Ambient Noise

Ambient noise is the background noise, encompassing a myriad of sources, some of which are known and others unknown. The noise sources may include natural and anthropogenic sources near and far away. Ambient noise varies with season, location, time of day, and frequency.

The ambient noise in an environment will influence how well an animal may detect sounds of interest, such as calls by other members of their species, or sounds from prey and predators. Animals will only react to sounds that they can detect. To be detected, sounds must exceed the hearing threshold of the animal, and they have to approach or exceed the ambient sound levels in the same frequency band. When the hearing threshold is below the current ambient noise level, as quite often occurs, then ambient noise limits the maximum distance at which a sound source can be detected. Because both hearing thresholds and ambient noise levels vary with frequency, it is important to examine the spectral (variation with frequency) properties of the ambient noise.

Two recent studies of Arctic ambient noise have been performed in the Beaufort and Chukchi seas. Roth et al. (2012) performed three years of ambient noise measurements from 2006-2009 with autonomous acoustic recorders deployed on the continental slope in 265m (869 ft) water depth, approximately 130 km (81 mi) north of Barrow, Alaska. Delarue et al. (2012) performed five years of measurements from 2007 to 2011 using multiple autonomous recorders deployed over a wide area of the eastern Chukchi Sea shelf in water depths of 18 m to 80 m (59 to 262 ft). Roth et al. (2012) report mean spectrum levels in September and October of 80-83 dB re 1 μPa^2/Hz at 20-50 Hz, decreasing at ~5 dB/octave above 50 Hz. All other months had lower levels due to lower average wind speeds and to presence of ice. May had the lowest spectrum level (65 dB re 1 μPa^2/Hz at 50 Hz); that was attributed to lowest mean wind speeds and high ice cover. Delarue et al. (2012) report similar ambient spectral levels in winter months, with a median level of 71 dB re 1 μPa^2/Hz from 10 Hz to 40 Hz but decreasing slightly less rapidly at ~4 dB per octave above 40 Hz. The summer spectral levels of Delarue et al. (2012) differ from those of Roth et al. (2012); Delarue et al. (2012) show increasing spectral levels with frequency from ~67 dB re 1 μPa^2/Hz at 20 Hz to 76 dB re 1 μPa^2/Hz at 100 Hz, then decreasing with frequency above 300 Hz at ~5 dB/octave. Interestingly, the low-frequency roll-off below 100 Hz observed by Delarue et al. (2012) is not observed in Roth et al.'s measurements. That roll-off is likely due in part to reduced support of low frequency sound propagation in the shallow waters of the shelf. It is not observed in the winter data and that is likely due to reduced wind and wave noise in the mid-frequency band when ice cover is present. Delarue et al. (2012) suggest their relatively higher levels between 100 and 300 Hz in summer are also influenced by noise from seismic surveys that have occurred on the shelf during their measurements. Delarue et al. (2012) also show that marine mammal vocalizations can locally or regionally influence ambient noise levels over substantial time periods. They specifically indicate that male bearded seal calls dominate the ambient noise field during their mating period from mid-April to early June over much of the Chukchi shelf, including most of the lease area, and their calls can raise the ambient spectrum from 100 Hz to 1 kHz by as much as 20 dB.

Propagation of Sound

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. Each of the three components is introduced below and then discussed in more detail in the following text.

- ***Source:*** the source of the emitted sound (such as an airgun or drillship). It has particular acoustic characteristics including its amplitude and its pitch.
- ***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.

Sources are generally characterized by their sound emissions known as *source level*. The source level does not necessarily indicate the sound level that could be measured at any location near the source.

Rather, it represents the equivalent pressure that would occur at a reference distance, typically 1 m (3.3 ft), from a point source under the assumption that, when observed by receivers at large distances, the point source and the actual source produce the same received sound pressure level. This definition of source level can lead to confusion about actual sound levels experienced near large or spatially distributed sources. For example, large vessels emit sound energy into the water from several parts of their hull and from their propellers. The source level is computed by scaling that received level back to 1 m (3.3 ft) from a single point location, assuming that the entire sound energy of the vessel was produced at that point location. The source level is therefore larger than the actual pressure level at 1 m (3.3 ft) from any single part of the vessel. Distributed sources with multiple elements, such as airgun arrays, also have source levels that are higher than the actual sound levels experienced close to any part of the source. The reason again is that the source level allocates all of the energy from multiple airguns to a single point location. The source level represents the pressure that would be measured at 1 m (3.3 ft) from that location. While point source levels are not useful for accurately predicting pressure very close to larger or distributed sources, they are very useful for predicting sound levels at larger distances. Generally the distance at which the approximation becomes valid is several times the dimension of the source itself. For synchronized sources, such as airgun arrays, the actual distance at which the point source approximation becomes accurate is also dependent on the spatial extent of the source relative to the sound wavelength, and it therefore depends on the frequency of the sound.

Path refers to the media through which sounds propagate on their way from the source to the receiver. The path affects the *Transmission loss,* which represents the total amplitude change from the source position (actually at 1 m [3.3 ft] from the source) to the receiver. Transmission loss is generally represented in decibels, and it is a measure of the overall decrease in acoustic intensity. It is comprised of several other loss mechanisms, including *spreading loss*, *reflection* and *refraction loss*, and *absorption*. Simply, spreading loss refers to the decrease in pressure that results from the increasing surface area a sound wavefront 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. In shallow water environments where acoustic paths are bounded by the surface and seabottom, the rate of spreading loss decreases due to trapping of sound energy by the boundaries. If the surface and bottom were perfectly-reflecting then the spreading loss at longer distances would be referred to as cylindrical – sound levels in this situation would diminish by 3 dB per doubling distance. Reflection (sound waves bouncing off surfaces) 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 underwater varies with temperature, sea conditions, source and receiver depth, water chemistry, bottom composition, and topography. Transmission loss parameters in air vary with air temperature and humidity, wind, turbulence, cloud cover, type of ground cover between source and receiver, and source and receiver height. In nearly all cases, transmission loss varies with frequency, which is an important consideration in the application of the source-path-receiver model.

Receiver refers to the listening device or animal that experiences the sound as it propagates along the acoustic path. The receiver can refer specifically to the hearing organs of animals but high-amplitude sounds can affect other organs. In any case, the receiver will have varying sensitivity to different frequencies. Hearing-related effects such as masking and auditory injury depend on the sound amplitude and the frequency distribution of the sound. Some sound metrics used for effects evaluation take into account the frequency-dependent hearing sensitivity of different species as was discussed in the Sound Metrics section above.

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 (Au and

Hastings 2008; Harris 1998; Richardson et al. 1995). 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 is included in the Chukchi Sea discussion.

3.1.4.2 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 3.1.4.3), 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 and vehicular traffic on the roads within the few 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 (EPA 1974; Shepard et al. 2001). Sound levels farther from equipment are closer to the natural background levels of 45 to 60 dBA (U.S. Bureau of Land Management [BLM] 2004). Noise sources and associated sound levels near the communities of Nuiqsut and Kaktovik would 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 3.1-12 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 3.1.4.3); 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 propagating over the shelf.

Biological sounds from marine mammals are generally less prevalent in the Beaufort Sea region relative to the Chukchi Sea. This is primarily a result of limited numbers of the two most vocal species, walrus and bearded seals, in the Beaufort Sea. Bowhead vocalizations could 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 16 to 48 km (10 to 30 mi) from shore. Bowhead vocalizations in September and October are limited to low frequency moans below approximately 1000 Hz. Bowhead calling structure evolves from simple calls to complex calls and songs from October to December, but most bowheads have already migrated into the Chukchi Sea by this time (Delarue et. al. 2009). The complex calls and songs extend in frequency from less than 100 Hz to several kilohertz. Wind and sea ice contribute greatly to the noise environment (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. 2004a). 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.

3.1.4.3 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 would 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 would 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 would 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 3.1.4.2). 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 efficacy of low frequency sounds may be reduced (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. (2013) 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 (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 (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 (Cornell 2010; George et al. 2013; 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). While sound production by fish in the Arctic is not well understood, acoustic recorders in the Chukchi Sea have captured some low frequency grunt-like sounds, mainly less than 100 Hz, which may be produced by Arctic cod (Nordeide and Kjellsby 1999; Cornell 2010).

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 3.3.6 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 (Au and Hastings 2008; NRC 2003a; Richardson et al. 1995), 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.

3.1.5 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). The effects of past oil and gas exploration and development must be considered in order to accurately and completely characterize current water quality in the Alaska Arctic Region OCS (Brown et al. 2010). 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 CWA Section 303(d)) identified within the Arctic Region by the State of Alaska (ADEC 2010).

3.1.5.1 Applicable Regulations

Both federal and state regulations are applicable to the activities evaluated in this EIS. The regulations define reporting requirements, permitting needs, as well as applicable water quality regulations and standards. Specific water quality parameters are discussed in Section 3.1.5.2.

Reporting. The federal CWA mandates that each state develop a program to monitor and report on the quality of its waters and prepare a report describing the status of its water quality. The relevant CWA sections are Section 305(b), which requires that the quality of all waterbodies be characterized, and Section 303(d) which requires that states list any waterbodies that do not meet water quality standards. Alaska's Integrated Water Quality Monitoring and Assessment Report combines the information into a single comprehensive report. Alaska's Final Integrated Water Quality Monitoring and Assessment Report for 2012 (ADEC 2013) is available in draft form at http://dec.alaska.gov/water/wqsar/waterbody/docs/2012_Integrated_Report_FINAL_24DEC13.pdf. Finalization of this report is pending EPA's approval of impaired waters.

Permitting. Pursuant to the CWA, wastewater discharges from oil and gas exploration facilities in the Beaufort and Chukchi seas require authorization by the EPA in the form of a NPDES permit, or if in state waters, by the ADEC in the form of an Alaska Pollutant Discharge Elimination System (APDES) permit. Discharges into the territorial seas, the contiguous zone, and the oceans may not cause an unreasonable degradation of the marine environment as determined under 40 CFR Part 125 Subpart M. On May 1, 2008, the State of Alaska submitted a final application to the EPA for authority to permit wastewater discharges in Alaska, and on October 31, 2008, EPA approved the application. ADEC assumed full authority to administer the wastewater and discharge permitting and compliance program for Alaska on October 31, 2012.

On October 29, 2012, EPA issued two general permits for exploration discharges into the Beaufort and Chukchi seas, permit numbers AKG-28-2100 and AKG-28-8100, respectively. The general permits authorize discharges from 13 categories of waste streams, subject to effluent limitations, restrictions, and requirements. The general permits became effective on November 28, 2012 and are effective for five years. The permits require operators to submit Notices of Intent to EPA requesting authorization to discharge at least 120 days prior to commencing discharges. Information about EPA's general permits for offshore oil and gas discharges in the Arctic OCS, including the Ocean Discharge Criteria Evaluations, can be found at https://yosemite.epa.gov/r10/water.nsf/npdes+permits/arctic-gp.

EPA's exploration general permits authorize discharges from the exploratory facilities, not the discharges from the support fleet.

EPA's Vessel General Permit (VGP) applies to discharges from the normal operation of all non-recreational, non-military vessels 79 feet long or more, which discharge to waters of the United States (defined at 40 CFR 122.2) extending to the outer reach of the three-mile territorial sea (see 40 CFR 122.2 and CWA Section 502(8)). The VGP ballast water discharge provisions also apply to any non-recreational vessel less than 79 feet long or commercial fishing vessel of any size. Information on the VGP is online at: http://cfpub.epa.gov/npdes/vessels/vgpermit.cfm.

Section 312 of the CWA sets out the principal framework for domestically regulating sewage discharges from vessels, and is implemented jointly by the EPA and the USCG. The CWA defines sewage as "human body wastes and the waste from toilets and other receptacles intended to receive or retain body wastes," and includes gray water discharges from commercial vessels (see 33 USC 1322(a)(10)). CWA Section 312 controls vessel sewage by regulating the equipment that treats or holds the sewage, called marine sanitation devices (MSDs) (see 33 USC 1322(a)(5)). Support vessels are required to use operable, U.S. Coast Guard certified MSDs onboard when operating in U.S. waters, including the three-mile territorial sea.

In addition, on January 29, 2015, the U.S. Environmental Protection Agency issued a final wastewater discharge general permit authorizing discharges from Oil and Gas Geotechnical Surveys and Related Activities in Federal Waters of the Beaufort and Chukchi Seas (Geotechnical General Permit; AKG-28-4300). The Geotechnical General Permit (GP) authorizes 12 types of wastewater discharges from oil and gas geotechnical surveys and related activities. The GP establishes effluent limitations and requirements to ensure the discharges will not cause unreasonable degradation of the marine environment. The GP became effective on March 2, 2015 and will expire on March 1, 2020.

Geotechnical investigations are usually associated with proposed oil and gas activities or placement of structures in offshore areas, and include collection of marine sediment borings to evaluate the engineering behavior of subsurface materials; determine the relevant physical, mechanical and chemical properties of these materials; assess risks posed by site conditions, including seafloor or shallow depth geologic hazards; locate potential archaeological resources and potential hard bottom habitats for avoidance; and assess specific locations to inform the placement of platforms, pipelines, or other infrastructure. The NPDES Geotechnical GP establishes limits on the types and concentrations of pollutants that can be discharged and other conditions on authorized facilities in order to ensure protection of the marine environment. The area of coverage for the Geotechnical GP includes federal waters of the U.S. in the Beaufort and Chukchi seas located seaward from the outer boundary of the territorial seas to the U.S. and Russia border and extending northward to the Alaska, U.S. and Yukon, Canada border. The area of coverage for the general permit does not include any areas within state waters. Therefore, a separate state permit is required to authorize discharges from geotechnical surveys and related activities in state waters (see discussion below). A detailed summary of the proposed NPDES Geotechnical GP is included in the EPA Fact Sheet, available online at http://www.epa.gov/region10/pdf/permits/npdes/ak/geotechnical_gp/akg284300_fs_geotechnical_gp_2013.pdf.

ADEC has developed a similar permit under its APDES permitting authority for oil and gas geotechnical surveying activity discharges to state waters of the Beaufort and Chukchi seas. The APDES general permit AKG283100 – Geotechnical Facilities in State Waters in the Arctic Ocean (the APDES Geotechnical GP) was issued on May 31, 2015. Like the NPDES Geotechnical GP, the APDES Geotechnical GP authorizes and sets conditions on the discharge of pollutants from geotechnical investigations facilities to state waters. In order to ensure protection of water quality, the permit places limits on the types and amounts of pollutants that can be discharged from these operations and outlines best management practices to which these operations must adhere. The APDES Geotechnical GP provides coverage for geotechnical investigations facilities in waters of the territorial seas of the Beaufort and Chukchi seas up to the three nautical mile demarcation line offshore between Point Hope at 166°50’20” west longitude and the border with Canada at 141°00’00” west longitude. A detailed summary of the APDES Geotechnical GP is included in the Final Fact Sheet, available online at https://dec.alaska.gov/water/wwdp/pdfs/PublicNoticedocs/AKG283100%20-%20Arctic%20Geotech%20Final%20FS%20v.final.PDF. The Arctic NPDES General Permit AKG-28-0000 for wastewater discharges from Arctic oil and gas facilities expired on June 26, 2011.

Water Quality Regulations and Standards. 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.

The USCG has regulations related to pollution prevention and discharges for vessels carrying oil, noxious liquid substances, garbage, municipal or commercial waste, and ballast water (33 CFR Part 151).

The State of Alaska regulates water quality standards within state waters. 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/).

3.1.5.2 Water Quality Parameters

The following water quality variables are discussed because of their importance to the functioning of the potentially affected ecosystem.

<u>Temperature and Salinity</u>

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 kilogram [mg/kg]), or 35 grams of salt dissolved in 1,000 grams of water. 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 turbidity in nearshore Beaufort Sea waters during summer show large variations due to changes in wind conditions. Under relatively calm conditions (winds less than 5 kn) during late summer, turbidity levels are likely to be less than 3 NTU and under high winds (greater than 25 kn), turbidity may be in excess of 80 NTU (Figure 3.1-13) (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 NTU (Boehm 2001). These levels are 10 to >100 times lower than values obtained during the open-water period of August 1999 (Figure 3.1-13) 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 2012a, 2012b).

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 3.1-6) (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 long-chained and multi-ringed 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.

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 (nanograms per liter or 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 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 used criteria are the Effects Range Low (ERL) and Effects Range Median (ERM) presented by Long et al. (1995, 1998). (It should be noted that more recent consensus- based sediment quality guidelines are available [Buchman 2008; MacDonald et al. 2000]). 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). In the state of Alaska, ADEC recommends using the threshold effects level and probable effects level sediment criteria as presented in the NOAA SQUiRT Tables (Buchman 2008).

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.

Table 3.1-6 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 (n = 49)	22	0.49	26.8	0.02	0.06	0.54	0.0005	0.005	0.20
2001 (n = 34)	17	0.38	31.9	0.02	0.09	0.64	0.001	0.01	0.16
2002 (n = 31)	20	0.51	14.2	0.03	0.07	0.47	0.0009	0.07	0.11
2004 Area wide (n = 42)	23	0.72	13	0.04	0.11	0.36	-	0.01	0.16
2004 NS (n =7)	25	0.81	12	0.04	0.10	0.40	-	0.01	0.14
2005 Area wide (n = 65)	27	0.93	10.6	0.05	0.09	0.31	0.0007	0.01	0.32
2005 NS (n = 9)	25	0.88	11.5	0.04	0.09	0.30	0.0008	0.02	0.28
2006 Area wide (n = 26)	23	0.60	13	0.04	0.09	0.31	-	0.008	0.17
2006 NS (n =12)	21	0.56	14	0.03	0.08	0.31		0.007	0.20
Average Surface Seawater[a]	35	1.2	13	0.01	0.16	0.10	0.0002	0.02	0.1
EPA Marine Water Quality Criteria[b]	Chronic	36	-	8.8	50[c]	3.1	0.94[d]	8.1	81

Notes:

a Millero 1996; c Criterion for hexavalent chromium Cr (VI);

b EPA 2009; d Criterion for inorganic mercury.

Source:

Neff 2010; Trefry et al. 2009

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 triterpane distribution 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) (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).

3.1.6 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 U.S. Beaufort and Chukchi seas ecosystem provides 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.

3.1.6.1 U.S. Beaufort and Chukchi Seas Marine Ecosystem Goods and Services

"Ecosystem functions" refer to the capacity of natural components and processes to provide goods and services that satisfy human needs, directly or indirectly (De Groot et al. 2002). 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 Beaufort and Chukchi seas 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 region are summarized in Table 3.1-7.

Table 3.1-7 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 Beaufort and Chukchi seas are dynamic, and are usually derived from interplay among various ecosystem components— the physical environment, chemical environment, and biological communities (Costanza et. al 2014). Ecosystem goods and services are only rarely the product of a single species or component. Therefore, the interactions of various ecosystem components are essential to the provision of ecosystem goods and services, and must be considered as important aspects of the affected environment. Incorporating ecosystem services considerations into decision-making processes supports functional, resilient ecosystems (Schaefer et al. 2015). The practical application of ecosystem services principles in policymaking and commercial activities makes tradeoffs in decision making more transparent, informs efficient use of resources, enhances resilience and sustainability, and potentially avoids unintended negative consequences of policy actions (Schaefer et al. 2015).

3.1.6.2 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 (e.g., 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 focuses 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 is 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 EIS 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 3.1-8). Historically, drill cuttings and fluids have been discharged from oil and gas drilling in the EIS project area, and residues from historical discharges may be present in the affected environment (Brown et al. 2010).

Table 3.1-8 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

Pollutant	Range of Concentrations Before Washing	After Washing
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	
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 U.S. Beaufort and Chukchi seas 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 for adverse effects 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 due to toxicity that could result from inputs of chemical contaminants.

Many of the organic contaminants associated with past development in the EIS project area (e.g., high molecular weight PAHs) 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 coefficients 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).

3.1.6.3 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 3.1-14).

Ecological assessments are 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 ecosystem of the U.S. Beaufort and Chukchi seas 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 U.S. Beaufort and Chukchi seas.

3.1.6.4 Oil Spill History

Several studies have reviewed the history of oil industry spills in the U.S. OCS and Canadian Beaufort Sea (Anderson et al. 2012; Hart Crowser 2000; Nuka Research and Planning Group 2013; State of Alaska 2007a, 2007b). 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 onshore 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 large (greater than or equal to 1,000 barrels) offshore oil spills have not occurred in the Alaska Arctic OCS regions, agencies rely upon estimates to represent expected frequency and severity of oil spills in these regions (Bercha Group, Inc. 2006, 2008, 2014 [in OCS Study MMS 2006-033, OCS Study MMS 2008-035, and OCS Study BOEM 2014-774]; Hutchinson and Ferrero 2011; 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. 2006, 2008, 2014 [in OCS Study MMS 2006-033, OCS Study MMS 2008-035, and OCS Study BOEM 2014-774]; 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 estimate 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 estimated Arctic offshore large oil spill frequencies.

3.1.6.5 Existing Regulatory Control of Discharges

Regulatory control of ocean discharges associated with oil and gas exploration activities in the offshore Alaska Arctic Region is largely under the purview of the EPA and ADEC. 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 describes 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 3.1.5 respectively, so therefore are not 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; Foster et al. 2010); 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 theory suggests 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 Bluhm (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 are absent (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). Favorable conditions on the western Beaufort Sea shelf off Point Barrow in the late summer and fall concentrate euphausiids and copepods (Ashjian et al. 2010; Moore et al. 2010; Okkonen et al. 2011). These concentrations attract large numbers of bowhead whales and other marine mammals (Clarke et al. 2011b, 2011c; Okkonen et al. 2011). Because of this unique biological community, the area has been designated as a time/area closure (see Section 2.4.8.2).

Zooplankton life histories and community structures are intricately coupled to phytoplankton production as prey resources. Therefore, areas with high primary phytoplankton productivity 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 similar to that in the Pacific Ocean and Bering Sea compared to the Arctic Ocean 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. 2006a). Each possess varying substrates such as fine sands, muds, and silts (BOEM 2010a) and are closely tied to the distribution of benthic fauna. For example, in benthic communities, mollusks, polychaete worms, and amphipods are patchily distributed 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 primary producers); macroscopic algae (large seaweeds); and benthic invertebrates.

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 (Dunton 1984; Horner and Schrader 1982). 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 Chukchi 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 approximately 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. Until recently, primary production was considered extremely low, based on a sparse data set, but recent work by Cota et al. (1996), Wheeler et al. (1996), Gosselin et al. (1997), and Pomeroy (1997) (as cited in Aagaard et al. 1999), indicate that annual primary production in the mostly ice covered waters of the Arctic Ocean is about 15 to 30 g C/m^2. Primary producers in the Arctic include phytoplankton, ice algae, and benthic microalgae and macrophytes, which are generally assumed to respectively contribute about 95 percent, 5 percent, and <1 percent to panarctic marine productivity (Aagaard et al. 1999). Although ice algae have historically been considered of minor importance, studies indicate they may be more important to total primary production in the Arctic Ocean than previously estimated (Gosselin et al. 1997).

Recent changes in benthic biomass in some arctic seas, or parts thereof, probably reflect shifts in energy flux patterns, regionally related to sea ice loss. Biomass changes over the past one to three decades include an increase in epifaunal biomass in parts of the Bering and Chukchi seas (Bluhm and Grebmeier 2011).

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 (Beck et al. 2003; Dean et al. 2000; Iken 1999; Iken et al. 1997) 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 1984; Dunton and Schell 1987).

Kelp beds have been found in the Beaufort Sea in Stefansson Sound, the Boulder Patch, and Camden Bay. The Boulder Patch is an isolated macroalgal-dominated rocky bottom habitat within the usually soft-sediment environment of the Beaufort Sea. This habitat is located in Steffanson Sound between Point Brower and Cross and Narwhal islands (Coastal Marine Institute 2011, map). 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 2003, 2007c). 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 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 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 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, *Phyllaria dermatome*. Two other known algae, *Laminarea latissima* 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 used 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 et al. 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 infauna taxa were substantially higher in Burger than in Klondike, but macrofaunal communities in both survey areas were similarly diverse. Macrofaunal community structure was discovered 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).

In the Beaufort Sea, Dunton et al. (1982) describes the discovery of the "Boulder Patch," an Arctic kelp community in an area of cobbles and boulders with attached kelp and invertebrate life. He reported that sponges and cnidarians were the most conspicuous invertebrates there because of the large size of some species, their abundance, and their striking shapes and colors. Two sponges, *Choanites lutkenii* and *Phakettia cribrosa,* and pink coral (*Gersemia rubiformis*) are widespread. At least four sea anenomes (order *Actinaria*) are present. Other conspicuous invertebrates include several species of *Tubularia*, a stalked hydrozoan. Smaller less-conspicuous epilithic animals (such as hydroids and encrusting sponges) form a turf-like covering on rocks. Mollusks, bryozoans, and members of the urochordate group are common on rocks and attached to other biota. The chiton, *Amicula vestita*, constitutes the greatest percentage of molluscan biomass, and juvenile mussels of the genus Musculus have the greatest density. Erect and encrusting colonies of bryozoans are common on rocks and red algae. The inconspicuous sea spider, *Nymphon grossipes*, is usually found among these dense mats of algae and attached invertebrates.

Aquatic Invasive Species

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

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

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

The potential for impacts by invasive species is considered within analyses of lower trophic levels for each alternative and under cumulative effects analysis for lower trophic levels.

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 postulated 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 primarily 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 invertebrates. 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 web 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 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 3.1.2.4. Such changes include warming air (Chapman and Walsh 2003) and sea temperatures, declining sea ice extent and thickness (Levi 2000; Parkinson et al. 2000; Rothrock et al. 1999), salinity changes (Arrigo

2009), rising sea level, increasing precipitation and decreasing snow extent, and loss of permafrost (IPCC 2007a). These changes in the physical environment could precipitate changes on lower trophic level ecology as described here. Although Arctic sea ice itself can be biologically productive, occasionally supporting large populations of diatoms and other primary producers (Gosselin et al. 1997), areal rates of CO_2-fixation in sea ice habitats tend to be much lower than rates found in the adjacent ice-free ocean. Therefore, a loss of Arctic sea ice might be expected to increase the area favorable for phytoplankton growth and enhance the productivity of the Arctic Ocean (Arrigo 2009). In fact phytoplankton primary production in the Arctic Ocean has increased approximately 20 percent from 1998-2009, mainly as a result of increasing open water extent and duration of the open water season (Frey et al. 2011). Recent field observations indicate that range shifts, and changes in the relative abundance of particular taxa have occurred within the last decade (Nelson et al. 2014).

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 are likely to 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 could 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 (diadromous species). The Alaskan Chukchi and western Beaufort seas support at least 107 fish species, representing 25 families (Harris 1993; Johnson et al. 2010; Logerwell and Rand 2010; Love et al. 2005; Mecklenburg et al. 2002) (see Table 3.2-1). Families and sub-families include lampreys, dogfish sharks, herrings, smelts, whitefish, trout and salmon, lanternfish, codfishes, sticklebacks, greenlings, sculpins, poachers, lumpsuckers, snailfish, eelpouts, pricklebacks, gunnels, wolffish, sand lance, and righteye flounders. Forty-nine known species are common to the Beaufort and Chukchi seas. A recent study by Logerwell and Rand (2010) identified five fish species formerly not known to occur in Arctic waters. A similar situation has been reported for Canadian Arctic waters where recent compilations of marine and anadromous fish resulted in updating the species known to occur in this area (Coad and Reist 2004; Meuter et al. 2013).

Freshwater species inhabiting the Arctic coastal plain have been better described than marine species (Table 3.2-1). While freshwater habitats could be affected by naturally or chemically dispersed oil from a spill moving up the freshwater channel, this section focuses more extensively on coastal and marine fish/fishery resources and habitats because there is greater potential for Arctic exploration activities to impact these resources

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.

The following information summarized from the Arctic Fishery Management Plan (NPFMC 2009) describes the current commercial, subsistence, and recreational fisheries in the Arctic.

Commercial fisheries in the Arctic are limited to several small fisheries solely in state waters that are managed by the State of Alaska. These include a small commercial fishery for chum salmon, although other fish species are incidentally harvested, in the Kotzebue Sound region. Fished from coastal set nets, salmon are sold locally; some are shipped to other markets outside the region. A commercial fishery for whitefish occurs in the delta waters of the Colville River that flows into the central Beaufort Sea (Fechhelm et al. 2007). This fishery is for Arctic and least cisco, and a few other species are harvested incidentally. The market for these fish is local, although some whitefish have been marketed in the Barrow and Fairbanks areas. While no large-scale fisheries currently exist in the Beaufort Sea, both the U.S. and Canada anticipate that sustained warming could enable and encourage the development of Beaufort Sea fisheries (Lewis-Koskinen 2010).

Subsistence fishing occurs throughout the coastal region by residents of villages in this region. Harvest areas are described on Figures 3.3-16 and 3.3-17. Table 3.3-7 in Section 3.3.2.3 Subsistence Resources provides an overview of Community Subsistence Harvest by Species Group (percent total harvest by species, total harvest, and pounds per capita).

Subsistence fishing activities occur near human settlements of Wainwright, Barrow, Nuiqsut, and Kaktovik, and in all nearshore areas during open water seasons and to a limited extent during winter. Near Wainwright, residents use gill nets to fish 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 24 km (15 mi) up the Kukpowruk River in September for grayling fishing. A variety of salmon, whitefish, flounder, smelt, herring, and an occasional char are taken. 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, Dolly Varden, Arctic grayling, burbot, lake trout, northern pike, capelin, rainbow smelt, Arctic cod, tomcod, and flounder.

There are few recreational fisheries in the area and no catch and release fishery management programs. Personal use fisheries may occur on a variety of species, occasionally in exclusive economic zone (EEZ) waters, but little data are available and these probably occur on a very small scale. Personal use fisheries may more accurately be described as subsistence fisheries, although there may be some level of "sport" fishing activity near Kotzebue or Barrow. Most recreational catch in the Arctic likely would occur in state waters and thus fall under the classification of sport, subsistence, or personal use fisheries, these fisheries are regulated by Alaska state law. No data are available to determine the trends in landings, including species targeted, in recreational fisheries in the Arctic Management Area.

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				
Somniosidae	*Somniosus pacificus*	Pacific sleeper shark	MA	MMT
Squalidae	*Squalus acanthias*	spiny dogfish	MA	MMT
Clupeoiformes				
Clupeidae	*Clupea pallasii*	Pacific herring	MA	MMT
Cypriniformes				
Catostomidae	*Catostomus catostomus*	longnose sucker	FW	MMT
Esociformes				
Esocidae	*Esox lucius*	northern pike	FW	MMT
Umbridae	*Dallia pectoralis*	Alaska blackfish	FW	MMT
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	MMT
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				

Order/Family	*Species Name*	Common name	Primary Assemblage[1]	Source[2]
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
	Gadus chalcogrammus	walleye pollock	MA	MMT
	Gadus macrocephalus	Pacific cod	MA	LR
Lotidae	*Lota lota*	burbot	FW	MMT
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	MMT
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

Order/Family	*Species Name*	Common name	Primary Assemblage[1]	Source[2]
	Leptagonus decagonus	Atlantic poacher	MA	MMT
	Podothecus veternus	veteran poacher	MA	MMT
	Ulcina olrikii	Arctic alligatorfish	MA	MMT
	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	Canadian 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 et al. 2002; LR = Logerwell and Rand 2010

3.2.2.1 Major Surveys of Coastal and Marine Fish Resources and Habitats

MMS (2008) and BOEM (2015) 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 conducted 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 35 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. Numerous tows 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, 512 fish belonging to 17 species were captured, 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 primarily during the open-water summer season and, to a lesser extent, in winter. The most prominent species encountered during the survey were Arctic cod, Arctic staghorn sculpin, fourhorn sculpin, capelin, shorthorn sculpin, hamecon (sculpin), 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. (1994) 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.

A three-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 captured, while Arctic cisco was the only abundant diadromous species.

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.

Logerwell and Rand (2010) conducted a recent study in Alaskan Arctic waters as part of a joint effort with NMFS, the University of Washington, and the University of Alaska Fairbanks. Researchers surveyed offshore marine fish and invertebrates and the physical and biological oceanography of the western Beaufort 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 species not previously documented in Arctic waters were identified in this study. Several BOEM sponsored studies of fish and lower trophic organisms in the Beaufort and Chukchi seas have recently been completed (BOEM 2011f, 2011g, 2011h, 2013b; 2015c; 2016b).

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 findings of Logerwell and Rand (2010) suggest that a similar trend is occurring in the Arctic. Five species previously not documented in the region were encountered in the Logerwell and Rand (2010) study, so it is possible older 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 previously undocumented 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.

Results from the 2014 Arctic Coastal Ecosystem Survey revealed interannual variation in nearshore Arctic fish assemblages, including Arctic cod, capelin, sculpin, and Pacific sand lance (NMFS 2014).

3.2.2.2 The Ecology of Alaskan Arctic Fish

Three large marine ecosystems (LMEs) encompass coastal and offshore waters of Arctic Alaska. They include 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 relevant 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 assemblage than the western Beaufort Sea (Craig 1984 citing Morris 1981; Craig and Skvorc 1982). Norcross et al. (2013) identified 59 fish species within 17 families based on bottom trawl survey over a 50-year period from 1959 to 2008 in the Chukchi Sea. Thedinga et al. (2013) captured 18 species using beach seine hauls and 24 species with trawl tows in the northeastern Chukchi Sea. Conversly, Johnson et al. (2010) identified 16 fish species in a 2004 to 2009 bottom trawl and seine study of nearshore waters in the western Beaufort Sea. Although the Chukchi Sea supports a more diverse fish assemblage than the western Beaufort Sea, Arctic waters support considerably 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 (656-ft) isobath) and oceanic waters and substrates (occurring seaward of the continental shelf break [>200-m isobath]) (Figure 3.1-5). 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; Gallaway and Fechhelm 2000; Moulton and George 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, it is important to note that when compared to lower latitude marine environments overall abundance would be considered low for Arctic fish species The recent report by Logerwell and Rand (2010), which documents the presence of commercially valuable walleye pollock and Pacific cod and confirms the extension of their ranges, leaves open the question of relative abundance of these species.

The following discussion of fish assemblages is limited to marine and migratory fish species since none of the proposed project activities occur near freshwater fish habitat and therefore no impacts are anticipated.

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 (Frost and Lowry 1983; Jarvela and Thorsteinson 1999; Logerwell and Rand 2010; Norcross et al. 2013; Thedinga et al. 2013). In areas where coastal surveys have been conducted, seasonal trends in relative abundance of dominant (abundant) fish species are evident (Jarvela and Thorsteinson 1999; Logerwell and Rand 2010). Robust population estimates or trends for marine fish of the region are unavailable. Distribution and abundance data for marine fish species are generally known at the coarsest grain of resolution (e.g., common, uncommon, rare), although a few studies include abundance estimates (qualitative or quantitative) for localized areas (Frost and Lowry 1983; Griffiths et al. 1998; Jarvela and Thorsteinson 1999; Logerwell and Rand 2010). 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) 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 is 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 western Beaufort Sea study that used bottom trawls to sample for demersal fish and hydroacoustics 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, Canadian 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, Canadian 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., char), 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 et al. 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, the scale of the primary marine fish assemblage has been further refined 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 the 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			
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				
Gadus chalcogrammus	walleye pollock	X	X	X	X	
Gadus macrocephalus	Pacific cod	X		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				

Species Name	Common name	Secondary Assemblage[2]				
		ND	NP	OD	OP	CP
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				
Aspidophoroides monopterygius	alligatorfish	X				
Eumicrotremus derjugini	leatherfin lumpsucker	X				
Eumicrotremus andriashevi	pimpled lumpsucker	X				
Liparis gibbus	variegated snailfish	X				
Liparis tunicatus	kelp snailfish	X				

Species Name	Common name	Secondary Assemblage[2]				
		ND	NP	OD	OP	CP
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	Canadian 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				

Species Name	Common name	Secondary Assemblage[2]				
		ND	NP	OD	OP	CP
Reinhardtius hippoglossoides	Greenland turbot	X		X		
Platichthys stellatus	starry flounder	X				
Pleuronectes quadrituberculatus	Alaska plaice	X				
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 attributed to being widespread and/or abundant include the fourhorn sculpin, twohorn sculpin, Canadian eelpout, and Arctic flounder (BOEM 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 use 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 considered 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 considered rare.

The Oceanic-Demersal Assemblage

Fish living on or close to substrates below oceanic waters are encompassed in the oceanic-demersal assemblage. The 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); as yet, there are no known bathypelagic fish in the Alaskan Beaufort Sea. However, the vertical distribution of water masses in this area is complex, and species associations differ among the layers. Arctic fish communities remain poorly understood because of the challenges of sampling in remote and mostly ice-covered waters (Meuter et al 2013). Recent interest in resource development has spurred research in a number of shallow, nearshore regions that has provided important baselines for understanding future changes. These activities have inevitably increased estimates of species richness and distributions while also highlighting the limitations of present knowledge. However, deeper waters in the Arctic Basin, as well as many parts of the outer shelf regions, remain poorly sampled. Future colonizations, should they occur, could therefore include species from all of these sources. (Mueter et al. 2013). 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 possible that they also feed on the amphipod-diatom ice community inhabiting the lower ice layer. Arctic cod are a common prey of ringed seal (*Phoca hispida*), bearded seal (*Erignathus barbatus*), beluga whale (*Delphinapterus leucas*), narwhal (*Monodon monoceros*) and other marine mammals, many marine birds (including gulls, guillemots, etc.) and fish (citing Klumov 1937; Andriyashev 1955). 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.

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, catadromous 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 five Pacific species are found within the EIS project area.

Pacific Salmon

Five species of Pacific salmon occur in the EIS project area (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), Johnson and Daigneault (2008), and Johnson and Litchfield (2015).

Salmon numbers decrease north of the Bering Strait, and they are relatively uncommon in the Beaufort Sea (Craig and Halderson 1986). Spawning runs in Arctic streams are minor compared to those of commercially important populations farther south (Craig and Halderson 1986). Chum is the only salmon species regarded as natal to the Mackenzie River watershed, although both pink and chum salmon appear to be natal to Alaska's North Slope rivers (Irvine et al. 2009).

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 limited number of 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

Kotzebue Sound is the northernmost documented spawning population of Chinook salmon in Alaska (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. com.). 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. com.). Strays have been captured in the Kuk River, near Wainwright (Craig and Halderson 1986) and in Fish Creek, which drains to Harrington Bay in the Beaufort Sea.

The northernmost known population of spawning coho salmon is in the Kuchiak River (Johnson and Litchfield 2015), 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; Johnson and Litchfield 2015). Sockeye salmon's northernmost documented spawning population is Kotzebue Sound (Stephenson 2006, citing Burgner 1991). Both sockeye and coho salmon are considered extremely rare in the Beaufort Sea, representing no more than isolated migrants from populations in southern Alaska or Russa (Mecklenburg et al. 2002).

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. Pink and chum salmon are the most commonly reported anadromous species in the Alaska Arctic north of Point Hope (Nielsen et al. 2013). 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 some of the other 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 two-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 early to mid-winter and fry emerge from the gravel in spring. At that time, the fry move downstream and remain in the estuary and nearshore areas 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 estuaries and nearshore areas (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 (Babaluk et al. 2000; Craig and Halderson 1986; 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 out-migrate (mostly at night) from natal streams directly to estuaries/tidal wetlands shortly after emergence. In more southern waters, outmigration occurs between February and June (chiefly during April and May). 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 out-migrating from 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 habitat for rearing chum salmon. Rearing juvenile chum salmon use a wide variety of prey species, such as 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 move between freshwater to marine waters (or vice-versa) at certain life phases for non-reproductive purposes (Craig 1989). In the Arctic, amphidromous species live longer, experience slower growth, and reach sexually maturity much later in life than Arctic anadromous fish. Amphidromous Arctic fish spend more time in brackish coastal waters than marine waters and overwinter in freshwater. 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 spawning takes place, 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 amphidromous 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 natal streams (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 causeway (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 amphidromous 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). It is postulated that Arctic cisco in the Colville River area originated from spawning stocks of the Mackenzie River in Canada (Fechhelm and Fissel 1988; Fechhelm and Griffiths 1990; Gallaway et al. 1983), 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. com.). 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 three- to four-month open-water season that follows spring breakup, amphidromous fish accumulate energy reserves for overwintering, and, if sexually mature, 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).

Amphidromous fish are more abundant along the mainland and island shorelines, but 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, 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 amphidromous 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. Amphidromous 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 amphidromous 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 amphidromous 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 influenced by variability in weather patterns, like the strength of easterly winds (Alaska Biological Research [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. Some species that exhibit life history characteristics may allow them to survive challenging environmental conditions and may also move to, or expand in, the high Arctic region (Hollowed et al. 2013). For a more detailed discussion of climate change in the Arctic, see Section 3.1.2.4.

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).

In 1977, a climate shift occurred in the Bering Sea, abruptly changing from a cool to a warm period (ACIA 2004, 2005). The warming brought about ecosystem shifts that favored herring stocks and enhanced productivity for Pacific cod, skates, flatfish, and non-crustacean 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 ACIA, published in the mid-2000s (ACIA 2004, 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. Logerwell and Rand (2010) conclude that climate change may have resulted in northward expansion of some species' ranges, including commercially valuable species such as pollock and Pacific cod. This survey was also the first to document commercial-sized snow 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 EIS project area.

A period of warming in the region between 1990 and 2007, documented and discussed by Moulton (2010) reviewed a number of biological responses 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 Fishery Conservation and Management Act of 1976, which has been renamed the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), was enacted, along with other goals, to promote the protection of EFH in the review of projects conducted under federal permits, licenses, or other authorities that affect or have the potential to affect EFH. The Magnuson-Stevens Act defines EFH as *"those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity"* (16 U.S.C. 1802). 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.

The 1996 amendments to the MSFCMA set forth a mandate for NMFS, regional Fishery Management Councils, and other federal agencies to identify and protect EFH of economically important marine and estuarine fisheries. In Alaska, the NPFMC is the regional council responsible for fisheries management within the 3- to 200- nm 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 two of these apply to Arctic waters: the *Fishery Management Plan for the Salmon Fisheries in the EEZ off Alaska* (Salmon FMP) (NPFMC 2012) 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 seas (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 five species of Pacific salmon, in addition to Arctic cod, saffron cod, and opilio (snow) crab (NPFMC 2012. 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.

EFH is designated based on the best available scientific information (NMFS 2005). The MSFCMA defines categories to describe the level of understanding used to designate EFH that have previously been cited in environmental reports:

- Level 1: Presence/absence distribution data are available for some or all portions of the geographic range of the species;
- Level 2: Habitat-related densities of the species are available;
- Level 3: Growth, reproduction, or survival rates within habitats are available; and
- Level 4: Production rates by habitat are available

In addition, Level 0 was established to describe EFH for those life history stages where EFH could be inferred from another life history stage or a species with similar habitat characteristics. Arctic cod EFH is designated based on Level 1 information for adults and late juveniles. There are insufficient data available to designate EFH for eggs, larvae and early juveniles (NPFMC 2009). Pacific salmon EFH in Alaska is designated based primarily on Level 1 information for all species and life stages (NMFS 2005). Table 3.2-3 displays the level used to determine EFH status for Pacific salmon species in the Arctic.

Table 3.2-3 EFH Information Levels for Alaska Stocks of Pacific Salmon in the Arctic

Species	Eggs & Larvae	Juveniles fresh water (fry smolt)	Juveniles estuarine	Juveniles marine	Adults, immature / maturing marine	Adults freshwater
Chinook	1	1	1	1	1	1
Coho	1	1	1	0[a]	1	1
Pink	1	0[a]	0[a]	0[a]	0[a]	1
Sockeye	1	1	0[a]	0[a]	0[a]	1
Chum	1	0[a]	0[a]	0[a]	0[a]	1-2

0[a] - Some information on a species' life stage from which to infer general distribution.
Data from NMFS 2005.

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 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 (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 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 limit of the EEZ, including the Gulf of Alaska, eastern Bering Sea, Chukchi Sea, and Arctic Ocean.

EFH for Arctic marine species has thus far been limited to three 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 *Fishery Management Plan for Fish Resources of the Arctic Management Area* (NPFMC 2009), and 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, Larvae, and Early Juveniles* - Essential fish habitat of snow crab eggs is inferred from the general distribution of egg-bearing female crab (see Adults). 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) and middle (50 to 100 m) 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) and middle (50 to 100 m) shelf in Arctic waters south of Cape Lisburne, wherever there are substrates consisting mainly of mud.

In 2008, Logerwell and Rand conducted an offshore marine fish survey in the Beaufort Sea. The survey was the first to document commercial-sized snow crab in the North American Arctic (Logerwell and Rand 2010). This information may lead to an expansion of the EFH for snow crab in the future to include the western Beaufort Sea.

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 spring/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 are 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 3.2-4 provides a list of marine and coastal birds in the EIS project area with common names, scientific names, and Iñupiaq names.

Table 3.2-4 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
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*	
Semi-palmated Plover	*Charadrius semipalmatus*	

Whimbrel	*Numenius phaeopus*	Siituvuk, Siituvak
Hudsonian Godwit	*Limosa haemastica*	
Bar-tailed Godwit	*Limosa lapponica*	
Ruddy Turnstone	*Arenaria interpres*	Taliqvak, Tuullignaq
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
Stilt Sandpiper	*Calidris himantopus*	
Baird's Sandpiper	*Calidris bairdii*	
Buff-breasted Sandpiper	*Tryngites subruficollis*	
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's 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*	
Eastern 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 (Petersen 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 3.2-2 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 Sea (Figure 3.2-2).

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 primarily on the Arctic coastal plain, especially near Barrow and a minute remnant population remaining on the Yukon-Kuskokwim Delta (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 3.2-3 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).

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 to feed in the pelagic and benthic environment.

Kittlitz's 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 ANWR (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 in the Chukchi Sea (Figure 3.2-4). 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. The Kittlitz's murrelet remained a candidate species until September 2013 when it was determined that listing under the ESA was not warranted (78 FR 617636176361763 as posted in the *Federal Register* October 3, 2013 (78 FR 61764).

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 eight to ten 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's Gull

Ross's 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's 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's gulls are commonly seen during these fall migrations along the coast from Wainwright to Cape Halkett, approximately 160 km (100 mi) 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).

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 are 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.

Yellow-billed Loon

The yellow-billed loon is a large diving waterbird 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 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 3.2-5 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). In October 2014, the USFWS made a determination that listing the yellow-billed loon is “not warranted” (79 FR 59195).

Other 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).

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. 2009c).

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 River 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 River Delta (Ritchie et al. 2002, 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 birds 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; Powell et al. 2010; U.S. Shorebird Conservation Plan [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 is 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 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. Braund and Associates (2010) note the importance of Thetis Island as a location that subsistence hunters are able to hunt eiders while also conducting seal hunts. 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 bird species.

3.2.4 Marine Mammals

3.2.4.1 Marine Mammals

Fifteen marine mammal species occur in the Beaufort and Chukchi seas (Table 3.2-5). 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 under the ESA. 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 of the marine mammal species are 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 (Allen and Angliss 2010, 2012a, 2012b, 2013, 2015) and status reviews (Boveng et al. 2008, 2009; Cameron et al. 2010; Garlich-Miller et al. 2011; and Kelly et al. 2010a). Figures 3.2-6 to 3.2-22 show the distribution of marine mammal species.

Table 3.2-5 Marine Mammal Species Found in the EIS Project Area

Common Name	Scientific Name	Iñupiaq Name[a]	ESA Status
Cetaceans			
Bowhead whale	*Balaena mysticetus*	Agviq	Endangered
Humpback whale	*Megaptera novaeangliae*		Endangered
Fin whale	*Balaenoptera physalus*		Endangered
Minke whale	*Balaenoptera acutorostrata*		Not listed
Gray whale	*Eschrichtius robustus*	Agviqluaq	Delisted
Beluga whale	*Delphinapterus leucas*	Qixalugaq/Sisuaq	Not listed
Narwhal	*Monodon monoceros*		Not listed
Killer whale	*Orcinus orca*		Not listed
Harbor porpoise	*Phocoena phocoena*	Agviqsuaq	Not listed
Pinnipeds			
Ringed seal	*Phoca hispida*	Natchiq	Not listed
Spotted seal	*Phoca largha*	Qasigiaq	Not listed
Ribbon seal	*Histriophoca fasciata*	Qaigulik	Not listed
Bearded seal	*Erignathus barbatus*	Ugruk	Not listed
Pacific walrus	*Odobenus rosmarus divergens*	Aiviq	Candidate
Fissipeds			
Polar Bear	*Ursus maritimus*	Nanuq	Threatened

[a] **Source:** Bacon and Akpik 2010

3.2.4.2 Cetaceans

The NOAA's Cetacean Density and Distribution Mapping (CetMap) Working Group has identified Biologically Important Areas (BIAs) for 24 cetacean species, stocks, or populations in seven regions within U.S. Waters (Clarke et al. 2015a). In the Arctic region, 18 BIAs were identified for three cetacean species, bowhead, beluga, and gray whales, totaling 589,469 km^2. BIAs are reproductive areas, feeding areas, migratory corridors, and areas in which small and resident populations are concentrated. BIAs are region-, species-, and time-specific. The delineation of BIAs does not have direct or immediate regulatory consequences. Rather, the BIA assessment is intended to provide the best available science to help inform regulatory and management decisions under existing authorities about some, though not all, important cetacean areas in order to minimize the impacts of anthropogenic activities on cetaceans and to achieve conservation and protection goals (Clarke et al. 2015a). Further, information regarding these BIAs is included within the description of habitat use by species below.

<u>Bowhead Whale: Western Arctic Stock</u>

Species Description

Bowhead whales are baleen whales of the family Balaenidae. They are large, slow-swimming, 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).

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-Chukchi-Beaufort 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 2015). 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 substantially.

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 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 2011 was 16,892 bowhead whales in the Western Arctic stock (Givens et al. 2013). This is a substantial increase over the previous estimate from the 2001 ice-based census of 10,470 bowhead whales (George et al. 2004b), which was subsequently revised to 10,545 bowhead whales (Zeh and Punt 2004, cited in Allen and Angliss 2011). The estimated annual rate of increase from 1978 to 2001 was 3.4 percent, during which time abundance doubled from approximately 5,000 to approximately 10,000 whales (George et al. 2013b). The estimated rate of increase from 1978 to 2011 is 3.7 percent (Givens et al. 2013).

Brandon and Wade (2006) noted that the population may be approaching carrying capacity despite showing no sign of a slowing in the population growth rate. However, the recent estimate by Givens et al. (2013) is well above the carrying capacity of 13,854 whales estimated by Brandon and Wade (2006), suggesting that that carrying capacity was unrealistically low or that carrying capacity is changing (George et al. 2013b). There is currently no evidence that the population is near carrying capacity or above the maximum net productivity level (Givens et al. 2013).

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

Historically, Western Arctic bowhead whales are known to be 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). Recent updates from the Alaska Department of Fish and Game (ADF&G) tagged bowhead whale tracking data show a tagged bowhead wintering south of 59°N latitude in the southwest Bering Sea (Citta 2013), and tracking data from summer 2012 showed a tagged whale spent an extended period of time near 76 and 78°N latitude in the Chukchi Sea (Citta et al. 2012). 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, 2012a) (Figure 3.2.-6). Some animals remain in the eastern Chukchi and western Beaufort seas during the summer (Clarke et al. 2011a, 2012, 2013, 2014, 2015b; Ireland et al. 2008).

Recent satellite tagging studies provide a more detailed look at winter distribution of bowhead whales. Winter bowhead distribution was generally concentrated around the Bering Shelf north of Navarin Canyon and the 200 m (656 ft) isobath. During the winter of 2008-2009, areas of higher use extended from the Bering Strait through the Anadyr Strait to Navarin Canyon, and in the following winter (2009-2010), their distribution shifted south of St. Lawrence Island from Cape Navarin to St. Matthew Island (Citta et al. 2012). Two whales migrated into the Chukchi Sea in March of 2009, though most did not begin migrating north into the Chukchi Sea until April (Quakenbush et al. 2010a). Satellite tagged whales (Citta et al. 2012) indicate a much greater use of continuously ice covered habitat in the northern Bering Sea than previously believed, and the association of wintering bowhead whales with the marginal ice front and the polynyas near St. Matthew and St. Lawrence Islands and the Gulf of Anadyr appears to be not as strong as previously assumed (Moore and Reeves 1993; NMFS 2008b). Data from 54 bowhead whales tagged between 2006 and 2012 indicate several core-use areas for this population, with Anadyr Strait and the Gulf of Anaydr used from late November to April when the Bering Sea is largely ice-covered north of the shelf break (Citta et al. 2015).

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 3.2-7). Tagged whales began migrating north in early April, passed into the Chukchi Sea by mid-April, on average, and all passed Barrow by May 7, during 2009 and 2010, travelling parallel to and within 40 km (24.8 mi) of the coast (Quakenbush et al. 2012). Once past Barrow, several of the tagged whales traveled directly to the Amundsen Gulf/Cape Bathurstpolyna (Citta et al. 2015; Quakenbush et al. 2010a and 2013) (Figure 3.2-8). Recent re-analysis of 30 years of ice-based census data indicates a trend toward an earlier arrival of bowhead whales at Barrow during the spring migration. Possible reasons for this include reduced multi-year ice in the Chukchi Sea and earlier development of leads, an overall reduction in the ice pack extent, the increasing bowhead whale population, or a combination of these reasons (George et al. 2013b). 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).

Bowhead whale distribution in the Beaufort Sea during summer-fall has been studied by aerial surveys through the Bowhead Whale Aerial Survey Project (BWASP). This project was funded or contracted by the MMS/BOEM and BLM annually from 1979 to 2010. The focus of the BWASP aerial surveys was the autumn migration of bowhead whales through the Alaskan Beaufort Sea, although data were collected on all marine mammals sighted. The NMFS National Marine Mammal Laboratory (NMML) began coordinating BWASP in 2007, with funding from MMS.

Bowhead whale and other marine mammal distribution data were also collected during most summers from 1979 to 1991 by MMS-supported contractors in the northeastern Chukchi Sea Planning Area (CSPA). A hiatus in broad-scale marine mammal aerial surveys in this region between 1991 and 2008 followed. In 2008, the Chukchi Offshore Monitoring in Drilling Area (COMIDA) project, funded by

MMS/BOEM, began broad-scale aerial surveys for marine mammals in the CSPA. The goal of COMIDA was to monitor marine mammal distribution, relative density, and behavior during the open-water months from mid-June or early July to the end of October.

In 2011, an Interagency Agreement between the BOEM and NMML combined BWASP with COMIDA under the auspices of a single survey called Aerial Surveys of Arctic Marine Mammals (ASAMM) (Clarke et al. 2012); both studies are funded by BOEM. The most recent survey years (2006 through 2014) were light ice years. Median distance of bowhead whales from shore was 23.6 km (14.7 mi) in the East Region and 24.2 km (15.0 mi) in the West Region during previous low-ice years, with annual median distances ranging from as close as 6.3 km (3.9 mi) in 2009 to 37.6 km (23.4 mi) in 2013 (Clarke et al. 2015b). Median depth of sightings during previous low-ice years was 39 m (128 ft) in the East Region and 21 m (69 ft) in the West Region; in 2014, median depth of on-transect sightings was 20 m (66 ft) and 19 m (62 ft), respectively (Clarke et al. 2015b). Bowhead distribution in 2014 was similar to that of other low ice years, with the exception of sightings in Camden Bay and offshore in the Chukchi Sea in 2014 (Clarke et al. 2015b). In September and October 2014, bowhead whales in the East Region of the study area were sighted in shallower water and closer to shore than in previous years of light sea ice cover; in the West Region, bowhead sightings in fall 2014 were in shallower water than in previous light ice years, but the distance from shore did not differ (Clarke et al. 2015b). Behaviors included milling, swimming, and feeding, to a lesser degree. Highest numbers of sightings were in the central Beaufort Sea and east of Point Barrow.

During the summer, most of the population is in the southern and eastern Beaufort Sea and Amundsen Gulf, including the Tuktoyaktuk Shelf core-use area (Citta et al. 2015). Tagging studies and aerial surveys also indicate summer movements to areas outside the Canadian Beaufort. These include the central Alaskan Beaufort Sea and Barrow, and as far as the northern coast of Chukotka, Russia (Citta et al. 2015; Clarke et al. 2012; Quakenbush et al. 2012). In August 2010, one whale traveled north and east from Amundsen Gulf to Viscount Melville Sound, a main route of the Northwest Passage, where it remained for about 10 days. A bowhead whale tagged off West Greenland arrived in the same area a few days after the Western Arctic bowhead departed, suggesting that the Western Arctic and Baffin Bay-Davis Strait stocks could intermingle during summer (Heide-Jørgensen et al. 2011). 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 was observed feeding in nearshore waters between Point Franklin and Barrow along the Chukchi Sea coast, although 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). Four bowheads were seen near Point Franklin in June 2011, but none were observed feeding (Clarke et al. 2012). In late June and early July 2012, single bowhead whales were seen scattered nearshore from Point Franklin to Cape Lisburne, with one sighting approximately 40 km (24.8 mi) north of Cape Lisburne (Clarke et al. 2013). Clarke et al. (2013) noted feeding behavior of one of those bowhead whales in early July near Icy Cape. Clarke et al. (2014) sighted bowhead whales scattered nearshore in the vicinity of Point Franklin and northwest of Icy Cape in July 2013, but none were observed feeding. In July 2014, two bowhead whales were seen offshore of Point Franklin (Clarke et al. 2015).

In September to mid-October bowheads begin their western migration out of the Canadian Beaufort Sea to the Chukchi Sea (Figure 3.2-10). Most westward travel across the Beaufort Sea by tagged whales was over the shelf, within 100 km (62 mi) of shore, although a few whales traveled farther offshore (Quakenbush et al. 2012).

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. Feeding during the fall migration is most likely a result of whales encountering food resources where they can briefly stop to feed before continuing on past Point Barrow to the Chukchi Sea. 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). Based on visual observations and tagging data, important feeding areas include Amundsen Gulf, near Point Barrow, Wrangel Island, the northern coast of Chukotka, the western Bering Sea, and near Kaktovik (Clarke et al. 2011a, 2011b, 2011c; Koski and Miller 2009; Quakenbush et al. 2010a and 2013).

The Barrow area is used as a feeding area during spring and fall, with peak use of the area between late-August and early-November during the fall migration (Citta et al. 2015). A higher proportion of photographed individuals showed evidence of feeding in fall than in spring (Mocklin 2009). Opportunistic sampling of zooplankton near feeding bowhead whales suggest they were preying on dense swarms of euphausids (*T. raschii*) or copepods (*Pseudocalanus spp.*) (Moore et al. 2000). 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 due to a combination of the physical and oceanographic features of Barrow Canyon, combined with favorable wind conditions (Ashjian et al. 2010; Moore et al. 2010; Okkonen et al. 2011). Data suggest that euphausiids were present in lower numbers than in 2009-2010 and that there might be a minimum threshold of abundance below which bowhead whales would not stay to feed (Shelden et al. 2012). The bowhead whale feeding aggregations may, therefore, have not been seen because of lack of prey or because the 2011 migration was late passing through the area, or both (Clarke et al. 2012). However, it is likely that bowhead whales feed annually in September and October between Smith Bay and Point Barrow, usually at depths less than 20 m and/or in Barrow Canyon (J. Clarke, pers. comm. 2013).

The area near Kaktovik appears to be one of the areas important to bowhead whales primarily during the fall (NMFS 2010e). BOEM-funded BWASP surveys show areas off Kaktovik as areas that are sometimes of high use by bowhead whales (Clarke et al. 2011b, 2011d, 2013, 2015b; NMFS 2010e). Data recently compiled by Clarke (2012) further illustrate the frequency of use of the area east of Kaktovik by bowhead mothers and calves during August, September, and October.

Historically, there have been few spring, summer, or autumn observations of bowheads in larger bays such as Camden, Prudhoe, and Harrison Bays, although some groups or individuals have occasionally been observed feeding around the periphery of or, less commonly, inside the bays as migration demands and feeding opportunities permit. Observations indicate that juvenile, sub-adult, and cow-calf pairs of bowheads are the individuals most frequently observed in bays and nearshore areas of the Beaufort, while more competitive whales are found in the Canadian Beaufort and Barrow Canyon, as well as deeper offshore waters (Clarke et al. 2011b, 2011c, 2011d, 2012, 2013, 2014, 2015b; Koski and Miller 2009; Quakenbush et al. 2010). Industry funded aerial surveys of the Camden Bay area west of Kaktovik reported a number of whales feeding in that region in 2007 and 2008 (Christie et al. 2010); however, more recent ASAMM surveys have not noted such behavior in Camden Bay. These mostly recent observations of juvenile/sub-adult/cow-calf bowheads in these areas may also indicate a population that is approaching the carrying capacity of the environment, and less competitive individuals are being pushed to use sub-optimal habitat. While data indicate that bowhead whales might feed almost anywhere in the Alaskan Beaufort Sea within the 50-m isobath, feeding in areas outside of the area noted between Smith Bay and Point Barrow and/or in Barrow Canyon are ephemeral and less predictable (J. Clarke, pers. comm. 2013).

From mid-September to mid-October, bowheads occur in the northeast Chukchi Sea. Tagged whales passed Point Barrow between July 21 and November 2, with a median date of October 10 (Quakenbush et al. 2012). Most of the tagged whales in 2006 through 2010 traveled west from Point Barrow through the Chukchi Sea between 71˚ and 74˚ N latitude. All but one traveled through the Chukchi Sea 193 Lease Sale area in the northeastern Chukchi Sea at least once (Figure 3.2-10) (Quakenbush et al. 2010b, 2012, 2013). 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. More bowhead whales were sighted during the 2010 Chukchi Sea Environmental Study Program (CSESP) surveys of these lease sale prospects than in the previous two years. Two bowheads were sighted in the Statoil study area in mid-September, and 35 sightings totaling 52 whales were made in the Burger study area and along the Burger to Wainwright transect in early October (Aerts et al. 2011, 2013).

The area of highest probability of use by satellite tagged whales in September was concentrated northeast of Point Barrow. The importance of this region as a feeding area is described above. 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 and 2013). Most tagged whales were crossing the Chukchi Sea in September heading to Wrangel Island and Chukotka (Figure 3.2-9). 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 and 2013). Bowhead whales increased in the COMIDA survey 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). This differed in 2011, when there were few bowhead whale sightings, despite tremendous survey effort (Clarke et al. 2012). In 2012, sighting rates of bowhead whales in the northeastern Chukchi Sea in September and October were an order of magnitude higher than in 2011, although distribution was as seen in other low-ice years (Clarke et al. 2013). The sighting rate of bowhead whales in this area in fall 2014 was higher than observed in fall 2008-2011 and 2013, but well below the sighting rate for this area in 2012 (Clarke et al. 2015b).

In October, the area of highest probability of use was 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 and 2013). Peak use of the Northern Chukotka/Bering Strait core-use area by satellite-tagged bowhead whales (2006-2012) occurred between late October and early January (Citta et al. 2015).

The fall migratory corridor from Amundsen Gulf back to Barrow was less defined than during the spring migration. Some whales travel closer to shore (within 10-15 miles of the coastline) and some travel farther 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 and 2013). 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 and 2013).

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 August 30, 2002 (67 FR 55767), NMFS announced the decision to not designate critical habitat. NMFS determined that as the population is increasing and nearing its pre-commercial whaling population size, and no known habitat issues are impeding population growth, critical habitat designation was unnecessary (Allen and Angliss 2011, 2012a).

Clarke et al. (2015a) compiled the existing information on bowhead habitat use and identified and delineated nine BIAs for bowhead whales in the Arctic: four reproductive areas, three feeding areas, and two migratory corridors. These areas are especially important during the times of year indicated in figures 8.1 through 8.3 in Clarke et al. (2015a) and figure 3.2-11 in this FEIS.

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 Resources and Uses) and have been hunted by Iñupiats for at least 2,000 years. Takes are regulated by quotas established under the authority of the IWC. The average annual combined take by subsistence hunters in Alaska, Russia, and Canada was 44 from 2009 through 2013 (Allen and Angliss 2015; Muto et al. 2016). Incidental mortality or injury from entanglement in commercial fishing gear is known to occur. Scarring attributed to ropes or entanglements have been observed on approximately 10 percent of whales harvested from 1988 to 2008 (Reeves et al. 2012). There are numerous documented cases of bowhead whales bearing ropes or rope scars, including a bowhead whale observed near Point Barrow with fishing net and line around the head (Allen and Angliss 2013). 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. 2011a). The overall rate of entanglement in U.S. commercial fisheries is unknown, but the minimum average annual entanglement rate was 0.2 whales from 2009 through 2013 (Allen and Angliss 2015; Muto et al. 2016).

Incidence of injury caused by vessel collisions appears to be low. Two to three percent of harvested whales examined between 1988 and 2007 had ship or propeller injuries (Reeves et al. 2012). The low incidence of observed injury or scarring 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, parasites, or other sources of natural 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 2013).

Hearing and Other Senses

Bowhead whales are grouped among low frequency functional hearing baleen whales (Southall et al. 2007). Inferring from their vocalizations, bowhead whales should be most sensitive to frequencies between 20 Hz - 5 kHz, with maximum sensitivity between 100-500 Hz (Erbe 2002). Vocalization bandwidths vary. 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. Bowhead calls have been distinguished by Würsing and Clark (1993): pulsed tonal calls, pulsive calls, high frequency calls, low-frequency frequency-modulated (FM) calls (upsweeps, inflected, downsweeps, and constant frequency calls). However, no direct link between specific bowhead activities and call types was found. Bowhead whales have been noted to produce a series of repeating units of sounds up to 5000 Hz that are classified as songs, produced primarily by males on the breeding grounds (Delarue et al. 2011). Tonal FM modulated vocalizations have a bandwidth of 25 to 1200 Hz with the dominant range between 100 and 400 Hz and lasting 0.4- 3.8 seconds. Bowhead whale songs have a bandwidth of 20 to 5000 Hz with the dominant frequency at approximately 500 Hz and duration lasting from one minute to hours. Pulsive vocalizations range between 25 and 3500 Hz and last 0.3 to 7.2 seconds (Clark and Johnson 1984; Cummings and Holliday 1987, in Erbe 2002; Würsig and Clark 1993).

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, 2012a, 2013, 2015).

It is uncertain as to whether the individuals that venture into the Chukchi Sea are from the Central or Western North Pacific stock or both. 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) states, “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). Data indicate that abundance of humpback whales in Southeast Alaska has increased, though a trend for this portion of the stock cannot be estimated from the data because of differences in methods and areas covered (Allen and Angliss 2013). 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, 2012a, 2013).

The humpback whale is listed as endangered under the ESA and designated as depleted under the MMPA. In April 2015, the NMFS finished a status review of humpback whales and announced a proposal to revise the listing status by splitting the endangered species into 14 distinct population segments (DPSs) and replacing the current species-level listing with listings by DPS, defined by breeding population (80 FR 22304, April 21, 2015). The result would be two listed as endangered (Cape Verde Islands/Northwest Africa and Arabian Seas DPSs), two as threatened (Western North Pacific and Central America DPSs), and ten not proposed for listing (the West Indies, Hawaii, Mexico, Brazil, Gabon/Southwest Africa, Southeast Africa/Madagascar, West Australia, East Australia, Oceania, and Southeastern Pacific DPSs). The Central North Pacific stock would fall within the Hawaii and Mexico DPSs and the Western North Pacific stock would become the Western North Pacific DPS and be listed as threatened (80 FR 22304, April 21, 2015).

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, 2012a; Calambokidis et al. 2008).

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 Alaskan Beaufort and Chukchi seas. Historically (1930s-1960s), sightings were made by the Russian whaling flotilla and during studies from 1990-1996 in Chukchi Sea waters off the Russian Chukchi Peninsula (Melnikov 1999). 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). BWASP and ASAMM data from 2006-2013 did not report any sightings of humpback whales in the Beaufort Sea (Clarke et al. 2011b, 2011c, 2011d, 2012, 2013, 2014, 2015b).

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). Aerts et al. (2011) observed one humpback whale during a transit to Nome in 2010. The 2012 ASAMM surveys observed 29 humpback whales on five different flight days with 24 of these observed during one flight on September 11 near Point Hope. The majority of observations were of single humpbacks; there were also five groups of two individuals and one group of four individuals. There were four recorded feeding events, three of which were observed on September 11 (Sims et al. 2013). Additionally, a number of humpback whales were observed by the ongoing Arctic Whale Ecology

Study (ARCWEST) and ASAAM, as well as during other research cruise and monitoring efforts, during the 2012 open water season. Humpback whales were also acoustically detected on recorders in the Chukchi Sea during joint industry monitoring programs in 2012 (LGL Research Associates, Inc. et al. 2013). Two distinct pairs of adult humpback whales were observed on August 27, 2013, during ASAMM surveys approximately 80 km (50 mi) northeast of Cape Lisburne (Clarke et al. 2014). All 22 sightings (46 whales) of humpback sightings during ASAMM surveys in 2014 were in the southcentral Chukchi Sea in September. Most were seen on September 4, 2014 90-110 km (56-68 mi) south of Point Hope in close association with fin whales and gray whales (Clarke et al. 2015b).

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 five 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 20th 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. This whale was in the process of stranding when taken so was not included in the average annual mortality rate from subsistence takes for 2005-2010 (Allen and Angliss 2012a). There are no other reports of subsistence takes from the Western North Pacific stock. 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, 2012a, 2015).

Mortality or injury due to interactions with commercial fisheries is possible. Incidental mortality of one western or central North Pacific humpback whale was reported in the Bering Sea/Aleutian Islands flatfish trawl fishery and two were reported in the Bering Sea/Aleutian Islands pollock trawl fishery between 2009 and 2013. The estimated annual mortality rate incidental to observed U.S. commercial fisheries was calculated as 0.6 humpbacks from for the western North Pacific stock. The estimated fishery-related minimum mortality and serious injury rate incidental to observed commercial fisheries for the Alaska part of the central North Pacific stock is 6.1 humpbacks per year for 2009 to 2013 (0.6 in federal groundfish fisheries and 5.5 in the state-managed Southeast Alaska salmon drift gillnet fishery) (Allen and Angliss 2015; Muto and Angliss 2016).

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). However, Au et al. (2006) note humpback whale songs having harmonics that extend beyond 24 kHz. Humpback whales are predicted to have good sensitivity from 20 Hz up to 6-7.5 kHz based upon inner ear anatomy (Houser et al. 2001). In summary, humpback whales produce at least three classes of vocalizations: (1) Complex songs with components ranging from at least 20 Hz–5 kHz with estimated source levels from 144– 174 dB; these are mostly sung by males on the breeding grounds (Au et al. 2000, 2006; Frazer and Mercado 2000; Richardson et al. 1995; Winn et al. 1970); (2) Social sounds in the breeding areas that extend from 50Hz – more than 10 kHz with most energy below 3kHz (Richardson et al. 1995; Tyack and Whitehead 1983); and (3) Feeding area vocalizations that are less frequent, but tend to be 20 Hz–2 kHz with estimated sources levels in excess of 175 dB re 1 Pa at 1m (Richardson et al. 1995; Thompson et al. 1986).

Fin Whale: Northeast Pacific Stock

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 (Allen and Angliss 2010, 2012a, 2015; NMFS 2010b). 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. There is some level of incomplete information on population status of fin 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. However, Visual surveys on the eastern Bering Sea shelf in 2002, 2008, and 2010 provide provisional abundance estimates of 419, 1,368, and 1,061 fin whales, respectively (Friday et al. 2013). Surveys conducted in 2001 to 2003 in coastal waters off western Alaska and the eastern and central Aleutian Islands recorded fin whales from Kodiak Island to Samalga Pass, with a resulting estimate of 1,652 whales for that area (Zerbini et al. 2006). These estimates cannot be applied to the entire Northeast Pacific stock, since they are based on surveys in only part of the stock’s range (Allen and Angliss 2015). The largest of the minimum estimates from the 2008-2010 surveys (1,368) is considered the best provisional estimate for fin whale abundance west of the Kenai Peninsula and a minimum estimate for this portion of the stock’s range; a minimum abundance for the entire stock in unknown (Allen and Angliss 2015). 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 2007 to 2010, fin whales were among the species commonly detected acoustically in the Chukchi Sea during July to October (Crance et al. 2011; Delarue et al. 2013; Hannay et al. 2011, 2013). Song sequences recorded in 2007 and 2010 matched one of the songs previously recorded in the Bering Sea (Delarue et al. 2013). In August 2012, fin whales were acoustically detected on a sonobuoy 50 km (31 mi) off of Barrow near the mouth of the Barrow Canyon. This is the farthest northeast record of fin whale calls in the Alaskan Arctic to date (Crance et al. 2015). 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). Observations made during the 2012 ASAMM surveys in the Chukchi Sea observed a total of five fin whales (including two calves) on September 11 near Point Hope. Three individuals were observed lunge feeding (Sims et al. 2013). Observations made during the 2013 ASAMM surveys in the Chukchi Sea observed a total of three fin whales on three separate days in July and August (Clarke et al. 2014). Two of the observations occurred off the coast between Point Hope and Cape Lisburne, and the late August sighting occurred north of Cape Lisburne in conjunction with the sighting of two distinct humpback whale pairs (Clarke et al. 2014). Fin whale observations during 2014 ASAMM surveys included 17 sightings of 36 whales, all in the southcentral Chukchi Sea in September. Most were seen on September 4, 2014 90-110 km (56-68 mi) south of Point Hope in close association with humpback whales and gray whales (Clarke et al. 2015b). Fin whales have been acoustically detected on recorders in the Chukchi Sea during joint industry monitoring programs in 2007, 2009, 2010, and 2011; however, acoustic detections decreased sharply from 2007 to 2009, with detections remaining rare thereafter (LGL Research Associates, Inc. et al. 2013).

There is evidence of fin 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 (Kawamura 1982; Nemoto 1970).

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 20th 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, 2012a).

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 killed incidental to entanglement in ground tackle of a commercial menchanical jog fishing vessel in 2012, for an average annual mortality and serious injury rate of 0.2 fin whales in 2009 through 2013 (Allen and Angliss 2010, 2012a; Muto and Angliss 2016). Ship strikes have also resulted in fin whale mortalities in Alaskan waters, with two reported between 2009 and 2013 (Allen and Angliss 2012a, 2013; Muto and Angliss 2016).

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). Fin whales produce a variety of low-frequency sounds in the 10-200 Hz band (Edds 1988; Thompson et al. 1992; Watkins 1981; Watkins et al. 1987). The most typical signals are long, patterned sequences of short duration (0.5-2s) infrasonic pulses in the 18-35 Hz range (Patterson and Hamilton 1964). Estimated source levels for fin whales are 140-200decibels (dB) re 1 µPa m (Clark and Gagnon 2004; McDonald et al. 1995; Patterson and Hamilton 1964; Thompson et al. 1992; Watkins et al. 1987).

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, 2012a, 2015).

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 2012b, 2015). There is 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). Until recently, there were only a few documented sightings of minke whales in the Chukchi Sea during summer (Ireland et al. 2008). 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 ship-based surveys in the Chukchi Sea, 2006 through 2008, with three in 2006, three in 2007, and eight sightings in 2008 (Funk et al. 2010). Minke whales were not sighted during aerial surveys of the northeastern Chukchi Sea study area in 2008-2010, but in 2011, there were five sightings of six minkes (plus an additional four sightings of probable minke whales) from July to September during ASAMM surveys. One minke whale seen during September at 71.89°N, 163°W (approximately 180 km [112 mi] northwest of Wainwright) is thought to be the farthest north confirmed sighting of a minke whale in the northeastern Chukchi Sea (Clarke et al. 2012). A total of seven minke whales were observed during four separate ASAMM surveys in July, August, and September of 2012 in the Chukchi Sea. Sightings of minke whales are becoming more common in the eastern Chukchi Sea, especially south of Point Lay (Clarke et al. 2012). Five minke whales were again sighted in July and August during the 2013 ASAMM surveys between just north of Cape Lisburne and just north of Icy Cape, and all were within 11 km of shore (6.8 mi) (Clarke et al. 2014). Three minke whales were seen in two sightings (one in the southcentral Chukchi Sea and one west of Icy Cape) during September 2014 ASAMM surveys (Clarke et al. 2015b). Roseneau (2010) indicates minke whales started occurring in the waters off Cape Lisburne in the mid-1990s and observed one to three individuals each summer through 2009. Acoustic detections of minke whales were recorded in the Chukchi Sea in 2011 for the first time and again in 2012 (LGL Research Associates Inc. et al. 2013). They are rare in the Beaufort Sea, with only one observation in each of 2007, 2008, and 2012 during industry vessel surveys in the region (LGL Research Associates Inc et al. 2013).

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, IWC, 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). The total estimated mortality and serious injury due to interactions with U.S. commercial fisheries was zero for 2009 to 2013 (Allen and Angliss 2012a, 2015; Muto et al. 2016).

Minke whales are preyed upon by killer whales (Perrin and Brownell 2009). Roseneau (2010) observed an adult minke killed and eaten by a pod of five male killer whales just north of Cape Lisburne in 1997.

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). However, an unpublished report (Ketten and Mountain 2009) and data (Tubelli et al. 2012) predicted a hearing range for minke whales of up to 30 kHz based on inner ear anatomy. Tubelli et al. (2012) predicted a best hearing range for minke whales up to 6-7.5 kHz, again based on inner ear anatomy. Minke whales produce a variety of calls ranging from 60 Hz to 20 kHz (Department of the Navy 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 were previously identified off southern Vancouver Island, British Columbia, Canada and Laguna San Ignacio, Mexico in the eastern North Pacific (Mate et al. 2011; Weller et al. 2012). Recent tagging data of a female that traveled roundtrip between Sakhalin Island and Baja California, Mexico suggests that some presumed western North Pacific gray whales may actually be eastern North Pacific gray whales (Mate et al. 2015). A gray whale tagged by ADF&G in 2012 moved from the nearshore Chukchi Sea between Barrow and Wainwright to the vicinity of Khatyrka, Russia (approximately 62º N., 176º E.) when the tag stopped transmitting (Citta 2012b). The eastern North Pacific stock, however, is the only one considered in this EIS, as it is unlikely that meaningful numbers of western North Pacific gray whales will occur in the EIS project area and that some of those previously believed to be western North Pacific gray whales are likely eastern North Pacific gray whales.

The eastern North Pacific gray whale population has been increasing over the past several decades. Abundance estimates from southbound migration population surveys reached a high of 21,135 whales in 1997/98 (Laake et al. 2009). The most recent population estimates were 16,369 in 2000/01, 16,033 in 2001/02, 19,126 in 2006/07, and 20,990 in 2010/11 (Durban et al. 2013; Laake et al. 2009). The lower estimates in 2000 to 2002 were likely related to high levels of mortality during an unusual mortality event in 1999 and 2000 (Rugh et al. 2005). An unusually high number of gray whales, 60 percent of which were adults, stranded along the west coast of North America. Many were emaciated, suggesting that starvation was a contributing factor. This was considered a short-term, acute event from which the population appears to have rebounded (Allen and Angliss 2012a). 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 more 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, 2012a), 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 3.2-12). 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, 2012a).

Gray whales are more common in the Chukchi than in the Beaufort Sea. Gray whales were observed in all survey months (late June through October) and years (2008 through 2014) during COMIDA and ASAMM aerial surveys (Clarke et al. 2011a, 2012, 2015). Gray whales were also the most frequently sighted and numerous whales reported during industry monitoring studies in the Chukchi Sea from 2006 to 2012 (LGL Research Associates, Inc. et al. 2013). They were consistently observed within 50 km (31.1 mi) of shore between Wainwright and Barrow (Clarke et al. 2011a, 2012, 2013, 2014, 2015; LGL Research Associates, Inc. et al. 2013). 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. In 2011, gray whales were seen very close to shore from east of Cape Lisburne to south of Point Hope, where they regularly occurred in the 1980s to early 1990s, but not during 2008 to 2010. Also, unlike previous years, few gray whales were seen offshore west of Point Hope in 2011 and 2012, while they were observed 50 to 100 km (31 to 60 mi) offshore between Point Franklin and Icy Cape (Clarke et al. 2012, 2013). Gray whales continued to be mostly absent from Hanna Shoal during all survey months in 2008 through 2014, although two sightings in September 2013 were near the southern edge of Hanna Shoal and a few gray whales were seen on Hanna Shoal in August and September 2014 (Clarke et al. 2014, 2015). This differed markedly from surveys of 1982 through 1991 when gray whales frequented Hanna Shoal (Clarke et al. 2011a, 2012, 2013). Sightings of gray whales near to Point Barrow increased in recent years. Native hunters observed growing numbers of gray whales during late summer and autumn (Moore and Laidre 2006). 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 summers of 2010 and 2011, gray whales regularly occurred in small groups north of Point Barrow and west of Barrow (George et al. 2011; Shelden et al. 2012). In 2011, there were no sightings of gray whales east of Point Barrow during ASAMM aerial surveys (Clarke et al. 2012). In contrast, gray whales were observed east of Point Barrow, primarily in the vicinity of Barrow Canyon, from August to October 2012 (Clarke et al. 2013). Gray whales were again observed east of Point Barrow in 2013, with all sightings in August except for one sighting in late October (Clarke et al. 2014). In 2014, gray whales were seen during all survey months in the northeastern Chukchi Sea and in July, August, and September in the southcentral Chukchi Sea and the western Beaufort Sea. Sightings in the Beaufort Sea included a few whales east of Point Barrow and one north of Cross Island near Prudhoe Bay (Clarke et al. 2015b). 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).

Clarke et al. (2015a) compiled the existing information on gray whale habitat use and identified and delineated five BIAs for gray whales in the Arctic: two reproductive areas, and three feeding areas. These areas are important during the specific times of year indicated in figures 8.6 and 8.7 in Clarke et al. (2015a) and figure 3.2-13 in this FEIS.

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). More calves were observed during the 2012 ASAMM surveys than any time since 1979 (Bower et al. 2013).

Survival and Mortality

Gray whales suffered heavy exploitation through commercial whaling in the 19th and early 20th 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 minimum 4.45 gray whales died annually from interactions with commercial fishing gear between 2008 and 2012 (Carretta et al. 2015). 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 (Carretta et al. 2015).

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 2012, the IWC approved a five-year quota (2013 through 2018) of 740 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.). The annual subsistence take averaged 127 whales from 2008 to 2012; all were taken in Russia (Carretta et al. 2015).

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. From 2008 to 2012, mortality and serious injury due to ship strikes averaged 9.8 eastern North pacific gray whales per year; none were reported in Alaska waters (Carretta et al. 2015). In 1997, one fatal ship strike of a gray whale was reported in Alaska (B. Fadely, Alaska Fisheries Science Center-National Marine Mammal Laboratory, 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 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 one-third 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). However, Lucifredi and Stein (2007) reported gray whales potentially responding to sounds beyond 22 kHz. 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 nine to 38 years and from six 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, 2012a). 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 surveys 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, 2012a, 2013, 2015). 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).

In 2012, efforts to estimate abundance of the eastern Chukchi Sea stock took place. Those data are currently being analyzed. Until that analysis is complete, 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. There is currently no evidence that the eastern Chukchi Sea stock of beluga whales is declining, but the current trend is unknown (Allen and Angliss 2010, 2012a, 2015).

Neither the Beaufort Sea beluga whale stock nor the eastern Chukchi Sea stock is listed as depleted under the MMPA or as 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 winter in offshore, although relatively shallow, waters of the western Bering Sea (Richard et al. 2001), and the Beaufort Sea stock may winter in more nearshore waters of the northern Bering Sea (R. Suydam, pers. comm. 2012c). In the spring, belugas migrate to coastal estuaries, bays, and rivers. Annual migrations may cover thousands of kilometers (Figure 3.2-14) (Allen and Angliss 2010, 2012a).

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 were regularly sighted during the September-October BWASP and the more recent ASAMM 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 low 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). In 2011, belugas were also seen along the Beaufort Sea continental slope and near Barrow Canyon, with a few scattered sightings nearshore, in all months (July through October) during which ASAMM surveys were flown (Clarke et al. 2012). Sighting rates were highest along the Alaskan Beaufort Sea slope, in the 201 to 2,000 m (659 to 6,562 ft) depth zone near Barrow Canyon, and in the >2000 m

(>6562 ft) depth zone in the Alaskan Beaufort Sea. Beluga distribution in 2014 was centered over the continental slope and Barrow Canyon in summer and fall and scattered in the northeastern Chukchi Sea in all survey months (Clarke et al. 2015b). Distribution patterns of belugas in the Alaskan Beaufort Sea have remained relatively consistent for the past 30 years (Clarke et al. 2013, 2015). Belugas seen during these surveys could be from either the Beaufort Sea or Chukchi Sea stocks.

Abundance and distribution of beluga whales in Barrow Canyon and the western Beaufort slope appear to be influenced by hydrographic conditions that may concentrate prey, such as Arctic cod, and enhance foraging opportunities. Recent analysis of oceanographic and wind data, acoustic detections of belugas, and 30 years of aerial survey data indicate larger group sizes and longer detection periods of belugas in and near Barrow Canyon when the Alaska Coastal Current (ACC) is well-developed and flowing east-northeastward during summer and autumn (Stafford et al. 2013).

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; R. Suydam, Department of Wildlife Management, North Slope Borough [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. Acoustic data from summer 2012 again noted few beluga whale vocalizations in the northeastern Chukchi Sea (LGL Alaska Research Associates, Inc. et al. 2013). Calls in July and August in the 2007 and 2008 study are concentrated in or 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, 2013). 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, 2013). 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, 2013). There were no recorders deployed inshore. Spring 2012 acoustic data were similar to those from previous years with detections beginning around mid-April and continuing (with some breaks in detections) through May with only sporadic detections in June and July. Higher calls then began again in early to mid-October (LGL Alaska Research Associates, Inc. et al. 2013).

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), or during surveys of Burger, Klondike, or Statoil leases from July to October 2010 (Aerts et al. 2011), possibly because the observation vessels influenced the distribution, behavior, and detectability of animals.

Belugas were seen, however, during aerial surveys conducted from June through November in the northeastern Chukchi Sea, 2008 to 2012, as part of the COMIDA project and from June through October 2011 and 2012 during ASAMM surveys. They were sighted every month except September, and none were sighted within Lease Sale Block 193 during 2008 to 2010 (Clarke et al. 2011a, 2013; Ferguson et al. 2013). In 2011, belugas in the Chukchi Sea were scattered both offshore and nearshore in June, September and October, were consistently within approximately 100 km (62 mi) of shore in July, and were primarily along the northwestern Alaskan coast in August. The highest sighting rate per depth zone was in shallow water (≤35 m [≤114 ft] depth) (Clarke et al. 2011a, 2012). The large groups (>150 whales) frequently seen near the coast south of Point Lay in June and mid-July in 2011 were reminiscent of large groups seen during surveys of the late 1970s through the early 1990s (Clarke et al. 2012). One group of 400 belugas, observed on June 25 south of Point Lay, was feeding. Such groups were not seen in this area in 2008 to 2010; there were also more sightings in 2011 (299) than in 2008 to 2010 combined (153) in the ASAMM study area (Clarke et al. 2012). Groups of 400 and 200 beluga whales were sighted near Kasegaluk Lagoon in July 2013 and July 2014, respectively (Clarke et al. 2014, 2015). 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. 2011b). In 2012 and 2013, ASAMM surveys reported numerous beluga whale sightings from July through October centered over the continental slope with few nearshore sightings off Barrow (Clarke et al. 2013, 2014). In 2014, belugas centered over the continental slope as well as Barrow Canyon, with more sightings than usual in the shallow nearshore areas (Clarke et al. 2015b).

The diet of beluga whales appears to be quite varied. Fish, including Arctic cod and saffron cod, and invertebrates, such as cephalopods and shrimp, seem to be important in the diet of belugas along the Alaskan Chukchi Sea coast (Seaman et al. 1982). Belugas in the eastern Beaufort Sea appear to feed predominantly on Arctic cod (Loseto et al. 2009). The stomachs of belugas harvested at Point Lay are often empty (Huntington et al. 1999). Prey available to, and likely consumed by, belugas in the area include herring, smelt, salmon, flounder, and capelin (Huntington et al. 1999). Subsistence hunters also noted shrimp in the stomachs of some harvested beluga whales in Kotzebue Sound (Whiting et al. 2011). Belugas harvested along the Chukotka coast of the northern Bering Sea often had Arctic cod or Arctic char in their stomachs (Mymrin et al. 1999).

Clarke et al. (2015a) compiled the existing information on beluga whale habitat use and identified and delineated four BIAs for beluga whales in the Arctic: one reproductive area, one feeding area, and two migration areas. These areas are important during the specific times of year indicated in figures 8.4 and 8.5 in Clarke et al. (2015a) and figure 3.2-15 in this FEIS.

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; Suydam 2009).

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 65.6 whales during 2008 to 2012. For the eastern Chukchi Stock, annual subsistence take by Alaska Natives averaged 57.4 belugas during 2008 to 2012 (Allen and Angliss 2015). 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, 2012a, 2015; Muto et al. 2016). Beluga whales are occasionally entangled in subsistence nets (R. Suydam pers. comm. 2012b). Killer whale predation on large whales is well documented in other populations and is likely to occur, at least seasonally, to these stocks as well (Shelden et al. 2006).

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). Recent research on seven healthy, wild beluga whales in Bristol Bay indicated that all heard well up to 128 kHz, two heard up to 150 kHz, and the lowest auditory thresholds were in the 45 to 80 kHz range (Castellote et al. 2014). 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’voitch and Sh’ekotov 1990). Call types recorded in the Chukchi Sea include low and high whistles, buzzes, chirps, and clicks (Hannay et al. 2011).

Using the evoked-potential technique in captive animals, Popov et al. (2013) tested two belugas for TTS after exposure to loud noise. This fatiguing noise had a 0.5 octave bandwidth, with center frequencies ranging from 11.2 to 90 kHz, a level of 165 dB re1µPa and exposure durations from 1 to 30 min. The highest TTS with the longest recovery duration was produced by noises of lower frequencies (11.2 and 22.5 kHz) and appeared at a test frequency of +0.5 octave. At higher noise frequencies (45 and 90 kHz), the TTS decreased. The TTS effect gradually increased with prolonged exposures ranging from 1 to 30 min. These authors found considerable TTS differences between the two whales tested.

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). Reliable estimates of abundance for narwhals in Alaska are currently not available (Allen and Angliss 2015).

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 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 acid 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).

<u>Killer Whale: Gulf of Alaska, Aleutian Islands, and Bering Sea Transient Stock</u>

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, 2012a, 2015).

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 587, based on photographic identification of individuals (Allen and Angliss 2015). 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. In 1982, Iñupiat hunters reported observing killer whale attacks on gray whales in Peard Bay, northwest of Barrow and Point Hope (George and Suydam 1998). 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). Vessel-based sightings of three groups of killer whales were recorded in the Chukchi Sea during two industry-sponsored surveys in 2010 (Aerts et al. 2011, 2013; Reiser et al. 2011). In August 2012, two large groups of killer whales were sighted during marine mammal surveys. A group of 13 whales (including two calves) was sighted during an ASAMM aerial survey northeast of Barrow in mid-August (Clarke et al. 2013), followed five days later by a sighting of 25 to 30 whales by a CSESP survey vessel near Hanna Shoal (Joling 2012). Another group of five killer whales (including one calf) was observed during ASAMM aerial surveys in mid-September 2012 approximately 80 km northwest of Point Hope, making these the first killer whale observations in the northeastern Chukchi and western Beaufort seas since federal agency aerial surveys resumed in 2006 (Clarke et al. 2013). No killer whales were sighted in the Chukchi Sea during the 2013 ASAMM surveys. Moreover, BWASP/ASAMM surveys have not observed any killer whales in the Beaufort Sea east of Barrow from 2006-2013 (Clarke et al. 2011b, 2011c, 2011d, 2012, 2013, 2014), and observers onboard industry vessels and conducting aerial surveys in the Beaufort Sea have not reported any confirmed killer whale sightings (LGL Alaska Research Associates, Inc. et al. 2013), and others have only noted minimal sightings (George and Suydam 1998; Leatherwood et al. 1982; Lowry et al. 1987).

Killer whales were acoustically detected during the 2007, 2009, 2010, 2011, and 2012 Chukchi Sea open water season, with detections predominantly off Cape Lisburne and Point Lay in all years with a few detections off Wainwright (Delarue et al. 2010a; Hannay et al. 2011; LGL Alaska Research Associates, Inc. 2013). Transient killer whales were determined to be the source of the calls after conducting further analysis of the 2007 data (Delarue et al. 2010b). 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, 2013).

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 flatfish trawl fishery and the Bering Sea/Aleutian Islands rockfish 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 for 2007 to 2011 is 0.6 per year (Allen and Angliss 2015; Muto et al. 2016). One ship strike of a killer whale was reported in the Bering Sea groundfish trawl fishery in 1998 (Allen and Angliss 2015). 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 (Department of the Navy 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 (Department of the Navy 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, 2015). The latter occurs throughout the Aleutian Islands and all waters north of Unimak Pass.

The most recent population estimate for the Bering Sea stock is 48,215. 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 2012a, 2015).

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). 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 2010 (Aerts et al. 2011, 2013; 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) and was the third most commonly identified cetacean species (after gray whales and bowhead whales) in the Chukchi Sea in 2010 (Reiser et al. 2011). 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 frequency of occurrence was also noted by Iñupiat of Kotzebue Sound:

> *"It seems like they're getting more and more of this porpoise. I'm getting to see more and more every year"* (Whiting 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. One harbor porpoise was entangled in a commercial salmon gillnet in Kotzebue in 2013 for a minimum average mortality and serious injury rate incidental to commercial fisheries of 0.2 in 2009 to 2013. One harbor porpoise was reportedly entangled in a subsistence gillnet in Nome in 2012, for a mean annual mortality of 0.2 porpoise in subsistence fisheries, 2009-2013 (Allen and Angliss 2015; Muto et al. 2016). This estimate is, however, unreliable due to lack of observers on several salmon gillnet fisheries in Alaska (Allen and Angliss 2010, 2012a, 2015). Subsistence fishermen in Barrow occasionally catch harbor porpoise in their nets during the summer (Allen and Angliss 2015; Suydam and 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 (Department of the Navy 2011) and peak frequency of echolocation clicks recorded in wild porpoises ranged from 129 to 145 kHz (Villadsgaard et al. 2007).

3.2.4.3 Ice Seals

<u>Ringed Seal</u>

Species Description

Ringed seals are the smallest of the true seals (family Phocidae) and the most common seal in the Arctic (NOAA 2014). Adults reach 1.5 m (4.9 ft) in length and up to 70 kg (154 lbs) in weight. They have a small head, short cat-like snout, and a plump body. Ringed seals are polymorphic in coloration and their pelage can be either light phase with a dark gray saddle with light rings or dark phase with a dark base coat with lighter rings (Kelly 1988b; 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*) (both listed as endangered under the ESA). 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 are 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) conservatively 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. (2010a) placed their maximum density estimate of ringed seals at Prudhoe Bay and along the coast south of Kivalina at 1.62 seals/km^2. Reliable abundance and minimum population estimates are forthcoming, pending further analysis of data collected in comprehensive and synoptic aerial surveys of ice-associated seals in the Bering and Okhotsk seas in 2012 and 2013 (Allen and Angliss 2015).

On July 28, 1993, the Saimaa ringed seal was listed as endangered under the ESA. 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 the four remaining ringed seal subspecies were 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. On December 28, 2012, NMFS published the final rule in the *Federal Register* (77 FR 76706) listing the Arctic, Okhotsk, and Baltic subspecies as threatened and the Ladoga subspecies of ringed seal as endangered. On March 11, 2016, the U.S. District Court for the District of Alaska issued a decision vacating NMFS' December 28, 2012 listing of the Arctic ringed seal as threatened. The Court determined that the listing was "arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law." The conclusion was based on a lack of a clear and quantifiable threat of extinction within the reasonably foreseeable future and that the proposed regulations for the threatened subspecies were neither necessary nor advisable for the conservation of Arctic ringed seals (Alaska Oil & Gas Ass'n v. Nat'l Marine Fisheries Svc. 2016). Arctic ringed seals are, therefore, not currently listed as threatened under the ESA. A notice of appeal of the District Court decision was filed on May 3, 2016 (NOAA 2016).

Distribution, Migration, and Habitat Use

Ringed seals are circumpolar and occur in all seasonally ice-covered seas of the northern hemisphere (King 1983) (Figure 3.2-16). Ringed seals are strongly ice-associated, and the seasonality of ice cover dictates their movements, feeding, and reproductive behavior. The annual cycle of a ringed seal 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 (they excavate lairs in the snow); 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 breed on either shorefast ice or pack ice. Some suggest that these breeding populations may represent different ecotypes (Kelly et al. 2010a). 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 between 100-1,000 kilometers (Kelly et al. 2010b). Adult Arctic ringed seals show site fidelity, returning to the same subnivean site after the foraging period ends. Movements are limited during the ice-bound months, including the breeding season, which limits their foraging activities and may minimize gene flow within the species (Kelly et al. 2010b).

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 over their breathing holes as pupping season approaches (Helle et al. 1984). Recent satellite telemetry data showed adult seals remained in localized areas of the southern Chukchi and northern Bering seas in high concentrations of pack ice or at the periphery of the shorefast ice from December through April. Sub-adults, however, were not constrained by the need to defend territories or maintain birthing lairs and followed the advancing ice southward to winter along the Bering Sea ice edge where there may be enhanced feeding opportunities and less exposure to predation (Crawford et al. 2012). Sub-adult ringed seals tagged in the Canadian Beaufort Sea similarly undertook lengthy migrations across the continental shelf of the Alaskan Beaufort Sea into the Chukchi Sea, passing Point Barrow prior to freeze-up in the central Chukchi Sea (Harwood et al. 2012).

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). Although found in both locations, densities of ringed seals 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). Satellite tagging data also indicate regular use of Peard Bay along the Chukchi Sea coast and Admiralty Bay/Dease Inlet along the western Beaufort Sea, east of Barrow, during summer and fall (NSB 2012a).

Ringed seals are typically the most abundantly observed seal species in the Beaufort Sea. Industry vessels and monitoring programs have observed large numbers of ringed seals in both the Chukchi and Beaufort seas (Aerts et al. 2008; Aerts and Richardson 2009; Brandon et al. 2011; Funk et al. 2008; LGL Alaska Research Associates, Inc. et al. 2013; Reiser et al. 2011; Savarese et al. 2010). ASAMM surveys in 2013 observed five individual ringed seals in five different sightings in mid- to late August in the Chukchi and Beaufort seas; however, some sightings noted as “small unidentified pinnipeds” may also be ringed seals (Clarke et al. 2014, 2015). Ringed seals were also acoustically detected in the Chukchi Sea on industry recorders in winter 2009-2010, winter 2011-2012 (with detections from 18 October 2011 to 26 June 2012), and summer 2012 (with detections from 13 August to 11 October 2012 (LGL Alaska Research Associates, Inc. et al. 2013). The authors note, however, that the lack of detected calls prior to winter 2009-2010 does not indicate the lack of presence of ringed seals in the Chukchi Sea but rather a previous lack of understanding of call types.

Ringed seals are thought to be primarily pelagic foragers. Their diet varies by season, age, and location. 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). Quakenbush et al. (2011b) found that general fish consumption increased and consumption of invertebrates decreased from the 1960s and 1970s to the 2000s. Among the fish consumed were, as noted above, Arctic cod and saffron cod, as well as Pacific herring, capelin, sand lance, prickleback, and eelblennny. A decrease in crustacean and shrimp consumption accounted for the decreased frequency of invertebrates in stomach contents. Amphipods and mysids were among the other invertebrates regularly consumed (Quakenbush et al. 2011b). Dominant prey (based on frequency of occurrence) in stomachs of ringed seals harvested off Barrow included cod (Arctic and saffron) sand lance, euphausiids, mysids, amphipods, and shrimp (Dehn et al. 2007). Consumption of Arctic cod increased with age and females ate more fish and males ate more zooplankton (Dehn et al. 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 1958; 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 1993).

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 1958).

Sources of mortality include commercial fisheries, subsistence harvests, and predation. Mortality incidental to commercial fishing has occurred in the Bering Sea/Aleutian Islands flatfish trawl, Bering Sea/Aleutian Islands pollock trawl, Bering Sea/Aleutian Islands Pacific cod trawl, and Bering Sea/Aleutian Islands Pacific cod longline fisheries, for an average annual mortality and serious injury rate of 4.1 ringed seals during 2009 to 2013 (Allen and Angliss 2010; Muto et al. 2016).

Ringed seals are hunted for subsistence use by Alaska Natives from communities along the coasts of the Beaufort, Chukchi and northern Bering 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 (Burns and Eley 1976; Heptner et al. 1976a; Sipilä 2003; Stirling and McEwan 1975; Stirling and Øritslsand 1995). Ringed seals constitute 98 percent of the polar bear diet in the Beaufort Sea (Iverson et al. 2006). Gulls and ravens could 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 (Kelly et al. 2010a). In 2011, over 60 dead and 75 diseased seals (mostly ringed seals) were reported in the Arctic (Beaufort and Chukchi seas) and Bering Straits regions of Alaska (NOAA 2011c). Characteristics of the disease included hair loss, skin sores on the hind flippers and face, and, for some, labored breathing and lethargy. In December, 2011, NOAA declared the deaths an unusual mortality event (UME) (NOAA 2011d). In February 2012, a young seal originally thought to be a ringed seal was found in Yakutat sick with symptoms consistent with this disease (NOAA 2012a). Results of DNA analyses subsequently determined this was a young ribbon seal that was misidentified due to excessive hair loss (Suydam pers. comm. 2012b). In 2012, Native subsistence hunters in the Bering Strait region documented over 40 seals with clinical signs of the disease (NOAA 2012b).

The underlying cause of the UME is still unknown. Despite numerous tests for viral, bacterial pathogens, and biotoxins, no specific disease agent or process has been identified. The following have been ruled out, so far: Phocine distemper; influenza; Leptospirosis; Calicivirus; orthopoxvirus and poxvirus; foot and mouth disease; vesicular exanthema of swine; pan picornavirus; and Rickettsial agents (NOAA 2012a, 2012b). Tissue samples were also collected to analyze heavy metals, radionuclides (radiation), and persistent organic pollutant levels (NOAA 2012b). Results are pending, although preliminary screening showed radiation levels within the typical background range for Alaska and not of a level that would cause the observed symptoms (NOAA 2012c). NOAA released an update in March/April of 2013, listing the possible causes for the UME still under investigation were: bacteria (*Streptococcus phocae* and Mycoplasma); algae (Cyanotoxins); hormones (endocrine); radiation (radionuclides); and vitamins (A, E, and B) (NOAA 2013).

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); however, some evidence indicates that the auditory bandwidth for phocids (which includes ringed seals) extends up to 100 kHz (Hemila et al. 2006; Kastelein et al. 2009; Reichmuth et al. 2013). 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 (Dehnhardt et al. 2001; Riedman 1990; Schulte-Pelkum et al. 2007; Schusterman et al. 2004; Wieskotten et al. 2010).

Spotted Seal

Species Description

Spotted seals, also called larga seals, are true seals of the family Phocidae. Adults grow to an average length of 1.5 m (5 ft), with weights ranging from 65 to 115 kg (140 to 250 lbs). Spotted seals have a round head, narrow snout, small body and short, narrow flippers (NOAA 2014). Males and females are similar in size and appearance. 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 DPSs based on genetics, geography, and breeding groups: the Southern DPS; the Bering Sea DPS; and the Sea of Okhotsk DPS (Boveng et al. 2009). The Southern DPS includes spotted seals breeding in the Yellow Sea and Peter the Great Bay in China and Russia and is the only DPS listed under the ESA (NOAA 2014). The Bering Sea DPS is the only spotted seal population that occurs in U.S. waters (NOAA 2014).

There are no accurate abundance estimates for spotted seals across their entire range or for the Bering DPS, specifically. The most recent aerial surveys of spotted seals during April to May 2012 and 2013 covered the vast majority of the spotted seal breeding area. Analysis of part of the data from April 2012 resulted in a mean estimate of 460,268 spotted seals and a minimum estimate of 391,000 seals (Allen and Angliss 2015). 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).

Distribution, Migration, and Habitat Use

Spotted seals are widely distributed on continental shelf areas of the Beaufort, Chukchi, Bering, southeastern East Siberian, and Okhotsk seas, and south through the Sea of Japan and the northern Yellow Sea. This distribution 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 3.2-17) (Frost et al.

1982; Frost et al. 1983). Counts in excess of 1,000 spotted seals hauled out in Kasegaluk Lagoon are not uncommon from late-July through late-September (Frost et al. 1993). Other major haul-outs along the Chukchi Sea coast include the mouth of the Kuk River (near Wainwright), and the mouth of the Kugrua River (Peard Bay area) (Frost et al. 1993). 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 3.2-17) (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 Sea 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 Beaufort Sea, Bering Strait, , or the Russian coast (Lowry et al. 1998).

The Beaufort Sea represents peripheral summer range for spotted seals (SAExploration 2015). Historically, 400 to 600 seals annually inhabited the Colville and Sagavanirktok river deltas, but recently only about 20 seals have been observed any one site (Johnson et al. 1999). Spotted seals in the Colville River Delta are likely associated with summer whitefish and/or salmon spawning runs, which suggests an ecological affinity to the river system more than to the ocean (Bureau of Ocean Energy Management 2014), although they are regularly observed in marine waters a few kilometers offshore (Green and Negri 2005, 2006; Green et al. 2007).

Spotted seals are known to haul out along the Beaufort sea coast and islands near Point Franklin, Dease Inlet, and Smith Bay between July and November (NOAA Office of Response and Restoration 2005, Huntington et al. 2012).

Spotted seals are generalists that eat a broad array of fish, crustaceans, and cephalopods from the continental shelf and shelf break waters (Dehn et al. 2007). Among the fish commonly consumed are Pacific herring, smelt, Arctic cod, and saffron cod. Saffron cod was more common in stomachs of harvested seals taken in the Chukchi Sea than in the Bering Sea and Arctic cod were consumed more often by spotted seals in the Bering Sea than in the Chukchi Sea (Quakenbush et al. 2009a). Spotted seals 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. Incidental take of spotted seals was reported in the Bering Sea/Aleutian Islands flatfish trawl and pollock trawl fisheries and in the Bering Sea/Aleutian Islands cod longline fishery between 2008 and 2012 for a minimum average mortality of 1.52 seals per year (Allen and Angliss 2015; Muto et al. 2016).

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 for a more detailed discussion).

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). Symptoms characteristic of the disease outbreak described above for ringed seals were documented in low numbers of spotted seals in the Bering Strait/Chukchi Sea region in 2011. The disease outbreak predominantly affected ringed seals and the number of affected spotted seals was small and below the level that warranted a UME declaration (NOAA 2011d; Stimmelmayr pers. comm. 2012b)

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). A recent study from Sills et al. (2014) notes the range of sensitive hearing for spotted seals extends across seven octaves in water, with lowest thresholds between 0.3 and 56 kHz, and four octaves in air, from approximately 0.6 to 11 kHz. The seals appeared to be efficient at extracting signals from background noise (Sills et al. 2014). 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, of the family Phocidae, 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 1.5 m (5 ft) and weights of about 70 to 90 kg (154 to 198.4 lbs) (Boveng, et al. 2013; 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.

A reliable population estimate for the entire stock of ribbon seals is not available. Aerial surveys were flown over portions of the eastern and central Bering Sea in 2003, 2007, and 2008. An estimate of 61,100 seals was developed for areas surveyed in 2007 (Allen and Angliss 2015). Recently developed new survey methods provide partial, but useful, abundance estimates. During the spring of 2012 and 2013, U.S. and Russian researchers conducted aerial surveys of the entire Bering Sea and Sea of Okhotsk (Moreland et al. 2013). These data are still being analyzed, but Conn et al. (2014) used a sub-sample of the data collected from the US portion of the Bering Sea in 2012 to calculate an abundance estimate of approximately 184,000 ribbon seals in those waters. Although a preliminary estimate, it is considered a reasonable estimate for the entire US population of ribbon seals since few ribbon seals are expected to be north of the Bering Strait in the spring when these surveys were conducted.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 was not in danger of extinction or likely to become an endangered species within the foreseeable future. In response to new information and ongoing litigation regarding ribbon seals, NMFS published a notice of initiation of a new status review in the *Federal Register* on December 13, 2011 (76 FR 77467). The finding of the 2011 status review was announced in the *Federal Register* on July 10, 2013 (78 FR 41371) with a decision that listing the ribbon seal as threatened or endangered under the ESA was not warranted.

Distribution, Migration, and Habitat Use

Ribbon seals occur in the northern North Pacific Ocean and adjoining sub-Arctic and Arctic seas, primarily the Bering Sea and the Sea of Okhotsk and 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 the western Beaufort Sea, , to the Chukchi Sea and Bristol Bay in the Bering Sea (Figure 3.2-18). 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 subsistence hunters, concluded that few ribbon seals passed through the Bering Strait. Ribbon seals were rarely seen by subsistence 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 seals 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 have been identified as an important prey item 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 were observed mortalities of ribbon seals incidental to the Bering Sea/Aleutian Islands flatfish trawl fishery, the Bering Sea/ Aleutian Islands Atka mackerel trawl fishery, and the Bering Sea/ Aleutian Islands pollock trawl fishery between 2009 and 2013, for an estimated annual mortality rate of 0.6 seals (Allen and Angliss 2015; Muto and Angliss 2016).

There is little evidence of predation on ribbon seals, and they are not considered primary prey of any predators, though 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 (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, of the family Phocidae. They are distinguished by their girth, small head in proportion to body size, unpatterned gray to brown pelage, long and 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). The 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. barbatus barbatus* in the Atlantic and *E. barbatus nauticus* in the Pacific. *E. b. nauticus* was further divided into two DPSs, the Okhotsk DPS and the Beringia DPS (Heptner et al. 1976c; Ognev 1935).

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 Sea in the 1970s and not corrected for seals in the water, was 3,150 seals (Stirling et el. 1982); however, this is likely a gross underestimate (Cameron et al. 2010). Abundance and minimum population estimates are awaiting further analysis of data collected in 2012 and 2013 (Allen and Angliss 2015).

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. On December 28, 2012, NOAA Fisheries published a final rule listing the Beringia and Okhotsk distinct population segments (DPSs) as threatened (77 FR 76739). Beringia bearded seals occur in U.S. waters off Alaska's coast. On July 25, 2014, the U.S. District Court for the District of Alaska issued a decision vacating NOAA Fisheries' December 28, 2012, listing of the Beringia DPS of bearded seals as threatened. The Court determined that the listing was "arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law." The conclusion was based on a lack of a clear and quantifiable threat of extinction within the reasonably foreseeable future and that exisiting protections were adequate (Alaska Oil & Gas Ass'n v. Frank Pitzker, et al. 2014). Therefore, at this time, Beringia DPS bearded seals are not listed as a threatened species under the ESA. NOAA Fisheries has appealed the district court's decision to the U.S. Court of Appeals for the Ninth Circuit.

Distribution, Migration, and Habitat Use

Bearded seal distribution is circumpolar (Burns 1967, Burns and Frost 1979, Kelly 1988a) 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 Chukchi and Beaufort 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 3.2-19) (Cameron et al. 2010).

Recent acoustic data indicate some 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 surveys in all years (2008 through 2010). Sightings were concentrated between Wainwright and Barrow during summer but otherwise spread throughout the survey area (Clarke et al. 2011a, 2012). Two female bearded seals tagged in Kotzebue Sound in 2011 travelled to and occupied the central Chukchi Sea prior to moving south to the Bering Sea with advancing sea ice in the fall (Native Village of Kotzebue 2012). Sub-adult males tagged in 2009 and 2011 remained nearer to shore between Point Hope and Wainwright, while the adult male tagged in 2009 traveled to an area near Prudhoe Bay, with occasional forays into deeper water to the north (Native Village of Kotzebue 2012).

Bearded seals were commonly observed during BWASP fall surveys and in the more recnet ASAMM 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). Bearded seals were also sighted across the northeastern Chukchi and Alaskan Beaufort seas during the 2011 ASAMM surveys. Five were hauled out on ice; the rest were in open water (Clarke et al. 2012). During the 2012 ASAMM survey, observations of bearded seals were mainly in the Beaufort Sea east of the Prudhoe Bay area with scattered sightings in the western part of the Beaufort Sea and northeastern Chukchi Sea (Clarke et al. 2013). ASAMM surveys in 2013 sighted 82 bearded seals with sightings occurring in all survey months (although sightings dropped off after August) throughout the Beaufort and northeastern Chukchi seas (Clarke et al. 2014). Seven bearded seals were sighted in 2014 from mid-July through September; all were in the water (Clarke et al. 2015b). Bearded seals were the second most commonly sighted ice seal species in both the Beaufort and Chukchi seas during industry observations (LGL Alaska Research Associates, Inc. et al. 2013).

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 Beaufort, Chukchi, and Bering 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 primarily prey on benthic organisms, such as epifaunal and infaunal invertebrates and demersal fishes. Crabs, shrimp, and clams are major prey items for bearded seals in the Beaufort, Chukchi and Bering seas. Tanner crabs are important in the southern Bering Sea, and spider crabs are important in the northern Beaufort, Chukchi, and Bering seas. Sculpins, Arctic cod, and saffron cod can also be important prey items for the bearded seal (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; Quakenbush et al. 2011a; Wilke 1954). Prey preferences apparently have changed over time, as the amount and diversity of fish consumed has increased, while crustacean consumption (primarily decapod) has decreased from the 1960s-1970s to the 2000s (Quakenbush et al. 2011a).

Reproduction and Growth

Female bearded seals reach sexual maturity at five to six years of age, and males become sexually mature at six to seven years of age. 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 central Chukchi Sea and Bering Strait occurs in late April (Heptner et al. 1976d).

Newborn bearded seals in the Chukchi and Bering seas weigh an average of 33.6 kg (74.1 lbs) and are 1.3 meters (4.3 ft) long. The pups are able to enter the water within hours of birth and begin to forage while still nursing (Cameron et al. 2010). 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). By the time of weaning, at 12 to 18 days, the pup’s weight increases to approximately 85 kg (187.4 lbs).

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 trawl fisheries is rare but known to occur. Mean annual mortality due to commercial fisheries was 1.2 bearded seals from 2009 to 2013 (Allen and Angliss 2015; Muto et al. 2016).

Mortalities incidental to permitted marine mammal research activities may occasionally occur. Between 2007 and 2011, one mortality, resulting from research on the Alaska stock of bearded seals, was reported (Tammy Adams, Permits, Conservation, and Education Division, Office of Protected Resources, NMFS, cited in Allen and Angliss 2015).

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; however, the observed prevalence is not unusual (Cameron et al. 2010). Symptoms characteristic of the disease outbreak described above for ringed seals were documented in low numbers of bearded seals in the Bering Strait/Chukchi Sea region in 2011.

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 and 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 feature 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.

<u>Pacific Walrus</u>

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", in honor of one of their more distinguishing characteristics (Kastelein 2009). 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 species is made up of two subspecies, the Atlantic walrus (*O. r. rosmarus*) and the Pacific walrus (*O. r. divergens*). Of the two subspecies, the Pacific walrus is the only stock occurring in the EIS project area and discussed in this section (USFWS 2010; Quakenbush 2010).

The walrus is the largest pinniped species in the Arctic. Males are larger than females, ranging in length from 3 to 3.7 m (10 to 12 ft) and can weigh up to 1,814 kg (4,000 lbs), compared to 3 m (10 ft) and 544 to 1,134 kg (1,200 to 2,500 lbs) for females (Kastelein 2009). Females attain maximum size by about 10 years old, while males attain full body size at about 15 to 16 years of age (Fay 1982; USFWS 2009b).

Walruses are social and gregarious animals that tend to travel and haul out on ice or land in densely packed groups. When hauled out, walruses tend to lie close together, with young animals often on top of adults. Group sizes can range from a few individuals, up to several thousand animals (Gilbert 1999; Kastelein 2002).

Population Status and Trends

The current size of the Pacific walrus population is unknown, as is the size of the pre-exploitation population, though the pre-exploitation numbers have been estimated to have been between 200,000 to 250,000 animals (USFWS 2008a). A portion of the spring range of Pacific walrus was surveyed in 2006 using a combination of thermal imaging and satellite transmitters. The number of walruses within the area of the Bering Sea pack ice that was surveyed was estimated at 129,000 individuals, which represents only a partial population estimate, since only about half of the potential walrus habitat was surveyed (Speckman et al. 2011).

Pacific walruses are not designated as depleted under the MMPA, and are not listed as threatened or endangered under the ESA.

In February 2008, the USFWS received a petition to list the Pacific walrus under the ESA. The 90-day finding on this petition was published in the *Federal Register* on September 10, 2009 (74 FR 46548) and found that there was substantial information in the petition to indicate that listing the Pacific walrus under the ESA may be warranted. A status review of the Pacific walrus under the ESA was initiated on October 1, 2009, and on February 10, 2011, the USFWS published a notice of a 12-month finding in the *Federal Register* (76 FR 7634 [2011a]). It was determined that listing the Pacific walrus was warranted but precluded by higher priority actions. The two factors considered primary threats to the Pacific walrus in the foreseeable future and the reason for the determination are the impacts of the loss of sea ice in summer and fall and subsistence harvest of the species. Upon publication of the notice, the Pacific walrus was added to the USFWS's list of candidate species. A final decision as to whether to list the species as threatened or endangered under the ESA or to remove it from the candidate list is expected in 2017.

Distribution, Migration, and Habitat Use

Pacific walrus range across continental shelf waters of the southern Chukchi Sea and northern Bering Sea (Figure 3.2-20). The majority of adult males remain in the Bering Sea to forage from coastal haulouts 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).

Walruses 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. 2011).

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 haulouts in the southern Chukchi Sea (Belikov et al. 1996).

During aerial surveys of the northeastern Chukchi Sea, walruses were observed in June to October 2008 through 2011 (Clarke et al. 2011a, 2012). Distribution was broad and associated with sea ice in June to early August, but shifted to nearshore open water and coastal habitat in late August and September; few walruses were seen in the area in October 2008 to 2010 (Clarke et al. 2011a). Walruses were generally more common in the benthic-dominated ecosystem areas immediately southwest of Hanna Shoal (also referred to as the Burger and Statoil study areas) than in the pelagic-dominated Klondike prospect area further southwest during 2008 to 2010 CSESP surveys of the Lease Sale 193 area in the northeastern Chukchi Sea (Aerts et al. 2011). High biomass and numbers of bivalves, polychaetes, and sipunculid worms in these areas represent abundant prey for benthic feeding walruses (Blanchard et al. 2011). Walruses detected during fall BWASP surveys in 2006 and 2007 were north and east of Barrow (Clarke et al. 2011b, 2011c).

Pacific walruses are uncommon in the Beaufort Sea, with periodic sightings of small groups dating back to, at least, the 1980s. Most walrus sightings in the U.S. Beaufort Sea are west of Cape Halkett, but walruses have been observed as far east as Kaktovik and the Canadian border (Funk et al., 2010; LGL et al. 2014). Twenty-five walruses in 22 groups were recorded by vessel-based observers in the Beaufort Sea from 2006–2012. Five sightings (six individuals) of walruses were recorded during aerial surveys in 2006, one cow-calf pair was sighted in 2007, two adults were sighted in 2008, and 11 sightings (12 individuals) were recorded during aerial surveys in 2010 (LGL et al. 2014). No walruses were observed in the Alaskan Beaufort Sea during aerial surveys in 2011 or 2012 (Clarke et al. 2012; LGL et al. 2014).

During the 2012 ASAMM aerial studies, there were 470 sightings of 12,892 Pacific walruses observed from June to October throughout the northeastern Chukchi Sea, and most of the walruses were sighted in July and August (Clarke et al. 2013). There were 28 sightings of 923 walruses in the western Beaufort Sea from Point Barrow east to 153°W (Clarke et al. 2013). As in 2008, walruses were not observed hauled out on land in 2012, which is likely due to the continued presence of sea ice in and near the study area in fall (Clarke et al. 2013). However, a group of approximately 10,000 walruses was observed hauled out on land near Point Lay in September 2013, accounting for almost a third of all walrus sightings from July through September in the northeastern Chukchi Sea; no walruses were sighted in the Chukchi Sea in October 2013 (Clarke et al. 2014). Additionally, there were five sightings of 12 walruses in the western Beaufort Sea from Point Barrow east to 151.8º W in August 2013 (Clarke et al. 2014). During the 2014 ASAMM aerial surveys, there were 319 sightings of 56,675 walruses observed from July to October. This total includes resightings of a large, coastal haulout of 35,000 walruses near Point Lay in September (Clarke et al. 2015b). Excluding the Point Lay haulout sightings, most walruses were sighted in the northeastern Chukchi Sea in July and August. Four walruses were observed in the western Beaufort Sea from Point Barrow east to 154.2°W (Clarke et al. 2015b).

Acoustic detections indicate that walruses 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).

Walruses have been visually and acoustically detected in the vicinity of Hanna Shoal and between Hanna Shoal and Wainwright as late as December (Clarke et al. 2011a; Hannay et al. 2011). The Hanna Shoal region serves as a critical foraging area for Pacific walruses from summer through fall. Walruses that were satellite-tagged in 2010 through 2015 by the USGS and in 2013 to 2015 by ADF&G regularly frequented Hanna Shoal during July through mid-September (Crawford et al. 2016; USGS 2011b, 2012, 2016. This was particularly true in 2012 when tracking showed nearly all of the tagged walruses on or near Hanna Shoal from August into September (USGS 2011b, 2012, 2016) where grounded ice remained later than in surrounding areas. Walruses observed offshore during August and September 2011 ASAMM aerial surveys showed a preference for Hanna Shoal, presumably using it as a feeding area (Clarke et al.

2012). In late September, walruses were also sighted offshore on Hanna Shoal in late September 2014 (Clarke et al. 2015b). Based on combined foraging and occupancy utilization distributions of walruses during June through September described in Jay et al. (2012), the USFWS delineated a Hanna Shoal Walrus Use Area (USFWS 2013c). Diving and haulout behaviors of adult female walruses- fewer dives, longer dives, and longer haul out periods- corroborate the importance of this high quality foraging habitat. In areas of higher prey densities, walruses are expected to dive less frequently, dive for longer durations, and spend more time resting (Crawford et al. 2016).

Sea ice serves as a platform for resting between feeding bouts, breeding, calving, and care of dependent young (Fay et al. 1984b; Kelly 2001). Walruses 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 haulouts, when possible, possibly because calves are more vulnerable to trampling (Fishbach et al. 2009).

Foraging trips last for a few hours to several days and foraging trips from sea ice tend to be shorter than those from land. It is presumably more cost effective to haul out near productive feeding areas and expend less energy traveling (Cooper et al. 2006).

The number of walruses using coastal haulouts along the Chukchi coast increased dramatically over the last decade and the season of haulout use appears to be increasing. Until recently, the formation of coastal haulouts occurred primarily along the Russian portion of the Chukchi Sea coast, including along the Chukotka Peninsula (Robards and Garlich-Miller 2013). Recent increased use of coastal haulouts along the northwestern Alaska coast is influenced by the availability of sea ice. Prior to 2007, use of coastal sites on the Alaskan Arctic coastline was intermittent and typically during the fall migration (Robards and Garlich-Miller 2013). 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 walruses 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, walruses 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 haulouts with 2,500, 1,000, and 200 animals were documented east of Cape Lisburne, while a coastal haulout near Point Lay had approximately 4,000 animals. The Point Lay haulout persisted through much of September, with counts ranging from <1,000 to >15,000 animals (Clarke et al. 2011a). In 2011, the haulout near Point Lay was observed earlier (mid-August) and persisted longer (to early October) than in previous years; group sizes ranged from 1,000 to 20,000 walruses (Clarke et al. 2012). There were no terrestrial walrus haulouts observed during the 2012 COMIDA aerial surveys (Clarke et al. 2013). As noted above, a terrestrial walrus haul-out of approximately 10,000 animals was observed in September 2013; in September 2014 there was an estimated 35,000 walruses similarly hauled out (Clarke et al. 2014, 2015). Additionally, 98 percent of all walrus sightings in July and August 2013 were of individuals hauled out on ice (Clarke et al. 2014). In late April 2016, more than 3,000 bulls hauled out along Alaska's Cape Greig – a spot where they had never been seen before (UPI 2016).

Walruses are benthic feeders, specializing in invertebrates. Prevalent prey in both the Chukchi and Bering seas include bivalves, gastropods, and polychaete worms. Polychaete worms are more common in walruses' stomachs in the Chukchi Sea and bivalves are more common in animals from the Bering Sea (Sheffield and Grebmeier 2009). Sheffield and Grebmeier (2009) suggest that walruses exploit different benthic prey throughout their range depending on biomass availability and not just species.

Reproduction and Growth

Male walruses 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 can weigh between 45.4 to 68 kg (100 to 150 lbs) and are approximately 1.37 m (4.5 ft) in length (Fay 1982; USFWS 2008a).

Walruses 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 walruses generally remain with groups of adult females after weaning, whereas young males associate with groups of other males (Fay 1982).

Survival and Mortality

Walruses 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 and 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).

Walruses were historically harvested commercially. American whalers in the Bering Sea intensified hunts in the mid to late1880s. 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 Chukchi and Bering Sea coasts of Alaska (U.S.) and Chukotka (Russia). See Section 3.3.2, Subsistence Resources and Uses, for further details. Hunting walrus for non-subsistence purposes, such as for ivory, is illegal, yet occurs periodically.

Incidental mortality of Pacific walruses in commercial fisheries is insignificant. Observed mortality in the Bering Sea/Aleutian Islands flatfish fishery averaged 2.0 walrus per year between 2006 and 2010 (USFWS 2014).

Disturbance-induced stampedes from haulouts can lead to injuries and mortalities for which calves and young animals are particularly vulnerable to trampling injuries (Garlich-Miller et al. 2011). A mortality event documented by the USGS in September 2009 may have resulted from trampling of young walruses hauled out onshore near Icy Cape. One hundred thirty one (131) carcasses were counted on sandy beaches from Wainwright to Icy Cape and represents the first reported large mortality event for walruses hauling out on the Alaskan Chukchi Sea coast. The change in haul out patterns may relate to the loss of sea ice over the Chukchi Sea continental shelf (Fischbach et al. 2009).

Pacific walruses are one of the largest animals of the Chukchi and Bering seas. As such, they have relatively few natural predators. The principal natural predators of Pacific walruses 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).

In August and September 2011, approximately six percent of Pacific walruses hauled out at Point Lay had skin ulcers or sores similar to that of the disease outbreak reported for ringed seals (discussed above). Most instances of disease involved juveniles and subadults (NOAA 2012b). Although a similar disease condition has been observed in Chukotka, Russia, the only haulout where it was reported in Alaska was at Point Lay and other Alaskan walrus hunting communities report healthy animals (Stimmelmayr 2012a). In December 2011, NOAA and the USFWS declared the walrus (and ringed seal) deaths an UME (NOAA

2011d). There have been no reports of widespread illness or mortality in harvested walrus as of June 2012 (NOAA 2012b). Please refer to the Ringed Seal section for a more detailed history of this UME.

Hearing and Other Senses

As with other otariids, the estimated auditory bandwidth of walruses is estimated as 100 Hz to 50 kHz in water and 100 Hz to 35 kHz in air (Finneran and Jenkins 2012).

Walruses produce a variety of sounds in and out of water. Acoustic threats include roars, grunts, and guttural sounds, ranging in frequency from 13 Hz to 4 kHz. Males sing on the mating grounds and at summer seasonal haulouts and their 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).

Walrus tactile and olfactory senses are well developed. Walruses use their whiskers to examine and manipulate objects. The longer, thicker whiskers are used to detect objects and the shorter thinner ones near to the mouth are used for identification (Kastelein 2009). While hauled out on land or ice, walruses appear to rely on their sense of smell to gather information about their surroundings. Anatomical evidence, such as large nares, indicate the importance of olfaction, but the olfactory sensitivity of walruses has not been adequately tested (Kastelein 2009).

3.2.4.4 Fissipeds

<u>Polar Bear: Chukchi/Bering Seas Stock and Southern Beaufort Sea Stock</u>

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 2.43 to 3.35 m (8 to 11 ft) tall and weigh up to 635 kg (1,400 lbs). Females typically stand 2.43 m (8 ft) tall and 181 to 318 kg (400 to 700 lbs) in weight (USFWS 2009c; Amstrup 2003). Although polar bear fur appears white, the hairs are actually a clear hollow tube. As the sun’s rays reflect off the fur, it makes the fur appear white. Prior to their summer molt, the fur can appear to range in color from white, to yellow, to grey, to almost brown, sometimes due to staining from seal oils (USFWS 2009c). The nose, lips, and skin are black (Amstrup 2003; DeMaster and Stirling 1981).The appearance of white fur helps the polar bear blend into its snow covered environment; other adaptations to living on sea ice include 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 (USFWS 2009c). The polar bear’s 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 the Chukchi/Bering Sea population difficult (Lentfer and Galster 1987).

There is currently no reliable population estimate for the Chukchi/Bering seas stock. The IUCN Polar Bear Specialist Group had previously estimated a population of approximately 2,000 animals. However, the estimate is imprecise and not useful for evaluating status and trends for this population (Lunn et al. 2002). Currently, the estimated population size is unknown and data are insufficient to determine trends (IUCN/SSC PBSG 2015). Capture-recapture research conducted in spring 2008 to 2011 revealed that polar bears of the Chukchi/Bering Sea population were of large body size, good body condition, and had high indices of recruitment compared to most other populations. This may be due to high biological productivity and prey availablility coupled with the relatively recent history of sea-ice loss in the Chukchi Sea (Rode et al. 2014). 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.

The Southern Beaufort Sea population has been studied since 1967. Mark–recapture models were recently used to investigate Southern Beaufort Sea polar bear population dynamics from 2001 to 2010, years during which summer sea ice generally declined (Bromaghin et al. 2015). The overall population growth rate declined by approximately 0.3 percent per year for the years 2001 to 2006 (Hunter et al. 2007). From 2004 through 2006, the population declined by 25 to 50 percent, possibly due to poor ice conditions that limited access to prey and low prey availability. Survival of adults and cubs improved beginning in 2007. Abundance was relatively stable from 2008 to 2010, with an estimated abundance of approximately 900 bears in 2010 (Bromaghin et al. 2015). The area to which this applies extends from Point Barrow east to the Baillie Islands in Canada (Regehr et al. 2006).

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. Lawsuits challenging the May 15, 2008, listing of the polar bear and other regulatory measures were filed in various Federal district courts. These lawsuits were consolidated before the Court. On June 30, 2011, the Court upheld the USFWS's decision to list the polar bear as a threatened species under the ESA.

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 in Alaska and adjacent territorial and U.S. waters (Figure 3.2-21). This 2010 ruling designated critical habitat in Alaska and adjacent territorial and U.S. waters and encompasses 484,734 km^2 (187,157 mi^2). Excluded from designation were 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. The sea ice critical habitat area was located over the continental shelf in water 300 m (984 ft) or less in depth. The terrestrial denning habitat included 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 contained about 95 percent of known historical den sites from the southern Beaufort Sea population. Barrier island habitat included 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. However, after additional lawsuits were filed and numerous court rulings on related regulatory measures (see 77 FR 23432, April 19, 2012 for a summary of relevant events), on January 10, 2013, the U.S. District Court issued an order vacating and remanding to the USFWS their December 7, 2010, Final Rule designating critical habitat for the polar bear. This decision was appealed and, on February 29, 2016, a brief was filed by the US State Court of Appeals for the Ninth Circuit reversing the district court's judgment vacating the USFWS designation of polar bear critical habitat in Alaska, affirming the district court's denial of cross-appeal claims, and remanding for entry of judgment in favor of USFWS. The panel held that the USFWS polar bear cirtical habitat designation was not "arbitrary, capricious or otherwise in contravention of applicable law" (Alaska Oil and Gas Ass'n v. Jewell).

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 (Quakenbush et al. 2009b; Stirling et al. 1999). 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 3.2-22). According to the USFWS, 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 (Amstrup et al. 2005; Garner et al. 1990; USFWS, 2010a). The IUCN Polar Bear Specialist Group defines the range as extending from Icy Cape, Alaska, west to Chauniskaya Bay. The U.S.-Russia Bilateral Agreement defines the eastern boundary of the this stock as a line north through Barrow and the western boundary as a line north through the Kolyna River (Belikov et al. 2012). All delineations consider the southern distribution of the Chukchi/Bering stock as determined by the southern edge of the pack ice.

The eastern boundary of the Southern Beaufort Sea stock is near the community of Tuktoyatuk, Canada (Obbard et al., 2010) and the western and southern boundaries are near Icy Cape, Alaska (Amstrup et al. 2000; USFWS 2010b) (Figure 3.2-22). Research by USGS suggests expanding the boundaries since the area annually occupied by individual female polar bears in the southern Beaufort Sea increased by an average of 240 percent between 1985-93 and 2007-09 (Derocher et al. 2012). 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 the Colville Delta, centered near Point Lay, Alaska (Amstrup et al. 2000; Garner et al. 1990; Garner et al. 1994). Telemetry data showed that adult female polar bears marked in the Southern Beaufort Sea spend about 25 percent of their time in the northeastern Chukchi Sea, whereas females captured 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 than 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, 2006a, 2009; Stirling et al. 1999).

In the Beaufort Sea, and to a lesser extent in the Chukchi Sea, females historically denned and gave birth to their young on the drifting pack ice (Amstrup and Gardner 1994). 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). Additionally, a decline in hunting and more erosion may have made den sites on land more attractive. 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, 2006b, 2010). Polar bear denning occurs along the Alaska Chukchi Sea coast at Cape Lisburne, Cape Beaufort, the barrier islands between Point Lay and Peard Bay, the Kukpowruk, Kuk, and Sinaruruk rivers, Nokotlek Point, Point Belcher, Skull Cliff, and Wainright Inlet (Durner et al. 2010). Most denning for the Chukchi/Bering stock occurs on Wrangel and Herald islands, but also on the Chukotkan coast and occasionally on the sea ice. Using land for resting or denning by polar bears from this population is uncommon in Alaska (Belikov et al. 2012).

Distribution patterns have changed in recent years. An increasing number of bears in the Southern Beaufort Sea population are remaining on land or coming ashore during increasingly ice-free summers (Atwood et al. 2016; Derocher et al. 2012). 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 a shifting distribution during summer and fall, apparently in response to ice retreating farther offshore than in the past (Schliebe et al. 2006b). Data from females radio-collared between 1986 and 2014 showed a three-fold increase in the percent of bears coming ashore, an earlier arrival on shore, increased duration on shore, and a later departure back to the sea ice (Atwood et al. 2016). Similar observations were made during aerial surveys of the Alaskan Beaufort Sea from 1979 and 2005 (Gleason and Rode 2009). Habitat associations changed during the course of the study as fewer bears associated with ice and more associated with land and open water, particularly in September. From 1979 to 1987, polar bears were primarily on sea ice along the shelf break near Barrow; from 1997 to 2005, they were observed on barrier islands or along the mainland coast near Kaktovik (Gleason and Rode 2009). The increased land use by polar bears in the Southern Beaufort Sea is likely driven by declining availability of sea ice habitat and to the availability of subsistence harvested bowhead whale carcasses and the density of ringed seals offshore (Atwood et al. 2016; Derocher et al. 2012; Schliebe et al. 2008).

Recent annual range expansion may relate to the increased use of land-based refugia during the ice-free season and the tendency for polar bears to remain on sea ice as long as possible, thus increasing the distance between winter and summer habitats (Derocher et al. 2012). In recent years, Southern Beaufort Sea polar bear distribution shifted to the north and west of the area occupied in the 1980s and 1990s. Prior to 2007, only four radio-collared bears moved beyond the northern boundary of the population zone and none moved farther than 125 km (77 mi) north. Over half of the bears collared in 2007 moved to ice more than 600 km (373 mi) north of the boundary (900 km (559 mi) offshore) and as far west as Wrangel Island in the Russian Chukchi Sea. These trends likely indicate shifting boundaries in response to sea ice habitat changes (Derocher et al. 2012).

Polar bears in the Chukchi Sea are also increasingly using land habitats in parts of their range, likely in response to loss of sea ice habitat. Comparisions were made of land use patterns of radio-collared female polar bears in 1986–1995 and 2008–2013 (Rode et al. 2015a). Bears predominantly occupied sea ice, but used land during the summer sea ice retreat and in winter for maternal denning during both time periods. However, the proportion of bears on land for more than seven days between August and October increased from 20.0 to 38.9 percent and the duration on land increased by 30 days between time periods. Most of the bears that used land in the summer and for denning went to Wrangel and Herald Islands in Russia. Summer and denning locations and duration spent ashore related to the timing and duration of sea ice retreat (Rode et al. 2015).

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). In 2011, only one polar bear was sighted during ASAMM surveys of the northeastern Chukchi Sea. The bear was swimming in open water approximately 65 km (40 mi) northwest of Icy Cape. Pack ice was estimated as 110 km (68 mi) offshore. No bears were sighted along the Alaskan coastline during 2011 ASAMM surveys (Clarke et al. 2012).

During the 2012 ASAMM aerial surveys, there were 65 sightings of 277 polar bears. In the northeastern Chukchi Sea, 32 sightings of 42 polar bears were observed and sightings were scattered along the shore between Barrow and Point Franklin, between Icy Cape and Point Lay, and east of Cape Lisburne (Clarke et al. 2013). There were three sightings of four polar bears offshore on sea ice between 103 and 165 km (64 and 103 mi) from shore, and four sightings of four polar bears swimming offshore between 1 and 111 km (.62 and 69 mi) from shore (Clarke et al. 2013). Most of the polar bears sighted on shore in the Chukchi Sea region were observed during surveys of the coastal transect (Clarke et al. 2013). During the 2013 ASAMM aerial surveys, there were only three sightings of five bears in the northeastern Chukchi Sea south of Barrow and near Icy Cape, with all sightings either on the beach or within 1 km (0.62 mi) of the beach (Clarke et al. 2014). On September 12, 2013, one polar bear cub was sighted with two other bears east of Icy Cape (Clarke et al. 2014). During the 2014 ASAMM aerial surveys, there were four sightings of single polar bears. Three were on shore or on barrier islands between Wainwright and Barrow and one was swimming in broken floe sea ice 153 km (95 mi) from shore (Clarke et al. 2015b). Polar bear sightings were also common during fall BWASP aerial surveys of the Beaufort Sea. During 2006 to 2009, all bears, except one, were on or near shore between Cape Halkett and Kaktovik. In 2009, one bear was seen swimming in open water 140 km (87 mi) north of the barrier islands (Clarke et al. 2011b, 2011c). In 2011, all polar bears sighted during ASAMM surveys were nearshore or onshore between Smith Bay and Kaktovik. No bears were sighted on ice; sea ice was not present near any of the sightings (Clarke et al. 2012).

During the 2012 ASAMM aerial surveys in the western Beaufort Sea, there were 33 sightings of 235 polar bears, found along the shore between Demarcation Bay and Camden Bay, between Harrison Bay and Smith Bay, on barrier islands northeast of Deadhorse, and on Bernard Spit near Kaktovik (Clarke et al. 2013). There is no coastal transect in the Beaufort Sea, and transits to and from survey blocks were often on deadhead or over land; therefore, the opportunity to find polar bears along the coastline, where they would most likely be seen when the ice edge has receded offshore, is lower than in the Chukchi Sea (Clarke et al. 2013). However, there were 13 sightings of 15 swimming polar bears; six of the swimming bears were within 1 km of shore (.62 mi) and 9 of the swimming bears were offshore between two and 82 km (1.24 and 51 mi) from shore (Clarke et al. 2013). Of those, two of the offshore swimming bears were near broken floe sea ice (10-40 percent ice cover) and the other seven offshore bears were swimming in open water (Clarke et al. 2013).

Most of the polar bears (78 percent or 215 animals) observed in 2012 were seen at two locations, Cross Island and near Kaktovik; polar bears are attracted to bowhead whale carcasses from fall subsistence hunts, which are hauled there by villagers from Nuiqsut (at Cross Island) and Kaktovik. Polar bear sightings during the 2013 ASAMM aerial surveys in the western Beaufort Sea were very similar to those in 2012. There were a total of 12 sightings of 33 bears onshore between Demarcation Point to Point Barrow, with the majority of sightings occurring on Cross Island and near Kaktovik (Clarke et al. 2014). Four bears were sighted 61-96 km (37.8-59.5 mi) offshore in the western Beaufort Sea; all four were near broken ice floes (Clarke et al. 2014). In 2014, most polar bear sightings in the western Beaufort Sea were east of Kaktovik to Oliktok Point and between Smith Bay and Point Barrow. All were nearshore; none were observed swimming offshore. Most (34 sightings of 182 bears) concentrated on Cross Island, northeast of Deadhorse, or near Kaktovik were bears scavenge carcasses of bowhead whales taken during the fall subsistence hunt (Clarke et al. 2015b). Polar bears are apex predators in the Arctic marine ecosystem. Unlike other bear species that are generally omnivorous, polar bears are primarily carnivorous (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). In ice-free periods in Western Hudson Bay, polar bears commonly consumed vegetation, such as berries (Derocher et al. 1993). Polar bears in the Beaufort Sea (e.g., at Barter Island, Cross Island, and 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). Stable isotope analyses provide evidence that bowhead whale comprised 50-70 percent of the fall diet for bears that remain near to shore for much of the year and forage on bowhead whale bone piles (Rogers et al. 2015). Small numbers of polar bears (<30 within the Chukchi/Bering Sea and Southern Beaufort Sea populations) have been documented consuming terrestrial foods, such as bird eggs, but no study has documented a meaningful contribution of terrestrial foods to individual polar bear nutrition (Rode et al. 2015b).

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 the fall (September to November), pregnant females seek sites onshore or on sea ice to excavate dens in snow where they will give birth and spend the winter (Amstrup and Gardner 1994; Lentfer and Hensel

1980; Ramsay and Stirling 1990; USFWS 2009c). 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 uses. Subsistence hunting by Alaska Natives is discussed in Section 3.3.2, Subsistence Resources and Uses.

Annual legal harvest of polar bears is between 700 and 800 or 3-4% of the estimated size of the total population of about 20-25,000 animals (Wiig et al. 2015). The harvest level has been thought to be sustainable in most subpopulations (PBSG 2010). Although poaching, or illegal hunting of polar bears, is not thought to be of major concern, reports suggest that as many as 150 to 250 bears may be illegally harvested from the Chukchi/Bering stock each year (Kochnev 2006). Mortality of bears in defense of life and property occur throughout the polar bears' range.

The Southern Beaufort Sea stock are hunted in both Alaska and Canada under a bilateral agreement between the Inupiat hunters of Alaska and Inuvialuit hunters of Canada for the management and conservation of Southern Beaufort Sea polar bears. The agreement is titled, "Polar Bear Management Agreement for the Southern Beaufort Sea" (IUCN/SSC Polar Bear Specialist Group 2000).

On October 22, 2015, the U.S.-Russia Polar Bear Commission (Commission), established under the *Agreement Between the Government of the United States and the Government of the Russian Federation on the Conservation and Management of the Alaska-Chukotka Polar Bear Population,* unanimously agreed to maintain the annual taking limit adopted in 2010 for the Alaska-Chukotka polar bear population. In 2010, the Commission established an annual taking limit on the number of bears that may be removed from this population as a result of human activities, such as bears taken for subsistence purposes and in defense of human life. This annual taking limit, which corresponds with the annual sustainable harvest level for this population, is 58 polar bears per year, of which no more than 19 will be females. Under the Agreement, the annual taking limit is to be shared equally between the United States of America and the Russian Federation. The USFWS intends to establish and finalize a reporting and management regime by September 2016 (81 *Federal Register* 3153, January 20, 2016).

Polar bear stocks in Alaska have no direct interaction with commercial fisheries activities (Allen and Angliss 2012b, 2015).

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, 2015). 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).

The occurrence of diseases and parasites in polar bears is rare compared to other bears, with the exception of the presence of Trichinella larvae; Trichinella has been documented in polar bears throughout their range, and, although infestations can be quite high, they are normally not fatal (Rausch 1970, p. 360; Dick and Belosevic 1978, p. 1,143; Larsen and Kjos-Hanssen 1983, p. 95; Taylor et al. 1985, p. 303; Forbes 2000, p. 321 as cited in USFWS 2008b).

In 2012, veterinarians who accompanied the USGS on capture missions observed hair loss and other abnormal characteristics in polar bears that appeared similar to the UME observed in ice seals, though it is unknown if the condition is the same as the one exhibited by ice seals and walruses under the UME (NOAA 2012b; USGS2012). In 1998-1999 similar clinical signs were recorded in polar bears, with up to 20 percent of bears exhibiting hair loss. Between 1999 and 2011, individual bears were anecdotally observed with comparable hair loss.

In 2012, 23 out of 82 bears captured by the USGS, had unusual hair loss/thinning and/or nodules in the Barrow, Kaktovik, and Prudhoe Bay regions (NOAA 2012b). The USGS collected a number of biological samples from both affected and unaffected bears for histopathology, genetic sequencing of viruses, fungal and bacterial cultures, contaminants, and serology (NOAA 2012b; USGS 2012). Microscopic examination of skin lesions revealed the changes distinct from those observed in seals and walruses and most likely represents a different condition in polar bears (NOAA 2012b). Reports from local hunters from Gambell, St. Lawrence Island, all polar bears harvested during spring 2012 were normal and healthy and subsequent examinations of the hides by a USFWS walrus harvest monitor confirmed the normal condition, no hair loss or ulcers were present (NOAA 2012b).

Hearing and Other Senses

Polar bears use their sense of smell to locate ringed seal lairs and breathing holes, and to detect scent markings that are used as a form of communication. 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). Owen and Bowles (2011) used behavioral procedures to measure the in-air auditory thresholds and hearing sensitivity of five female polar bears at frequencies between 125 Hz and 31.5 kHz. Results showed that the greatest sensitivity occurred between 8 and 14 kHz.

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 Section 3.1.1. 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 the extent (area of ocean covered by ice) and thickness of sea ice cover during the past 30 years (Perovich et al. 2010).

Concurrent with climate change is a change in ocean chemistry known as ocean acidification, with the greatest degree of acidification worldwide predicted to occur in the Arctic Ocean. Ocean acidification may adversely affect marine mammals through effects on prey populations (e.g., changes to larval development). While it is still unclear what ultimate biological impacts will result from these biogeochemical changes, it is probably safe to assume that they will have detrimental effects on ecosystems that are already under pressure from rising temperatures and other climate-driven stressors (Mathis et al. 2015). In addition, lower ocean pH affects underwater sound attenuation and may result in a noisier soundscape.

For descriptions of climate change impacts to other resources see Section 3.2.1.3 for lower trophic levels, Section 3.2.2.4 for fish, and 3.1.4 for acoustics.

Kovacs (et al 2011) investigated the impacts of sea-ice changes on Arctic marine mammals and reported that some ice-associated marine mammals are already showing distribution shifts, compromised body condition and declines in production/abundance in response to sea-ice declines. In contrast, temperate marine mammal species are showing northward expansions of their ranges, which are likely to cause competitive pressure on some endemic Arctic species, as well as putting them at greater risk of predation, disease and parasite infections. The negative impacts observed to date within Arctic marine mammal populations are expected to continue and perhaps escalate over the coming decade, with continued declines in seasonal coverage of sea ice. This situation presents a significant risk to marine biodiversity among endemic Arctic marine mammals.

Range shifts are already taking place and are expected to continue, which will alter population structure and genetic exchange rates (O'Corry-Crowe 2008). Population reductions of some ice-associated species have already been documented in the Atlantic Arctic sector and are expected to continue, perhaps at escalated rates (Kovacs et al. 2011).

The impacts of climate change on marine mammals in the Arctic may 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. Species likely most sensitive to climate change are those with limited distributions and high site fidelity, specialized feeding habits, and a dependence on ice for foraging, reproduction, and predator avoidance. Those with large population sizes, circumpolar distributions, more varied diets, and flexible habitat needs would be less sensitive (Laidre et al. 2008). 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 and spotted seals (non-U.S. DPS only) are now listed as threatened and walrus are a candidate species for listing (*Federal Register* on May 15, 2008 (73 FR 28212); *Federal Register* on October 20, 2009 (74 FR 53683); *Federal Register* on October 22, 2010 (75 FR 65239); *Federal Register* on February 10, 2011 (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. 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. Although the loss of sea ice habitat can have a direct effect on polar bear persistence, other factors associated with climate change have the potential to adversely affect populations as well (Atwood et al 2015). In most parts of their range, polar bears, with the exception of pregnant denning females, have typically spent most of their annual life cycle on the sea ice. In recent years, polar bears are increasingly spending time onshore where they interact more with humans and infrastructure, including local residents, tourists, and industrial activities. Being onshore increases the potential for lethal outcomes for polar bears. Further, historically, sea ice has acted as a structural barrier to anthropogenic activities in the Arctic Ocean. Continued declines in the extent of summer sea ice and lengthening of the open water season are predicted to result in increased exposure of polar bears to industrial and commercial activities such as the exploration and extraction of oil and gas and trans-Arctic shipping (Gautier et al. 2009; Rogers et al., 2013; Smith and Stephenson, 2013; Stephenson et al., 2013; Miller and Ruiz, 2014).

Rode (et al 2015) has documented an increased frequency and duration of land use by polar bears in association with reduced summer sea ice, and suggests that Chukchi Sea polar bears may continue to increase the amount of time they spend on land in the future. This pattern of increased land use in response to sea ice loss is consistent with other studies (Schliebe et al. 2008, Stirling et al. 1999, and Prop et al. 2015) and predictions for polar bears (Derocher et al 2013 and Freitas et al. 2012), suggesting that one of the primary ways in which polar bears will respond to continued sea ice loss will be through increased use of Arctic coastal terrestrial habitats.

The increased frequency with which female polar bears in the southern Beaufort Sea 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 would continue as long as ice remains near enough to the coast in the fall to provide land access for pregnant females. Although population-level effects of sea-ice loss have only been observed in polar bears at the southern edge of their range in western Hudson Bay, models predict decreased survival (including breeding rates and cub litter survival) of polar bears in the southern Beaufort Sea with reduced sea-ice coverage (Hunter et al. 2011; Regehr et al. 2009). Reduced body size and cub recruitment in polar bears has been documented in years when sea ice availability was reduced (Rode et al. 2010).

The extent and duration of sea-ice habitats used by Pacific walrus are diminishing resulting in altered walrus behavior, mortality, and distribution (MacCracken 2012).

Over the past several decades, the number of walrus coming to shore along the coastline of the Chukchi Sea in Russia has increased, and recent use of coastal haulouts along the northwestern Alaska coast has been influenced by the loss of sea ice over the Chukchi Sea continental shelf (Allen and Angliss 2010; Clarke et al. 2011a; Clarke et al. 2012; Fischbach et al. 2009). Use of shore-based haulouts may leave walrus, particularly calves and juveniles, vulnerable to disturbance related to stampedes and trampling mortalities (Fischbach et al. 2009). With increasing sea ice loss, it is likely that walruses will increase their use of coastal haul-outs and nearshore foraging areas, with consequences to the population that are yet to be understood (Jay et al 2015).

The latest research indicates that the Pacific warus population in the Bering and Chukchi seas likely declined by approximately 50% between 1980 and 2000 (Taylor and Udevitz 2015). The decline has likely been exacerbated by declines in sea ice associated with global climate change that are reducing the carrying capacity of the environment for walruses (Garlich-Miller et al. 2011, Taylor and Udevitz 2015). A major concern is the effects of declining sea ice on future energetics of females and young animals that must now make long feeding trips from coastal haulouts to areas of high prey abundance, rather than using nearby ice edges for resting as they did in the past (Kovacs et al. 2015).

MacCracken (2012) predicts in short-term a continuing northward shift in walrus distribution, increasing use of coastal haulouts in summer and fall, and a population reduction set by the carrying capacity of the near shore environment and subsistence hunting. In the long term, MacCracken suggests walrus may seasonally abandon the Bering and Chukchi Seas for sea-ice refugia to the northwest and northeast due to ocean warming and pH decline which alter walrus food resources, and subsistence hunting exacerbates a large population decline.

Loss of sea ice habitat and associated ecosystems would 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. Reductions in sea ice could potentially increase prey availability for bowhead whales through either increased production or advection (George et al. 2015; Moore and Laidre 2006). Research by George et al. (2015) showed that the improved body condition of bowhead whales harvested by Iñupiat positively correlated with summer sea ice loss during the past 25 years. 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 to be a relatively recent phenomenon (Clarke et al. 2011a). In 2013, NOAA NMML began a multi-year study to determine relationships between dominant currents passing from the Bering Sea into and through the Chukchi Sea and prey resources delivered to the Barrow Arch area (an area of high bowhead whale and prey concentrations between Wainwright and Smith Bay), and to provide information about the dynamic nature of those relationships relative to whale distribution and habitat utilization in the eastern Chukchi and extreme western Beaufort Seas. The study is providing baseline data on the occurrence, distribution, and habitat use of large whales to document the seasonal range expansion of bowhead, gray, humpback, and fin whales (NMML 2016).

Higdon (et al. 2013) reports that while sightings of killer whales are increasing in the eastern Canadian Arctic, local observations gathered from the Canadian Beaufort Sea in 1993 and 2006 indiciate no apparent increase in killer whale presence. Along with range expansion of the more temperate species, comes the possibility for competition for resources with Arctic species (ACIA 2005).

Clarke (et al. 2013) compiled visual sightings and acoustic detections of subarctic cetaceans in the southern Chukchi Sea during summer and early autumn from 2009 to 2012 and concluded that because there have been so many physical changes to the Arctic system, including sea ice reduction, seawater warming, increased storms, and possibly increased primary production, that it is difficult to determine the reason for the increased number of sightings. Whether baleen whales are responding to these environmental changes or merely reoccupying their former range as their populations “recover” from the low numbers caused by commercial whaling is difficult to tease apart.

In addition to potential range expansion, the timing of marine mammal migration may also be shifting as a result of climate change. Ramp (et al. 2015) investigated the temporal variation in the occurrence of fin and humpback whales in a North Atlantic summer feeding ground, the Gulf of St. Lawrence (Canada), from 1984 to 2010 using a long-term study of individually identifiable animals. These two sympatric species both shifted their date of arrival at a previously undocumented rate of more than 1 day per year earlier over the 27 years of the study thus maintaining the approximate 2-week difference in arrival of the two species and enabling the maintenance of temporal niche separation. However, the departure date of both species also shifted earlier but at different rates resulting in increasing temporal overlap over the study period indicating that this separation may be starting to erode. The analysis revealed that the trend in arrival was strongly related to earlier ice break-up and rising sea surface temperature, likely triggering earlier primary production.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 3.2-6). Among these species, it is expected that only barren-ground caribou (*Rangifer tarandus granti*) may experience interactions with the offshore oil and gas exploration activities addressed in this EIS during critical periods of their life cycle; therefore, this section focuses only on caribou. Descriptions of distribution, life cycle, and habitat characteristics of other terrestrial mammal species are not included in this EIS.

Table 3.2-6 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 ermine*	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 use habitats along Alaska’s North Slope: the Western Arctic, the Porcupine, the Central Arctic, and the Teshekpuk herds (ADF&G 2014; MMS 2008). Of those, the Western Arctic and Porcupine herds make up approximately half of the total caribou population in Alaska (ADF&G 2008). Barren-ground 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 mountain foothills or on open coastal tundra (ADF&G 2008). North Slope caribou tend to calve in the same general areas year after year followed by movements to insect relief areas in the Brooks Range foothills and along certain stretches of the Arctic coast, which is further explained below. 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).

Population Status and Trends

The Western Arctic Caribou Herd

The geographic range of the Western Arctic Caribou Herd (WAH) is over 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 3.2-23) (ADF&G 2009; Dau 2005). During spring, the caribou travel north from the Seward Peninsula and Nulato Hills to their calving grounds toward the Lisburne Hills before the herd moves eastward through the Brooks Range. 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 WAH is dispersed in the fall as the animals the animals 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).

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. Since that time, the size of the herd has declined. In July 2011, the population was reported to be about 325,000, which represented an estimated four to six percent annual decline since its peak in 2003 (Woodford 2012). The last photo census revealed a steeper decline in the population with the herd estimated to number 235,000 caribou as of July 2013 (Harper 2013). The WAH calving area is inland on the NPR-A.

The Central Arctic Caribou Herd

As their name suggests, the Central Arctic Caribou Herd (CAH) roam the central region of northern Alaska (USFWS 2009d). The CAH range extends from the Itkillik River east to the Canning River and south from the Beaufort coast to the south slopes of the Brooks Range (Figure 3.2-24). The 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 approximately 31,857 animals in 2002 (ADF&G 2009; Cameron and Whitten 1979; Lenart 2005). In July of 2013 over 70,000 caribou were counted, which is similar to their peak of 70,034 in 2010 (ADF&G 2014). Once thought to be part of the WAH, the CAH is now recognized as a distinct herd, an identification based on where females within the herd give birth to their calves (USFWS 2009d). 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 2009d). Soon after calving season, CAH move outward both east and west to summer ranges, which extend from the ANWR coastal plain west, beyond Prudhoe Bay. In the fall, many of these caribou migrate south through the Brooks Range mountains, overwintering 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, foraging in wind-blown valleys and tundra benches for lichens necessary to survive during long, cold winters (USFWS 2009d).

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. (Lawhead and Prichard 2002; Lenart 2007).

The Porcupine Caribou Herd

The PCH ranges through eastern portions of the Arctic Slope, the Brooks Range, northeastern Interior Alaska, and Canada's Northwest Territories (Figure 3.2-25). Named for the major river within its range, the Porcupine herd uses an area roughly the size of Wyoming in ANWR, 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 (ADF&G 2014).

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 ANWR coastal plain between the Katakturuk and Kongakut rivers. Commonly, one-half to three quarters or more of the calves are born within this area (ADF&G 2014; USFWS 2009d). The PCH winters in the southern portion of its range, including ANWR, where they are an important resource for the Gwich'in people (USFWS 2009d).

The Teshekpuk Caribou Herd

The TCH is distributed primarily within the NPR-A, with its summer range extending between Barrow and the Colville River (see Figure 3.2-26). In certain 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 (ADF&G 2014; MMS 2007a). In 2014, the TCH was estimated at approximately 32,000 (ADF&G 2014). 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 on the Beaufort Sea (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 (ADF&G 2014). 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 3.2-7).

Table 3.2-7 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. Generally, the winter diet of caribou consists of lichens, with a shift to vascular plants, such as *Eriophorum spp.*, sedges, and grasses, during the spring (Thompson and McCourt 1981). However, when TCH caribou winter near Teshekpuk Lake, where relatively few lichens are present, they typically 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 pregnant 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 are theorized to be used during calving migrations because they tend to be corridors free of or with shallow snow (Lent 1980). Bulls and non-pregnant 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 (Bergerud 1987; Heard and Williams 1991). 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 (Griffith et al. 2002; Whitten and Cameron 1980).

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 2009d). 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 (Eastland et al. 1989; Lent 1966; Thompson and McCourt 1981), while orthophyll shrubs (especially willows) are the predominant forage during the post-calving 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 3.2-25 and 3.2-27). 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 is generally 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 2009d). Fancy and Whitten (1991) found PCH calf mortality was highest in years of late snowmelt when calving occurred closer to the Brooks Range foothills and in Canada.

During the post-calving 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. During this time, most of the PCH has moved or is relocating to the Brooks Range foothills, away from the coast.

Summer Distribution/Insect-Relief Areas

After calving, caribou collect in large “post-calving aggregations” to avoid predators and seek relief from 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 WAH 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 (18.6 mi) 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 3.2-23). 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, over 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 ANWR or in Canada (Figure 3.2-28). The CAH overwinters primarily in the northern foothills of the Brooks Range (Figure 3.2-28) (MMS 2007a ; Roby 1980). The TCH was presumed 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 (Bergerud 1974; Bergerud and Elliot 1986; Henshaw 1968). 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 (Bergerud 1974; MMS 2007a; Roby 1980).

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. BOEM NEPA documents define a sociocultural system as encompassing social organization, cultural values, and institutional organization of communities (Impact Assessment, Inc. 2011; MMS 2007a, 2007c). The discussion of subsistence and cultural values associated with this economic activity can be found in Section 3.3.2. This description is limited to 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; Nuiqsut; Barrow; Wainwright; Point Lay; Point Hope; Kivalina; Kotzebue; and Nome. Prudhoe Bay/Deadhorse, located between Kaktovik and Nuiqsut on the Beaufort Sea coast, is an industrial site and oil field, not a community.

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 EIS 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 have created employment, generated contracts for service providers within the NSB and the state, and provided 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. Exploration for oil and gas was also initiated offshore into the Beaufort and Chukchi seas in the late 1970s and early 1980s. 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 Alaska Department of Natural Resources (ADNR) Division of Oil and Gas provide a more detailed description of the history of oil and gas development and production. These studies are available on the BOEM and ADNR websites: http://www.boem.gov/About-BOEM/BOEM-Regions/Alaska-Region/Environment/Environmental-Analysis/Environmental-Impact-Statements-and--Major-Environmental-Assessments.aspx 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 State of Alaska 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). In August 2011, BOEM approved Shell's proposal to conduct exploration drilling on three leased tracts near Camden Bay in the Beaufort Sea. In 2012, Shell commenced preliminary drilling activity at one well site on the Sivulliq prospect.

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 June 30, 2016, there were 42 active leases in the Beaufort Sea OCS where exploration activity could occur. Thirty exploratory wells have been drilled, and there is production from a joint federal/state unit of over 28.7 million barrels of oil since 2001 (BOEM 2015a).

Federal OCS lease sales in the Chukchi Sea have been offered since 1988. Two-dimensional seismic data collection began in 1969. None of the five large prospects drilled between 1989 and 1991 resulted in commercial development of oil or gas. The potential for significant Arctic oil and gas resources remains high (Bird et al. 2008). The USGS estimated 90 billion barrels of oil and 1,669 trillion cubic feet of natural gas may exist in areas north of the Arctic Circle, of which approximately 84 percent is expected to occur in offshore areas. In February 2008, the federal government issued 487 leases for more than 2.66 billion dollars in the Chukchi Sea Planning Area (see Figure 1-3). Several companies have conducted seismic and scientific surveys. In December 2011, BOEM approved Shell's proposal to conduct exploration drilling on leases in the Chukchi Sea. In 2012, Shell commenced preliminary drilling activity at one well site on the Burger prospect; in 2015, Shell commenced drilling a second exploratory well, which was drilled to total depth. However, Shell announced in September 2015 it would seal the Burger J wells and would not conduct further drilling in the Arctic for the forseeable future (ADN 2015a). The Department of the Interior also cancelled plans to conduct lease sales in the Chukchi and Beaufort seas in 2016 and 2017. As of June 30, 2016, there is one active lease in the Chukchi Sea OCS.

State and federal oil and gas lease sales and production, both onshore and offshore, have generated substantial revenue for the federal, state, and local governments. They have created economic opportunities for Alaskan residents, including Alaska Native corporations and residents of local communities. The baseline economic conditions reflect highly variable, complex, and dynamic socioeconomic impacts of some 40 years of oil and gas development on adjacent communities (MMS 2009, Galginaitis 2009).

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 (Alaska Department of Commerce, Community, and Economic Development [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) (ADCCED 2011a; Alaska Department of Labor and Workforce Development [ADLWD] 2005; NSB 2005). 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, primarily from sand and gravel mining. The Red Dog Mine in the NAB 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 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. The State of Alaska currently receives 90% of the Federal revenue from Federal onshore leases in Cook Inlet and 50% of the revenue from Federal onshore leases in NPR-A. This includes income from bonuses, rentals, production royalties, and compensatory royalties. 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 (NEI and Institute of Social and Economic Research [ISER] 2011). Offshore oil production would also add to the thru put of the Trans-Alaska Pipeline System, paying tariffs, extending the life of the pipeline, and supporting the value of onshore property owned or leased by the oil industry, the major source of NSB revenue.

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 2010, 2011). 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). The FY 2013 budget was $377 million, and FY 2013 actual revenues from property taxes were $328.8 million (NSB 2014). For FY 2015, the budget was $403.8 million.

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), and the NAB FY 2014 budget is $14.6 million (NAB 2014). The Red Dog Mine, 90 miles north of Kotzebue, is the world's largest zinc and lead mine. Owned by NANA Regional Corporation (NANA) 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 was $10.8 million (City of Nome 2011a). The Nome FY 2014 budget was $8.7 million (City of Nome 2015). 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 in 2010 (City of Nome 2010). Property taxes generated $2.4 million in 2013 (City of Nome 2014). 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). In FY 2014, state revenue from tax and royalty revenue from oil and gas production totaled $3.2 billion. 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. Production taxes are the biggest source of state revenue. Royalties, corporate income taxes, and petroleum property taxes bring additional revenues to the state (ADNR 2011).

For FY 2015, state revenue was adjusted to reflect lower oil prices. Oil revenue still dominates the state of Alaska's unrestricted general fund revenues, accounting for 75 percent of the funds (ADNR 2015a). The state budget for FY 2016 has been funded, but the state faces a $3.5 billion dollar budget imbalance (ADNR 2015b). In the forecast period of FY 2014 through FY 2023 in the Spring 2014 *Revenue Sources Book*, "oil revenue is expected to contribute less than 90 percent of all unrestricted revenue, although revenues from oil production will continue to dominate as a major contributor, forecast to be 82 percent to 89 percent of General Fund Unrestricted Revenue" (ADNR 2014). For the Spring 2015 *Revenue Sources Book*, the used a revised oil price forcast of lower prices per barrel. In FY 2015 and FY 2016, oil revenue is expected to compose about 75 percent of all unrestricted revenue, but this is a significant decrease from past years when oil revenue accounted for at least 88 percent of general fund unrestricted revenue (ADNR 2015b). Revenue for the State of Alaska will continue to be sensitive to the oil price, oil production, and the cost of oil production.

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).

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% Tobacco $1 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% Alcohol 6% 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% Cap Sales 1% Bed 5%

Notes:

a) Definitions of city and borough powers and responsibilities are defined in the Alaska 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 Socioeconomics Section 4.5.3.1

Sources: Alaska Department of Community and Economic Development Community Database Online Available from: http://www.commerce.state.ak.us/dca/commdb/CF_BLOCK.htm

Federal Revenue and Expenditures

Nationwide, federal revenue from personal income tax, corporate tax, and other types was $2.11 trillion in 2009 (U.S. Office of Management and Budget [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). Beaufort Sea offshore oil and gas federal revenue for calendar year 2013 contributed $10.6 million from royalties, and $5.1 million in rent. Chukchi Sea offshore oil and gas federal revenue for calendar year 2013 contributed $7.6 million from rent (USDOI 2013). The pending expiration of offshore federal leases held by oil companies in the Chukchi and Beaufort seas will affect this revenue.

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 2010a). 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 oil and mining industry generate high income jobs and service contracts as direct employees, and for local businesses and the construction industry. The government sector is a major employer, particularly in the NSB and NAB. Transportation and utilities also provide substantial levels of employment.

Employment

About 63.8 percent of Alaska's potential workforce is employed (American Community Survey 2010). 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 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.

Employment and Residency

North Slope oil field operations have historically provided 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 through 2010 as shown in Table 3.3-4. The transient population is also reflected in the jump in potential work force statistics between 2000 and 2010 for North Slope Borough in Table 3.3-2. Prudhoe Bay's worker enclave had a population of 2,174 individuals and no (0) households. Local employment opportunities for NSB residents in the oil and gas industry have been increasing, primarily through service contracts with regional and village Alaska Native Corporations. For example local residents are hired as protected species observers and subsistence representatives during exploration and construction activities.

The 2010 average unemployment rate for the state of Alaska is 9.6 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 2010 was 7.9 percent with 35 percent of the potential work force not seeking work. Similar to other rural areas, the NSB and NAB generally experience much higher rates of unemployment than the state or nation. Unemployment rates in 2010 that appear higher than in 2000 are shown in ***bold/italics*** below.

Table 3.3-2 Employment, Unemployment and Underemployment in the EIS Project Area

	2000[a]		2010[b]	
North Slope Borough	**#**	**%**	**#**	**%**
Total Potential Work Force[c]	4,875		6,822	
Not in Labor Force	1,357	28	2,468	36.2
In Labor Force	3,518	72	4,354	63.8
Armed Forces	3	0.1	0	
Civilian Labor Force	3515	99.9	4,354	100
Employed	2,990	85	3,284	48.1
Unemployed[d]	525	14.9	N/A	***24.6***
Nome	**#**	**%**	**#**	**%**
Total Potential Work Force[c]	2,547		2,699	
Not in Labor Force	814	32	640	23.7
In Labor Force	1,733	68	2,059	76.3
Armed Forces	9	1	17	0.6
Civilian Labor Force	1,724	99	2,042	75.7
Employed	1535	89	1,834	68
Unemployed[d]	189	10.9	N/A	10.2
Northwest Arctic Borough	**#**	**%**	**#**	**%**
Total Potential Work Force[c]	4,535		5,170	
Not in Labor Force	1,658	37	1,738	33.6
In Labor Force	2,877	63	3,432	66.4
Armed Forces	3	0.1	0	
Civilian Labor Force	2,874	99.9	3,432	66.4
Employed	2,427	84.4	2,529	48.9
Unemployed[d]	447	15.5	N/A	***26.3***
Alaska	**#**	**%**	**#**	**%**
Total Potential Work Force[c]	458,054		546,981	
Not in Labor Force	131,458	28.7	155,117	28.4
In Labor Force	326,596	71.3	391,864	71.6
Armed Forces	17,111	5.2	18,161	3.3
Civilian Labor Force	309,485	94.8	373,703	68.3
Employed [c]	281,532	86	337,683	61.7
Unemployed[d]	27,953	9.0	N/A	***9.6***

	2000[a]		2010[b]	
USA	**#**	**%**	**#**	**%**
Total Potential Work Force[c]	217,168,077		238,733,844	
Not in Labor Force	78,347,142	36	83,569,867	35
In Labor Force	138,820,935	64	155,163,977	65
Armed Forces	1,152,137	0.8	1,126,503	0.5
Civilian Labor Force	137,668,798	99.2	154,037,474	64.5
Employed	129,721,512	94	141,833,331	59.4
Unemployed[d]	7,947,286	6	N/A	***7.9***

Notes:

a) 2000 Census Data
b) 2010 Census Data
c) Population aged 16+
d) Unemployed and seeking work

An *Alaska Economic Trends* special issue on the northern region of Alaska reported 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 of limited job opportunities, 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 3.3.9, 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, construction and maintenance of ice roads. Previous MMS lease sale EIS documents include descriptions of a historic lack of Alaska Native employment in and near Prudhoe Bay (MMS 2007a, 2008). 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 (NEI 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 (NEI and ISER 2010).

The major employers are the NSB, North Slope School District, and the Alaska Native corporations and tribal organizations. 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 2011a). 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 Alaska Native Claims Settlement Act [ANCSA] village corporation), and NANA (regional ANCSA corporation) (ADCCED 2011b). With the exception of KIC, all of NANA Region's ANCSA village corporations have merged with NANA, 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 eight 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 2010 per capita income and 2010 average annual earnings for the NSB at $22,109 and $64,532 respectively. The respective per capita income and average annual earnings for the same reporting period were $21,278 and $55,387 for the NAB, $20,549 and $60,096 for the Nome Census Area, and $30,726 and $76,891 for the State of Alaska (Census2010a).

Figure 3.3-5 demonstrates the proportion of workers making under $20,000 per year. This is likely due to a lack of employment 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 2011 dividend per share for each of the three regional corporations in the EIS project area: Arctic Slope Regional Corporation (ASRC); NANA; and Bering Straits Regional Corporation. As an example of the higher end of dividend payments, ASRC has distributed over $543 million in dividends to shareholders since its incorporation (ADCCED 2011a; ASRC 2014).

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 EIS 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 of the Beaufort and Chukchi seas and the Siberian Yupiit of the Bering Strait and points south, 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.

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	7,523	9,492	710,231
Largest community	Barrow	Kotzebue	Nome	Anchorage
% of area pop.	48%	43%	45%	41%
Race (2010)				
Alaska Native	54.1%	81.4%	75.8%	14.8%
White	33.4%	11.2%	16.4%	66.7%
African American	1.0%	0.5%	0.3%	3.3%
Asian	4.5%	0.6%	1%	5.4%
Native Hawaiian/ Pacific Islander	1.1%	0.2%	0.1%	1.0%
Other race	0.7%	0.2%	0.2%	1.6%
Median Age (2010)	35.1	24.5	26.7	33.8
Male/Female Ratio (2009)	167.4	115.3	114	108.5
Educational Attainment (2010)				
Less than High School	26.2%	20.5%	16.2%	9.3%
High School	39.2%	42.3%	42.4%	27.4%
Some College/Associate Degree	19.4%	24.8%	26.5%	36.3%
Bachelor's Degree+	13.6%	12.5%	14.9%	24.3%
Labor Force (16+ population)	4,354	5,170	6,486	528,189
Participation in Labor Force	63.8%	66.4%	67.9%	72%
Unemployment Rate	24.6%	26.3%	17.3%	8.6%
Per capita income (2010)	$22,109	$21,278	$20,549	$30,726
Mean Annual Earnings (2010)	$64,532	$55,387	$60,096	$76,891

Source: ADLWD 2005; US Census (2010), US Census Bureau (2010) American Community Survey 5 Year Estimates

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 (Census 2010a). 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 has a high proportion of working age adults. Men outnumber women, particularly among young adults (Goldsmith 2007). Complete race and poverty tables can be found in Section 3.3.9, 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 (Census 2010b). 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 (33.8 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 7,523 (Census 2010b). The vast majority of the NAB population is Alaska Native (Table 3.3-3). The median age of the borough is estimated at 24.5 years, which is substantially younger than the state median age (33.8 years) (Table 3.3-3). An estimated 62.8 percent of borough residents have educational attainment of a high school diploma or less; 37.2 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 is included in the EIS project area as a center of exploration support activities. The majority of the Nome Census Area is Alaska Native (75.8 percent), although slightly lower than the NAB (Census 2010b). The median age of the borough is estimated at 26.7 years, which is notably younger than the state median age (33.8 years) (Table 3.3-3). An estimated 58.6 percent of borough residents have educational attainment of a high school diploma or less; 41.4 percent 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***. 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 within Alaska or the United States. 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 or http://quickfacts.census.gov/

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, and like other North Slope communities is a highly active subsistence community for marine and terrestrial mammals (Census 2010a; 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.

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). It was later incorporated as a municipality in 1975. The current population is 402 (Census 2011a), 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 with archaeological sites indicating habitation from 500-900 anno Domini (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 of 25.7 percent (NSB 2011d) 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 that is growing slowly and steadily (Census 2010a). 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 78.3 percent of residents over the age of 16 worked in 2010. Local government is the main industry, employing 74.8 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 2011a). The Point Hope peninsula is one of the oldest continuously occupied "Tikeraqmuit" Iñupiat 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 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 peoples 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 3,598, which was a modest increase from 3,505 in 2000 (Census 2011a). Nome has the largest white population in the EIS project area (estimated at 30.4 percent in 2010) communities. Individual poverty rates are low in Nome (3.9 percent) compared to other communities in the EIS project area (see Table 3.3-5 in Section 3.3.9, Environmental Justice), however nearly all of the individuals living in poverty are Alaska Native by ethnicity.

Complete community profiles can be found in other publications such as the NSB Comprehensive Plan (NSB 2005) and the Alaska Community Database website (ADCCED 2011b).

3.3.1.4 Social Organizations and Institutions

The following represents a brief overview of social and governmental organizations in the EIS project area and their roles among communities. Cultural values are incorporated into governmental and tribal (governmental) bodies in the EIS 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, have established tribal governments 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). As a federally recognized tribal government, these tribes are accorded the right of federal government-to-government consultations per federal policies that affect them and executive orders that pertain to this federal tribal relationship. Tribal governments are of two types: those with formal constitutions established under the Indian Reorganization Act (IRA) of 1934 (as amended in 1936 by the Alaska Reoganizations Act), and those recognized as traditional councils, formed through custom and necessity according to the traditions of the particular tribe.

The tribal governments formed under the Indian Reorganization Act of 1934 are known as IRA councils. IRA councils in the EIS project area include: Nome Eskimo Community, Native Village of Kivalina, Native Village of Kotzebue, 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). Communities represented by traditional councils include: Kaktovik Village, Native Village of Nuiqsut, Native Village of Barrow, and Native Village of Wainwright (see Table 3.3-6).

Municipal Government

The state recognizes incorporated 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 EIS 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 (NSB 2016). 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 conveyed 44 million acres and $962.5 million in compensation funds to 12 regions and their associated villages. The 13th Regional Corporation received a share of the compensation funds, but not land, on behalf of eligible Alaska Natives who no longer resided in Alaska. The three Native Regional Corporations in the EIS project area are the ASRC, NANA, and Bering Straits Regional Corporation. These ANCSA corporations reflect a mix of traditional and Western values (Braund and Kruse 2009).

The 2011 dividend per shareholder is shown in Table 3.3-5. ASRC generated 2.55 billion in revenue in 2011, the highest for the 12 Alaska regional corporations and above its record $2.3 billion in 2008(ADCCED 2012; ASRC 2014; Stricker 2010).

Table 3.3-5 ANCSA Corporations in EIS Project Area and Shareholder Dividends

ANCSA Corporation	Region	2011 Revenue (mil)	Net Income (mil)	Approximate Shareholders	Dividend Per Share (2011)
Arctic Slope Regional Corporation	North Slope	$2,550.0	$54.14	11,000	$50.84
NANA Regional Corporation	Northwest Alaska	$1,760.23	$25.52	12,500	$14.70
Bering Straits Regional Corporation	Nome and Seward Peninsula	$197.71	$8.85	6,300	$2.35

Alaska 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 some 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 (or tribal associations) often function as service providers for Alaska Native members within the ANCSA regions, with authorizing resolution from the member tribes. Maniilaq is the regional Alaska 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), and some have established co-management agreements with NMFS.

AEWC was established in 1977 to protect the subsistence practice of bowhead whaling that the IWC 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 the website at: 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 EIS 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 EIS 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

<table>
<tr><th>Municipality</th><th>Regional Govt.</th><th>ANCSA Regional Corp.</th><th>Regional Native Non-Profit</th><th>Tribal Govt</th><th>ANCSA Village Corp</th><th>Other Non-profit Orgs*</th><th>Housing Authority</th><th>Econ Dev. or CDQ Group</th><th>Utilities</th></tr>
<tr><td>City of Kaktovik</td><td rowspan="7">North Slope Borough (NSB)</td><td>Arctic Slope Regional Corporation (ASRC)</td><td>Arctic Slope Native Assoc. (ASNA)</td><td>Kaktovik Village (aka Barter Island)</td><td>Kaktovik Iñupiat Corp.</td><td>Alaska Eskimo Whaling Commission (AEWC)</td><td>Tagiugmiullu Nunamiullu</td><td rowspan="7"></td><td></td></tr>
<tr><td>Prudhoe Bay</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td><td>TDX Power</td></tr>
<tr><td>City of Nuiqsut</td><td rowspan="5">ASRC</td><td rowspan="5">ASNA</td><td>Native Village of Nuiqsut</td><td>Kuukpik Corp.</td><td>AEWC</td><td rowspan="5">Tagiugmiullu Nunamiullu Housing Authority</td><td></td></tr>
<tr><td>City of Barrow</td><td>Native Village of Barrow, Iñupiat Traditional Government, Iñupiat Community of the Arctic Slope (ICAS)</td><td>Ukpeagvik Iñupiat Corp.</td><td rowspan="2">AEWC & Eskimo Walrus Commission (EWC)</td><td>Barrow Utilities & Electric Coop.</td></tr>
<tr><td>City of Wainwright</td><td>Village of Wainwright</td><td>Olgoonik Corporation</td><td></td></tr>
<tr><td>Point Lay</td><td>Native Village of Point Lay, ICAS</td><td>Cully Corporation</td><td>EWC</td><td>Arctic Slope Telephone Association</td></tr>
<tr><td>City of Point Hope</td><td>Native Village of Point Hope</td><td>Tikigaq Corporation</td><td rowspan="2">AEWC & EWC</td><td></td></tr>
<tr><td>City of Kivalina</td><td rowspan="2">Northwest Arctic Borough (NAB)</td><td rowspan="2">NANA Regional Corp. (NANA)</td><td rowspan="2">Maniilaq Assoc.</td><td>Native Village of Kivalina</td><td>NANA</td><td>Native Village of Kivalina</td><td rowspan="2">NAB Economic Development Commission</td><td>Alaska Village Electric Cooperative</td></tr>
<tr><td>City of Kotzebue</td><td>Native Village of Kotzebue</td><td>Kikiktagruk Iñupiat Corp.</td><td rowspan="2">EWC</td><td>Northwest Iñupiat Housing Authority</td><td>Kotzebue Electric Association</td></tr>
<tr><td>City of Nome</td><td>N/A</td><td>Bering Straits Corporation</td><td>Bering Straits Foundation, Kawerak, Inc.</td><td>Nome Eskimo Community</td><td>Sitnasuak Native Corporation</td><td>Bering Straits Regional Housing Authority</td><td>Norton Sound Economic Development Corp. Bering Strait Development Council</td><td>Nome Joint Utility System</td></tr>
</table>

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 so are only seasonally available. 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 § 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. 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. As Wheeler and Thornton (2005) stated, Euro-American conceptions [of subsistence] tend to be static, restrictive and minimalist, often defining subsistence as 'the minimum resources necessary to support life'. However, to the Iñupiat and Siberian Yupiit 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 2011).

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. Also, market economy wages contribute to acquisition of more efficient harvest tools, better firearms, snow machines, boats, and all-terrain vehicles.

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.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 1981, 1982; Kruse et al. 1981). 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 Peoples 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 (Braund et al. 1997; Worl 1980). 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 2008b). 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, 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 Integrated Activity Plan [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 NPR-A Final Integrated Activity Plan/EIS (BLM 2012); the Alpine Satellite Development Plan for the Proposed Greater Mooses Tooth One Development Project Supplemental Final EIS (BLM 2014); 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 Beaufort Sea Sale 202 EA (MMS 2006c); the Chukchi Sea Lease Sale 193 Final EIS (MMS 2007a); Chukchi Sea Planning Area Oil and Gas Lease Sale 193 Final Supplemental EIS (BOEM 2011b); the Chukchi Sea Planning Area Oil and Gas Lease Sale 193 Final Second Supplemental EIS (BOEM 2015b); the 2012-2017 Five Year Oil and Gas Leasing Program Final EIS (BOEM 2012); the 2017–2022 Outer Continental Shelf Oil and Gas Leasing Draft Proposed Program (BOEM 2015a); and USGS (2011).

Additional information is included in: ACI et al. 1984; ADF&G 1995; Alaska Natives Commission 1994; Besse 1983; Braund and Burnham 1984; Braund and Associates 1989a, 1989b, 1996, 2010; Braund and Associates and ISER 1993a, 1993b; Brower et al. 2000; Brower and Opie 1997; 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; Huntington et al. 1999; Impact Assessment 1989, 1990a, 1990b; Jacobson and Wentworth 1982; Kassam and Wainwright Traditional Council 2001; Kruse et al. 1983a, 1983b; Lowenstein 1994; Lutton 1985; Minn 1982; Moulton 1997; NEI 2006; Nelson 1982; NMFS 2004; NSB Contract Staff 1979; NSB 1998; 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, 2010; 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 2011b). 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 3.3-8 through Figure 3.3-17.

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:
ADF&G 1986, 1988, 1989, 1992, 1993, 2007; Braund and Kruse 2009; MMS 2008

Bowhead whale (Agviq)

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 3.3-9). 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 3.3-9. 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).

The reliability of Traditional Knowledge of bowhead whale observations was summarized by the AEWC (2013) as:

> *"including both environmental understanding gained and passed down through generations and ongoing local environmental observations, [Traditional Knowledge] can be a rich source of information for regulators facing decisions related to activities in the Arctic. In the case of bowhead whales, the reliability of traditional knowledge has been scientifically verified on at least two occasions. First, the population census of the Bering-Chukchi-Beaufort Seas stock of bowhead whales, undertaken over decades by the North Slope Borough Department of Wildlife Management, is based on a study design conceived in 1982 to test four concepts articulated by Eskimo hunters about bowhead whale behavior and population status (summarized by Albert, T. 2001. The influence of Harry Brower, Sr., an Inupiaq Eskimo hunter, on the bowhead whale research program conducted at the UIC-NARL Facility by the North Slope Borough. pp. 273-286. In: Norton, D. (ed.). Fifty More Years Below Zero: Tributes and Meditations for the Naval Arctic Research Laboratory's first half century at Barrow, Alaska. University of Alaska Press, Fairbanks, AK and Arctic Institute of North America, Calgary, Alberta and Fairbanks, AK. pp. 548.). This research, which was subjected to intense peer review at annual meetings of the Scientific Committee of the International Whaling Commission and through a series of peer review meetings on the biology of the bowhead whale, was successful in verifying Eskimo hunters' understanding of bowhead whale behavior during the spring migration at Barrow (Albert 2001). It also led the way to development of a robust and successful research program focused on the periodic census of the bowhead whale population, with related data and statistical analysis. More recently, a study of traditional knowledge related to bowhead whales at St. Lawrence Island were found to be consistent with studies of the Bering-Chukchi-Beaufort Seas stock of bowhead whales conducted elsewhere (Noongwook, G., Native Village of Savoonga, The Native Village of Gambell, Huntington, H.P., George, J.C. 2007. Traditional Knowledge of the Bowhead Whale (Balaena mysticetus) around St. Lawrence Island, Alaska. pp. 47-54. Arctic. Vol. 60, No. 1.)"* (AEWC 2013).

The IWC is the authority which sets the quota for bowhead subsistence hunts, and the AEWC allocates that quota among the whaling communities in multi-year periods. There were 280 strikes allocated over the five year period from 2008 through 2012, with no more than 67 whales struck in any year (up to 15 unused strikes may be carried over each year). The term strike is defined as penetration with a whaling weapon. The term "strike limit" is used to refer to this limitation on the number of whales that may be struck, and the term "unused strike" refers to an unused portion of the limit on the number of whales that may be struck. The strike limit is larger than the landed limit, to take into account whales that may be struck but not successfully landed. The term "landed" refers to the number of whales that are actually harvested. At the end of the 2010 harvest, there were 15 strikes that were not used and were available for carry-forward. The combined strike quota for 2011 was 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). There were similar strike quotas for the recent 2015 harvest. In 2014, there were 15 unused strikes which carried forward. The combined strike quota for 2015 was 82 (67 + 15) (Federal Register 2015).

In 2012, the IWC adopted catch limits allowing Alaska and Russia hunters to land up to 336 bowhead whales during the next five year period, 2013 to 2018 (AEWC 2012b). The IWC catch limits are implemented by NMFS, which released a *Final EIS For Issuing Annual Quota to the Alaska Eskimo Whaling Commission for a Subsistence Hunt on Bowhead Whales for the Years 2013-2018* with a Record of Decision released in 2013. The Record of Decision for this EIS grants *"the AEWC an annual strike quota of 67 bowhead whales, not to exceed a total of 306 landed whales over the six years 2013 through 2018 with unused strikes carried forward, subject to limits, and added to the annual strike quotas of subsequent years, provided no more than 15 unused strikes are added to the annual strike quota for any one year"* (NMFS 2013). The selection of this alternative in the ROD maintains the status quo for six years with respect to how the hunt is managed (NMFS 2013).

Under a Cooperative Agreement between NOAA and the AEWC, the AEWC allocates the strikes and catch limit for landed whales among 11 Alaska communities that harvest bowhead whales. These communities include: Kaktovik, Nuiqsut, Barrow, Wainwright, Point Hope, Kivalina, Gambell, Savoonga, Wales, and Little Diomede. 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 2010. 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 2010. Data from four communities on the Chukchi Sea from 1982 through 2014 was compiled by BOEM from various sources for Lease Sale 193 and depicts the annual bowhead whale subsistence harvest of Barrow, Wainwright, Point Hope and Kivalina (BOEM 2011b, 2015b) and is described in Table 3.3-8.

Table 3.3-8 Bowhead Subsistence Harvest for Barrow, Wainwright, Point Hope and Kivalina from 1982 to 2014.

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
2001	27	6	4	0
2002	22	1	0	0
2003	16	5	4	0
2004	21	4	3	0

Year	Barrow	Wainwright	Point Hope	Kivalina
2005	29	3	7	0
2006	22	2	0	0
2007	20	4	3	0
2008	21	2	2	0
2009	19	1	1	0
2010	22	3	2	0
2011	18	4	3	0
2012	24	4	5	0
2013	22	3	6	0
2014	18	3	6	0

Source: BOEM 2011b, 2015b; Suydam et al. 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015
Note: Summarized in these references by the authors from data provided by AECW to NSB. Suydam et al. (2005) indicates that four 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

Summary information for the number of bowhead whales landed between 2001 and 2014 is described in Table 3.3-9. From the fourteen year period of 2001 to 2014 the AEWC villages have landed 546 bowhead whales, or an average of 39 whales per year (AEWC and NSB 2011; Suydam et al. 2015). Additional harvest data are provided in Table 3.3-10 for the years 2005 to 2014. In 2014, 53 bowhead whales were struck resulting in 38 landed whales (Suydam et al. 2015). The spring hunt efficiency was 58 percent, much lower than the 95 percent efficiency of the autumn hunt. Barrow landed 18 whales, Wainwright landed three whales, and point Hope landed six whales. In 2013, Barrow landed 22 whales, Point Hope landed 6 whales, Wainwright landed three whales, and and Point Lay landed zero whales. The 2013 spring hunt was described as late by some whaling captains with little open water and with ice hugging the shore that kept crews from hunting (Restino 2013), but the 2013 Fall hunt was more successful. As reported by the IWC in 2012, 69 bowhead whales were struck with 55 bowhead whales landed during the Alaskan subsistence hunt with 21 whales landed during the spring hunt and 18 landed in the fall (Suydam et al. 2013). Barrow is the largest AEWC community and takes over half of the total, with an average of 21 bowhead whales landed per year in the last decade. The rest of the communities take one to three whales per year, while the smaller communities of Wales, Point Lay, and Little Diomede have highly intermittent harvests, and Kivalina has taken no whales in this period. In 2012 Point Lay landed one whale (Suydam et al. 2013). The IWC reports that in 2011, 51 bowhead whales were struck during the Alaskan subsistence hunt, with 38 whales landed with 20 landed during the spring hunt and 18 landed in the fall by Kaktovik, Nuiqsut, Barrow and Wainwright (IWC 2012; Suydam et al. 2011b). 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). The fall harvest in Wainwright continued in 2011 with one bowhead whale being landed (IWC 2012). 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 2001 to 2014 by AEWC Communities.

	Gambell	Savoonga	Wales	LittleDiomede	Kivalina	Point Hope	Point Lay	Wainwright	Barrow	Nuiqsut	Kaktovik	Total
Total Landed	32	49	2	1	0	42	22	40	274	45	39	546
Annual Average	2.3	3.5	0.1	0.1	0	3.0	1.6	2.9	19.6	3.2	2.8	39

Source: AEWC and NSB 2011; Suydam et al. 2015

Table 3.3-10 Summary of bowhead whales landed, struck and lost, and total struck 2005 to 2014 by communities in EIS project area.

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
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

Village	Landed	Struck and Lost	Total Struck
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
2011			
Kaktovik	3	-	3
Nuiqsut	3	-	3
Barrow	18	6	24
Wainwright	4	1	5
Point Lay	1	-	1
Point Hope	3	3	6
2012			
Kaktovik	3	-	3
Nuiqsut	4	-	4
Barrow	24	8	32
Wainwright	4	2	6
Point Lay	1	-	1
Point Hope	5	-	5
2013			
Kaktovik	3	-	3
Nuiqsut	4	1	5
Barrow	22	2	24
Wainwright	3	2	5
Point Lay	-	-	-
Point Hope	6	2	8
2014			
Kaktovik	3	-	3
Nuiqsut	5	-	5
Barrow	18	6	24
Wainwright	3	3	6
Point Lay	-	-	-
Point Hope	6	6	12

Source: Suydam et al. 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015
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, 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 hunt 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 Braund and Associates (2010). Bowhead whale subsistence harvest areas for the Beaufort and Chukchi seas are provided on Figures 3.3-10 and 3.3-11. Harvest areas for the recently resumed bowhead whale hunt near Point Lay are unavailable and are not depicted on Figure 3.3-11. 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 through the BOEM Environmental Studies Program Information System at: http://www.data.boem.gov/homepg/data_center/other/espis/espismaster.asp?appid=1.

Beluga Whale (Quilalugaq)

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 3.3-13.

The Alaska Beluga Whale Committee (ABWC) monitors the subsistence harvest of beluga whales by Alaska Native hunters. 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) (see also Section 3.2.4.2). The harvest by all Alaska Native communities is approximately 300 to 350 belugas a year. According to the ABWC, the eastern Chukchi Sea stock (Kotzebue, Point Lay and Wainwright harvest from this stock) averaged 99 per year during 2007-2011, but it should be noted according to Suydam (in NMFS 2012) that if numbers harvested in the Kotzebue Sound area are separated from the Chukchi Sea stock, that number would go down. The Eastern Bering Sea (Norton Sound, Yukon and the Kuskokwim Delta) is the stock that is harvested the most heavily in Alaska and averaged 166.8 per year in 2007-2011 (Suydam 2012a). For 2011, the reported beluga whales harvest were: Kotzebue 30 whales landed; Kivalina 3; Point Hope 32; Point Lay 23; Wainwright 9; Barrow 6; and Kaktovik 0 (unconfirmed as there may have been 2 -3 harvested) (Suydam 2012a). The harvest in 2012 was reported as none landed at Kaktovik and Nuiqsut; 5 landed at Barrow during the summer; 34 landed at Wainwright during July; 14 landed July 11, at Point Lay; 84 Landed at Point Hope during April and May; 3 landed at Kivalina (April to June and one about July-August); and 3 landed at Kotzebue (mid-June to July) (Suydam 2013).

Ice Seals

Harvest areas for seals are described on Figures 3.3-14 and 3.3-15

Spotted Seal (Qasigiaq)

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). Five Alaska Native communities in the Northwest Arctic region of Alaska voluntarily reported a total of 119 spotted seals were harvested during 2012 (Ice Seal Committee 2013).

Bearded Seal (Ugruk)

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). Five Alaska Native communities in the Northwest Arctic region of Alaska voluntarily reported a total of 258 bearded seals were harvested during 2012 (Ice Seal Committee 2013).

Ringed Seal (Natchiq)

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 (Burns and Harbo 1972; Frost et al. 1988, 1997, 1998, 1999; Johnson et al. 1966 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). Five Alaska Native communities in the Northwest Arctic region of Alaska voluntarily reported a total of 40 ringed seals were harvested during 2012 (Ice Seal Committee 2013).

Ribbon Seal (Qaigulik)

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). Five Alaska Native communities in the Northwest Arctic region of Alaska voluntarily reported a total of one ribbon seal was harvested during 2012 (Ice Seal Committee 2013).

Walrus *(Aiviq)*

Walrus (*Odobenus rosmarus*) are harvested at higher levels in the Chukchi Sea communities than in the Beaufort Sea communities. Subsistence harvest mortality levels are estimated at 5,789 animals per year (Allen and Angliss 2010). The mean 5-year harvest level for 2006-2010 was 4,852 for the U.S. and Russia (USFWS 2014). 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 3.3-12 and 3.3-13.

Polar Bear *(Nanuq)*

Polar bears (*Ursus maritimus*) are harvested primarily during the winter months on ocean ice and along ocean leads. The 2009-2013 mean harvest was 35.6 bears per year (per the IUCN). The 2010-2017 mean annual harvest of Central Beaufort Sea bears was 62 per year, with 30 per year in the U.S. and 32 per year in Russia. The Alaska Nanuuq Commission is directed by commissioners appointed by each village and is active in most polar bear matters both national and international (Alaska Nanuuq Commission 2012). In 2012, the U.S. – Russian Polar Bear Commission approved a multi-year quota system to ensure that levels of polar bear harvest are sustainable (Alaska Nanuuq Commission 2012). In 2012, the U.S. – Russian Polar Bear Commission adopted a 5-year sustainable harvest level of 290 polar bears with no more than one third to be female, with the requirements that the 5-year sustainable harvest level be allocated over the 5-year period using methods recognized by this Commission's Scientific Working Group as biologically sound, and that these methods include the identification of annual sustainable harvest levels, for consideration by the Commission in setting annual taking limits. This cooperative management regime for the subsistence harvest of polar bears provides for the long-term viability of the polar bear population (78 FR 35364, June 12, 2013). 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 3.3-15.

Fish

Both marine and anadromous fish inhabit coastal Arctic waters. Marine fish include Arctic cod (Iqalugaq), saffron cod (Uugaq), two-horn and four-horn sculpins, Canadian eelpout, Arctic flounder (Nataagnaq), capelin, Pacific herring, Pacific sand lance, and snailfish. Migratory (anadromous) fish common to the Arctic environment include Arctic and Bering cisco (Qaaktaq), least cisco (Iqalusaaq), rainbow smelt (Ilhuagniq), humpback whitefish (Pikuktuuq), broad whitefish (Aanaakliq), 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 (Amaqtuuq) and chum salmon (Iqalugruaq) 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 (Iqalukpik), Arctic grayling (Sulukpaugaq), burbot (Tittaaliq), lake trout (Iqaluaqpak), northern pike (Siulik), capelin, rainbow smelt, Arctic cod, tomcod (Uugaq), and flounder. Harvest areas are described on Figures 3.3-16 and 3.3-17.

Waterfowl

Migratory birds and their eggs (Mannik) are an important food source. Species harvested vary be region but generally include black brants (Niglingaq), long-tailed ducks (oldsquaw) (Aaqhaaliq), eiders, snow geese (Kanuq), Canada geese (Iqsragutilik), and pintail ducks (Kurugaq), 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 (Aqargiq) 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 3.3-16 and 3.3-17.

Caribou *(Tuttu)*

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 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 3.3-16 and 3.3-17.

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 Coastal Management Plan (NSB 2007) and the NAB's Coastal Management Plan (NAB 2006). Extensive marine and terrestrial subsistence map efforts were conducted by Braund & Associates (2010) for the communities of Kaktovik, Nuiqsut, and Barrow in an effort to develop a geographic information system (GIS) 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 3.3-9 through 3.3-11). 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 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). Kaktovik residents report that prior to rivers opening up in May and June they travel via snowmachine to the Camden Bay area to hunt for ducks (Huntington 2013).

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). Camden Bay to the west of Kaktovik has been reported to be an important area of local use by Kaktovik residents (Huntington 2013). When the ice goes out in Camden Bay, Kaktovik residents fish there for Arctic char and Arctic cisco (Huntington 2013). Residents also report that they hunt seals and beluga whales here as well as caribou and geese along the Camden Bay's shores. Berry picking occurs along the shorelines at Camden Bay. Camden Bay is also used as a route for travel to other rivers such as the Canning River and further west during the ice-free summer seasons (Huntington 2013).

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 32.2 km [20 mi] 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: ADF&G 2000; Brower and Hepa 2000; Caufield and Pedersen 1981; Chance 1966, 1997; Coffing and Pedersen 1985; Craig 1987; George and Fuller 1997; Haynes and Pedersen 1989; Huntington and Quakenbush 2009; Impact Assessment, Inc. 1990; Jacobson and Wentworth 1982; MMS 1983, 1986, 1990, 1996a, 1996b, 1998, 2001, 2003; Nielson 1977; NSB 1979; Oldham n.d.; Patterson 1974; Pedersen 1979, 1984, 1990 1995a and b; Pedersen and Coffing 1984, 1985;; Pedersen and Linn 2005; Pedersen et al. 1991; Pedersen et al. 2000; 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 and Migratory fish	*							■	■	■	■	■	

Source: Braund 2010; Braund and Kruse 2009; MMS 2007a, 2007c, 2008; NSB 1979 *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 2007). 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. The waters surrounding Cross Island has been reported to be an important area of local use by Nuiqsut residents who use the area during the fall (Huntington 2013; Braund and Associates 2010). 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 2007). 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.

It has been reported that if whales are not found near Cross Island then whalers will travel east along or inside the barrier islands as far as Camden Bay in search of whales (Huntington 2013). Residents of Nuiqsut reported in interviews that "*sea ice off of Cross Island and disturbance from human activity are reasons why whales may not be found or may not be accessible in the Cross Island area*" (Huntington 2013). Nuiqsut residents also have observed that the fall migration of bowhead whales is taking place earlier than it did in the 1990s and that the whales now come past Cross Island in late August and early September(Huntington 2013).

Seals are also hunted near the Colville Delta and along the coast from Cape Halkett to Foggy Island (EDAW-AECOM 2007). 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. In Camden Bay, Arctic cisco are harvested as they move westward through the bay in the fall from the area of the Mackenzie River towards the Colville River (Huntington 2013). 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 activities (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: ADF&G 2000, 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. 1981; Kruse et al. 1982; MMS 1983, 1986, 1990, 1996a, 1996b, 1998, 2001, 2003; Moulton and Field 1988; Nielson 1977; NSB 1975, 1978, 1979, 2003; Patterson 1974; Pedersen 1979, 1986, 1988, 1995, 2001; Pedersen et al. 2000; USACE 1997; USDOI 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: Braund 2010; Braund and Kruse 2009; MMS 2007a, 2007c, 2008; NSB 1979 * many Inupiaq names for these resources

Barrow

Barrow is one of two communities, the other being Wainwright, 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 and Associates 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 and Associates 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 and Associates 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 and Associates 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), and ringed seals 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, migratory and marine fish	*	■	■		■	■	■	■	■	■	■	■	
Berries/roots/plants	*					■	■	■	■	■			

Source: Braund 2003, 2010; Braund and Kruse 2009; MMS 2007a, 2007c, 2008 * 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. 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 1978, as cited in NSB 2007) 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 travel up the coast as far as Peard Bay to hunt bowheads in the spring. Whaling camps are sometimes located 16 to 24 km (10 to 15 mi) 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 possibly in 50 years (Brower 2010; Suydam et al. 2010) and landed another whale in 2011 as well.

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; ADF&G 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].

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, migratory and marine fish	*	■	■	■				■	■	■	■	■	■
Berries/roots/ plants	*							■	■	■			

Source: Braund 2009; Kassam 2001 in MMS 2008
* many Inupiaq names for these resources

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 harvest approximately 30 to 50 belugas each year (Willie Goodwin – in MMS 2008). Frost and Suydam (2010) estimated that up to 60 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 (ADF&G 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.

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 32 km (20 mi) and 48 km (30 mi) north of Point Lay, respectively, with bearded seals concentrated in the Solivik Island area and up to three miles north off the island (MMS 2009b; NSB 2007). 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 32 km (20 mi) offshore (MMS 2009b; NSB 2007).

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 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).

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, migratory and marine fish	*****					■	■	■	■	■	■		
Berries/roots/plants	*****						■	■	■	■			
Marine invertebrates	*****						■	■	■	■			
Salmon	*****						■	■					
Moose	**Tuttuvak**							■					

Source: Pedersen 1979 in MMS 2008 * many Inupiaq names for these resources

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.

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 used (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).

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 and Migratory Fish	*****						■	■	■				
Berries/roots/plants	*****						▐	■	■	■			

Source: Pedersen 1977 in MMS 2008 * many Inupiaq names for these resources

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).

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 Braund and Associates (2008) and are found in Appendix D of the Red Dog Supplemental EIS prepared for the EPA in 2009 (Braund and Associates 2009).

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

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). A discussion of the seasonal harvest activities of Kotzebue and specific harvest areas follows as described most recently in Whiting et al. (2011).

Winter: Most harvest in December consists of land resources including caribou, furbearers and wood gathering. The inner areas of Kotzebue Sound are frozen with only occasional open water areas near the tip of Sisualik Spit and along the northern coast. Saffron cod and smelt fishing can occur in front of Kotzebue itself. Sheefish fishing with nets takes place in Kobuk Lake. During January caribou can be found over the ice from Sisualik toward Kobuk Lake and sometimes directly away from the coast toward the southern shore of Kotzebue Sound (Whiting et al. 2011). Arctic foxes have been observed offshore with the forming pack ice and red foxes are hunted along the shorefast ice. At Kobuk Lake fishing for sheefish with nets occurs under the ice. Leads and open water near Sisualik or Cape Blossom provide opportunities for ringed seals to be hunted (Whiting et al. 2011). By February the ice becomes thick enough to allow for red king crab pots to be placed up to a mile or two off the northern. Around the mouth of the Noatak River ice fishing with hooks for sheefish can occur. Fishing for sheefish with nets continues at Kobuk Lake. Hunting for caribou and furbearers occurs away from the coast. Ringed seal hunting increases in February as the daylight becomes longer. In March hunters use the leads in the northern area of the sound described by Whiting et al. (2011) from Cape Blossom to Cape Krusenstern - including the area that is the mouth of the Noatak River and northern Kobuk Lake. Hooking of sheefish at the mouth of the Noatak River continues and on Kobuk Lake (Whiting et al. 2011).

Spring: April marks the beginning of the turn toward spring in this area. The arrival of gulls and waterfowl begins at the end of this month along the coast. Red crab pot fishing continues through the ice off of the Cape Krusenstern coastline. Sheefish hooking continues at Kobuk Lake, at the mouth of the Noatak and sometimes near Kotzebue. During the month of May open water near Cape Blossom provides an opportunity for hunters to harvest ringed seals. Only female ringed seals are harvested at this time as males are rutting and their meat is not preferred. Near Kotzebue ice fishing with hook and line begins for saffron cod and smelt. Sheefish fishing also occurs during the first half of May near Kotzebue. Red king crab fishing continues along the northern coast of Kotzebue Sound. Whitefish are harvested by nets which are set through the cracks in the ice. The harvest of adult bearded seals in Kotzebue Sound begins during break up toward late May when temperatures start to climb. Hunting is dependent on ice conditions along the coast and when rivers are breaking up. Fishing for herring and smelt can occur by with rods and cast nets as the fish move into the inner sound areas before they begin to spawn. Toward the end of May Dolly Varden are sometimes caught near Cape Krusenstern (Whiting et al. 2011).

Summer: June marks the time of the year for bearded seal hunting on the broken ice pack in Kotzebue Sound. Ringed seals, ribbon seals (though considered rare) and walrus traveling into the Chukchi Sea are also harvested during this time period. The beluga whales start to move into the sound in June along the northern coast and where they are then pursued by hunters and are caught by boat or in nets. Along the northern sound Dolly Varden from the Kivalina and Noatak rivers and other freshwater outlets are caught with rods or nets. In mid-June chum salmon are harvested by nets along the northern coast. When the gulls and Arctic terns begin to lay eggs in mid-June harvest occurs on the islands offshore of Kotzebue and in the lagoons. Pots for king crab fishing are not set until the ice has left the northern sound. In July, salmon fishing predominates, with chum, king, pink and occasionally silver and sockeye salmon being caught. King crab fishing continues by set pots. In August, the harvest of salmon continues by net with chum and king salmon comprising most of the catch. Dolly Varden is harvested more toward the end of August (Whiting et al. 2011).

Fall: During September waterfowl are hunted as they migrate through the area and in the lagoons. White fish are caught in the areas where pondweed washes up on beaches and present the opportunity for harvest to occur by a technique called sand trap fishing. Herring are fished for using rods and cast nets close to Kotzebue. In October, the lower Noatak River and lagoons, and inner parts of the sound and Kobuk Lake begin to freeze. Ice fishing resumes on the lagoon on the southeastern side of Kotzebue with saffron cod, Arctic cod and smelt being caught. During October, groundswell from storms can wash live clams onto the beaches near Sisualik were they are then collected. In November winter weather can strand marine mammals and fish that create more opportunities for harvest. Overflow can push fish including ciscoes, herring, or smelt through the cracks up onto the ice where they are then shoveled up by locals. If there is open water in front of Kotzebue, hunters will hunt spotted seals from boats. Ice trapped spotted seals are occasionally taken at Kobuk Lake as they are unable to migrate back to the sound. Young bearded seals and ringed seals are taken along the northern coast of the sound. Seal hunting also continues at Sisualik and toward Sealing Point if there is open water next to the beaches at these areas. Saffron cod and smelt are fished in the lagoon on the southeastern side of Kotzebue. Sheefish are fished with nets in early November (Whiting et al. 2011).

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

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 ADF&G 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 3.3-19 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: ADF&G 1986, 1988, 1989; Braund and Kruse 2009; MMS 2008; NSB 1993, 2007

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) ADF&G (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), ADF&G (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, ADF&G (1992)	
Estimated Pounds Harvested	170,940.00
Mean Household Pounds	2,713.33
Harvested Per Capita Pounds Harvested	885.60

Source: ADF&G 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), ADF&G (1993)	
Resource	**Percentage (%) of Harvest**
Bowhead Whale	29
Fish	34
Caribou	30
Birds	2
Other	5
Nuiqsut Subsistence Harvest Summary, ADF&G (1993)	
Estimated Pounds Harvested	267,818.00
Mean Household Pounds	2,943.05
Harvested Per Capita Pounds Harvested	741.75

Source: ADF&G 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 1998 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), ADF&G (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, ADF&G (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: ADF&G 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: ADF&G 2000; BOEM 2011b, 2011c; Braund 1989, 1993; Braund and Associates 2010; Chance 1966; Craig 1987; EDAW-AECOM 2007; George and Fuller 1997; George et al. 1993; Hess 1999; MMS 1983, 1986, 1990, 1996a, 1996b, 1998, 2001, 2003, 2006b, 2006c, 2007a, 2007c, 2008, 2009a, 2009b; Nielson 1977; NSB 1979, 2002; Patterson 1974; Pedersen 1979; Pedersen et al. 1979; Philo et al. 1994; Sonnenfeld 1956; 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 use 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: ADF&G 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 used 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: ADF&G 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: ADF&G 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
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 Native Village of Kotzebue conducted a three year harvest survey program (2002 to 2004). Findings of this study indicated that estimated total harvested varied from 1,401,325 pounds in 2002, to 892,782 pounds in 2003 and 1,022,847 pounds in 2004 with a total of 227 households surveyed (Whiting 2006). Household harvests averaged 5,031 edible pounds in 2002, 2,996 pounds in 2003, and 3,237 pounds in 2004. Five species accounted for nearly 90 percent of the harvest in the three study years, namely caribou, sheefish, bearded seal, chum salmon and moose as the main harvest species (Whiting 2006). Caribou were the most widely harvested species, since they were taken by 69 percent to 85 percent of the households. Findings of this three year study show higher rates of harvest than those that were previously reported as this project included only Alaska Native households. Two earlier single year studies by Georgette (1986) and by Fall and Utermole (1995) surveyed native and non-native Alaskan households. Previous work by Georgette had noted that Alaska Native households harvested five times as much wild food as non-Native households in Kotzebue (Georgette 1986 in Whiting 2006). The 1986 study had similar findings, describing four species – caribou, bearded seal, sheefish, and chum salmon – as contributing 74 percent of the total harvest (Whiting 2006). Whiting (2006) found that, those same four species contributed 82 to 90 percent of the total harvest.

Similarly, more recent data has indicated that levels of harvest in the Kotzebue area are consistent with the earlier surveys. 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 (Whiting 2006). 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: Whiting 2006

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 difficult to precisely 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 and extent 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 would 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 (Bielawski 1997; Callaway et al. 1999). Warmer summers are reported to be affecting the seasonality of when the hunts take place. Whalers in Kaktovik used to start hunting in August but now the whaling season primarily occurs in September as it has become more difficult to preserve meat during the warmer weather (Huntington 2013). Nuiqsut whalers have also reported that in some recent years they have seen whales earlier than Kaktovik whalers and have noted this is odd as the migration which is from the east should be passing Kaktovik first (Huntington 2013). In Camden Bay, sea ice is not seen during the summer months as long or as regular as in the past 15 to 20 years. "*Whalers reported that while they used to sit on ice floes when hunting (mostly to save gas) while waiting and watching for whales and they also used the ice to hunt bearded seals but this is no longer possible as the ice now retreats after breakup and does not return until fall freeze up and have observed that there is less ice in the summer*" (Huntington 2013).

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. The AEWC noted that "*worsening ice conditions have made it too dangerous and difficult for our whaling captains and their crews to carry out the larger spring bowhead hunt. Because of the changing conditions, crews from Wainwright, Point Hope and Point Lay have all been conducting fall hunts in an effort to provide for their communities and meet their 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 could 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 ICAS, the EPA, and the 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 was prepared by Dr. Jana McAninch on behalf of the NSB Department of Health and Social Services (McAninch 2012). 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 was 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. The most recent NSB Census was conducted in 2015; however, the results are not available for inclusion in this FEIS.*
>
> *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	324	92.0	27.0	4.3	32.7
Atqasuk	233	93.1	24.3	6.4	39.1
Barrow	4,212	68.6	28.0	4.7	32.9
Kaktovik	239	90.0	30.5	7.9	30.1
Nuiqsut	402	89.6	25.2	6.0	28.4
Point Hope	674	93.3	25.3	6.2	35.3
Point Lay	189	88.9	25.1	4.2	30.7
Wainwright	556	91.7	27.6	5.4	33.6
Northwest Arctic Borough (NAB) Community					
Kivalina	374	97.9	21.3	5.3	40.4

Source: Census 2010a

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. 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 WAH, 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 would be experienced. The additional fine-grain of detail available for NSB communities therefore provides an extra source of information that would help in the analysis of impacts; but the lack of this same level of detail for Kivalina would 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.
Sources: ABVS 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 17th out of 22 Alaskan census areas for overall health outcomes, based on a combination of standard health indicators (Mobilizing Action Toward Community Health [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 (ABVS 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

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. (144 per 100,000 residents compared with 43 per 100,000) (McAninch 2012). 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 2012). 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 2009 there were a total of 288 cases of cancer reported in the NSB (McAninch 2012). This corresponds to an age-adjusted annual incidence rate of 530.1 cancers per 100,000 population, compared with 487.1 for all of Alaska and 467.4 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 2009 are approximately double the national rates; however, rates of prostate and breast cancers are much lower than 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.

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

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 2012; National Coalition of STD Directors [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 2012).

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 2012).

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 (Baggett et al. 2006; DiGirolamo et al. 2007) 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 (CDC 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 NSB more than doubled (McAninch 2012).

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 and Luick 2007; Bersamin et al. 2006; 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 2012). 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 2012).

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: Alaska Native Tribal Health Consortium (ANTHC) 2008

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
In the past 12 months, felt a household member had been hurt by drugs or alcohol[1]	30%
In the past 12 months, felt the health of their community had been hurt by drugs or alcohol	
Often	57%
Sometimes	35%

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. Alaska Natives are at particular risk of suicide, comprising 39 percent of all suicides in the state (Alaska Injury Prevention Center [AIPC] 2006). In the NSB, young people are particularly susceptible to suicide; in 2009 the suicide rate for young men aged 15-24 was 56 per 100,000; this compares to an overall rate of 20 per 100,000. Suicide rates among young Alaska Native males (aged 15-24 years) illustrate the severity of the health disparity showing a suicide rate of 142 per 100,000 (McAninch 2012). 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 2012).

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 2012). 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 2012). 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 (Centers for Disease Control and Prevention [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 (Alaska Network on Domestic Violence and Sexual Assault [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 (Alaska Bureau of Vital Statistics 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 could 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 could 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	•	•	•	•	•	•
Subsistence participation and diet	•	•	•	•	•	
Health care services and emergency preparedness	•	•	•	•	•	•
Alcohol and drug misuse	•	•		•	•	•
Culture and language			•		•	
Environmental contamination	•		•		•	•
Climate change		•	•	•		

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). Section 3.3.2.2 describes the subsistence activities and wage economic opportunities which are well developed and highly interdependent (Kruse et al. 1981; Kruse 1981, 1982). Subsistence harvest activities are both cash dependent and highly cash efficient. The small increments of cash that are used in subsistence activities produce great quantities of subsistence food resources that in turn support networks of sharing and cultural and ceremonial practices.

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 3.3.1, Socioeconomics.

Subsistence Participation and Diet

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 (Adler et al. 1994, 1996; Bjerregaard et al. 2004; Ebbesson et al. 1999; Murphy et al. 1995; Reynolds et al. 2006).

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 2012).

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

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). Household heads with full-time employment relied heavily on traditional food sources (McAninch 2012) and often produce large quantities of subsistence foods that are widely shared throughout the community. However, it should be noted that increased income does not appear to substantially reduce participation in subsistence activities. In some communities there are “super households” that harvest subsistence resources at higher levels in comparison to other households, and through sharing, provide food for a large network of households. The “super households” often have secure cash incomes within which they use to purchase reliable subsistence equipment (i.e., boats, motors, snow machines) and defray the operating costs of subsistence activities, especially fuel.

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 (Bersamin and Luick 2007; Nobmann et al. 2005). 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).

Subsistence harvest patterns and rates of change of harvest are complex. Elders often remain very much attached to preferred subsistence foods, long after they are able to harvest these foods directly. As an example, the rates of harvest of bowhead whales remain high, and sharing networks are very active for this resource which remains central to the cultural identity of the Iñupiat. At the same time, many rural residents have expressed concerns that some subsistence foods may be contaminated. A common explanation for the trend away from some subsistence food sources in some areas of the Arctic has been residents' concern over the quality of traditional foods. 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. The may be several elements for some residents to choose store-bought foods over traditional foods. In some cases a family structure may not have anyone to hunt for the family and lack of transportation and/or time, high costs of fuel required for operation of equipment (boats/snow machines) or traditional knowledge to hunt and gather. Younger generations may have changing food preferences, and changing values regarding activities on the land

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 predominance of foods that have a longer shelf-life, which tend to be high in fat, salt, and calories.

Health Care ServicesHealth 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 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 3.3-46). 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 2012). 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.

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

The ANTHC 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 2012). 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 would strengthen public services in all communities, and is in the process of revising their Emergency Preparedness Plan (NAB 2010).

Alcohol and Drug Misuse

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 2012), 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.

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

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).

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 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). 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 2012).

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 (Canadian Environmental Assessment Agency [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 3.1.3), water quality (Section 3.1.5), and environmental contaminants and ecological processes (Section 3.1.6) 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, which is increasingly becoming recognized as a determinant of health in the Arctic (ACIA 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 could 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 would 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 EIS project area in conjunction with seismic testing and geophysical hazard survey 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

With the exception of Antarctica, the New World appears to have been the last major land mass on earth to have been colonized by a human population, most likely due to the high latitude of land that had to be traversed to reach this hemisphere. This high-latitude area is most often referred to as Beringia, a term used as early as 1937 to include those portions of the continental shelf between the present shores of northeast Asia and Alaska that were exposed during periods of lowered sea level. Archaeologists commonly use a broader definition that expands Beringia to include northeastern Siberia, western Alaska, Kamchatka, and much of northwestern Canada (Hoffecker 1996). While Beringia is a geographic concept, it is also defined by temporal boundaries that are a function of climate and sea level. Early chronologies had Beringia, at a depth of 50 m (164 ft) below present sea level, flooded as early as 15,000 to 14,000 years ago. New data, including fossil insects from submerged peat deposits in the Chukchi Sea dating to 11,330-11,000 years B.P., have expanded the temporal boundaries of Beringia, since the last glaciations, to roughly 25,000 to 10,000 years B.P. During this period, the continental shelf was exposed, forming a vast land bridge between Asia and North America over 1,000 km (621 mi) wide from north to south (Elias 1996; Hoffecker 1996).

The archaeology of Beringia remains in a relatively early phase of development, as archaeologists on both sides of the Bering Strait continue to build cultural chronologies for the continental shelf and adjacent areas of northeast Asia, Alaska, and the Yukon (Hoffecker 1996). In eastern Beringia, the region comprised of Alaska and adjacent portions of Canada that were not covered by the massive continental glaciers, a small number of archaeological sites revealing evidence of very early occupations have been identified. These include the two Trail Creek cave sites on the Seward Peninsula, which contained traces of lithic artifacts and bone deeply buried in cave deposits, underlain by bone deposits lacking lithics but dated to approximately 13,000 to 16, 000 years ago. Additional early sites in this region have largely been found in central Alaska and consist of open localities on terraces, ridges, or knolls above major rivers. These sites typically contain deposits in Aeolian sediments varying in thickness from a few centimeters to several meters, with dates from the end of the Pleistocene through the Holocene, or roughly from 12,000 years ago to the present (Hoffecker 1996; West 1996). Important among these are the Campus Site, near Fairbanks, first assigned dates ranging to between 12,000 and 8,000 years ago but perhaps only 3,000 years or so in ages (Mobley 1996); the Chugwater Site on Moose Creek Bluff, also near Fairbanks and dated to perhaps 11,000 years B.P. (Lively 1996); and the Broken Mammoth Site, at the confluence of Shaw Creek and The Tanana River near Delta Junction, with evidence of occupation as old as 11,800 – 11,200 B.P. (Holmes 1996). These sites, and others like them, are largely limited to lithic materials and bone fragments, though plant macrofossils, insects, mammal hair, and pollen have also been recovered (Holmes 1996), and indicate that remains of early occupations can be found elsewhere, both offshore on those portions of the continental shelf exposed during periods of low sea level, and onshore, in areas devoid of retreating ice masses. The retreat of the glaciers at the end of the Pleistocene opened up new areas of Beringia for colonization, both at higher elevations like the Alaska Range, as well as low-lying coastal areas of Alaska that had been completely inundated by ice. Sites in these areas date to the early Holocene and later (10,000 – 9,500 years B.P. and younger) and include locations along Cook Inlet, the Kenai Peninsula, and the mainland coast and islands of southeastern Alaska (Hoffecker 1996).

More specific to the EIS project area, 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 Indigenous 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 Thule culture, from 1,500 years ago to 1778; and historic Thule 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). 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; West 1996). 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).

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; Meltzer 2009).

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) 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. First 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).

By about 1,500 years ago, Prehistoric Thule 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). 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 Native Alaskan 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).

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 established trade routes to exchange goods along the coast and into the Interior for at least 100 years prior. Trade goods found at historic sites include glass beads, metal knife blades, and brass fittings from trade muskets (Anderson 1984).

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 Native Alaskans 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).

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).

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 Native Alaskans. 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).Whaling persisted until the baleen market collapsed after 1916 (Spencer 1984). 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 Alaska Natives. Other Euroamerican commercial interests attracted northern Native societies into the larger Western economic sphere. Domestic reindeer herding, 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). 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).

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 m 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 (Dixon et al. 1986; MMS 2007c). 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 EIS 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, such as vehicles used for onshore support operations and infrastructure, 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 (Dixon et al. 1986; MMS 2007c).

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. 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).

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 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 U.S. government is the sole owner of the Beaufort Sea and the Chukchi Sea Outer Continental Shelf lands, the energy (conventional and renewable) and mineral resources 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 three nautical miles, 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 NPR-A, managed by the 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 NPS (NAB 2004). See Figure 3.3-18 for general ownership patterns on the North Slope of Alaska near the Beaufort and Chukchi seas.

3.3.5.1 Land and Water Ownership

<u>Federal Ownership</u>

Federal Waters

Beyond the three-mile limit owned by the state, the U.S. 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 (NOAA n.d.; Office of the Press Secretary 1983).

Federal Lands

The federal government owns the land in the ANWR, containing about 30,135 square miles, the NPR-A, containing about 36,875 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.

<u>State Ownership</u>

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 Land 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 corporation selections or similar reasons. In the EIS 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 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 (University of Alaska, Anchorage [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 Land 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 Native Americans 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 repealed in 1971 with the passage of ANCSA; however, ANCSA 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 managed by the federal government, or in some instances a state agency pending the recovery by the federal government, 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 U.S. under the administration of the Bureau of Indian Affairs. 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 NPR-A. The allotments run along the coast between Cape Lisburne and Point Hope, all through the Point Hope region, and can be found along coast and rivers in the southern portion of the EIS project area.

<u>Borough and Other Municipal Lands</u>

Under the Alaska Statehood Act, municipal governments are entitled to select lands from the State of Alaska. In the EIS 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 (NSB 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 (United Nations [UN] 1993). The classifications below are based on the nationally standardized scheme by Anderson et al. (1976), and the Michigan Resource Information System (MIRIS). There may be municipal and state planning documents that formally designate areas of land use for planning purposes.

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, sport hunting and fishing, with recreational boating on rivers and in nearshore waters. Recreation is discussed in detail in Section 3.3.7.

Subsistence

Subsistence, which refers to harvest activities involving hunting, fishing, trapping, and gathering as a way of life, is a widespread 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 EIS 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 3.3.1 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 have occurred 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, Kasegaluk Lagoon, and Cape Krusenstern National Monument.

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 and the Alpine, 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.

3.3.5.3 Land and Water Management

<u>Federal Lands Management</u>

Arctic National Wildlife Refuge

The ANWR, managed by the USFWS, was established in 1960 as the Arctic Wildlife Range. ANWR was expanded in 1980 to nearly 20 million acres and was incorporated into the National Wildlife Refuge system pursuant to the Alaska National Interest Lands Conservation Act (ANILCA). The area contains three Wild rivers and the largest designation of Wilderness areas in the National Wildlife Refuge System (USFWS 2000b). Due to controversy over management of the coastal plain, Section 1002 of the ANILCA established a 1.5 million acre Coastal Plain Resource Assessment Area in ANWRfor baseline study to quantify the extent of oil and gas resources and to characterize important biological resources. This area, referred to as the “1002 Area” is the northernmost section of the refuge adjacent to the Beaufort Sea. The U.S. Geological Survey (USGS) 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, the 1002 Area is currently managed as a “Minimal management” area, and oil and gas facilities are not permitted unless Congress would take action. Activities such as subsistence practices, outfitting, float planes and motor boats, and oil and gas studies are permitted under this management category (USFWS 2015a). In total, the refuge has five management categories: Intensive, Moderate, Minimal, Wild River, and Wilderness.

The USFWS submitted an updated version of the 1998 Comprehensive Conservation Plan (USFWS 1988) for the ANWR in 2013, and a Record of Decision was issued in April of 2015 to implement the plan (USFWS 2015b). The updated plan recommends the Brooks Range, Porcupine Plateau, and Coastal

Plain Wilderness (1002 Area) to Congress for Wilderness designation. The plan also recommends the Atigun, Hulahula, Kongakut, and Marsh Fork Canning rivers to Congress for inclusion in the National Wild and Scenic Rivers System (2015a). Until Congress makes a designation, ANWR will continue to manage the recommended lands for Wilderness under the Minimal management category. The recommended rivers will be managed under interim guidelines. USFWS will implement the updated plan over the next 15 to 20 years.

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). In 2014, a Record of Decision was released for the NPR-A Integrated Activity Plan, and NPR-A Plan is currently in the implementation phase (BLM 2015). The Greater Mooses Tooth Unit 1 is within NPR-A. In 2014, the Final Supplemental EIS for development of petroleum resources in the Greater Mooses Tooth Unit 1 was released, and the area is also within the implementation phase (BLM 2015).

Alaska Maritime National Wildlife Refuge

The Alaska Maritime National Wildlife Refuge (AMNWR) is managed by the USFWS 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 EIS 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 AMNWR 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. The plans contain management guidelines and classifications for specific management units. The documents identify 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 2008, and updates the 1989 plan. The Northwest Area Plan identifies management intent, land-use deisgnations, and management guidelines for 19.1 million acres of state-owned uplands, state-selected uplands, and state-owned tidelands (ADNR 2008). The plan 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 five-year program of proposed oil and gas lease sales to the legislature. Currently, Division of Oil and Gas conducts competitive annual area-wide 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 (NSB 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 (NSB 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, Point Thomson, 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). It should be noted that several of the communities with the North Slope have prepared, or are contemplating preparation of, Community Comprehensive Plans.

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 nm from the point of average low tide. The first 12 nm 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). Areas out to 24 nm 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).

The area out to 200 nm is the EEZ, within which the U.S. has sovereignty over the mineral deposits and living resources (Office of the Press Secretary 1983).

In the wake of the Deepwater Horizon event in the Gulf of Mexico in April 2010, the President issued an 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 EO seek 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 OCSLA gives the USDOI 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

Oil and gas leases within the three-mile limit are sold by the Alaska Department of Natural Resources, Division of Oil and Gas and were in that category (ADNR 2005, 2011). As a result of the ACMP expiration, oil and gas lease sales are not expected to adhere to a coastal management program. Oil and gas leases in state waters are subject to specific regulations and stipulations.

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. As of February 1, 2013, information about the expired ACMP is available on the ADNR website (http://www.alaskacoast.state.ak.us/).

3.3.6 Transportation

3.3.6.1 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 1,469 m (4,820 ft); construction of a new airport is nearing completion. It is serviced daily by Ravn (formerly ERA Alaska) (ADCCED 2016). Daily flights carry passengers, cargo, and mail, and commercial flights connect Kaktovik to Fairbanks and Deadhorse. Chartered aircraft also use this airport.

Nuiqsut

Air travel provides the primary transportation system for year round access to Nuiqsut. Nuiqsut is connected to the ConocoPhilips Alpine and Kuparuk facilities and a gravel mine by a gravel road. Nuisqut residents also have access via the gravel road to the airstrip at CD-3 near the Alpine facilities. The 1,324 m (4,343 ft) long by 27 m (90 ft) wide gravel airstrip at Nuiqsut is owned and operated by the NSB. There are two private heliports oprated by Pioneerr Natural Resources , Inc. This airport is serviced by regional business and private charters provide regularly scheduled flights (ADCCED 2016). 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 1,981 m (6,500 ft) long by 46 m (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, Ravn, and private charters service this airport, with connections to Fairbanks, Barrow, Kaktovik and Nuiqsut. 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 and is the only year-round access to the community. This airport has a 2,164 m (7,100 ft) long by 46 m (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 Ravn (ADCCED 2016). 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 1,370 m (4,494 ft) long by 27 m (90 ft) wide gravel airstrip is owned and operated by the NSB and is the primary airstrip. A 914 m (3,000 ft) long by 30.5 m (100 ft) wide gravel airstrip exists at the old Wainwright Air Station. This airport is serviced daily by commercial and chartered service by Ravn and other regional businesses from Barrow (ADCCED 2016). 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 1,372 m (4,500 ft) long by 30.5 m (100 ft) wide gravel airstrip, owned by the U.S. Air Force, is Point Lay's only year-round access. Ravn and other regional businesses provides daily commercial airline service to this community (ADCCED 2016), between Barrow/Wainwright and Point Lay. Freight arrives by air cargo year-round. Federal government chartered aircraft also use this airport on a limited basis.

Point Hope

The state-owned 1,219 m (4,000 ft) long by 23 m (75 ft) wide paved airstrip provides Point Hope's only year-round access. Bering Air, Ravn (daily), Grant Aviation (by charter), and Tanana Air Service (by charter) provide daily service to this community from Kotzebue (ADCCED 2016). Freight arrives by air cargo year-round. Federal government chartered aircraft also use this airport on a limited basis.

Kivalina

Air transportation is the primary means of year-round transportation into this community. The primary means of transportation into this community is by plane which lands on the state-owned 914 m (3,000 ft) long by 18 m (60 ft) wide gravel airstrip. Daily flights are available from Kotzebue (ADCCED 2011b). Bering Air, Ravn (daily), Grant Aviation (by charter), and Tanana Air Service (by charter) fly to this community (ADCCED 2016).

Kotzebue

Air transportation is the primary means of year-round transportation into this community. 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 1,920 m (5,900 ft) long by 46 m (150 ft) wide main paved runway and 1,181 m (3,876 ft) long by 27 m (90 ft) wide crosswind gravel runway. The runway and runway safety areas were lengthened and expanded during construction completed in 2014. A seaplane base is also operated by the state in Kotzebue. This airport is serviced daily from Anchorage and Nome, and throughout the week by the following carriers: Alaska Airlines; Bering Air; Ravn; Hageland Avaition Service and Tanana Air Service (by charter) (ADCCED 2016).

Nome

Nome is primarily accessible by air, and is a regional transportation center for surrounding villages (ADCCED 2015). There are two state-owned public-use airports in Nome: Nome Airport and Nome City Field Airport. The larger Nome Airport has two paved runways; one runway 1,882 m (6,175 ft) long by 46 m (150 ft) wide, and the other runway 1,829 m (6,000 ft) long by 46 m (150 ft) wide. In June 2014, construction began to expand the runway safety areas from the existing 300-foot width to 500-feet. The runway safety areas which are the surfaces adjacent to the runways for use in the event of aircraft overshoot, undershoot, or deviation from the runway (Mondor 2014). The project will also resurface taxiways. Scheduled passenger service at the Nome Airport is provided by the following carriers: Alaska Airlines, Arctic Transportation Services, Bering Air (winter seasonal and by charter), Evergreen Helicopters, and Ravn Alaska. The Nome City Field Airport has one gravel runway 594 m (1,950 ft) long by 34 m (110 ft) wide.

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 2010c). 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.

3.3.6.2 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 occurs during the open water season beginning about mid-summer and lasting through fall 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. Lightering from large vessels to smaller vessels occurs in shallow water landing and beach landing areas. Smaller craft are used to transport cargo upriver at Nuiqsut (BLM 2003). At Kotzebue lightering occurs from up to fifteen nautical miles 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 335 m (1,100 ft) long causeway connects East Dock to a no-longer-used 30.5-by-82 m (100- by-270-ft) long wharf constructed from grounded barges (BLM 2003). West Dock, a 3,993 m (13,100 ft) long by 12 m (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 1,372 m (4,500 ft) from shore and has a draft of 1.2 to 1.8 m (4 to 6 ft). The second facility is about 2,438 m (8,000 ft) from shore and has a draft of 2.4 to 3 m (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 large bulk carriers, *Panamax* and *Handymax* lighter to the DeLong Mountain Terminal a distance of three to five nautical miles from shore instead of directly loading at the terminal.

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 61 m (200 ft) in length with a depth of 7 m (22.5 ft). The West Gold Dock is 58 m (190 ft) in length with a depth of 7 m (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. Offshore gold dredging/mining operations also use the small boat harbor at the Port of Nome (ADNR 2012).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). The Port of Nome is used routinely by USCG Cutters Alex Haley and Munro and the USCG buoy tenders Sycamore and Hickory during logistical support operations and shore leave (Michels 2012). Design concepts for the Port of Nome – specifically to accommodate an increased USCG presence in the Arctic – include lengthening the current causeway to accommodate larger vessels such a polar class and fast response cutters (Michels 2012). As noted by the Port of Nome, vessel traffic has increased from 94 dockings in 1990 to 296 port calls in 2011 (Michels 2012). Port Clarence, located south of the Bering Straits and approximately seventy miles northwest of Nome has been identified as a potential deep draft port for large vessels and is a candidate site in a 2013 study by USACE to evaluate locations for a deep-draft port system (2013). The USACE 2013 report covers the first year of the three-year study (through 2014), this project is still in the study and seeking funding/support stages. Port Clarence has been identified as an area that is already used as a safe harbor and could be used for staging of activities and coordination of vessels. The Port of Nome is the other site recommended as a feasible deep draft port by this study (USACE 2013).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 and vessels for ice management. In 2012, Shell Oil Co. launched a 360-foot tug supply vessel the M/V Aiviq which is an anchor-handling icebreaker. This vessel is classified as a Polar Class 3 ship that according to international shipping standards would allow it to operate year round in second year ice (Beilinson 2012).

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. Shipping routes are (and likely in the future) only used for certain months of the year due to seasonal transition periods where the risks of such use increase due to ice conditions. The Northern Sea Route has become an opportunity for Russia (and China) to bring services and commodities transported on large vessels escorted by icebreakers (including petroleum products via ice strengthened super tankers) to the Asian markets (Whitney 2012). In 2011 there were 34 ships that shipped 820,000 tons of cargo along the Northern Sea Route compared to 46 ship transits in 2012 (Pettersen 2012). 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, 2009; Brigham and Ellis 2004; U.S. Arctic Commission 2010; US Navy Arctic Roadmap 2014). The USCG estimates that along the Northern Sea Route cargo transport will increase from 1.8 million tons in 2010 to 64 million tons by 2020 (USCG 2013a). Transits through the Bering Straits have steadily increased 118 percent in the past four years (2008 – 2012) (USCG 2013a). In 2012 there were approximately 480 Bering Strait transits, in 2011 there were approximately 4104100 transits; in 2010 approximately 425; in 2009 approximately 280 and in 2008 approximately 220 (USCG 2013a; Whitney 2012). Vessel traffic of tank vessels, cargo and tugs have increased the most in the 2008 to 2012 timeframe (USCG 2013a; Whitney 2012). The larger vessels transit the Bering Strait on the Russian side while smaller tugs and barges which bring supplies to coastal Alaskan communities transit along the U.S. side of the Strait (DeMarban 2012). Along the Northern Sea Route in 2012 a record 49 commercial ships were reported to have transited between northern Europe-Western Siberia and Asia (McConnell et al. 2013) carrying over 1 million tons of cargo that consisted primarily of petroleum products, iron ore, gas condensates and coal (McConnell et al. 2013; USCG 2013a). This represents a fifty percent increase from transits in 2011 and during 2012 the first transit of a liquefied natural gas (LNG) carrier occurred along the Northern Sea Route (McConnell et al. 2013). Increased vessel traffic in the Bering Strait is expected to continue to grow as industrial activities expand and the Northern and Northwestern Sea Routes become active transcontinental shipping routes (Robards, 2013). At present transit through the Northern Sea Route is a distance savings of forty percent in terms of fuel costs and travel time (USCG 2013a).

Shipping in the Arctic along the coastline of Alaska, 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.

In response to the growing need for the USCG to be able to fulfill mandated missions in the Arctic in 2012 the USCG conducted Arctic Shield 2012 in Alaska. The purpose of conducting this USCG action was to provide a consistent and reliable USCG presence in the Arctic during the summer operational window as a result of the substantial increase in maritime activity in the Arctic during the summer of 2012 (USCG 2012a). The intent of Arctic Shield 2012 was to provide the USCG with Arctic domain awareness and opportunities to respond to any maritime safety, maritime security, or maritime stewardship mission demands. In addition the program provided the USCG with operational experience in the Arctic, including operation of their assets, deployment of personnel, and conducting exercises, especially the deployment of several types of oil spill response equipment from USCG vessels (USCG 2012a). In 2013, the USCG released its Arctic Strategy (USCG 2013b) to guide efforts in the Arctic for the next ten years focusing on improving awareness, modernizing the governance and broadening partnerships in the area. The Department of Defense released an Arctic Strategy in 2013 describing opportunities and hazards that as a result of increased maritime traffic (Department of Defense 2013) recognizing the needs for scientific information, mapping and Arctic capable fleets and equipment.

There are three USCG icebreakers, with only two currently operating: the *Healy* and the *Polar Star*. The *Healy* is the USCG's newest and most advanced polar icebreaker and can support scientific missions in the Polar Regions that include logistics, search and rescue, ship escort, environmental protection and enforcement (USCG 2013c). The USCG *Polar Star* icebreaker returned to service in 2013 (USCG 2013d). The USCG icebreaker *Polar Sea* has been inactive since 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 a new vessel - the *R/V Sikuliaq* - a research vessel that is ice strengthened and able to work in moderate seasonal ice in the Arctic region - is ported at the Marine Science Center in Seward, Alaska (UAF 2011, 2012, 2013). This vessel is owned by the National Science Foundation and is operated by the University of Alaska Fairbanks as part of the U.S. academic research fleet (UAF 2013). A key finding of the Arctic Climate Impacts Assessment was that reductions in sea ice is likely to lead to increase in marine transportation and access to resources and development (Arctic Council 2009; Ellis 2007; 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 initiated a Port Access Routing Study to increase safety of vessel traffic that transit the Bering Straits (Colvin 2011). The USCG's Bering Strait Port Access Routing Study will evaluate the need for ship routing measures in the Bering Strait. This process involves an extensive study of many factors and requires the coordination of the US and Russia. It should be noted that any internationally binding Ship Routing Measures will be approved by the International Maritime Organization (USCG 2012). The Port Access Routing Study and workshops for developing the study examined potential ship routing measures including a traffic separation scheme, recommended route, precautionary area and areas to be avoided (USCG 2012). 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 2011. 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 2010). The Coast Guard accepted public comment during 2015 to be incorporated into the final Bering Strait Port Access Routing Study.

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 to 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. As a foundation for building safe infrastructure for marine transportation throughout the Arctic, the Office of Coastal Survey has developed a nautical charting plan that sets forth the layout of additional nautical chart coverage and describes the requisite activities needed to build and maintain nautical charts (NOAA 2011e). In 2012 the NOAA ship *Fairweather* conducted a mission to collect information that will determine NOAA's future efforts for charting survey projects in the Arctic. The goal is to collect depth measurements that will allow NOAA cartographers to eventually guide charting decisions and update nautical charts and future new hydrographic surveys (NOAA 2012d).

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 MSFCMA

3.3.6.3 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're 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."* As commented by 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 subsistence hunters. And I don't want to see more of that. It's our garden."* As commented by 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".* As commented by 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.* As commented by 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.* As commented by 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.* As commented by 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.* As commented by 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.* As commented by 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.* As commented by 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.* As commented by George (unable to hear), Manilliq, Kotzebue at Open Water Meeting 2011, Anchorage, AK.

Aquatic Invasive Species

With respect to transportation, the introduction of invasive and non-native species into the marine environment could occur through the discharge of ballast waters (NRC 1996) or through hull fouling (see Section 3.2.1 for a full discussion of current information on aquatic invasive species).

3.3.7 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 is 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 EIS 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.

3.3.7.1 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 year round such as wildlife viewing and photography, sailing, float boating, hiking/backpacking, camping, fishing, hunting, and winter sports (BLM 2008b). Lack of daylight in the winter months is the limiting factor for many recreational activies such as wildlife viewing and photography, sailing, float boating, hiking/backpacking and camping. 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, ANWR, the NPR-A, 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 Prudhoe Bay, and in the vicinity of Nuiqsut and the Colville River. 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 EIS 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; 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. BOEM (2012) indicated that recreation and tourism are not major sources of employment in the NSB and Northwest Arctic Borough (NAB) with total employment of 619 in these sectors in 2008.

It is important to note that some inland recreation originates or terminates on the coast, and therefore the coast and offshore areas around coastal communities and recreation activities are a part of the recreational setting.

3.3.7.2 Activities

Low levels of recreation activities are estimated to occur in the EIS 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 EIS project area, including the offshore environment, nearshore environment, as well as in the vicinity of the coastal communities evaluated in this document. There are specific onshore areas that attract outside tourists for hiking, rafting, wildlife viewing, and sport hunting and fishing.

No agency currently tracks dispersed recreation in the offshore environment. The USCG has noted the increased presence of small cruise ships and recreational/expedition sailboats venturing through the offshore area en route through the Northwest Passage in recent years (Loomis and Murphy 2012). 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 EIS project area.

Offshore

Offshore recreation activities in the EIS 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 and NWAB also have observed an increase in yachts or personal pleasure boats traversing the EIS project area. Opportunities exist for expeditions to the North Pole that would traverse through the EIS project area. It is expected that as transportation increases in the Northwest Passage that the presence of recreational vessels and yachting expeditions transiting though the offshore will also increase.

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 typically hundreds of miles apart with vast stretches of federal and state lands in between. Access to the undeveloped areas is difficult and costly and occurs primarily in the summer months as winter conditions are a limiting factor. Some winter recreation may occur but would be infrequent due to harsh and hostile conditions. As a result, much of the recreation occurs around the coastal communities in the summer and early fall, where some infrastructure exists, such as airports, hotels, and guide services. Package tours, wilderness adventures and sport hunting and fishing are the three main types of recreational tourism that occur in the NSB (NSB 2007). Several options for commercial flightseeing are available out of Kaktovik, Barrow, and Kotzebue as packaged tours. In the NSB, Barrow is the community that has the most developed tourism sector with access by air (BOEM 2012). Charter boats are available in towns for wildlife viewing and photography. Hikers and rafters coming out of the Arctic National Wildlife Refuge may end in Kaktovik using chartered aircraft of access and pick up and drop off (BOEM 2012). Hiking and backpacking opportunities out of Kaktovik, Barrow, and Kotzebue exist, although there are no specific facilities or services in the backcountry to support these activities, and no designated trails. Three rivers are used by rafters for wildlife viewing within the Arctic National Wildlife Refuge including the Hulahula, Kongakut, and the Sheejek rivers with float times lasting 10-12 days (NSB 2007). Within the NPR-A recreational guided boating on rivers occurs mainly on the Colville, Etivuk, Nigu and Utukok rivers (BLM 2011). The aurora borealis also draws visitors, and these tours are often paired with wildlife viewing or other guided activities (Alaska Photo Graphics 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 ADF&G permits sport hunting, trapping, and fishing on the North Slope in Game Management Units 26 and 23, with certain restrictions (ADF&G 2010). Independent sport hunters and fishers tend to charter aircraft to areas along the Brooks Range and coastal communities but can also access the area via the Dalton Highway (BOEM 2012). Caribou, moose, brown bear, and Dall sheep are the main species hunted by sport hunters. There is a hunting lodge operated in Umiat, located on the Colville River (NSB 2007). Sport fishing is largely an incidental activity conducted opportunistically during game hunts and river trips (BLM 2011).

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 Photo Graphics 2011).

Organized tours of the Prudhoe Bay are available as packages with travel from air or bus from Fairbanks along the Dalton Highway. These types of tours involve tours of the oil fields, wildlife viewing and visiting the Arctic Ocean. Independent tourists are not able to drive past Deadhorse due to security inside the oilfields.

Kotzebue is the hub of recreation and tourism activities in the NWAB. Attractions to the area surrounding Kotzebue include organized tours related to Alaska Native life and cultural experiences, city tours and tundra walks, drop offs to the nearby national parks, wildlife viewing, hunting and fishing, backcountry trips and ecotourism (NAB 2006). Independent and structured adventure tourism occurs mainly in the summer months and departs from Kotzebue to areas including the Noatak National Preserve, Gates of the

Arctic National Park and to the Noatak and Kobuk Rivers (NAB 2006). Outfitters and guides provide recreational opportunities from Kotzebue for sport fisherman and hunters seeking more remote caribou and moose hunts in Northwest Alaska (NAB 2006).

3.3.8 Visual Resources

3.3.8.1 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).

3.3.8.2 Methods

Baseline visual resources within the analysis area were established by: (1) completing a regulatory review to establish areas where visual resources are managed by federal, state, or local planning documents, and (2) assessing potential viewer groups, visual resource attributes, and visual distance zones (visibility) within the analysis area. Landscape character attributes were described in terms of the basic elements of form, line, color and texture of prevailing landform, water, vegetation, and cultural modification. This approach was applied across the analysis area to ensure that baseline data in visual resources was evaluated consistently across all jurisdictions. Viewer groups were identified through coordination with recreation, cultural, and subsistence resources, and review of scoping comments. These sources were used to understand how specific locations within the analysis area are used, and the types of viewer groups that may be associated with those uses. Characteristics of identified viewer groups, such as seasonality, amount of use, predominant viewer activity, and distance from proposed project were included in this inventory. Qualitative indicators considered in this analysis also included seasonality and motion. Seasonality could influence visibility within the EIS project area due to lighting and atmospheric conditions. Motion was evaluated to provide a baseline of activity level within the analysis area.

3.3.8.3 Regulatory Framework

The EIS project area includes inland areas administered by the NPS, the USFWS, the BLM, 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 RODs for NEPA compliance documents.

3.3.8.4 Viewer Groups

Viewer Groups were identified for the EIS project area. Viewer groups were classified based on their geographic location or setting, and predominant activity or land use (i.e., recreation, subsistence, industrial activity).

Three predominant viewer groups were identified for the project: native communities; recreators (including Arctic marine tourists); and industrial workers. Viewer groups and their anticipated exposure to the proposed EIS 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 EIS 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 EIS project area. Other recreation groups include those accessing the area by boat. Recreators may also experience views of the EIS project area from the air when traveling to/from recreation destinations. These recreators are in small groups and may be present in the EIS project area from June through September.
- *Arctic Tourists*: Arctic tourists include individuals traveling through the project area by ship. These individuals may experience views of the EIS project area from an on- or offshore perspective. Artic tourism is currently is limited in numbers of occurrence and may be present in the EIS project area from June through September.
- *Industrial Workers*: Industrial workers are primarily situated in Oil and Gas lease areas located on the north shore of the ACP between the Colville River Delta and Point Thomson on the western boundary of ANWR.
- *Viewer Distance:* Predominant viewer distance assessed within the following framework: Foreground / Middle ground (3 to 5 miles); Background (5 to 15 miles); and Seldom Seen (beyond 15 miles). The following assumptions were applied to the distance zone assessment: 1) offshore viewers may experience views of the analysis area from various locations, and therefore no fixed point can be established and a range of distance zone must be considered; and 2) views of the analysis area from on-land 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 / middle ground distance zones. During winter months visibility may be limited to areas within one mile, depending on the level of light present in an area from offshore vessels.

Viewer groups identified within the EIS project area are summarized in Table 3.3-48 below.

Table 3.3-48 Viewer Groups Located Within the Visual Resources Analysis Area

Geographic Area	Viewer Location	Type of User
Beaufort Sea	Onshore	Native communities of Nuiqsut and Kaktovik
		Industrial workers (Oil & Gas) centered on Prudhoe Bay and Deadhorse
		Recreators located in the ANWR[2]
	Offshore	Individuals engaged in subsistence
		Industrial workers
		Arctic tourists offshore from ANWR[2]
Chukchi Sea	Onshore	Native Communities of Barrow, Wainwright, Point Lay, Kivalina, and Kotzebue
		Industrial workers (Oil & Gas)

Geographic Area	Viewer Location	Type of User
		Recreators located in the AMNWR[3]
	Offshore	Individuals engaged in subsistence
		Industrial workers
		Arctic tourists
Entire EIS Project Area	Onshore / Offshore	Air travelers (industrial workers, tourists, researchers / scientists)

Notes:

[1] ANWR = Arctic National Wildlife Refuge, [2] N/A – Not Applicable, [3] Alaska Maritime National Wildlife Refuge
Cape Krusenstern National Monument: http://www.nps.gov/cakr/parkmgmt/lawsandpolicies.htm

3.3.8.5 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 features represent geographic areas that are classified largely based on homogenous topography within a province. Each province is distinct, and differences across adjacent features 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 AMNWR, and Cape Krusenstern National Monument.

3.3.8.6 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.

3.3.8.7 Activity and Viewpoints

Activities within the EIS project area are supported by air, marine vessel, or snowmobile travel. The modes of travel in the EIS project area provide common means of viewing the EIS project area. (For more detailed information on transportation, refer to Section 3.3.6.)

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 during the winter season 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). Trucks are used within community road systems, and on winter ice roads connecting oil and gas facilities to the Prudhoe Bay area.

3.3.8.8 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 EIS 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 Beaufort Sea, or from seaside cliffs, such as those characterizing the more rugged coastlines of the Chukchi Sea.

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 3.3-19 and 3.3-20). 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 3.1.1.6

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 3.3-21). 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 creating large arcshaped 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 (2.5 mi) at the northern end, and up to 100 km (21 mi) 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 3.3-22 and 3.3-23). 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 3.3-24). 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 Beaufort Sea, between Point Barrow east to the border between ANWR and the North Slope Foothills Areawide Oil and Gas Lease Sale Area. Structures related to oil and gas exploration and possible development in the 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 Beaufort Sea west of the ANWR. 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, although offshore oil and gas production structures have been constructed for the Northstar and Duck Island Projects. The primary onshore and near-shore (within three miles) activity extends from the Town of Barrow, east to Point Thomson, 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 area of the Beaufort Sea west of the ANWR from the remainder of the EIS project area, as it is primarily characterized by ongoing oil and gas activity. Views of the EIS project area from native communities and industrial nodes along the shoreline of this area would experience views of existing on- and offshore oil and gas activity. Viewers situated along the shoreline east of the North Slope Foothills Areawide Oil and Gas Lease Sale Area 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 3.3-25), whereas exploration structures would be temporary, such as the Mars Ice Island (Figures 3.3-26 to 3.3-28). 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 EIS 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 EIS project area, communities are generally small in scale compared to the surrounding landscape.

3.3.9 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.

3.3.9.1 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.

3.3.9.2 Ethnicity and Race

Each of the affected communities has a majority Iñupiat or Alaska Native population as shown in Table 3.3-50. 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.

3.3.9.3 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 (Census 2011). The U.S. Census 2006-2010 "American Community Survey" 5-Year Estimates, data found in Tables 3.3-51 and 3.3-52, are the best available estimates for household income and individual and family poverty. However, in the 2010 Census, Prudhoe Bay Census Designated Place is included in the NSB. This skews income data because there are over 2,100 workers who spend a majority of their year in this enclave.

U.S. Department of Commerce, Bureau of Economic Development personal income (per capita) summary for 2012 was $49,436 statewide compared to $28,051 nationwide (Census 2012). The highest average per capita personal income was NSB ($50,918), while Nome Census Area ($40,679) and NAB ($41,145) were less than the state average (DOC 2012).

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). These data points cannot be compared directly to 2012 DOC income data, but they demonstrate variability within the borough.

2009 income and poverty data are provided in Table 3.3-51 because this data was compiled before Prudhoe Bay was included in the 2010 Census data. Even then, the NSB fares better than the state, nation, and other affected regions in the measure of median household income. However, Alaska's higher cost of living pushes the poverty threshold about 125 percent times the U.S. level (Department of Health and Human Services [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, 2010 Estimates[a]

Community	2010 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	239	212	88.7%	24	10%	0	0	0	0	0	0	0	0	3	1.3%	0	0
Nuiqsut	402	350	87.1%	40	10%	0	0	1	0.3%	0	0	0	0	11	2.7%	0	0
Barrow	4,212	2,577	61.2%	712	16.9%	384	9.1%	41	1%	99	2.4%	34	0.8%	365	8.7%	131	3.1%
Wainwright	556	501	90.1%	45	8.1%	0	0	0	0	0	0	0	0	10	1.8%	0	0
Point Lay	189	167	88.4%	20	10.6%	0	0	0	0	1	0.5%	0	0	1	0.5%	0	0
Point Hope	674	603	89.5%	39	5.8%	0	0%	3	0.5%	6	1%	1	0.1%	28	4.2%	0	0
North Slope Borough	9,430	5,100	54.1%	3,147	33.4%	425	4.5%	94	1%	104	1.1%	67	0.7%	493	5.2%	249	2.6%
Kivalina	374	360	96.3%	8	2.1%	0	0	0	0	0	0	0	0	6	1.6%	0	0
Kotzebue	3,201	2,355	73.6%	512	16%	40	1.3%	29	0.9%	11	0.3%	12	0.4	242	7.6%	43	1.3%
Northwest Arctic Borough	7,523	6,121	81.4%	846	11.2%	42	0.6%	37	0.5%	12	0.2%	17	0.2%	448	6%	58	0.8%
Nome	3,598	1,971	54.8%	1,093	30.4%	78	2.2%	18	0.5%	9	0.3%	18	0.5%	411	11.4%	85	2.4%
Nome Census Area[c]	9,492	7,199	75.8%	1,552	16.4%	96	1.0%	27	0.3%	9	0.1%	22	0.2%	587	6.2%	115	1.2%
State of Alaska	710,231	104,871	14.8%	473,576	66.7%	38,135	5.4%	23,263	3.3%	7,409	1%	11,102	1.6%	51,875	7.3%	39,249	5.5%
United States	308,745,538	2,932,248	0.9%	223,553,265	72.4%	14,674,252	4.8%	38,929,319	12.6%	540,013	0.2%	19,107,368	6.2%	9,009,073	2.9%	50,477,594	16.3%

Notes:

a) Total Population, American Community Survey 2006-2010 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) 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 EIS Project Area[a]

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