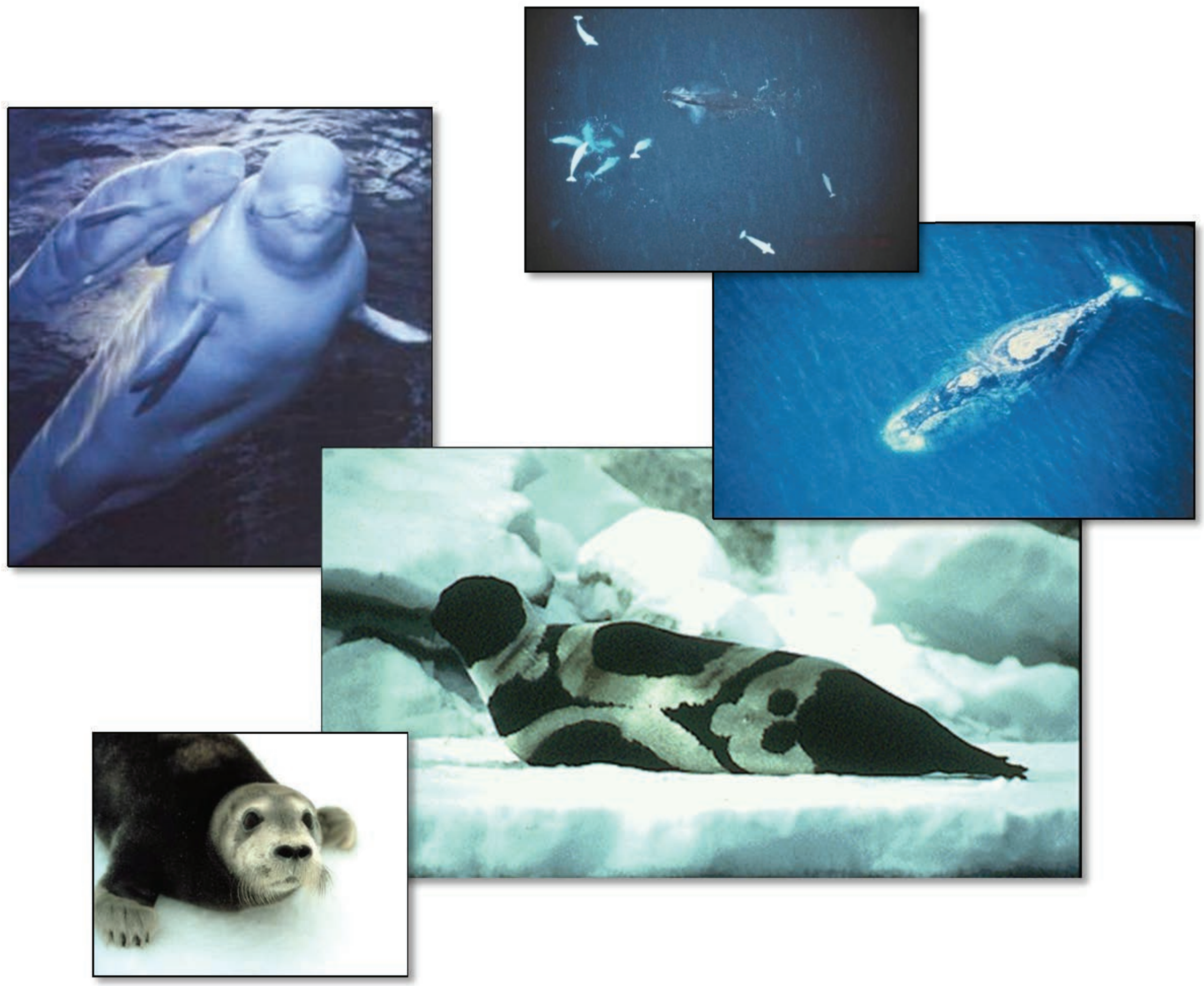
Effects of Oil and Gas Activities in the Arctic Ocean

Supplemental Draft Environmental Impact Statement



March 2013

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

The statutory responsibilities include BOEM's issuance of permits and authorizations under the Outer Continental Shelf Lands Act (OCS Lands Act) for seismic surveys and 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 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.

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 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 PDEIS on October 28, 2009 and announced their decision to prepare a new EIS to be called, *Effects of Oil and Gas Activities in the Arctic Ocean*, with 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 Final EIS would benefit from the inclusion of an additional alternative for analysis that cover 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 this Supplemental Draft EIS and allow for an additional public comment period before releasing the Final EIS 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 EIS since publication of the 2011 Draft EIS. Portions of the EIS where substantive changes have occurred include:

- Alternatives
    - Added a new alternative that contemplates a higher level of exploratory drilling activity overall than the previous high level of activity alternative (now contemplates a scenario with a maximum of four exploratory drilling programs in both the Beaufort and Chukchi seas each year).
    - 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.
- 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 and subsistence resources to include additional factors that more closely align with analyses conducted under the MMPA.
    - Included information regarding potential changes to the acoustic criteria currently used by NOAA to determine the level at which injury of marine mammals and behavioral effects from seismic airguns occurs. Because the acoustic criteria will go out for public comment and undergo a peer review process, we can only include some basic information at this time and then refer the public to the acoustic criteria document for comment when it is made available. The schedules for the public review process and finalization of the two documents are similar.

While NMFS has made several changes to the document based on public comments received on the 2011 Draft EIS, an appendix addressing responses to all public comments on both the 2011 Draft EIS and this Supplemental Draft EIS will appear in the Final EIS.

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) are serving as formal cooperating agencies; the Environmental Protection Agency (EPA) is serving 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.

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

A brief summary of the agencies' regulatory requirements follows:

1.2.1 MMPA Requirements

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

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

1.2.2 OCS Lands Act Requirements:

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

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

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

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

1.3 Project Overview

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 ancillary activities in the U.S. Beaufort and Chukchi seas, Alaska, by BOEM under the OCS Lands Act.

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 oil and gas exploration activities that are addressed and evaluated in this EIS are grouped into the following three categories:

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

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

1.4 Project Purpose and Need

1.4.1 Purpose

Energy use in the U.S. is expected to continue to increase from present levels through 2040 and beyond (EIA 2012). For example, the U.S. consumption of crude oil and petroleum products has been projected to increase from about 19.1 million barrels (Mbbl) per day in 2010 to about 21.9 Mbbl per day in 2035 (EIA 2011). 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 OCS Lands Act 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 may result in the disturbance of marine mammals through sound, discharge of pollutants, and/or the physical presence of vessels. Because of the potential for these activities to "take" marine mammals, oil and gas operators may choose to apply for an ITA.

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

1.4.2 Need

Authorizing "Take" under the MMPA: 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.

Authorizing Offshore Oil & Gas Activities: BOEM expects to receive applications to conduct exploration surveys, ancillary activities, and exploration drilling pursuant to the OCS Lands Act. To fulfill statutory mandates for proposed exploratory drilling projects, BOEM requires lessees to submit industry-obtained seismic survey data, high-resolution shallow hazards data, and well information with an Exploration Plan. BOEM and BSEE use the information to: (a) ensure safe operations, which refers to detection of shallow gas pockets, faults, channel boundaries or other geological or man-made features that could be hazards to drilling; (b) support environmental impact analyses; (c) protect resources through avoidance measures, such as prohibiting anchor locations within a boulder patch area or a potential archeological site; and (d) perform other statutory responsibilities.

1.5 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;
- Risks of oil spills;
- Climate change;
- Protection of subsistence resources and the Iñupiat culture and way of life;
- Availability of research and monitoring data for decision-making;
- Monitoring requirements; and
- Suggestions for, or implementation of, mitigation measures.

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

NMFS will include an appendix in the Final EIS that contains a summary of comments and responses received on the 2011 Draft EIS and this Supplemental Draft EIS.

2.0 ALTERNATIVES

A total of 11 alternatives were initially considered for this Supplemental Draft EIS, 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, and a level of exploratory drilling programs commensurate with the number of lease holders in the Beaufort and Chukchi seas. 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.
- Identifying a range of potential Additional Mitigation Measures that need further analysis and may be applied to alternatives pursuant to the MMPA ITA process and the BOEM OCS Lands Act permitting process.

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

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

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

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

The 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 and this Supplemental Draft EIS, as well as outlining the differences between the alternatives themselves.

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

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

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

Table ES-1 Differences in the Alternatives between the December 2011 Draft EIS and this Supplemental Draft EIS

Alternative	2011 Draft EIS	2013 Supplemental Draft EIS
Alternative 1 (No Action)	NMFS would not issue ITAs under the MMPA, and BOEM would not issue permits and notices under the OCS Lands Act.	Same as in 2011 Draft EIS
Alternative 2	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 in each sea per year Considered inclusion of required standard mitigation measures and additional mitigation measures.	Same as in 2011 Draft EIS
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 • Two exploratory drilling programs in each sea per year Considered inclusion of required standard mitigation measures and additional mitigation measures.	Same as in 2011 Draft EIS
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	This alternative differs from Alternative 4 from the 2011 Draft EIS in the following ways: • Considers up to four exploratory drilling programs in each sea per year

	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.	• It does not consider inclusion of any required time/area closures. Everything else about the alternative remains the same.
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 per sea per year to up to four per sea per year • Inclusion of required time/area closures. However, there are changes. The following are the required time/area closures considered in this EIS: o Kaktovik o Barrow Canyon and the Western Beaufort Sea o Shelf Break of the Beaufort Sea o Hanna Shoal o Kasegaluk Lagoon

		o Ledyard Bay
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 per sea per year to up to four per sea per year.

2.1 Alternative 1 – No Action

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

2.2 Alternative 2 – Authorization for Level 1 Exploration Activity

Alternative 2 is defined as the following:

2.2.1 Level of Activity

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

2.2.2 Mitigation

- Including *required* Standard Mitigation Measures (described in Section 2.7) that are part of every action alternative.
- Including a full analysis of a wide range of Additional Mitigation Measures (described in Section 2.8) that *could potentially* be required through the MMPA process and could vary by alternative (i.e. some might be different based on level and/or type of activity in a given year)

2.2.3 Assumptions

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

Exploratory activities (including deep penetration seismic, site clearance and high resolution shallow hazards, and exploratory drilling) in the next five years will be concentrated in areas of recently purchased leases. This does not mean that there will not be exploratory activities in other areas of the U.S. Arctic Ocean, especially if BOEM's next Five Year Lease Plan schedule includes sales in the Arctic OCS. In the U.S. Beaufort Sea, the two primary areas of interest for exploration are nearshore in Camden Bay and Harrison Bay. In the U.S. Chukchi Sea, the areas of interest are all well offshore in the lease areas, particularly around drill sites from the late 1980s, including Shell's Burger, Crackerjack, and Shoebill sites; ConocoPhillips' Klondike site; and Statoil's leases in the northeast part of the Lease Sale 193 area.

2.3 Alternative 3 – Authorization for Level 2 Exploration Activity

Alternative 3 is defined as the following:

2.3.1 Level of Activity

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

2.3.2 Mitigation

- Including *required* Standard Mitigation Measures (described in Section 2.7) that are part of every action alternative.
- Including a full analysis of a wide range of Additional Mitigation Measures (described in Section 2.8) 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 or CSEM surveys in the Beaufort Sea and up to **five** 2D/3D seismic or CSEM surveys in the Chukchi Sea per year, with up to **one** of that total number of surveys in each sea including ice breaking if necessary.
- Up to **five** site clearance and high resolution shallow hazards survey programs in the Beaufort Sea and up to **five** site clearance and high resolution shallow hazards survey programs in the Chukchi Sea per year.
- **One** on-ice seismic survey in the Beaufort Sea per year.
- Up to **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) that are part of every action alternative.
- Including a full analysis of a wide range of Additional Mitigation Measures (described in Section 2.8) 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 <u>With Additional Required Time/Area Closures</u>

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) 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.
    - <u>Kaktovik and Cross Island</u> – 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.
- Hanna Shoal[1] – An area of high biological productivity (benthic organisms); a feeding area for various marine mammals (walrus and bearded seals).
  - Walrus: July – August (USGS 2011)
  - Bearded Seals: September – October (Clarke et al. 2011a)
  - Except for emergencies or human/navigation safety, oil and gas exploration operations shall not occur within the Hanna Shoal area or the designated buffer zones from July 1 – August 30.
- 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.

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[1] Gray whales have been removed as a reason for designating Hanna Shoal as a time/area closure location. 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. in prep.).

- Including a full analysis of a wide range of Additional Mitigation Measures (described in Section 2.8) 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.

2.6 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) that are part of every action alternative.
- Including a full analysis of a wide range of Additional Mitigation Measures (described in Section 2.8) 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 A.

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

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

- Establishment and execution of 180 dB shutdown/power down radius for cetaceans and 190 dB shutdown/power down radius for ice seals, respectively.
- 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.

On-ice Seismic Surveys

- 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.

Exploratory Drilling Activities

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

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

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

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

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

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

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

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

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

- Shutdown of activities occurring in specific areas of the Beaufort Sea corresponding to the start and conclusion of the fall bowhead whale hunts in Nuiqsut (Cross Island) and Kaktovik beginning on 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.
- Required flight altitudes and paths for all support aircraft in areas where subsistence occurs, except during take-off, landing, and emergency situations.

2.8 Additional Mitigation Measures

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

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

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

- Prior to conducting the authorized survey, the seismic array operator shall conduct sound source verification tests for their airgun array configurations in the area in which the survey is proposed to occur.
- All PSOs shall be provided with and use appropriate 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 in order to detect marine mammals within the exclusion zones.
- Operators shall limit seismic airgun operations in situations of low visibility when the entire safety radius cannot be observed (e.g., nighttime or bad weather).
- Seismic operators shall use passive (or active) 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 (e.g. expansion of shutdown zone to 120 dB or 160 dB when cow/calf groups and feeding or resting aggregations are detected, respectively).

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

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

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

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

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

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

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

- Vessel and aircraft avoidance of concentrations of groups of ice seals by 0.8 km (0.5 mi).
- Specified shipping or transit routes to avoid important habitat in areas where marine mammals may occur in high densities.

Exploratory Drilling Activities ONLY

- Requirements to ensure reduced, limited, or zero discharge of any or all of the specific discharge streams identified with potential impacts to marine mammals or marine mammal prey or habitat.

- Operators are required to recycle drilling muds.

On-ice Seismic Surveys

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

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

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

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

Exploratory Drilling Activities ONLY

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

3.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

Chapter 3 of the EIS describes the current condition of the physical, biological, and social environment in the EIS project area to serve as a baseline to compare the potential 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.

<u>Extent</u>

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.

<u>Context</u>

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[2]: 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.

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.

[2] 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.

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, possible ship strikes, or habitat degradation.	Moderate impacts from noise disturbance, possible ship strikes, or habitat degradation.	Moderate to major impacts from noise disturbance, possible ship strikes, 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, possible ship strikes, or habitat degradation.	Moderate impacts from noise disturbance, possible ship strikes, or habitat degradation.	Moderate impacts from noise disturbance, possible ship strikes, 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. No impact from activities in the Beaufort Sea as they are uncommon there.	Minor impacts from disturbance, risk of injury or mortality, and changes in habitat in the Chukchi Sea. Despite the increased activity, there would be no increase in the impact level. No impact from activities in the Beaufort Sea as they are uncommon there.	Minor impacts from disturbance, risk of injury or mortality, and changes in habitat in the Chukchi Sea. Despite the increased activity, there would be no increase in the impact level. No impact from activities in the Beaufort Sea as they are uncommon there.	Minor impacts, although time/area closures would reduce potentially adverse effects on walrus in those areas. No impact from activities in the Beaufort Sea as they are uncommon there.	Minor impacts. Alternative seismic technologies for in-ice surveys would likely still require the use of ice and would therefore have similar disturbance effects on walrus as those technologies currently in use. No impact from activities in the Beaufort Sea as they are uncommon there.
Marine Mammals: Polar Bears	No effect	Minor impacts from temporary localized disturbance.	Minor impacts from temporary localized disturbance. Despite the increased activity, there would be no increase in the impact level.	Minor impacts 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.	Same as Alternative 3.	Same as Alternative 3.

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.

3.5 Physical Environment

3.5.1 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 minor 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.

3.5.2 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 or exceed disturbance and injury thresholds.

- 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.

3.6 Biological Environment

3.6.1 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. Ship strikes and habitat degradation is also possible. Oil and gas exploration activities that may alter whale habitat include: disturbance of sea ice from icebreaking, disturbance of benthic sediments during drilling, contamination of the marine environment from discharge of drilling muds and other waste streams from ships and support facilities.

Impacts

- All action alternatives would cause moderate adverse impacts to bowhead and beluga whales from noise disturbance, risk of ship strikes, 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.

3.7 Social Environment

3.7.1 Socioeconomics

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

Impacts

- Alternative 1 (No Action) would cause minor adverse impacts from unrealized local employment and tax revenue. The potential unrealized revenue for state and federal governments is unknown since the likelihood of exploration resulting in production cannot be predicted.
- All five action alternatives would cause minor beneficial impacts from a temporary rise in regional personal income and employment rates.
- Alternatives 3, 4, 5, and 6 would not cause an increase in the level of beneficial impact because income and employment rates are not expected to rise more than five percent.
- The time/area closures under Alternative 5 could reduce total income and employment rates and therefore the beneficial impact would be less than Alternative 4, but would still be minor.
- The alternative technologies requirement under Alternative 6 could cause additional costs from lost productivity so the beneficial impact would be less than Alternative 4, but would still be minor.

3.7.2 Subsistence

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

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

Impacts

- All action alternatives except 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.

3.7.3 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.

3.7.4 Visual Resources

Visual resources within the EIS project area are dominated by characteristics of the Beaufort and Chukchi seas. The visual characters of these 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.

3.8 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 minor cumulative adverse impacts to socioeconomics, and major cumulative adverse impacts to land and water ownership, use and management.

Any of the five action alternatives would have major 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) and other publicly available information. For the Beaufort Sea, the discussion and analysis is incorporated from the recent BOEM 2012-2017 OCS Oil and Gas Leasing Program Draft Programmatic EIS (BOEM 2011d).

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

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

5.0 IMPLEMENTATION, MONITORING AND REPORTING, AND ADAPTIVE MANAGEMENT

5.1 EIS Implementation and NEPA Compliance

The Final EIS will identify the Preferred Alternative. The Record of Decision (ROD) will provide a listing of activities addressed by the Preferred Alternative and will identify any conditions of approval that are relevant to industry authorization requests. The EIS and ROD together constitute a decision document to be used for ongoing and future permitting activities addressed by this EIS. NMFS and BOEM will use the EIS when issuing ITAs and G&G permits and ancillary activity notices for oil and gas exploration 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 intends to conduct site-specific NEPA analyses that either tier from the EIS or incorporate it by reference. BOEM would also use the EIS to assist in carrying out other statutory responsibilities such as working with NMFS and the U.S. Fish and Wildlife Service to ensure compliance with the Endangered Species Act and Magnuson-Stevens Fishery Conservation and Management Act, and where needed could modify permit conditions or lease operation to meet the requirements of any Endangered Species Act or MMPA authorization.

5.2 Monitoring and Reporting

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

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

To increase the understanding of –

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

- How individual marine mammals respond (behaviorally or physiologically) to the specific stressors associated with the action (in specific contexts, where possible, e.g., at what distance or received level).
- How anticipated individual responses, to individual stressors or anticipated combinations of stressors, may impact either: 1) the long-term fitness and survival of an individual; or 2) the population, species, or stock (e.g. through effects on annual rates of recruitment or survival).
- 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).
- The impacts of the activity on marine mammals in combination with the impacts of other anthropogenic activities or natural factors occurring in the region.
- The effectiveness of mitigation and monitoring measures.
- The manner in which the authorized entity complies with the incidental take authorization and incidental take statement.
- An increase in the probability of detecting marine mammals (through improved technology or methodology), both specifically within the safety zone (thus allowing for more effective implementation of the mitigation) and in general, to better achieve the above goals.

Applicants should target questions that have been identified as priorities (i.e. to fill data gaps). Proposed monitoring plans are evaluated using the above guidance, considering the likelihood of effectively answering the questions. Regulations prescribe that monitoring plans undergo an independent peer review 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's regulations written to implement this requirement state, "Upon receipt of a complete monitoring plan, and at its discretion, [NMFS] will either submit the plan to members of a peer review panel for review or within 60 days of receipt of the proposed monitoring plan, schedule a workshop to review the plan." Although the MMPA only includes this requirement for IHAs, in its implementing regulations, NMFS extended this requirement to include LOAs as well.

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

In the late 1990s and early 2000s, these meetings were not held because there was very little activity during the open-water season in the U.S. Arctic Ocean. NMFS began to reconvene the meetings in 2006 when the level of activities for the open-water season began to increase. These annual meetings came to be known as the Arctic Open-Water Meeting. However, while these meetings were initially small gatherings of 15 to 30 people in the 1980s and early 1990s, from 2006 through 2013 the meetings drew approximately 150 to 250 participants each day, thus making it difficult to include the focused and detailed reviews of the applicants' monitoring plans.

In order to ensure the focused independent peer review of the monitoring plans prescribed by the regulations, in 2010, NMFS divided the annual meeting into two separate parts, one larger and more open to stakeholder input, and one smaller meeting where a group of scientists specifically gathers to review the monitoring reports. In 2010, 2011, 2012, and 2013, after soliciting nominations from the industry ITA applicants, the Marine Mammal Commission, and the affected subsistence communities and representative organizations, NMFS convened panels of approximately five to seven scientists to provide an independent scientific review of the plans. During these reviews, NMFS charged the 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 selects those that were appropriate for potential inclusion in the applicant's final monitoring plans. NMFS then works with the applicants regarding the practicability of including these measures and protocols, and then includes the selected measures as requirements in the issued authorizations.

This process is still developing, and some strengths and weaknesses have been identified. 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. However, panel members have 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 the 2012 peer review panel meeting. Therefore, NMFS will strive to provide additional time for interaction where feasible. 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 recommendations in their reports (related to both the goals of monitoring, in addition to methodology) that could be more broadly applied to multiple applicants. This type of comprehensive consideration of multiple monitoring activities across multiple years is what was identified as a mechanism to accomplish combined monitoring in the U.S. Arctic.

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

- Developing and maintaining (on the NMFS website) a list of monitoring priorities and data gaps for Arctic oil and gas development projects;
- Soliciting input for this list from Open-Water Meetings, peer review panels, public comment periods, or, potentially, a longer term panel convened specifically to develop these priorities;

- Including specific recommendations for discrete monitoring projects (with suggested methodologies) that could be adopted by new applicants; and
- Considering and describing how to best build on existing monitoring results and best integrate data collection, analysis, and reporting with simultaneous monitoring efforts.

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

5.2.3 BOEM's Environmental Studies Program

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

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

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

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

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

5.3 Tools for Mitigating Impacts on Subsistence

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

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

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

(3) The annual Arctic Open-Water Meeting.

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

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

5.3.1 Conflict Avoidance Agreement and Plan of Cooperation

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.

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 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. As companies and the public began to voice these concerns, it became apparent that companies may not agree upon terms or sign CAAs, and NMFS would need to conduct a more rigorous and comprehensive independent analysis of the likely subsistence impacts and to specifically review the contents of each company's POC (since there might no longer be a CAA).

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, subsistence communities have found that the POC process has not been effective because it has been implemented in a one-way fashion (i.e. the company develops a POC without meaningful input from the subsistence communities) that has not included measures adequate to ensure no unmitigable adverse impact on subsistence uses.

Because the current process requires both negotiating CAAs (regardless of whether they are ultimately signed by either party) and developing POCs, NMFS plans to explore methods of clarifying the POC requirements of the MMPA. With input from both subsistence communities and the applicants for MMPA authorizations, NMFS plans to incorporate the effective pieces of the CAA negotiations into the POC while ensuring compliance with the MMPA.

NMFS foresees developing this more effective process to ensure no unmitigable adverse impact as an iterative process that would be addressed specifically at future annual Arctic Open-Water Meetings, as well as independently with NMFS, the industry, and the affected subsistence communities. NMFS further foresees more direct involvement in this process than has occurred in the past, and more transparency regarding what measures are necessary to protect the subsistence hunts of all species under NMFS' jurisdiction.

5.3.2 Arctic Open-Water Meeting

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

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

5.4 Adaptive Management

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

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

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

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

Following are some of the specific sources of information upon which adaptive management decisions could be based:

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

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

(3) Scientific input from the independent peer review;

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

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

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

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

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

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

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LIST OF ACRONYMS AND ABBREVIATIONS

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

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

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

EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EP	Exploration Plan
EPA	U.S. Environmental Protection Agency
EMS	Emergency Medical Services
EO	Executive Order
EP	Exploration Plan
EPA	U.S. Environmental Protection Agency
ERD	Extended Reach Drilling
ERM	Effects Range Median
ERL	Effects Range Low
ESA	Endangered Species Act
ESP	Environmental Studies Program
EVOS	Exxon Valdez Oil Spill
°F	Degrees-Fahrenheit
FEIS	Final Environmental Impact Statement
FLIR	Forward Looking Infrared
FM	frequency-modulated
FMPs	Fishery management plans
FOSC	Federal On-Scene Coordinator
FONSI	Finding of No Significant Impact
FR	Federal Register
ft	Feet
FY	fiscal year
g	gram
G&G	Geological and Geophysical
GAO	Government Accountability Office
GHG	Greenhouse Gas
GIS	Geographic Information System
Gm	geographic mile
GPS	Global Positioning System

GTP	gas treatment plant
HAP	hazardous air pollutants
Hg	elemental mercury
$HgCl_2$	Mercuric chloride
HIV	Human Immunodeficiency Virus
HRS	High Resolution Seismic
HyMAS	Hydrocarbon Microtremor Analysis
Hz	Hertz
IAP	Integrated Activity Plan
IB	Icebreaking
ICAS	Inupiat Community of the Arctic Slope
IHA	Incidental Harassment Authorization
in	Inch
in^3	Cubic Inch
IMPROVE	Interagency Monitoring of Protected Visual
ISER	Social and Economic Research
ITA	Incidental Take Authorization
IVI	Industrial Vehicle International
IWC	International Whaling Commission
Kg	kilograms
kHz	kilohertz
KIC	Kikiktagruk Inupiat Corporation
km	Kilometer
km_2	square kilometers
kn	Knot
LACS	Low Level Acoustic Combustion Source
Lb	pounds
LBCHU	Ledyard Bay Critical Habitat Unit
LCU	Lower Cretaceous Unconformity
L_{eq}	Equivalent sound level
LET	Local Earthquake Tomography

LME	Large Marine Ecosystem
L_{min}	RMS maximum noise level
L_{min}	RMS minimum noise level
LOA	Letters of Authorization
LFS	Low-Frequency Spectroscopy
LRI	lower respiratory tract infections
m	Meter
mg/kg	milligrams per kilograms
Mg/L	Milligrams per liter
Mg/m^3	Milligrams per cubic meter
mi	Mile
min.	Minutes
MIRIS	Michigan Resource Information System
mm	Millimeter
MMbbls	million barrels
MMO	Marine Mammal Observer
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
MMt	million metric tons
MODU	Mobile Offshore Drilling Unit
Mph	Miles per hour
MSFCMA	Magnuson Stevens Fishery Conservation and Management Act
my	million years
myBP	million years before present
µPa	Micro Pascal
NAAQS	National Ambient Air Quality Standards
NAB	Northwest Arctic Borough
NANA	NANA Regional Corporation
NAO	North Atlantic Oscillation
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEP-A	National Environmental Policy Act

Ng/L	parts per trillion
NGO	non-governmental organization
NH	ammonia
NM	Nautical Miles
NMFS	National Marine Fisheries Service
NMI	nautical miles
NO	nitrogen oxides
N_2O	Nitrous Oxide
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NPFMC	North Pacific Fisheries Management Council
NPR-A	National Petroleum Reserve–Alaska
NRC	National Research Council
NSR	New Source Review
NTL	Notice to Lessees
NTU	Nephelometric Turbidity Units
NVDs	Night Vision Devices
NPFMC	North Pacific Fisheries Management Council
NPS	National Park Service
NRHP	National Register of Historic Places
NSB	North Slope Borough
NSB DHHS	North Slope Borough Department of Health and Social Services
NSR	New Source Review
O_3	ozone
OBC	Ocean-bottom-cable
OBN	ocean bottom node
OCRM	Office of Ocean and Coastal Resource Management
OCS	Outer Continental Shelf
ODPCP	Oil Discharge Prevention and Contingency Plan
OMB	U.S. Office of Management and Budget

OPEC	Organization of Petroleum-Exporting Countries
OSRB	Oil Spill Response Barge
OSRO	Oil Spill Removal Organizations
OSRP	Oil Spill Response Plan
OSRV	Oil Spill Response Vessels
Pa	Pascals
PAH	polycyclic aromatic hydrocarbons
Pb	lead
PCB	Polychlorinated Biphenyl
PCH	Porcupine Caribou Herd
PDO	Pacific Decadal Oscillation
PEA	Programmatic Environmental Assessment
PEIS	Programmatic Environmental Impact Statement
PILT	payment in lieu of tax
PGS	Petroleum Geo-Services
$PM_{2.5}$	Particulate matter 10 microns in diameter
PM_{10}	Particulate matter 10 microns in diameter
P	Pressure
P_1	Sound having pressure
POC	Plan of Cooperation
P_{ref}	Standard Reference Pressure
ppm	parts per million
ppt	parts per thousand
PSD	Prevention of Significant Deterioration
Psi	per square inch
PSO	Protected Species Observer
psu	practical salinity units
PTE	potential-to-emit
PTS	permanent threshold shifts
R/B	biomass ratio
RDD	Resource Development Districts

RFFA	reasonably foreseeable future actions
RMS	root-mean-square
ROD	Record of Decision
RSC	reduced sulfur compounds
RUSALCA	Russian-American Long-term Census of the Arctic
s	Second
SA	Subsistence Advisor
SAR	Search and Rescue
SBI	Shelf Basin Interactions
SBS	Southern Beaufort Sea stock
SCR	Selective catalytic control
SEL	sound exposure level
SEIS	Supplemental Environmental Impact Statement
SEMS	Safety and Environmental Management Systems
SFEIS	Supplemental Final EIS
SO	sulfur dioxide
SOPCs	Stressors of Potential Concern
SQRU	Scenic Quality Rating Unit
SSV	Sound Source Verification
SDC	Steel Drilling Caisson
SLRU	Sensitivity Level Rating Unit
SPLASH	Structure of Populations, Levels of Abundance, and Status of Humpbacks
SQRU	Scenic Quality Rating Unit
STI	Sexually transmitted infection
TA&R	Technology Assessment & Research
TAPS	Trans-Alaska Pipeline System
TB	Tuberculosis
TCH	Teshekpuk Caribou Herd
TCP	Traditional cultural properties
TK	Traditional Knowledge
TPY	tons per year

TTS	temporary threshold shifts
µPa	Micro Pascal
ULSD	ultra-low sulfur diesel
URI	Upper respiratory tract infection
U.S.	United States of America
USACE	U.S. Army Corps of Engineer
USCG	U.S. Coast Guard
USDOI	U.S. Department of the Interior
USFWS	United States Fish and Wildlife Service
USGS	U.S. Geological Survey
USPS	U.S. Park Service
VLCC	Very Large Crude Carrier
VLOS	Very Large Oil Spill
VOC	volatile organic compounds
WAH	Western Arctic Caribou Herd
WCD	Worst Case Discharge

1.0 PURPOSE AND NEED

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

1.1 Background

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

Department of the Interior – Agency Reorganization

Pursuant to DOI 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, but in accordance with the historical context

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

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

On December 30, 2011, NMFS published an 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, NMFS and BOEM determined that the Final EIS would benefit from the inclusion of additional alternatives for analysis that cover 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. 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 this Supplemental Draft EIS and allow for an additional public comment period before releasing the Final EIS and Record of Decision (ROD). Table 1.1 identifies the differences in the alternatives between the December 2011 Draft EIS and this document. In addition to the range of alternatives, public comments and information 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 analysis of potential mitigation measures. While NMFS has made several changes to the document based on public comments received on the 2011 Draft EIS, an appendix addressing responses to all public comments on both the 2011 Draft EIS and this Supplemental Draft EIS will appear in the Final EIS. 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).

Table 1.1 Differences in the Alternatives between the December 2011 Draft EIS and this Supplemental Draft EIS

Alternative	2011 Draft EIS	2013 Supplemental Draft EIS
Alternative 1 (No Action)	NMFS would not issue ITAs under the MMPA, and BOEM would not issue permits and notices under the OCS Lands Act.	Same as in 2011 Draft EIS
Alternative 2	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 in each sea per year Considered inclusion of required standard mitigation measures and additional mitigation measures.	Same as in 2011 Draft EIS
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 • Two exploratory drilling programs in each sea per year Considered inclusion of required standard mitigation measures and additional mitigation measures.	Same as in 2011 Draft EIS

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 Draft EIS 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.
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	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 per sea per year to up to four per sea per year • Inclusion of required time/area closures. However, there are changes. The following are the required time/area closures considered in this EIS:

	• 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.	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
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 per sea per year to up to four per sea per year.

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

For clarity, the oil and gas exploration activities that will be assessed and evaluated throughout the EIS for potential environmental impacts are categorized as:

- **Deep penetration geophysical surveys** (e.g. seismic surveys, including open-water, towed streamer 2-dimensional [2D] or 3-dimensional [3D] surveys, in-ice towed streamer 2D or 3D surveys, on-ice 2D or 3D surveys or Ocean-Bottom-Receiver [cable or node; OBC] surveys; gravity and gradiometry surveys; and controlled source electromagnetic surveys [CSEM]). These surveys are conducted to identify prospective blocks for bidding in lease sales and to optimize drilling sites on leases acquired in sales. On average, data from deep penetration geophysical surveys provide imagery to a depth of approximately 10,000 meters (m) (6.2 miles [mi]) below the seafloor. However, penetration may be deeper or shallower depending on the equipment used and the depth to the geologic formations to be imaged. Companies can submit requests to conduct these types of deep penetration surveys to BOEM for approval under the regulations found at 30 CFR Parts 550 and 551.

- **Shallow hazards surveys** (also called high-resolution or site clearance surveys) and geological studies are considered ancillary activities when conducted on-lease under the 30 CFR Part 550 regulations. These surveys are used to examine the area of potential drill sites for geologic hazards, man-made hazards, prehistoric and historic archaeological resources, and biological populations. These types of activities either use acoustic sources to provide imagery of the sub-seafloor to a depth of less than 1,500 m (0.9 mi) or sediment sampling devices. A suite of instruments could be used depending upon the information needed. Standard equipment for shallow hazards surveys includes: single beam and multibeam echosounders; side scan sonar; magnetometer; subbottom profiler; and other seismic sources. Sediment sampling devices include grab samplers and coring equipment, and may result in bottom disturbance from associated activities, such as anchoring. Shallow hazards activities can also be authorized under BOEM regulations found at 30 CFR Part 551.
- **Exploratory drilling**. Any drilling conducted by a lessee for the purpose of searching for commercial quantities of oil, gas, and sulfur is authorized under 30 CFR Parts 250 and 550, regulated by BSEE and BOEM, respectively.

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

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

The EIS will assist NMFS and BOEM in carrying out other statutory responsibilities and serve to support future decisions relating to the agencies' roles in authorizing or permitting deep penetration geophysical surveys, shallow hazards surveys, and exploratory drilling activities or incidental take of marine mammals. 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 will also coordinate with BSEE to ensure compliance with OCS authorizations.

NMFS' issuance of ITAs for the take of marine mammals is a federal action for which environmental review is required under the Council on Environmental Quality (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 G&G, ancillary, and exploratory drilling activities and will assist BOEM in performing NEPA evaluations for G&G permit applications and ancillary activity notices. NMFS intends to use this EIS as the required NEPA documentation for the issuance of ITAs for Arctic oil and gas exploration activities. NMFS may tier from this EIS to support future Arctic MMPA authorization decisions if proposed oil and gas activities fall outside the scope of this EIS. 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.

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 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. 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 requiring compliance with the MMPA includes both federal and state marine waters.

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

The OCS Lands Act, 43 U.S.C. § 1331 *et seq.* prescribes a four stage process for development of offshore federal oil and gas resources: (1) a five-year oil and gas leasing program; (2) lease sales; (3) exploration pursuant to exploration plans; and (4) development and production plans. Environmental reviews are conducted for each of these stages. Government-to-Government consultation occurs in stages two through four, and there is opportunity for public comment in all four stages.

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

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

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

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

1.1.3 New Requirements for OCS Offshore 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 Notice to Lessees and Operators (NTL) 2010-N05, Increased Safety Measures for Energy Development on the OCS.

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

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

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

The new Workplace Safety Rule covers all offshore oil and gas operations in federal waters, including equipment, safety practices, environmental safeguards, and management oversight of operations and contractors. The Workplace Safety Rule makes mandatory the previously voluntary practices in the American Petroleum Institute's Recommended Practice 75 (RP 75). Companies are required to develop and maintain a Safety and Environmental Management System (SEMS). A SEMS program is a comprehensive management program for identifying, addressing, and managing operational safety hazards and impacts, with the goal of promoting both human safety and environmental protection. BOEM's latest 2012-2017 OCS Oil and Gas Leasing Program Final Programmatic EIS, Section 4.3.3.3.4 Reforms and Research to Reduce Risk, robustly describes all recent reforms. This document is available at: http://www.boem.gov/Oil-and-Gas-Energy-Program/Leasing/Five-Year-Program/2012-2017/Five-Year-Program.aspx.

1.2 Proposed Action

The proposed actions of 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 the U.S. Beaufort and Chukchi seas, Alaska, and
- The authorization of G&G permits and ancillary activities in the U.S. Beaufort and Chukchi seas, Alaska, by BOEM under the OCS Lands Act.

As described below in Section 1.3, these federal actions are related, but distinct, actions.

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 2012). For example, the U.S. consumption of crude oil and petroleum products has been projected to increase from about 19.1 million barrels (Mbbl) per day in 2010 to about 21.9 Mbbl per day in 2035 (EIA 2011). 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 OCS Lands Act and issuing authorizations to "take" marine mammals under the MMPA are discussed below.

Authorizing Take under the MMPA: 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 OCS Lands Act.

ITAs may be issued as either (1) regulations and associated Letters of Authorization (LOAs) or (2) Incidental Harassment Authorizations (IHAs). An IHA can only be issued if the proposed action will not result in a potential for serious injury and/or mortality or where any such potential can be negated through required mitigation measures. Where the proposed activity has the potential to result in serious injury and/or mortality (that cannot be negated through mitigation measures), only regulations and associated LOAs may be used to authorize take. However, regulations and LOAs may also be issued when there is no potential for serious injury and/or mortality if the applicant requests it, which applicants sometimes do for multi-year activities because it offers some administrative streamlining benefits. 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.

Authorizing Offshore Oil & Gas Activities: Regulation of these activities is in part determined by their location. Activities in the Beaufort Sea and Chukchi Sea Planning Areas of the Arctic OCS include exploration seismic surveys conducted under BOEM-issued geophysical permits, BOEM-authorized ancillary survey activities on federal leases, and BOEM/BSEE-approved exploratory drilling activities on federal leases. Proposed activities in state waters would be authorized and regulated by the State of Alaska. NMFS has jurisdiction to authorize incidental take under the MMPA resulting from certain activities whether they occur in Federal or state waters.

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

1.3.2 Need

Authorizing "Take" under the MMPA: 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.

Authorizing Offshore Oil & Gas Activities: BOEM expects to receive applications to conduct exploration surveys, ancillary activities, and exploration drilling pursuant to the OCS Lands Act. To fulfill statutory mandates for proposed exploratory drilling projects, BOEM requires lessees to submit industry-obtained seismic survey data, high-resolution shallow hazards data, and well information with an Exploration Plan. BOEM and BSEE use the information to: (a) ensure safe operations, which refers to detection of shallow gas pockets, faults, channel boundaries or other geological or man-made features that could be hazards to drilling; (b) support environmental impact analyses; (c) protect resources through avoidance measures, such as prohibiting anchor locations within a boulder patch area or a potential archeological site; and (d) perform other statutory responsibilities.

Exploration seismic surveys (both 2D and 3D) provide industry with information on subsurface geology to identify prospective blocks and to make decisions on competitive bids in Federal OCS lease sales.

Under the OCS Lands Act, the government must receive "fair market value" for the lands that it leases. BOEM uses a two-phased system of bid evaluation to assess the adequacy of bids. Each high bid is first examined for technical and legal adequacy (i.e., conformity with antitrust laws). Each valid high bid is then analyzed from a fair market value perspective, which assesses the value of the right to explore for, develop, and produce the hydrocarbon potential of the block. The value is based on BOEM's analysis and interpretation of geologic and geophysical information obtained through industry's exploration seismic surveys, and previous exploration drilling. BOEM estimates the likelihood of oil and/or gas being discovered on the area of the lease and completes an economic analysis of the possible oil/gas development options. Bids that do not meet BOEM's fair market value criteria may be rejected.

BOEM regulations implementing the OCS Lands Act set the initial lease term for oil and gas leases (30 CFR 556). In the Arctic OCS, the initial lease term is set at ten years. The lease will expire at the end of its primary term if the leaseholder (or lessee or operator) is not conducting operations on the lease (30 CFR 550.180 and 30 CFR 556.70). The leaseholder may retain the lease as long as oil or gas is produced from the lease in paying quantities, or while drilling or well reworking activities are conducted, or a suspension has been granted by BOEM.

1.4 Scope and Objectives

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

1. Evaluate a broad range of reasonably foreseeable levels of exploration activities (e.g. deep penetration seismic surveys, shallow hazards surveys, and exploratory drilling activities), including the use of alternative technologies and methodologies intended to reduce the amount and/or intensity of sound output, in state and federal waters in the U.S. Beaufort and Chukchi seas. The EIS may be used, based on a case-by-case evaluation, as the sole NEPA compliance document for future agency actions covered by this EIS, or it may serve as a tiering document (as contemplated by the CEQ regulations) where it is determined that further NEPA analysis may be required.
2. Provide environmental information that can be used to help NMFS evaluate whether to issue ITAs under the MMPA for activities in state and federal waters in the U.S. Beaufort and Chukchi seas and to help BOEM evaluate whether to grant G&G permits or other authorizations under the OCS Lands Act for proposed activities.
3. Project the amount and extent of OCS and state water G&G, ancillary, and exploratory drilling activities that are likely to occur in the U.S. Beaufort and Chukchi seas based on the best available information.
4. Identify and analyze any direct, indirect, and cumulative impacts that may result from the proposed action, including the benefits of one or more measures to mitigate adverse environmental effects.
5. Evaluate a range of monitoring and mitigation measures that might be implemented relative to the level of deep penetration geophysical surveys, shallow hazards surveys, and exploratory drilling to minimize impacts to marine resources and to ensure no unmitigable adverse impact to subsistence users.

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

Specifically, NMFS and BOEM have, through this EIS:

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

NMFS will use the EIS to support the consideration of future MMPA authorizations for deep penetration geophysical surveys, shallow hazards surveys, and exploratory drilling activities in state and federal waters in the U.S. Beaufort and Chukchi seas. There are multiple scenarios under which NMFS can obtain input from the public regarding the agency's issuance of MMPA authorizations (e.g. through the structure of the Open Water Meeting or 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.

It should be noted that 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. While information and analysis from this EIS may inform those separate analyses, it is not intended to wholly satisfy BOEM's NEPA obligation with respect to proposed exploration plans.

1.5 Issues and Concerns to be Addressed in the EIS

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

- Protection of subsistence resources and Iñupiat culture and way of life;
- Disturbance to bowhead whale migration patterns;
- Impacts of seismic operations on marine fish reproduction, growth, and development;
- Harassment and potential harm of wildlife, including marine mammals and marine birds, by vessel operations, movements, and noise;
- Impacts on water quality;
- Changes in the socioeconomic environment;
- Impacts to threatened and endangered species;
- Impacts to marine mammals, including disturbance and changes in behavior;

- Incorporation of traditional knowledge in the decision-making process; and
- Effectiveness and feasibility of marine mammal monitoring and other mitigation and monitoring measures.

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

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

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

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 of the 2011 Draft EIS.

Issues and concerns associated with oil and gas related activities in the marine environment have also been documented for decades by the scientific community, in government publications, at scientific symposia, and through scoping and public meetings/comments, and other NMFS and BOEM NEPA analyses. In addition, public testimony and Traditional Knowledge from Alaska Natives have provided valuable information about seismic survey operations and exploratory drilling activities. 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 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 to some degree in previous NEPA documents produced by both the NMFS and MMS. Summaries of these documents are contained herein. Portions of these NEPA documents are appropriately incorporated by reference in other chapters of this EIS, as directed by 40 CFR 1502.21 of the CEQ's regulations.

- In 2003, MMS prepared the ***Beaufort Sea Planning Area Oil and Gas Lease Sales 186, 195, 202 Final Environmental Impact Statement (OCS EIS/EA MMS 2003-001)***. The Final EIS analyzed the environmental effects of these three sales – Sale 186 in 2003, Sale 195 in 2005 and Sale 202 in 2007 – all of which consider leasing the same geographical area in the Beaufort Sea.
- In 2006, MMS prepared Draft and Final Programmatic Environmental Assessments (PEAs) on the *Arctic Ocean Outer Continental Shelf Seismic Surveys - 2006* (MMS 2006, or PEA) for permitting up to four seismic surveys to be conducted in the open water season in both the Beaufort and Chukchi seas, for a total of up to eight annual surveys. NMFS was a cooperating agency in the preparation of the MMS PEA. A Final PEA was released by MMS on June 22, 2006 and adopted by NMFS.
- On November 17, 2006, NMFS and MMS issued a NOI to jointly prepare a **Programmatic EIS (PEIS) for *Seismic Surveys in the Chukchi and Beaufort seas, Alaska***. The PEIS assessed the impacts of MMS' six annual authorizations under the OCS Lands Act to the U.S. oil and gas industry, to conduct a higher level of offshore geophysical seismic surveys in the Beaufort and Chukchi seas off Alaska over a longer time frame than evaluated in the PEA, and to assess the impacts of NMFS' authorizations under the MMPA to incidentally harass marine mammals while conducting those surveys. The Draft PEIS assumed that up to six offshore geophysical seismic surveys would be conducted annually in both the Beaufort and Chukchi seas off Alaska (for a total of up to 12 annual surveys) and evaluated the environmental effects of the increased level of seismic effort (which represents a 50 percent increase in activity compared to the level of seismic effort analyzed in the MMS 2006 PEA). On March 30, 2007, the EPA announced the availability for comment of the MMS/NMFS Draft PEIS (MMS 2007a). However, on October 28, 2009, NMFS published a notice of withdrawal of the 2007 PEIS (74 FR 55539).
- In May 2007, MMS issued the **Final EIS for the *Chukchi Sea Planning Area Oil and Gas Lease Sale 193 and Seismic Surveying Activity in the Chukchi Sea*** and also examined a proposal for exploration seismic survey permitting in 2007 in the proposed sale area and two alternatives for the 2007 seismic surveys (OCS EIS/EA MMS 2007-026).
- In August 2007, NMFS prepared a **Supplemental EA** (SEA; NMFS 2007a) and issued a new Finding of No Significant Impact (FONSI) to update the 2006 Final PEA for analysis of an **Arctic seismic survey ITA**, including NMFS' issuance of an IHA to Shell Offshore Inc. (Shell) for the 2007 season. The 2007 SEA analyzed the effects on the human environment of issuing an IHA to Shell for the take of marine mammals incidental to conducting deep penetration 3D seismic surveys in both the Beaufort and Chukchi seas and marine surveys, including site clearance and shallow hazards surveys, in the Beaufort Sea during the 2007 Arctic open-water season. Where appropriate, sections of the 2006 Final PEA and 2007 Draft PEIS were incorporated into the 2007 SEA by reference.
- In October 2007, NMFS prepared an **EA for the issuance of an IHA to Shell** to take marine mammals incidental to conducting an offshore drilling project in the U.S. Beaufort Sea (NMFS 2007b) and issued a FONSI on October 24, 2007. This EA analyzed the effects on the human

environment of issuing an IHA to Shell for the take of marine mammals incidental to conducting open-water offshore exploratory drilling in OCS blocks of the U.S. Beaufort Sea.

- For the 2008 Arctic open-water season, NMFS received applications from five oil and gas companies requesting IHAs to conduct various types of seismic and site clearance and shallow hazards surveys in the Arctic Ocean. In July 2008, NMFS prepared a new **seismic/site clearance survey SEA** (2008 SEA; NMFS 2008) to update analyses contained in the 2006 Final PEA since it was determined that the 2008 surveys would have environmental impacts similar to the activities analyzed in the 2006 Final PEA. Where appropriate, sections of the 2006 Final PEA and 2007 Draft PEIS, as well as NMFS' 2007 SEA, Arctic Regional Biological Opinion, MMS' 2007 *Chukchi Sea Planning Area Oil and Gas Lease Sale 193 and Seismic Surveying Activities in the Chukchi Sea - Final Environmental Impact Statement* (MMS 2007b), and MMS' *Beaufort Sea Planning Area Oil and Gas Lease Sales 186, 195, 202 Final Environmental Impact Statement* (MMS 2003), were incorporated into the 2008 SEA by reference. After completion of the 2008 SEA, NMFS issued five FONSIs in July and August 2008 for each of the five IHAs issued by NMFS.

- In August 2009, NMFS published an **EA for the issuance of an IHA to Shell**, which analyzed the impacts to the human environment that may result from the take of marine mammals incidental to conducting an open water marine survey program in the Chukchi Sea, Alaska, during 2009. Portions of several of the NEPA documents mentioned above were incorporated by reference into the 2009 EA. Among other things, the 2009 EA updated information on the potential impacts to marine mammals based on previous years of monitoring. NMFS issued a FONSI on August 14, 2009.

- In October 2009, MMS published an **EA for the Shell *2010 Exploration Drilling Program-Camden Bay, Beaufort Sea, Alaska* (OCS EIS/EA MMS 2009-052)**, which analyzed the environmental impacts of exploration drilling. Shell proposed to drill two exploration wells during the July to October 2010 open-water-drilling season. The EA tiered from existing environmental documents and incorporated by reference other environmental documents (see EA pages 2 and 3 for the list of environmental documents).

- In December 2009, MMS published an **EA for the Shell *2010 Exploration Drilling Program—Burger, Crackerjack, and Southwest Shoebill Prospects in the Chukchi Sea Outer Continental Shelf, Alaska* (OCS EIS/EA MMS 2009-061)**. Shell proposed to drill exploration wells at up to three of five possible drill sites during the July to October 2010 open-water-drilling season. The EA tiered from existing environmental documents and incorporated by reference other environmental documents (see EA pages 6 and 7 for the list of environmental documents).

- In June 2010, BOEMRE published an **EA for Statoil's *Proposed Seismic Survey Activity in the Chukchi Sea Planning Area* (OCS EIS/EA BOEMRE 2010-020)**. The EA tiered from two previous environmental documents: (1) Final PEA, Arctic Ocean Outer Continental Shelf, Seismic Surveys—2006 (OCS EIS/EA MMS 2006-038) June 2006; and (2) Final EIS, Chukchi Sea Planning Area, Oil and Gas Lease Sale 193 EIS and Seismic Surveying Activities in the Chukchi Sea (OCS EIS/EA MMS 2007-026) May 2007.

- In July 2010, BOEMRE published an **EA for Shell *Exploration & Production Proposed Ancillary Activities—Marine Surveys in the Beaufort Sea, Alaska* (OCS EIS/EA MMS 2010-022)**. Ancillary activities are activities conducted by a leaseholder on BOEMRE-issued leases for the purposes of obtaining data and information to develop an Exploration Plan or Development and Production Plan. Shell proposed shallow hazard and site clearance surveys, ice gouge surveys, strudel scour surveys, marine baseline studies, and seafloor soil sampling. The EA tiered from existing environmental documents and incorporated by reference other environmental documents (see EA pages 2 and 3 for the list of environmental documents).

- In July 2010, NMFS prepared an EA for the issuance of IHAs to take marine mammals incidental to conducting open-water seismic and marine survey programs in the U.S. Beaufort and Chukchi seas (NMFS 2010). This EA analyzed the impacts to the human environment from the issuance of an IHA to Shell for the take of marine mammals incidental to conducting an open-water marine survey program in the U.S. Beaufort and Chukchi seas and the issuance of an IHA to Statoil for the take of marine mammals incidental to conducting 3D and 2D open-water seismic surveys in the Chukchi sea. Several of the earlier NEPA documents mentioned in this list were incorporated into NMFS's 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 CPAI in the Chukchi Sea. All leases were obtained in Lease Sale 193 held in February 2008.
- In August 2011, BOEMRE issued an EA and 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*** (BOEMRE 2011b). The 2008 FEIS for Lease Sale 193 was challenged in the U.S. District Court for the District of Alaska. On July 21, 2010, the District Court issued an Order remanding Sale 193 to BOEMRE to satisfy its obligations under NEPA in accordance with the Court's opinion. The District Court's Order was amended on August 5, 2010, and guidelines for compliance with the Order were established by the Court on September 2, 2010. The Draft Supplemental EIS augments the analysis in the Final EIS for Lease Sale 193 by analyzing the environmental impact of natural gas development and evaluating incomplete, missing, or unavailable information pursuant to 40 CFR 1502.22 to respond to the Court's remand. A Draft Supplemental EIS was made available to the public on October 15, 2010. In March 2011, BOEMRE announced that a Very Large Oil Spill analysis would also be included in the Supplemental EIS. The analysis was completed and integrated within the Revised Draft Supplemental EIS, which was released for public comment on May 27, 2011.
- In 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 Draft EIS have been incorporated into this Supplemental Draft 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 BOEMRE 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).

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

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

1.8.1 National Environmental Policy Act of 1969

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

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

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

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

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

1. **Scoping**. As the first step in the 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 (DEIS)**. After scoping is completed, a DEIS is prepared. The DEIS describes and evaluates a range of reasonable alternative actions, including no action. If the lead agency has decided upon a preferred alternative by the time a DEIS is prepared, it is identified. The DEIS evaluates physical, biological, socioeconomic, and environmental impacts that might result from the alternatives carried forward for analysis, and it describes the significance of environmental effects surrounding the various alternatives, including the proposed action. Finally, it identifies ways to mitigate the potential impacts – to avoid, minimize, rectify, reduce, or eliminate those impacts over time or to compensate for any potential harm to the environment that might be caused by any of the alternatives.
3. **Public Comment on the DEIS**. Following publication of a DEIS, a public NOA for review is published in the FR, which begins a public comment period of no less than 45 days. A public hearing may be conducted to provide an opportunity for interested parties to provide oral comments on the DEIS. Following the public comment period, the lead agency considers all of the comments received and prepares a final EIS (FEIS) and includes responses to the comments on the DEIS.
4. **Final Environmental Impact Statement (FEIS)**. The FEIS must identify the lead agency's preferred alternative (unless another law prohibits the expression of such a preference) and may identify the environmentally preferable alternative, which may be different. Once the FEIS is completed and published, there is a 30-day "wait" period before an agency may issue its Record of Decision (ROD) (see below).
5. **Record of Decision**. Following completion of the FEIS process as described above, the lead agency prepares a ROD. The ROD must: (1) state what the decision was; (2) identify all alternatives considered in reaching the decision and which were considered to be environmentally preferable; and (3) state whether all practicable means to avoid or minimize environmental harm have been adopted, and if not, why not (40 CFR 1505.2). If a monitoring and enforcement program is applicable for any mitigation, it must be adopted and summarized in the ROD (40 CFR 1505.2).

As noted earlier in this Chapter, NMFS determined to prepare a Supplemental Draft EIS prior to issuing the FEIS. While not one of the five required steps in the EIS process, NMFS and BOEM determined that the Final EIS would benefit from the inclusion of additional alternatives for analysis that cover a broader range of potential levels of exploratory drilling scenarios in the Beaufort and Chukchi Seas. 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 Draft EIS, the agencies determined a Supplemental Draft EIS should be released for public comment. Following the public comment period, the lead agency will consider all comments received and prepare an FEIS, which will include responses to comments on the 2011 Draft EIS and this Supplemental Draft EIS.

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

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

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 impact on the species or stock and its habitat (i.e. mitigation, monitoring and reporting of such takings). ITAs may be issued as either (1) regulations and associated LOAs or (2) IHAs. IHAs can be issued only when there is no potential for serious injury and/or mortality or where any such potential can be negated through required mitigation measures.

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

1.8.6 Outer Continental Shelf Lands Act

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

1.8.7 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 essential fish habitat (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.

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

1.8.9 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 Arctic OCS back to the Department of the Interior 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 found at 30 CFR Part 550.

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 United States.

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 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

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 ecological 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)

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

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

1.9 Organization of the Document

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

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Dear Reviewer Letter

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Table of Contents

Acronym List

1.0 Purpose and Need

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

2.0 Proposed Action and Alternatives

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

3.0 Affected Environment

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

4.0 Environmental Consequences

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

5.0 NEPA Compliance Implementation and Recommendations

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

6.0 Consultation and Coordination

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

7.0 References

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

8.0 Glossary

- Contains useful definitions of terms found in the EIS.

Figures

- Contains all project figures and maps.

Appendices

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

2.0 PROPOSED ACTION AND ALTERNATIVES

2.1 Introduction

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

2.2 Issues Considered in Developing the Alternatives

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

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

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

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

In a separate but parallel process for government-to-government consultation, federally-recognized Tribal governments in each North Slope community were notified of the EIS process and invited to participate.

The first contact was via letter, dated January 29, 2010; follow-up calls were made with the potentially affected Tribal governments, and each entity was visited during the scoping process. The Scoping Comment Analysis Report (CAR) (see Appendix C in the 2011 Draft EIS) 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 about alternatives and mitigation measures NMFS may require in their ITAs that were raised during public scoping meetings and submitted to NMFS during the public comment period. A more complete presentation of formal comments received during the scoping process is included in Appendix C of the 2011 Draft EIS.

Many of the comments received during the public comment period for the 2011 Draft EIS 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) 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.

As noted in Chapter 1, NMFS has revised the range of alternatives, 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. The Final EIS will include an appendix that contains a summary of comments and responses received on the 2011 Draft EIS and this Supplemental Draft EIS.

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.

Category	Comment
Monitoring and Mitigation Measures	NMFS should not issue ITAs unless they can ensure that mitigation measures will remove the potential for serious injuries or mortality to marine mammals from activities associated with oil and gas operations.
	The proposed EIS should consider alternatives that address shortcomings in monitoring and mitigation measures.
	The EIS should include a list of Conflict Avoidance Agreements for all Native groups in Alaska and adopt similar requirements to minimize impacts on subsistence hunting activities.
	Required mitigation measures, specifically safety and exclusion zones, should be adaptive and based on sound research and must be reasonable and feasible. Specific suggestions include: ◊ 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); ◊ Gravity, magnetic, and gravity gradiometry data collection; and ◊ Low-sulfur fuel.

2.3 Oil and Gas Exploration Activities Evaluated in the EIS

2.3.1 BOEM Process for Permitting

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

- **Geological & Geophysical (G&G) Exploration Permits** – In accordance with 30 CFR Part 551, a permit must be obtained from BOEM prior to conducting geological or geophysical exploration on unleased lands or on lands under lease by a third party (someone other than the applicant). On-lease G&G exploration can be conducted under a G&G permit or an Ancillary Activity Notice in accordance with 30 CFR Part 550 Subpart B.
- **Ancillary Activities** – These on-lease geological and geophysical activities include shallow hazards and site clearance surveys and two-dimensional (2D) and/or three-dimensional (3D) deep penetration seismic. Ancillary activities also include on-lease geotechnical sampling; however, these activities are not addressed in this EIS. A notice of proposed ancillary activities must be submitted to BOEM, which conducts 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 Subpart B). The EP must include information on the timing and location(s) of the proposed activity, a plan of operations, the affected environment, and the potential effects on the environment. BOEM conducts a technical and environmental review of the proposed EP 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. Authority to review and approve APDs belongs to BSEE.

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 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 OCS Lands Act, 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 and may also add controlled source electromagnetic (CSEM) studies to further define prospects and select proposed drilling locations.

- Prior to submitting an EP and drilling a well, companies are required to conduct shallow hazards surveys (also called "site clearance" or "high-resolution geophysical surveys") to provide information on water depth, seafloor morphology, near-surface morphology, potential shallow faults or gas zones, depth and distribution of ice gouges in the seabed, and other natural or manmade hazards. These shallow hazards surveys are used to evaluate the near-surface geology, locate shallow hazards, obtain engineering data for drilling or placement of structures (platforms and pipelines), and detect archaeological resources and certain types of benthic communities. These surveys may be conducted over portions of individual lease blocks (about 3 mi x 3 mi) or several contiguous lease blocks, depending on the exploration targets of the company. These surveys would typically need to be completed at least one season in advance of submittal of an EP and a drilling operation. Companies may also use high resolution geophysical equipment to survey off-lease areas for possible subsea pipeline routes.

- Based on the evaluation of 2D/3D seismic data and shallow hazard surveys, companies may propose in the EP to drill one or more exploration (test) wells in the area of interest. The type of drilling rig used depends on water depth, sea ice conditions, ice-resistance of the rigs, and unit availability. Data obtained from drill cuttings, well cores, and various 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 associated typical support operations. Table 2.2 summarizes the support vessels and operations associated with each activity.

Table 2.2 Summary of Typical Support Operations for Exploration Activities

Activity	Typical Support Operations
Marine streamer 2D and 3D surveys	• 1 source/receiver vessel • 1 support vessel • Likely 1 vessel for monitoring

Activity	Typical Support Operations
Multi-azimuth seismic survey (multiple passes in different directions with one source/receiver vessel)	• 1 source /receiver vessel • 1 support vessel • Likely 1 vessel for monitoring
Wide-azimuth seismic survey (multiple passes with multiple source vessels and at least one receiver vessel	• 2 to 4 source vessels • 1 to 2 receiver vessels • 1 support vessel • 1 vessel for monitoring
Rich-azimuth seismic survey (multiple passes with multiple source vessels and at least 1 receiver vessel)	• 2 to 4 source vessels • 1 to 2 receiver vessels • 1 support vessel • 1 vessel for monitoring
Full-azimuth coil-pattern seismic survey (single source/receiver vessel)	• 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	• 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 transport drilling rig 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

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

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

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

The most commonly used marine energy sources are airguns, which emit highly compressed air bubbles that transmit acoustic energy though the water column into the subsurface. Seismic waves reflect and refract off subsurface rock formations and travel back to acoustic receivers called hydrophones. Streamers are passive listening equipment, consisting of multiple hydrophone elements, which are towed behind the vessel. The characteristics of the reflected seismic waves (such as travel time and intensity) are used to evaluate geologic structures, subsurface deposits, and natural resources to help facilitate the location of prospective drilling targets and provide the information for a company to determine their bidding strategy for an OCS lease sale. 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 provides details on the acoustic characteristics of each of these exploration methods, including source levels, frequency, propagation, and the effect of environmental factors on these characteristics. However, in general, broadband peak source levels of a typical full-scale array range from 248 to 255 dB re 1 µPa at 1 m with most of the energy emitted between 10 and 120 Hz, although pulses may contain energy up to 1,000 Hz (Richardson et al. 1995).

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

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

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

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

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

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

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

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

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

2.3.2.3 In-Ice Towed-Streamer 2D/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.

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

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

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

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

Ocean-bottom Node Seismic Surveys

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

The OBNs used in oil and gas operations are four component (4C) receivers that include three orthogonal geophones and one hydrophone, capable of measuring both shear (S) and compressional (P) waves, which cannot be done using 2C cables or towed streamers. The nodes are typically deployed in groupings called patches, using Remotely Operated Vehicles in deep water and ropes/cables in shallower water. The geologic target depth determines the node spacing and size of the patch. Generally, node spacing ranges between 50 m and 500 m (164 ft and 1,640 ft). If enough nodes are available, large patches (160 to 250 km^2) are collected as a single survey. However, a larger area can also be surveyed using smaller patches (10 to 30 km^2) with fewer nodes, which are combined to complete the entire survey (Ray et al. 2004, Beaudoin and Ross 2007, Chopra 2007, Duey 2007). An Ultra Short Baseline system (which measures the distance and bearing from a transceiver mounted on a survey vessel to an acoustic transponder at the node and combines these data with GPS, vessel heading and attitude) is commonly used to calculate the node position.

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

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

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

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

2.3.2.5 High-Resolution Shallow Hazards Geophysical Surveys

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

The suite of equipment used during a typical shallow hazards survey consists of: single beam and multibeam echosounders which provide water depths and seafloor morphology; a side scan sonar that provides acoustic images of the seafloor; a subbottom profiler which provides 20 to 200 m (66 to 656 ft) sub-seafloor penetration with a 6 to 20 cm (2.4 to 7.9 inches [in]) resolution; a single channel seismic system with 40 to 600 m (131 to 1,969 ft) sub-seafloor penetration; and a multichannel seismic system with 1,000 to 2,000 m (3,280 to 6,562 ft) sub-seafloor penetration. Magnetometers, that detect ferrous items, have not been required in the Alaska OCS to date 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 kHz (Koomans 2009);

- Multibeam echosounders: 216 to 242 dB re 1 µPa at 1 m between 180 kHz and 500 kHz (Hammerstad 2005, HydroSurveys 2010);
- Side scan sonar: 194 to 249 dB re 1 µPa at 1 m between 100 and 1,600 kHz (HydroSurveys 2008, Dorst 2010);
- Subbottom profilers and single channel seismic: 200 to 250 dB re 1µPa at 1 m between 0.2 kHz and 200 kHz (Laban et al. 2009, Richardson et al. 1995); and
- Multichannel seismic: 196 to 217 dB re 1 µPa at 1 m between 0 and 200 Hz (NMFS 2008a, 2009, 2010; Richardson et al. 1995).

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

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

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

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

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

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

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

2.3.2.7 Vertical Seismic Profiling

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

2.3.2.8 Controlled Source Electromagnetic Survey

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

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

2.3.2.9 Gravity and Gradiometry Surveys

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

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

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

2.3.3 Exploratory Drilling

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

No drilling activity can be conducted until the BOEM has approved an EP and BSEE has approved the well-specific APD. BSEE engineers and geoscientists are required by law to review each APD for proper engineering considerations, site specific engineering and geologic conditions, and compliance with BSEE regulations, 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 (i.e. well logs, cores). Directional wells (any well that is not vertical) may be drilled if a suitable surface location cannot be used or if there is a subsurface anomaly that should be avoided. A well is considered to be directional when the inclination of the well bore path is over three degrees from vertical. Directional drilling is different than extended reach drilling (ERD). ERD is a term used for wells drilled with significant horizontal departures from the surface location; on the order of several km (10,000s of feet). ERD is an evolving technology for production wells but currently is not used for exploration.

2.3.3.1 Artificial Islands

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

2.3.3.2 Caisson-Retained Island

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

2.3.3.3 Steel Drilling Caisson

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

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

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

2.3.3.4 Floating Drilling Vessels

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

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

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.

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

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

Jackup Rig

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

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

The actual dimensions of a jackup rig would depend on the environment in which the unit would be operating and the maximum operating water depth. A typical jack up rig with a maximum operating depth of 50 m (164 ft) is approximately 50 m (164 ft) in length, 44 m (144 ft) beam, and 7 m (23 ft) deep.

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.

Noise levels from jackup rigs have not been measured in the Arctic (Wyatt 2008). 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. Although sound level measurements have not been conducted to date for jackup rigs in the Arctic, MAI (2012) describe 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). It is assumed that the first time a jackup rig is in operation in the Arctic detailed measurements will be conducted to determine the acoustic characteristics. Noise from icebreakers would also be the same as described above.

2.3.3.5 Exploratory Drilling Activity Discharges and Emissions

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

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. 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 but only for the Arctic OCS (Consolidated Appropriations Act, 2012). Companies with current permits received from (or initiated with) EPA prior to the transfer of authority retain those valid permits. 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, EPA, 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 OCS Lands Act 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.

Regardless of whether approved under existing EPA permits or via a new BOEM EP approval, emission of air pollutants, such as nitrogen dioxide, sulfur dioxide, and carbon monoxide 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. EPA, the State of Alaska (ADEC), BSEE, and the U.S. Coast Guard (USCG) each have a set of requirements for oil spill contingency and response planning. The requirements of the different agencies overlap with each other to some degree. However, in some cases each agency requires independent documentation in order to ensure that the applicable requirements are met[1].

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 Clean Water Act (CWA), as amended by the Oil Pollution Act (OPA), certain facilities that store and use oil are required to prepare and submit these plans. Under 40 CFR Part 112 FRPs must: identify a qualified individual having full authority to implement removal actions and require immediate communication between that person and the appropriate federal authorities and responders; identify and ensure availability of resources to remove, to the maximum extent practicable, a worst-case discharge; and describe training, testing, drills, and response actions of persons 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.

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[1] The 2011 Draft EIS contained a standard mitigation measure (listed in Appendix A of the 2011 Draft EIS 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.

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

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

Also overlapping with the ADEC and BSEE requirements, operators are required to submit "Response Plans for Oil Facilities Transferring Oil or Hazardous Material in Bulk" (33 CFR Part 154) to the USCG, Department of Homeland Security. The USCG response plans must include detailed descriptions of equipment, facility operations, vapor control systems, methods of ensuring the availability of response resources by contract or other approved means, description of worst case discharge, and information on training, exercises, and inspection and maintenance of response resources. Many of the requirements described in 33 CFR Part 154 are analogous to the ADEC (18 AAC 75.425) and BSEE (30 CFR Part 254) requirements, and operators may opt to fulfill requirements of 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 Oil Pollution Act of 1990 (OPA), Public Law (P.L.) 101-380. Under the OPA, liability for actual costs of removal rests with the responsible party. The OPA establishes oil-spill response planning and preparedness requirements for offshore facilities. Executive Order 12777 implementing OPA assigned regulatory oversight for offshore oil and gas to the Department of the Interior, with oversight delegated to BSEE.

Environmental protection from oil spills is also regulated under the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 CFR Part 300) as required by Section 311(d) of the CWA, 33 USC 1321(d) as amended by the OPA, P.L. 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 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

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

Industry interacts with local communities through a local hire program and through community-wide meetings. Local residents are typically trained and hired through several programs to assist with exploration activities, including the Protected Species Observer (PSO) program (formerly referred to as the Marine Mammal Observer program), Subsistence Advisor (SA) program, Communication and Call Centers (Com Centers) program, and Oil Spill Response. The PSO program would employ, among others, local Iñupiat residents to monitor and document protected species in the EIS project area. The PSOs are trained to identify marine mammals and other protected species, document interactions using computers, and comply with health and safety regulations. The SA program recruits local residents to communicate local concerns and subsistence issues to the oil and gas operators. The SA coordinates with other village members and documents subsistence information, which may then be used to develop appropriate mitigation measures, address concerns related to subsistence activities, and to avoid potential conflicts. The Com Center program involves hiring local residents to monitor and relay radio transmissions between subsistence vessels and industry vessels. This sharing of information is intended to reduce or eliminate the potential for conflict between subsistence users and industry vessels. Providing these employment opportunities to local residents creates the potential for positive economic benefits to local communities and provides a vector for communication between industry and local residents.

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

The Open Water Season CAA is a private agreement between members of industry and the Alaska Eskimo Whaling Commission (AEWC). In order to ensure that potential adverse impacts to the bowhead whale subsistence hunt are mitigated, the AEWC requests that any operator intending to conduct activities related to offshore oil and gas exploration, development, or production during the open-water season and prior to or during the fall bowhead whale subsistence hunts in the Beaufort and Chukchi seas enter into the CAA. While the CAA is not required by the MMPA, mitigating potential adverse impacts to the availability of marine mammals for subsistence uses is a requirement of the MMPA. 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, to 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.

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. One potential alternative, the low frequency passive seismic method, relies on naturally produced sounds and does not introduce any sound into the environment. Table 2.3 summarizes some of the alternative technologies in consideration by the oil and gas industry. However, these alternative acoustic sources are in various stages of development, and none of the systems with the potential to augment or replace airguns as a seismic source 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 – Hydraulic	System has been built and tested but requires renovation prior to deployment. Estimated time is 3 months to 1 year.	This tool cannot replace all airgun surveys but has the potential to replace airguns for certain geologic prospects in certain environments.
Marine Vibrators – Electric	If funds were available, it would take 2 to 4 years to fully develop and test a system for commercial use.	This tool cannot replace all airgun surveys but has the potential to replace airguns for certain geologic prospects in certain environments.
Low-frequency Acoustic 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.
Low Frequency Passive Seismic Methods for Exploration	This is being offered commercially.	This technology is not yet proven in all environments. Passive acoustic data have the potential to enhance oil recovery at a better resolution than magnetic or gravimetric methods especially in areas that are environmentally sensitive (Bussat and Kugler 2009).

2.3.5.1 Marine Vibrators

Hydraulic

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

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

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

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

Electric

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

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

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

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

2.3.5.2 Low-frequency Acoustic Source (patented)

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

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

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

2.3.5.3 Deep-Towed Acoustics/Geophysics System

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

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

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

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

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

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

2.3.5.4 Low Frequency Passive Seismic Methods for Exploration

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

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

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

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

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

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

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

Surface-wave amplitudes is a one-dimensional (1D) method that images the geological structure of the sub-surface by analyzing passive acoustic data that have not been geophysically processed. The transformation of incoming micro-seismic surface-waves, scattered at vertical discontinuities, into body waves may produce these data, but the process is not well understood (Gorbatikov et al. 2008).

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

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

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

2.3.5.5 Quieting Mitigation Technologies in Development

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

Airgun Silencer

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

Airgun Design

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

Bubble Curtain

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

The use of bubbles as a mitigation for seismic noise has also been pursued. During an initial test of the concept, the sound source was flanked by two bubble screens; it demonstrated that bubble curtains were capable of attenuating seismic energy up to 28 dB at 80 Hz while stationary in a lake. This two-bubble curtain configuration was field tested from a moving vessel in Venezuela and Aruba where a 12 dB suppression of low frequency sound and a decrease in the sound level of laterally projecting sound was documented (Sixma 1996, Sixma and Stubbs 1998). A different study in the Gulf of Mexico tested an "acoustic blanket" of bubbles as a method to suppress multiple reflections in the seismic data. The results of the acoustic blanket study determined that suppression of multiples was not practical using the current technology. However, the acoustic blanket measurably suppressed tube waves in boreholes and has the capability of blocking out thruster noises from a laying vessel during an OBC survey, which would allow closer proximity of the shooting vessel and increase productivity (Ross et al. 2004, 2005).

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

2.3.5.6 Fiber Optic Receivers

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

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

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

2.4 Alternatives Considered in the EIS

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

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

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

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

2.4.1 Review of Multiple Exploration Activities

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

For planning purposes, NMFS and BOEM can project a reasonable level of exploration activities in the near term based upon current leases, upcoming lease sales, 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 (i.e. three or more years in the future) can be difficult. In order to help predict the level of exploration activities for a given year, communications for upcoming G&G and exploratory drilling activities are ongoing between NMFS, BOEM, and industry throughout the year; but NMFS and BOEM are officially notified of the specific planned activities upon receipt of an application for an ITA, G&G permit, or ancillary notice, which may be submitted just several months prior to the activity taking place. Therefore, while NMFS and BOEM can estimate the level of proposed activity on an annual basis, there is some uncertainty.

2.4.2 Review of Mitigation Measures

The evaluation of measures intended to reduce adverse impacts to marine mammals and other protected resources and to ensure that there will be no unmitigable adverse impact on the availability of marine mammals for subsistence uses are the main foci of this document and are key components of the development of alternatives. Mitigation measures directed at protecting subsistence uses include measures incorporated into previous ITAs, many of which were developed over a number of years through the annual negotiation of a CAA between offshore oil and gas operators and the AEWC. Mitigation 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. These measures (e.g. shutdown zones, certain time/area closures to protect known subsistence uses) have been used consistently in past permits and authorizations.

2) **Additional Mitigation Measures** – These measures, which are evaluated *but not required* in all five action alternatives, may or may not be required for future activities depending on the outcome of the MMPA authorization 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, which may or 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.

In Chapter 4, all of the mitigation measures currently categorized as described above are comprehensively evaluated in the context of the manner and degree in which the measure is likely to reduce adverse impacts to marine mammals, likely effectiveness, and practicability of implementation of the measures. This analysis, which also includes consideration of public comments received on previous proposed ITAs, the scoping period of this EIS, and on the 2011 Draft EIS, 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) Never be required; or

c) 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.

All Additional Mitigation Measures ultimately identified in the Final EIS 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) using the additional detail that will be available once applicants have determined the specific activities that they propose to conduct in a given year and submitted their applications. These measures will be further evaluated using this more specific information to determine the degree to which the measure is likely to reduce impacts to marine mammals or subsistence uses based on the proposed specified activity, the likely effectiveness of the measure, and the practicability of the measure. Some of the types of more specific information that will be used to make the decision of whether to require a given measure include:

- The timeframe, duration, and location of the proposed activity and the spatiotemporal 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).

In this EIS, NMFS and BOEM present and assess a reasonable range of G&G, ancillary, and exploratory drilling activities expected to occur, as well as a reasonable range of measures intended to reduce adverse impacts on the human environment, in order to accurately assess the potential consequences of issuing ITAs under the MMPA and permits under the OCS Lands Act. Based upon past lease sales, the timing of the future scheduled lease sales in the 2012-2017 Five Year Program for the Arctic OCS, G&G permits, ancillary activity notices, exploration drilling activities, and requests for ITAs, NMFS and BOEM have determined a reasonable range and level of activities for which permits and authorizations may be requested in the foreseeable future. While the level of activity proposed may vary from one year to the next, the structure of the action alternatives represents a reasonable range of exploration activities for which permits and authorizations may be requested.

2.4.3 Activity Definitions

The following discussion and table provide explanation and definitions for what is meant by the different types of activities considered in each of the action alternatives in this EIS. 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; and recent industry plans for both seismic surveys and exploratory drilling programs in the Beaufort and Chukchi seas. 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 (i.e. open-water season only, ice-covered season only, etc.), number of days of active operations, and size of the program activity area. Surveys or drilling programs could be conducted by a single company or companies working together using the same vessels and equipment. 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.

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

Site clearance and shallow hazards survey programs are contemplated in each action alternative and 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 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)	2 (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	60-90	Late September – December	Approximately 75 line miles (120 km) per day
CSEM Survey	1	• 1 source and layout vessel	0.5-10 Hertz electromagnetic signal	60	July – November	unknown
Site Clearance and High-Resolution Shallow Hazard Surveys	1 Source/ Receiver vessel	• 1 vessel for monitoring, as needed	• Four, 10 in^3 (0.16 liter) airguns • 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
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 • 3 support vessels • Aircraft for crew changes	Drill	40 days per well (dependent on well depth)	July – October	25 mile (40 km) radius around the well; 2-4 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	40 days per well (dependent on well depth)	July – October	25 mile (40 km) radius around the well 2-4 wells per season

The following alternatives are summarized in Table 2.5.

2.4.4 Alternative 1 – No Action

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

2.4.5 Alternative 2 – Authorization for Level 1 Exploration Activity

Alternative 2 is defined for analytical purposes as the following:

2.4.5.1 Level of Activity

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

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. These surveys generally occur from January through May. Each survey takes between 30 and 90 days, depending on ice conditions, weather, equipment operations, size of area to be surveyed, timing of subsistence hunts, etc. Because of the limited time period of open water, it is likely that concurrent surveys would be conducted in the same general time frame and may overlap in time, but will not overlap in space (i.e. within a minimum of approximately 24 km [15 mi] of each independent survey operation) for reasons regarding data integrity. It is assumed for analytical purposes

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[2] 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.

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 scheduled in BOEM's next 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; ConocoPhillips' Klondike prospect; and Statoil's leases in the northeast part of the Lease Sale 193 area (see Figure 1.3).

2.4.6 Alternative 3 – Authorization for Level 2 Exploration Activity

Alternative 3 is defined for analytical purposes as the following:

2.4.6.1 Level of Activity

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

Alternative 4 is defined for analytical purposes as the following:

2.4.7.1 Level of Activity

- Up to **six** 2D/3D seismic or CSEM surveys in the Beaufort Sea and up to **five** 2D/3D seismic or CSEM surveys in the Chukchi Sea per year, with up to **one** of that total number of surveys in each sea done in-ice with ice breaking if necessary.

[3] This alternative is new and was not included in the 2011 Draft EIS.

- 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[4] – Authorization for Level 3 Exploration Activity With Additional Required Time/Area Closures

Alternative 5 is defined for analytical purposes as the following:

2.4.8.1 Level of Activity

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

[4] This alternative was previously identified as Alternative 4 in the 2011 Draft EIS. Some modifications to the required time/area closures have been made to this alternative since publication of the 2011 Draft EIS, as noted below.

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 in Chapter 3, Sections 3.2.3 and 3.2.4, and under additional mitigation measures described in Appendix A[5]:

- Kaktovik and Cross Island[6] – 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.
- Hanna Shoal[7] – An area of high biological productivity (benthic organisms); a feeding area for various marine mammals (walrus and bearded seals).
    - Walrus: July – August (USGS 2011)
    - Bearded Seals: September – October (Clarke et al. 2011a)

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[5] In the 2011 Draft EIS, 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 Pt. Barrow to Smith Bay) appear to be more important feeding areas for bowhead whales than does the Camden Bay area (Clarke et al. 2011b, c, d). 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. 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.

[6] This time/area closure has been added since publication of the 2011 Draft EIS. 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.

[7] Gray whales have been removed as a reason for designating Hanna Shoal as a time/area closure location. 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. in prep.).

    - Except for emergencies or human/navigation safety, oil and gas exploration operations shall not occur within the Hanna Shoal area or the designated buffer zones from July 1 – August 30.

  - 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.

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

[8] This alternative was previously identified as Alternative 5 in the 2011 Draft EIS.

- For exploratory drilling programs, any level up to the maximum contemplated in this EIS, as the 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.

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 issued for the type of activity identified. Full descriptions of these measures are contained in Appendix A.

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

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

- Establishment and execution of 180 dB shutdown/power down radius for cetaceans and 190 dB shutdown/power down radius for ice seals, respectively.
- 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.

On-ice Seismic Surveys

- 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.

Exploratory Drilling Activities

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

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

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

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

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

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

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

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

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

- Shutdown of activities occurring in specific areas of the Beaufort Sea corresponding to the start and conclusion of the fall bowhead whale hunts in Nuiqsut (Cross Island) and Kaktovik beginning on 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.
- Required flight altitudes and paths for all support aircraft in areas where subsistence occurs, except during take-off, landing, and emergency situations.

2.4.11 Additional Mitigation Measures

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

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

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

- Prior to conducting the authorized survey, the seismic array operator shall conduct sound source verification tests for their airgun array configurations in the area in which the survey is proposed to occur.
- All PSOs shall be provided with and use appropriate 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 in order to detect marine mammals within the exclusion zones.
- Operators shall limit seismic airgun operations in situations of low visibility when the entire safety radius cannot be observed (e.g., nighttime or bad weather).

- Seismic operators shall use passive (or active) 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 (e.g. expansion of shutdown zone to 120 dB or 160 dB when cow/calf groups and feeding or resting aggregations are detected, respectively).

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

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

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

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

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

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

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

- Vessel and aircraft avoidance of concentrations of groups of ice seals by 0.8 km (0.5 mi).
- Specified shipping or transit routes to avoid important habitat in areas where marine mammals may occur in high densities.

Exploratory Drilling Activities ONLY

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

On-ice Seismic Surveys

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

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

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

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

Exploratory Drilling Activities ONLY

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

2.4.12 Marine Mammal Monitoring Programs and Reporting Requirements

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

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

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

2.4.12.2 Reporting Requirements

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

- 90-day Report: A draft report will be submitted to the Director, Office of Protected Resources, NMFS, within 90 days after the end of any activity authorized under an ITA in the Arctic Seas. 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 five days of completing the measurements. In addition to reporting the radii of specific regulatory concern, distances to other sound isopleths down to 120 dB rms (if measurable) will be reported in increments of 10 dB.
- 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:

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 OCS Lands Act. During the Five-Year Program stage, the public is afforded the opportunity to make recommendations regarding the size, timing, and location of proposed lease sales for the next five years. At the lease sale stage, BOEM invites the public to make comments regarding a specific sale and potential exclusions.

The President of the United States can place a moratorium on an area or the U.S. Congress can permanently close an area. The current alternatives in this EIS consider a wide array of geographic restrictions that could be used, alone or in combination, to mitigate impacts to different resources in the context of the specific activity that is being permitted.

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

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

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

2.5.2 Caps on Levels of Activities and /or Noise

During the scoping period, commenters suggested that there should be a cap established to limit the total number of oil and gas seismic and exploratory drilling activities that may occur in the EIS project area on a per season basis. The alternatives carried forward for analysis in this EIS include a range of exploration activities at different activity levels. While these separate activity level alternatives do not function as "caps," they do serve as the maximum annual level of activities for which NEPA coverage under this EIS exists for NMFS' and BOEM's issuance of ITAs and permits, respectively, in a given year. If the agencies receive additional requests for authorizations and permits for such activities beyond the level analyzed in this PEIS 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.

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

BOEM has the statutory authority to make a decision on exploratory drilling activities. NMFS does not authorize the exploration activities, but rather authorizes the take of marine mammals incidental to specified activities. 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.

Separately, a commenter suggested that a sound cap or sound budget that limits the total amount of noise (from oil and gas exploration sounds, as well as other sounds that are not part of the proposed action) allowed per season should be considered as an alternative. The factors discussed in the paragraphs above (activity level caps) apply to this recommendation as well. Additionally, there are insufficient data to support a cumulative noise cap as the current understanding of the likely impacts from noise and ability to quantify those impacts are generally limited to observed responses to a single sound source. 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 is information showing generally (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 interfere, to some degree, with a marine mammal's ability to communicate with conspecifics or collect other important environmental information (which supports the general goal of reducing noise, which is explored both in mitigation measures and alternatives in this EIS). However, there is no specific information regarding at what level or over what period of time an elevated overall background noise will trigger any specific significant impacts to marine mammal health or fitness, which would make the designation of a noise cap an arbitrary and unsupportable action. Additionally, the soundscape 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 establish a "noise cap" in advance with any accuracy in the absence of the details of proposed activities. 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 soundscape) have no responsibility either to indicate their future plans or report their prior sound production, which would be necessary for the budget "accounting."

In Chapter 4, NMFS will consider the combined noise impacts from multiple surveys. Similarly, in the cumulative impact analysis, NMFS will consider the potential noise (and other types of) impacts from other known activities occurring in the EIS project area. This information will be analyzed on a qualitative basis and potentially in the development of mitigation or monitoring measures contained in this EIS. Additionally, NMFS and BOEM are aware of several ongoing scientific efforts to better quantify different aspects of potential cumulative impacts in the Arctic (e.g. the Cumulative Effects of Anthropogenic Sound on Marine Mammals Workshop sponsored by British Petroleum [BP] and the NOAA Sound Mapping Working Group) and any applicable available preliminary or final products will be considered in the EIS, as appropriate. While NMFS will consider the potential impacts from exposure over time to multiple sound sources in this document, a "budget" implies a quantitative management of total sound that cannot currently be supported by the science.

2.5.3 Duplicative Surveys

A question was raised as to why restrictions could not be placed on companies that are repeating seismic surveys in the same geographic area. Based upon the OCS Lands Act and applicable regulations (30 CFR Parts 550 and 551), BOEM does not have the discretion to require companies to share proprietary data, combine seismic programs, change lease terms, or prevent companies from acquiring data in the same geographic area. The agency does not have the authority to deny seismic permits simply on the grounds that they are duplicative – meaning the acquisition of the exact same data using the exact same equipment and technology in the exact same location. Continuing improvements in seismic survey technology, operations, and data processing could provide better quality data, which would support better decisions and higher drilling success rates (i.e., fewer unsuccessful wells or “dry holes”). To improve data quality and imaging in the same area, surveys have been shot, for example, in different orientations, using different cable lengths, using new wide azimuth techniques, or using 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 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) 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.

However, oil and gas exploration activities generate a wide range of waste streams in addition to those associated with the current “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.

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. 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 Level of Exploratory Drilling Programs Commensurate with the Number of Lease Holders in the Beaufort and Chukchi Seas

An alternative representing a high level of exploration activity (i.e., equal to the number of lease holders in the Alaskan Beaufort and Chukchi Seas) was considered but eliminated from further analysis. As per the CEQ regulations (40 CFR 1502.14), it was the intent of NMFS and BOEM to consider a range of reasonable alternatives to the proposal. CEQ guidance on this regulation states:

> "40 CFR Section 1502.14 requires the EIS to examine all reasonable alternatives to the proposal. In determining the scope of alternatives to be considered, the emphasis is on what is "reasonable" rather than on whether the proponent or applicant likes or is itself capable of carrying out a particular alternative. Reasonable alternatives include those that are practical or feasible from the technical and economic standpoint and using common sense, rather than simply desirable from the standpoint of the applicant" (CEQ, *Forty Most Asked Questions Concerning NEPA Regulations,* Quest. 2a, March 23, 1981).

Speaking to this concern during the commenting period on the December 2011 Draft EIS, oil and gas industry representatives encouraged NMFS to consider a broad range of exploration scenarios. The industry representatives expressed concern that with so many existing leases, the maximum development alternative at the time—a total of four exploration projects, two in the Beaufort Sea and two in the Chukchi Sea—was too limiting.

There are currently 183 leases in the Beaufort Sea and 487 leases in the Chukchi Sea, for a total of 670 leases. There are 11 lessees/owners of these leases. The intention with the range of alternatives analyzed in the EIS is not to limit the amount of exploration and development but rather to address realistic scenarios. The extreme case would be to analyze a total of 670 Arctic exploration projects (one for each lease), but this is unrealistic given the logistical and technological limitations for such an undertaking—it would challenge common sense. On the other hand, the possibility of analyzing an alternative that allows for one exploration program per lease holder, for a total of 11 concurrently operating exploration projects, does bear a closer look.

Each exploration project in the Arctic requires extensive commitment of resources and personnel. Recent projects permitted in the Chukchi Sea have required up to five support vessels in addition to the drillship itself: at least one ice management vessel, an anchor handler vessel, two supply ships, and possibly a 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.

There are limitations to the numbers of drill rigs/drill ships, icebreakers, oil-spill response vessels, and other support equipment generally available to support Arctic drilling operations. For example, there are currently only four drilling rigs ready to operate in the Arctic. Further, there are minimum timelines to consider in terms of permitting and regulatory process. Shell is the only lessee/operator currently permitted by DOI to begin exploratory drilling in the Beaufort Sea and Chukchi Sea Planning Areas. Even if Shell discovers commercial quantities of oil in 2013, potentially increasing interest in Arctic exploration, it is very unlikely that more than eight drilling programs (as analyzed under Alternative 4) would be operational in the time frame of this EIS. Such a scenario would require more resources than are currently available and is not reasonably foreseeable. Therefore, an alternative representing a higher level of activity (more than 8 programs) will not be analyzed further in this EIS. However, the absence of an alternative analyzing a higher level of activity does not limit the number of possible drilling programs. Should a higher level of activity be proposed at some point in the future, further NEPA analysis would be developed to analyze those requests.

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 or CSEM surveys in the Beaufort Sea (Beaufort) and up to three 2D/3D seismic or CSEM surveys in the Chukchi Sea (Chukchi) per year. Up to one of the total number of surveys in each sea done in-ice with ice breaking if necessary.	Up to six 2D/3D seismic or CSEM surveys in the Beaufort and up to five 2D/3D seismic or CSEM surveys in the Chukchi per year. Up to one of the total number of surveys in each sea done in-ice with ice breaking if necessary	Up to six 2D/3D seismic or CSEM surveys in the Beaufort and up to five 2D/3D seismic or CSEM surveys in the Chukchi per year. Up to one of the total number of surveys in each sea done in-ice with ice breaking if necessary	Same as Alternative 3	Same as Alternative 3
		Up to three site clearance and high resolution shallow hazards survey programs in the Beaufort and up to three site clearance and high resolution shallow hazards survey programs in the Chukchi per year.	Up to five site clearance and high resolution shallow hazards survey programs in the Beaufort and up to five site clearance and high resolution shallow hazards survey programs in the Chukchi per year	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 2.4.9 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 2.4.10 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: • Barrow Canyon/ Western Beaufort Sea • Shelf Break of the Beaufort Sea • Hannah Shoal • Kasegaluk Lagoon • Ledyard 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, possible ship strikes, or habitat degradation.	Moderate impacts from noise disturbance, possible ship strikes, or habitat degradation.	Moderate to major impacts from noise disturbance, possible ship strikes, 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, possible ship strikes, or habitat degradation.	Moderate impacts from noise disturbance, possible ship strikes, or habitat degradation.	Moderate impacts from noise disturbance, possible ship strikes, 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. No impact from activities in the Beaufort Sea as they are uncommon there.	Minor impacts from disturbance, risk of injury or mortality, and changes in habitat in the Chukchi Sea. Despite the increased activity, there would be no increase in the impact level. No impact from activities in the Beaufort Sea as they are uncommon there.	Minor impacts from disturbance, risk of injury or mortality, and changes in habitat in the Chukchi Sea. Despite the increased activity, there would be no increase in the impact level. No impact from activities in the Beaufort Sea as they are uncommon there.	Minor impacts, although time/area closures would reduce potentially adverse effects on walrus in those areas. No impact from activities in the Beaufort Sea as they are uncommon there.	Minor impacts. Alternative seismic technologies for in-ice surveys would likely still require the use of ice and would therefore have similar disturbance effects on walrus as those technologies currently in use. No impact from activities in the Beaufort Sea as they are uncommon there.
Marine Mammals: Polar Bears	No effect	Minor impacts from temporary localized disturbance.	Minor impacts from temporary localized disturbance. Despite the increased activity, there would be no increase in the impact level.	Minor impacts 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.	Same as Alternative 3.	Same as Alternative 3.

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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. In many cases, the original documents are referenced and the pertinent information has been summarized. In other cases, pertinent sections of documents have been reproduced from the original. All source documents are cited in the text with full references in Chapter 7 of this document.

3.1 Physical Environment

3.1.1 Physical Oceanography

3.1.1.1 Water Depth and General Circulation

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

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

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

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

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

3.1.1.2 Currents, Upwelling and Eddies

Beaufort Sea

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

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

The second oceanic regime includes the outer shelf and continental slope. Along the outer shelf and continental slope, the Beaufort undercurrent, or shelf break jet, carries Bering Sea water from the Chukchi Sea between late spring and early fall; from mid-fall to mid-spring, warmer, saltier Atlantic Water upwelled from greater depths is transported by the Beaufort undercurrent jet (Pickart 2004, Weingartner 2008, Nikolopoulos et al. 2009). The jet configuration changes seasonally. From late spring to early fall, the subsurface jet carries Bering Sea water, and from mid-fall to mid-spring upwelled Atlantic water is transported by the Beaufort undercurrent jet (Pickart 2004). Wind-driven upwelling is occasionally strong enough to push the undercurrent onto the shelf (Weingartner 2008, Pickart et al. 2011). This flow along the Beaufort Sea slope appears to be highly unstable, and it is therefore likely to be a source for the numerous eddies that extend into the Canada Basin (Shimada et al. 2001, Weingartner 2008).

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

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

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

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

Chukchi Sea

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

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

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

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

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

3.1.1.3 Temperature and Salinity

Beaufort Sea

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

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

Chukchi Sea

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

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

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

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

3.1.1.4 Tides and Water Levels

Beaufort Sea

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

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

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

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

Chukchi Sea

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

3.1.1.5 Stream and River Discharge

Beaufort Sea

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

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

Chukchi Sea

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

3.1.2 Sea Ice

3.1.2.1 Ice Dynamics

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

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

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

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

3.1.2.2 Landfast Ice

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

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

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

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

3.1.2.3 Stamukhi

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

3.1.2.4 Pack Ice and Ice Gouges

During winter, movement in the pack ice zone of the Beaufort Sea generally is small and tends to occur only during strong wind events of several days' duration. The long-term direction of ice movement tends to be from east to west, however, there may be short-term perturbations from this general trend due to variable weather (MMS 2008).

The seabed of the Alaskan Beaufort Sea shows evidence of modification by ice keels, which gouge the seafloor. The keels of sea-ice pressure ridges cut through seafloor sediments to form 'V' shaped incisions called gouges, also referred to as scours. Gouging is associated with ice keels driven by forces from the associated ice pack. An OCS study commissioned by MMS (2006-059) 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 cited in MMS 2006-059). Most ice gouges are less than 0.5 m (2 ft) deep, but the deepest gouges exceed 2 m (7 ft) in depth (NRC 2011). 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 between Smith Bay in the west to near Camden Bay in the east (Weeks et al. 1983 in MMS 2006-059). 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 2006-059). 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 2006).

3.1.2.5 Leads and Polynyas

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

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

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

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

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

3.1.2.6 Changes in Sea Ice

Arctic sea ice is changing in extent, thickness, distribution, age, and timing of melt. Analysis of long-term data sets show substantial decreases in both extent (area of ocean covered by ice) and thickness of sea ice cover during the past 30 years. Sea ice extent, the primary measure by which Arctic ice conditions are judged, has been monitored using satellite imagery since 1979. The annual maximum extent (March) and minimum extent (September) are the measures used for interannual comparisons (Perovich et al. 2012). The September 2012 minimum ice extent was the second lowest since 1979 (Perovich et al. 2012; see Figure 2.1). 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 (NSIDC 2011b, Perovich et al. 2012). The March 2010 ice extent was four percent lower than the 1979 to 2000 average. A time series of anomalies in sea ice extent (1979 to 2009) reveals both interannual variability and general decreasing trends. March ice extent decreased at a rate of 2.7 percent per decade, while September extent decreased 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 2008 followed by higher values in 2009, 2010, and 2011 (Comiso 2011). The Beaufort and Chukchi seas have experienced reductions of overall mean thickness of level ice due to the replacement of multi-year by first-year ice over large areas (Shirawasa et al. 2009).

The landfast ice season has shortened since the 1970s, with coastlines being ice-free over a month earlier for the Beaufort Sea and two weeks earlier for some areas of the Chukchi Sea (Mahoney et al. 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. 2004).

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

3.1.3 Geology

This section presents brief summaries of the regional geologic setting, stratigraphy and petroleum resources of northern Alaska, exploration history of the Alaska North Slope region, potential targets of undiscovered oil and gas resources in the Arctic Alaska offshore, and Arctic Alaska seafloor features. The Alaska Outer Continental Shelf lies north of the petroleum-resource rich Alaska North Slope where the large Prudhoe Bay oil-field was discovered in 1968 by Atlantic Richfield. The surface and subsurface geology of the Alaska North Slope is very complex and has been studied extensively by numerous workers within federal and state agencies, academia, and the oil and gas industry over the last 50 years. Limited exploration has occurred on federal lands within the Alaska Outer Continental Shelf (OCS) region that includes the Beaufort Sea and Chukchi Sea along the northwest coast of Alaska between Kotzebue and Barrow. The rocks under the Beaufort and Chukchi seas of the Arctic Ocean within the Alaska OCS are interpreted by examination of rocks exposed at surface, those encountered during exploration activities onshore north of the Brooks Range the south, from the 35 exploration wells drilled in Alaska OCS waters and from wells drilled near-shore within State of Alaska waters, within three miles of the coastline. The onshore and near-shore surface and subsurface rocks have been grouped into the Arctic Alaska Petroleum Province by numerous previous workers. The Arctic Alaska Petroleum Province is also referred as the Northern Alaska Province. These workers speculate that a large portion of conventionally recoverable oil and gas in Alaska OCS federal off-shore waters (Beaufort and Chukchi seas of the Arctic Ocean) occur in rocks similar in age and composition to those found within the Arctic Alaska Petroleum Province (Houseknecht and Bird 2006, Bird 2001). In the early 1990s the Northstar (Seal Island) field was discovered and is recognized as the first petroleum producing field from Arctic Alaska federal offshore lands. The Northstar field lies within both State of Alaska and federal waters north of Prudhoe Bay.

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

- ***Prospect*** **-** an untested geologic feature having the potential for trapping and accumulating hydrocarbons.
- ***Pool*** – a subsurface accumulation of liquid or gaseous hydrocarbons, typically within a single stratigraphic interval, that is hydraulically separated from any other hydrocarbon accumulation.
- ***Field*** **-** a pool or grouping of related pools, sufficiently large to be economically producible.
- ***Play*** – a family of geologically related prospects, having similar hydrocarbon source, reservoir, and trapping mechanism.
- ***Basin*** – a large downwarped region serving as a center of sediment deposition. It can contain numerous geologic plays.
- ***Province*** – a large area or region unified geologically by a single dominant structural element or a number of contiguous elements. A province can be defined to contain a single basin or may contain several related or similar basins.
- ***Planning Area*** – an administrative subdivision of an offshore area used as the initial basis for considering blocks to be offered for lease in the Department of Interior offshore oil and gas leasing program.
- ***Undiscovered, technically recoverable resources (UTRR)*** – focus on geologic attributes. The resource potential is estimated without being constrained by economic considerations, such as the existence of transportation infrastructure to take the resources to market. The only constraint is

that conventional recovery techniques are assumed. The reported resources are those that would be produced at the surface, but estimates of recovery efficiency are based on current, known techniques. Ranges of values imply that some improvement in efficiency is considered, but dramatic improvements from unknown future techniques are not included.

3.1.3.1 Regional Physiography

The Arctic Alaska offshore region is divided into five distinct physiographic features (Figure 3.1-14). The boundaries of the features are delineated by geology, geography, water depth, and bathymetric surface relief of seafloor morphology. From east to west they include the Beaufort Shelf, the Canada Basin-Beaufort Shelf, the Chukchi Borderland, the Chukchi Shelf, and the Hope Basin. The Canada Basin-Beaufort Slope lies north of the Beaufort Shelf where its border with the Beaufort Shelf is recognized by sharp break in bathymetric slope that extends north and is expressed as a deep-water abyssal plain. This abyssal plain increases in depth northward and is ice-covered throughout much of the year. North of the Chukchi Shelf and west of the Canada Basin-Beaufort Slope is the Chukchi Borderland. The Chukchi Borderland is composed of submarine ridges and basins that trend north-south with water depths greater than 1,000 m (3,281 ft). Along the sub-sea boundaries of the features marked by sharp breaks in slope morphology, gravity-driven slope failures indicate that the most historically active seafloor features are gravity-driven slope failures (Grantz et al. 1994).

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

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

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

3.1.3.2 Regional Geologic Setting

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

The stable continental margin continued to exist through early Mesozoic time (about 200 myBP). The Chukchi and Arctic platforms are separated by the Hanna Trough that straddles the U.S.-Russia maritime boundary and extends from Point Lay northward to the North Chukchi Basin and straddles the U.S.–Russia maritime boundary. The Hanna Trough is a structural depression characterized by extensional normal faulting that received thick accumulation of sediments during Mississippian time (310 to 345 myBP) and into the early Mesozoic (Houseknecht and Bird 2006). The Barrow Arch is recognized as the expression of the onset of continental rifting (spreading apart) during the Late Jurassic through Early Cretaceous time (100 myBP). The trace of the Barrow Arch roughly parallels the northern Alaska coastline from Prudhoe Bay west past Point Barrow and continues to the northwest extending to the North Chukchi Basin (Figure 3.1-14). During this period of continental rifting, tectonic uplift dominated to the north of the Barrow Arch, whereas south of the arch, deposition of sediments continued into Cretaceous time. The oceanic Canada Basin and associated passive margin resulted from the development of the Barrow Arch (Houseknecht and Bird 2006). Also during this time of rifting along the southern margin of the Arctic and Chukchi platforms, a volcanic arc-continent collision perpetrated the creation of the Brooks Range, the adjacent Colville foreland basin, and the Herald Arch. The Herald Arch begins at the west end of the Brooks Range just south of Point Hope and extends northward to Cape Lisburne and continues west toward the North Chukchi Basin. The Herald Arch separates the Hope Basin to the south from the Chukchi Shelf on the north (Figure 3.1-14).

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

3.1.3.3 Stratigraphy and Petroleum Resources

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

Northern and Arctic Alaska

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

The pre-Mississippian age Franklinian sequence consists of fractured carbonate, argillite, quartzite, volcanic, and granitic rocks that represents the stable continental platform before Devonian time (345 to 395 myBP). The Franklinian sequence was deformed, uplifted, and eroded during Cambrian (500 to

600 myBP) through Devonian time. Following the uplifting event, the Franklinian high was eroded and was the northerly source of sediments for the Ellesmerian sequence. The Franklinian rocks have undergone burial and metamorphism. This characteristic has given the Franklinian sequence rocks limited petroleum potential and they are considered to be the economic basement rocks of the Arctic Alaska Petroleum Province (ADNR 2009, Houseknecht and Bird 2006).

The Ellesmerian sequence consists of marine carbonates and quartz- and chert-rich clastic rocks and is the most important sequence geologically in terms of petroleum production. The Ellesmerian sequence rocks were deposited over a 150 my period during the Mississippian through Early Jurassic time (approximately 195 myBP). The Ivishak Formation is an alluvial fan-delta complex that was deposited within the Ellesmerian sequence in Permo-Triassic time (200 to 300 myBP) and forms the reservoir for the giant Prudhoe Bay Oil Field that has produced over 12 billion barrels of oil (ADNR 2009). Continental shelf deposits of the Ellesmerian accumulated on a south-facing passive margin of the Arctic Platform (Houseknecht and Bird 2006). To the west, thick accumulations of Ellesmerian strata were deposited into the Hanna Trough. On the Chukchi Platform beyond the trough, Ellesmerian sediments are rare and when present have very limited thickness. Although the Ellesmerian sequence contains both petroleum source and reservoir rocks, petroleum was not generated in the source rocks, which lie near the top of the sequence, until they were buried by Beaufortian and Brookian deposits (Houseknecht and Bird 2006).

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

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

2006). Documented oil and gas accumulations and fields within the Brookian sequence include West Sak, Schrader Bluff, Ugnu, Flaxman Island, and Badami. One known field of the Brookian sequence is recognized in the OCS, the Hammerhead accumulation (ADNR 2009).

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

<u>Hope Basin</u>

The Hope Basin is disconnected from rocks found within onshore Alaska north of the Brooks Range and the Arctic offshore north of the Herald Arch. The Hope Basin lacks most of the key geological attributes that are found in northern Alaska which are favorable to creation of petroleum deposits. In U.S. waters, the Hope Basin is filled with Cenozoic age (up to 65 myBP) rocks with characteristics that suggest gas is the dominant resource (Sherwood 1998). Cretaceous age (65 to 145 myBP) rocks with potential oil attributes may lie within the Hope Basin in Russian waters (Sherwood 1998, Gautier and Klett 2010). Outcrops surrounding Hope Basin indicate that basin fill consists of Eocene age (34 to 56 myBP) volcanics, volcaniclastics, conglomerates and sandstones, which are overlain by Oligocene age (24 to 34 myBP) shallow-marine to nonmarine sandstones, siltstones, and conglomerates (MMS 2006a). The Hope Basin also includes the smaller local Kotzebue basin. The two basins are separated within the planning area by the Kotzebue Arch. The Tertiary aged (65 to 2 myBP) divergent Hope and Kotzebue basins are recognized to be related to right-lateral movement along the Kobuk fault zone recognized onshore in northwest Alaska. Basin development likely began in the early Tertiary (MMS 2006a).

3.1.3.4 Exploration and Production

<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 targeting strata within the Brookian sequence of rocks. Of the remaining five plays, one is targeting Beaufortian Rift sequence rocks, and another is targeting Upper Ellesmerian sequence rocks. The remaining three plays are targeting undeformed pre-Mississippian basement rocks, Endicott Formation rocks, and Lisburne Formation rocks (MMS 2006a).

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

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

Exploration History

Arctic Alaska

Oil seeps were first discovered in the Cape Simpson area near the northernmost tip of Alaska by the U.S. Geological Survey in 1917. Based on the presence of these seeps, President Warren Harding established the Naval Petroleum Reserve No. 4 in 1923. The Naval Petroleum Reserve No. 4 was later renamed the National Petroleum Reserve-Alaska (NPR-A). NPR-A consists of approximately 23 million acres situated within the west central portion of northern Alaska. The onset of World War II prompted the first publicly funded exploration program in the NPR-A from 1944 to 1953 (Sherwood et al. 1996). As a result of the drilling from 1944 to 1953, small oil fields were discovered at Umiat, Simpson, and Fish Creek and gas fields were discovered at Gubik, South Barrow, Meade, Square Lake, Oumalik, and Wolf Creek. Following passage of Alaska statehood in 1959, exploration was focused on State of Alaska lands situated between the NPR-A and the Arctic National Wildlife Refuge (ANWR) to the east. Following the initial lease sale of State of Alaska lands in 1964 and 1965, came the 1968 discovery of the Prudhoe Bay field, the largest oil field ever found in North America at that time (Sherwood et al 1996). The Prudhoe Bay discovery lead to other oil fields being discovered including Kuparuk (1969), West Sak (1969), Milne Point (1970), Flaxman Island (1975), Point Thomson (1977), and Sag Delta-Duck Island (1978), later called the Endicott field (MMS 2006a).

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

Beaufort Shelf

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

Chukchi Shelf

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

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

Hope Basin

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

Petroleum Production

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

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

3.1.3.5 Seafloor Features

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

Permafrost

The occurrence and extent of permafrost onshore Alaska is well documented and understood, however, the occurrence and extent of permafrost offshore is not well known. Permafrost is defined as rock or soil that has exhibited temperatures below 0°Centigrade continuously for 2 or more years. Onshore Northern Alaska permafrost extends to depths of 660 m (2,165 ft). Permafrost in sediments off-shore was first recognized in 1972 beneath the Beaufort Sea off the McKenzie River Delta. Off-shore permafrost depths are variable due to interaction with warm marine currents and saline rich groundwater. Seafloor sediments are usually unbonded due to the salinity of the seawater. Buried sediments normally do not contain ice due to the presence of dissolved salts, confining pressure, and capillary forces. These characteristics lower the freezing point of pore water below the ambient temperature. Numerous geophysical surveys and geotechnical investigation boreholes indicate that permafrost is widespread beneath the Beaufort inner shelf, however highly irregular. Fine-grained, semi-lithified deposits of the Gubik Formation are recognized to having a direct relationship with bonding of seafloor sediments found within the Beaufort Shelf. Low permeable silts and clays of the Flaxman Member of the Gubik Formation form a barrier to the infusion of saltwater that would lower the thaw point and cause ice to melt. The depth to the surface of subsea permafrost and boundary between bonded and unbounded permafrost is highly variable. Depths to bonded permafrost have been shown to be as shallow as 10 m (33 ft) in 2 m (6.6 ft) of water. Studies have identified that the depth to subsea permafrost is variable due to different degrees of ice bonding before the region was inundated with warm water of the Holocene age (10,000 years BP) marine transgression. Other studies have speculated that the amount and distribution of subsequent thawing is probably due to the introduction of saline groundwater originating from deeper depths. These observations suggest that subsea permafrost melting is occurring from above and below (MMS 2003).

In Pleistocene times (2 myBP to 10,000 year BP) the Beaufort Shelf was exposed to the Arctic atmosphere during several lowstands of sea level. Throughout this period, bonded permafrost is thought to have formed to depths of several hundred meters beneath the exposed shelf. Pleistocene age highstands of sea level generated warm seawater and saline advection from the seawater into the underlying sediments causing the bonded permafrost to melt partially both from above by thermal heating and from below by geothermal heating. Geotechnical investigations in the Prudhoe Bay area reported that seafloor sediments are at or below the freezing point, although it is not bonded permafrost (MMS 2003).

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

Ice Dynamics

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

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

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

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

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

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

Sediment Transport Dynamics

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

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

Buried Channels

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

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

Shallow Gas

Shallow gas, when concentrated and under pressure by being trapped at shallow subsurface depths, typically between 100 and 1,000 m (300 and 3,000 ft), poses a drilling hazard. Numerous anomalies associated with shallow gas have been indicated on seismic profiles throughout the Beaufort Sea as isolated pockets beneath permafrost, associated with faulted strata, and as concentrations in submerged coastal plain sediments and peat deposits. Because these anomalies are avoided after being identified in shallow hazard surveys and because the gas is not an exploration target, shallow gas has not been detected in most offshore Beaufort Sea exploration wells. Free-flowing gas was encountered in one U.S. Geological Survey well in Stefansson Sound, and shallow gas has been inferred from seismic data in Harrison Bay and extensive areas of the outer shelf (MMS 2003). Shallow gas was also encountered at about 1,700 feet in the Hammerhead structure drilled in the 1980s (e.g. Unocal 1986).

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

3.1.4 Climate and Meteorology

3.1.4.1 Introduction

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

3.1.4.2 Regulatory Overview

Council on Environmental Quality Draft NEPA Guidance

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

1) The GHG emissions effects of a proposed action and alternative actions; and

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

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

Final Mandatory Reporting of Greenhouse Gases Rule

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

3.1.4.3 Meteorology

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

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

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

Due to the influence that proximate water bodies have on the meteorological conditions within the project area, the following meteorology discussion is separated into areas in and adjacent to the Beaufort and Chukchi seas. Specific weather stations were selected to represent existing conditions in each sub-area, including data on air temperature, precipitation, and wind. These weather stations were selected based on availability of substantial data records and their proximity to the onshore communities within the project area. Table 3.1-1 lists the weather stations analyzed for describing existing conditions in the Beaufort Sea and Chukchi Sea sub-areas. Table 3.1-2 at the end of this section provides a summary of air temperature, precipitation, and winds for the weather stations listed in Table 3.1-1 (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 (WRCC 2011a). Historically, extreme temperatures have been recorded as high as 82 °F in Deadhorse (August 1999) and as low as -59 °F in Barter Island (February 1950) (WRCC 2011b).

Chukchi Sea

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

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

Precipitation

Beaufort Sea

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

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

Chukchi Sea

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

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

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

Wind

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

Beaufort Sea

For weather stations along the Beaufort Sea, onshore winds are predominantly from the east, east-northeast, and northeast, while offshore winds are chiefly from the west, west-southwest, and southwest (WRCC 2011c). The dominance of onshore winds, also known as the sea breeze effect, is more prevalent in the summer months and reaches a peak in June when snow cover over land has diminished, and the land-sea thermal gradient is the most pronounced (MMS 2007b).

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

Chukchi Sea

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

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

Storms

Beaufort Sea

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

Chukchi Sea

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

Table 3.1-2 Meteorological Data Summary by Community

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

Notes:

N/A = Data not available.

1) Indicates direction wind blows *from*.

2) Days receiving at least 0.1 inch of precipitation

3) Period of Record: 1999 – 2006

4) Period of Record: 1992 – 2002

5) Period of Record: 1949 – 1988

6) Period of Record: 1999 – 2008

7) Period of Record: 1996 – 2008

8) Period of Record: 1949 – 1969

9) Period of Record: 1954 – 1984

10) Period of Record: 1996 – 2008

11) Days receiving at least 0.1 inches of precipitation

Sources:

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

3.1.4.4 Climate Change in the Arctic

Climate Change

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

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

Climate Cycle Systems

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

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

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

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

Changes in the Arctic

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

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

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

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

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

- A warming trend in the Arctic of 0.16 ºF per decade compared to 0.11 ºF per decade for the globe;
- A warming trend of 0.7 ºF per decade over last four decades;
- Precipitation has increased approximately one percent per decade over the past century;
- Snow extent has declined approximately 10 percent and permafrost has warmed by almost 3.6 ºF over the past three decades;
- Arctic Sea level has risen 10 to 20 centimeters (cm) in the past 100 years;
- Annual average sea ice extent has decreased by about eight percent, and the summer sea ice extent has decreased by 15 to 20 percent over the past three decades;
- Mean annual temperatures have increased by about 3.5 to 5.5 ºF over the last five decades;
- Sea ice thickness has decreased by 42 percent since the mid-1970s; and
- Winter temperatures have 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," plays a large-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 burning fossil fuels, including those from oil and gas drilling and boreal forest fires (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 an ongoing BOEM-funded study (Mathis 2011). The greatest degree of ocean acidification worldwide is predicted to occur in the Arctic Ocean. This amplified scenario in the Arctic is due to the effects of increased freshwater input from melting snow and ice and from increased CO_2 uptake by the sea as a result of ice retreat (Fabry et al. 2009). Measurements in the Canada Basin of the Arctic Ocean demonstrate that over 11 years, melting sea ice forced changes in pH and the inorganic carbon equilibrium, resulting in decreased saturation of calcium carbonate in the seawater (Yamamoto-Kawai 2009). Bates et al. (2009) showed the effects of decreasing pH on the saturation states of inorganic carbonate in the Chukchi and Beaufort seas, and the interaction of carbonate states with primary productivity.

3.1.4.5 Greenhouse Gas Emissions

Gases that trap heat in the atmosphere are often called greenhouse gases (EPA 2011c). Due to this ability, GHGs are widely considered an important contributing factor in climate change. Some GHGs such as carbon dioxide (CO_2) occur naturally and are emitted to the atmosphere through natural processes and human activities. Other GHGs (e.g. fluorinated gases) are created and emitted solely through human activities. The principal GHGs that enter the atmosphere because of human activities are:

Carbon Dioxide (CO_2) – CO_2 enters the atmosphere through the burning of fossil fuels (oil, natural gas, and coal), solid waste, trees and wood products, and also as a result of other chemical reactions (e.g. manufacture of cement). CO_2 is also removed from the atmosphere when it is absorbed by plants as part of the biological carbon cycle (EPA 2011d).

Methane (CH_4) – CH_4 is emitted during the production and transport of coal, natural gas, and oil. CH_4 emissions also result from livestock and other agricultural practices and by the decay of organic waste in municipal solid waste landfills (EPA 2011c).

Nitrous Oxide (N_2O) – N_2O is emitted during agricultural and industrial activities, as well as during combustion of fossil fuels and solid waste (EPA 2011d).

Fluorinated gases – Hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride are synthetic, powerful GHGs that are emitted from a variety of industrial processes. Fluorinated gases are sometimes used as substitutes for ozone-depleting substances. These gases are typically emitted in smaller quantities, but because they are potent GHGs, they are sometimes referred to as “High Global Warming Potential” gases (EPA 2011d).

These particular gases are covered under the United Nations Framework Convention on Climate Change, an international agreement that requires participating countries to develop and periodically submit an inventory of greenhouse gas emissions (EPA 2011e).

In 2005, activities in Alaska were estimated to contribute 52.1 million metric tons (MMt) of gross[1] CO_2e, accounting for approximately 0.7 percent of the total US gross GHG emissions. From 1990 to 2000, GHG emissions from activities in Alaska were estimated to increase by approximately 13 percent which is on par with the national total, which rose by approximately 14 percent over the same period. The main source of Alaska’s GHG emissions is residential, commercial, and industrial fuel use followed by the transportation sector. In 2010, the fossil fuel industry was estimated to produce approximately 2.9 MMt of CO_2e, representing approximately 5.2 percent of the state’s CO_2e emissions. Approximately 2.4 MMt of those emissions are attributed to the oil industry, equaling approximately 4.3 percent of the state’s total. Table 3.1-3 provides historical and estimated current GHG emissions in Alaska by sector. Current conditions are estimated as values for the year 2010 as projected as part of a study conducted in 2007 by Center for Climate Strategies (CCS 2007).

[1] Excludes emissions removed due to carbon sequestering.

Table 3.1-3 Alaska Historical and Estimated Existing GHG Emissions, by Sector

Million Metric Tons CO_2e	1990	2000	2005	2010 Estimation	Source of 2010 Estimates
Electricity Production	**2.6**	**3.1**	**3.2**	**3.6**	
- Coal	0.4	0.8	0.6	0.6	
- Natural Gas	1.9	1.9	2.1	2.1	
- Oil	0.3	0.5	0.6	0.9	
Residential/Commercial	**3.8**	**4.3**	**3.9**	**3.9**	Based on USDOE regional projections
- Coal	0.8	0.8	0.7	0.7	
- Natural Gas	1.8	2.2	1.9	1.9	
- Oil	2.4	2.4	3.1	3.6	
- Wood (CH_4 and N_2O)	0.01	0.00	0.00	0.00	
Industrial (Non-Fossil Fuel Production)	**15.7**	**19.6**	**21.6**	**23.5**	Based on USDOE regional projections
- Coal	0.00	0.001	0.001	0.001	
- Natural Gas	13.2	17.3	18.5	19.9	
- Oil	2.4	2.4	3.1	3.6	
- Wood (CH_4 and N_2O)	0.01	0.00	0.00	0.00	
Transportation	**15.1**	**16.8**	**19.0**	**19.6**	
- Aviation	7.2	10.6	12.9	13.0	FAA aircraft operations forecasts
- Marine Vessels	4.4	2.4	2.4	2.6	DEC commercial marine inventory growth factors
- Onroad Vehicles	3.4	3.7	3.6	3.9	WRAP inventory VMT projections
- Rail and Other	0.08	0.08	0.12	0.13	Historical trends and USDOE regional projections
Fossil Fuel Industry	**4.9**	**3.2**	**3.0**	**2.9**	
- Natural Gas Industry	0.2	0.4	0.5	0.4	Historical trends and DNR natural gas production forecasts
- Oil Industry	4.7	2.8	2.5	2.4	Historical trends and DNR oil production forecasts
- Coal Mining (Methane)	0.01	0.01	0.01	0.01	Historical trend
Industrial Processes	**0.05**	**0.2**	**0.3**	**0.5**	
- Limestone and Dolomite Use	0.00	0.00	0.01	0.01	Alaska manufacturing employment growth
- Soda Ash	0.01	0.01	0.01	0.01	National projections for 2004-2009 (USGS)
- ODS Substitutes	0.001	0.2	0.3	0.4	EPA 2004 ODS cost study report
- SF_6 from Electric Utilities	0.04	0.02	0.02	0.02	Based on national projections (EPA)

Million Metric Tons CO_2e	1990	2000	2005	2010 Estimation	Source of 2010 Estimates
Waste Management	**0.6**	**0.9**	**1.0**	**1.2**	
- Solid Waste Management	0.6	0.8	1.0	1.1	Projected based on 1995-2005 trend
- Wastewater Management	0.1	0.1	0.1	0.1	Projected based on population
Agriculture	**0.05**	**0.05**	**0.05**	**0.06**	
- Manure Management	0.001	0.002	0.004	0.005	USDA livestock projections
- Enteric Fermentation	0.01	0.02	0.02	0.02	USDA livestock projections
- Agricultural Soils	0.04	0.04	0.03	0.03	Projected based on historical trend
Total Gross Emissions	**42.8**	**48.3**	**52.1**	**55.2**	
Forestry and Land Use[1]	-0.3	-1.4	-1.4	-1.4	Projections held constant at 2000 level.
Net Emissions[2]	**42.5**	**46.9**	**50.7**	**53.8**	

Notes:
Forestry activities are negative because they represent an increase in carbon sequestering.
Net Emissions take into account carbon sequestering.
Source: CCS 2007

3.1.5 Air Quality

Air quality is a function of the air pollutant emission sources within an area, atmospheric conditions (such as wind direction and speed), and characteristics of the area itself (topography and air shed size). Pollutants transported from outside an area can also affect its air quality. Air pollutants are emitted from both man-made (anthropogenic) and natural sources. Industrial, residential, transportation-related, and construction-related emissions are anthropogenic sources; these sources can be either ongoing or temporary. Natural sources include windblown dust, forest fires, and volcanic eruptions; these typically contribute only to temporary increases in air pollution.

Air quality in the majority of Alaska's Arctic region, including the Beaufort and Chukchi seas, is generally considered very good due to minimal human habitation and industrial development, along with the distance from population centers such as Anchorage or Fairbanks (MMS 2007c). Widely scattered air pollutant emission sources exist in the onshore coastal regions of the EIS project area, with the only major industrial complex of more concentrated emission sources being Prudhoe Bay, Kuparuk, and Endicott oil-production facilities in the North Slope Areawide Oil and Gas Lease Sale Area (North Slope area). Dust and other pollutants from combustion sources in Europe and Asia also have the potential to be transported to the Arctic, having temporary and usually seasonal effects on visibility; such effects are commonly referred to as regional (or arctic) haze. Regional haze is discussed further under the subheading Other Air Quality Evaluation Criteria in Section 3.1.5.2.

3.1.5.1 EIS Project Area

For purposes of defining existing air quality in the EIS project area, it is convenient to divide the project area into three zones: the state's seaward boundary (0 to 4.8km [0 to 3 mi]); within 40 km (25 mi) of a state's seaward boundary (i.e., 4.8 to 45 km [3 to 28 mi] from the coast); and beyond 40 km (25 mi) of the state's seaward boundary (i.e., 45 to 322 km [28 to 200 mi] from the coast). These three zones are subject to different air quality regulatory requirements and different ambient air quality background levels. Air pollutant sources located offshore are regulated under the OCS Air Regulations (discussed below).

Certain ADEC rules are also applicable to offshore areas within 40 km (25 mi) of Alaska's seaward boundary (inner OCS); the EPA applies the corresponding onshore area (COA) rules to these areas, so they are basically treated the same as onshore sources for permitting purposes. Outer OCS offshore areas (beyond 40 km [25 mi] of the State's seaward boundary) are expected to have minimal anthropogenic sources of air pollution. In December 2011, Congress moved air permitting authority for the outer OCS from EPA to BOEM; however, authority for existing permits (and any pending as of December 2011) remained with EPA. The onshore areas are regulated by EPA and ADEC, and do not fall under the OCS regulations.

Except for the areas around Prudhoe Bay, Barrow and Kotzebue are the largest communities in terms of population within the onshore areas, and would thus be expected to have the highest current air pollutant levels. In addition, Kivalina is reported to have elevated dust levels, and Nuiqsut is located adjacent to the North Slope Area which has industrial activity. The other communities in the study area (Point Hope, Point Lay, Wainwright, and Kaktovik (located within the Arctic National Wildlife Refuge [ANWR]) are assumed to have lower background levels than the industrial areas and larger communities. However, in the absence of background air quality data in these remote regions, they are conservatively included in the onshore group for air quality purposes in this EIS.

3.1.5.2 Regulatory Framework and Pollutants of Concern

Air Quality Standards

Air quality in Alaska and the inner OCS is regulated by the EPA and ADEC, while air quality in the outer OCS is regulated by BOEM (as of December 2011). 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 carbon monoxide (CO) and particulate matter less than 10 microns in diameter (PM_{10}). Outdoor carbon monoxide emissions come from combustion sources, such as automobiles, airplanes, and industrial engines (ADEC 2011b). Fuel combustion is also a source of particulate matter emissions. In rural communities, airborne dust (PM_{10}) can be caused by windflow over glaciers, gravel pits, vehicles on dirt roads, dry river beds, and human activity on non-vegetated land (ADEC 2011c). On the OCS, marine engines cause emissions of nitrogen oxides (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
		Primary	Secondary	
Ozone (O_3)	8-hour (2008 Std) 8-hour (1997 Std)	0.075 ppm 0.080 ppm	0.075 ppm 0.080 ppm	0.075 ppm
Particulate Matter equal to or	Annual	15.0 μg/m^3	15.0 μg/m^3	15 μg/m^3

Pollutant	Averaging Period	National Standards		Alaska State Standards
		Primary	Secondary	
less than 2.5 micrometers in diameter ($PM_{2.5}$)	24-hour	35 µg/m^3	35 µg/m^3	35 µg/m^3
Particulate Matter equal to or less than 10 micrometers in diameter (PM_{10})				
	24-hour	150 µg/m^3	150 µg/m^3	150 µg/m^3
Carbon Monoxide (CO)	8-hour	9 ppm (10 mg/m^3)		10 mg/m^3
	1-hour	35 ppm (40 mg/m^3)		40 mg/m^3
Nitrogen Dioxide (NO_2)	Annual	0.053 ppm (100 µg/m^3)	0.053 ppm (100 µg/m^3)	100 µg/m^3
	1-hour	0.100 ppm		0.100 ppm
Sulfur Dioxide (SO_2)	Annual	0.03 ppm (80 µg/m^3)		80 µg/m^3
	24-hour	0.14 ppm (365 µg/m^3)		365 µg/m^3
	3-hour		0.5 ppm (1300 µg/m^3)	1300 µg/m^3
	1-hour	0.075 ppm		0.075 ppm
Reduced Sulfur Compounds (as SO_2)	30-minute			50 µg/m^3
Ammonia (NH_3)	8-hour			2.1 mg/m^3
Lead (Pb)	Rolling 3-Month Average	0.15 µg/m^3	0.15 µg/m^3	0.15 µg/m^3
	Quarterly Average	1.5 µg/m^3	1.5 µg/m^3	

Notes:
µm = micrometers (for particulate diameter)
µg/m^3 = micrograms of pollutant per cubic meter of air
mg/m^3 = milligrams of pollutant per cubic meter of air
ppm = parts per million

Source: EPA Office of Air Quality Planning (EPA 2011f) and Alaska Administrative Code (AAC) 18-50.010 (AAC 2011).

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 [Pub. L.] 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 Pub. L. 112-74 transferred authority for the control of air stationary source emissions, 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. However, all actions on the Alaska OCS proposed within 25 miles of shore remain subject to air quality regulations of the ADEC and may require State of Alaska permitting if within the three-mile boundary.

Control of stationary source emissions on the Alaska OCS is now regulated by BOEM, EPA, and ADEC, depending on the location and timeframe of the proposed action. 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 conduct an analytical evaluation of 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 BOEM Significance Levels (SLs). Control of emission sources on the OCS by BOEM is required only when the rig, drillship, or platform is expected to cause a significant air quality effect on the nearest shore area. Should the analysis demonstrate pollutant concentrations that exceed any SL, the application of Best Available Control technology (BACT) would be required by the BOEM Alaska OCS Region. If the action proposes a permanent facility, additional analysis would be required to show the application of BACT would result in compliance with the BOEM Maximum Allowable Increases (MAIs). Additional controls would be required until the MAIs are met. An EP must demonstrate compliance with Subpart C before the EP could be "deemed submitted" by BOEM Alaska OCS Region. Any required application of BACT or other emission controls would be enforced by the BSEE Alaska Region.

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 believed to be occurring as a direct consequence of emissions of GHGs from many types of sources in every nation of the world. The EPA issued the Final Mandatory Reporting of Greenhouse Gases Rule (EPA 2009a), which requires reporting of of GHGs from large sources and suppliers in the United States. The reporting is intended to collect accurate and timely emissions data to inform future policy decisions. Under the rule, suppliers of fossil fuels or industrial GHGs, manufacturers of vehicles and engines, and facilities that emit 25,000 metric tons or more per year of GHG emissions are required to submit annual reports to the EPA. 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 PSD and Title V permitting (EPA 2012g).

Regional Haze

Regional haze refers to haze that impairs visibility over a large area. In general, visibility is measured by the farthest distance a viewer can see a landscape or feature, which may be limited by tiny particles in the air absorbing and scattering sunlight, which in turn degrades color, contrast, and clarity of the view. Many sources produce the particulate matter that causes haze. In addition to the primary sources of particulate matter discussed above, secondary particulate matter is also formed when gaseous pollutants undergo chemical reactions with sunlight in the atmosphere. Factors such as weather and humidity further influence the formation of haze. The EPA Regional Haze Rule is designed to protect and improve visibility in National Parks and Wilderness Areas throughout the country (EPA 1999a). Class I airsheds are federally designated areas under the Clean Air Act where no degradation of visibility is allowed. Alaska has four Class I areas subject to the rule (ADEC 2011d). Denali National Park is the closest Class I area to any of the EIS project area, ranging from approximately 650 km (404 mi) southeast of Kotzebue and approximately 750 km (466 mi) south of the more industrialized Prudhoe Bay area, to well over 1,000 km (621 mi) south of some of the outer OCS region (Wilderness Net 2011). The National Park

Service (NPS) and USFWS monitor regional haze at Denali. Potential new sources of air pollution as part of this EIS are expected to have no appreciable effect at this distant Class I area, so no further description of the area is provided. In addition, monitoring data from this site are not representative of the EIS project area, although they could be used to identify specific events (such as Asian dust storms, see below) for verification purposes.

The focus of the regional haze issue in Alaska is primarily on visibility degradation within the Arctic region. Arctic haze and Asian dust events are the primary areas of concern, both identified as being the result of international transport of pollutants into Alaska (ADEC 2002). Arctic haze is defined as "diffuse bands of tropospheric aerosol occurring northward of about 70° latitude and at altitudes of up to 9,000 meters (29,528 ft). These layers are hundreds to thousands of kilometers wide and 1-3 km (0.6-1.9 mi) thick" (ADEC 2002). Coal burning and metal smelting from sources in the industrial regions of Europe and Russia appear to be the primary contributors to Arctic haze. Sources in North America and the Orient only contribute a minor amount of pollution to the Arctic due to their position relative to oceans and prevailing meteorology which provide pollutant scavenging mechanisms before reaching the Arctic (ADEC 2002).

Dust storms in Mongolia and northern China also have the potential to create large dust incidents within the Arctic region. These Asian dust events typically occur in the springtime, usually April and May, and appear to have high enough loft to avoid the ocean scavenging mechanisms. Anthropogenic sources of pollution, likely associated with China's largely coal-fired economy, have also been shown to be transported concurrently with the dust events (ADEC 2002).

3.1.5.3 Existing Air Quality

Based on the physical environment, land uses, and low population density of the EIS project area, existing air quality is assumed to be generally good in all of the offshore and onshore locations, although as mentioned previously, dust emissions in even remote areas can cause localized increased particulate concentrations. The levels of some pollutants are expected to be slightly higher in the onshore areas due to increased numbers of fuel combustion sources; however these areas are still in attainment 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. By June 1, 2010, all rural areas in Alaska were to have transitioned to 15 parts per million (ppm) diesel fuel for all highway, non-road, locomotive, and marine engines. By October 1, 2010, retail and wholesale purchaser-consumer transitions were to be complete; and by December 1, 2010, 15 ppm sulfur content diesel fuel was to be in retail facilities in all rural areas (ADEC 2010f). The switch to ultra-low sulfur diesel is expected to result in improved air quality, as it will reduce emissions of smoke, particulate matter, sulfur dioxide, and toxics from diesel combustion sources.

Background Data

The EIS project areas included in this discussion are in attainment (or unclassifiable) for all criteria pollutants. ADEC maintains air quality monitoring sites in some rural communities where there is concern for dust problems (ADEC 2011c, ADEC 2011d). The majority of background air quality data in northern Alaska have been collected in the North Slope area; criteria air pollutant monitoring data have been used for source permitting in the North Slope area, and for several OCS facilities (Air Sciences, Inc 2009, Environ 2010, and AECOM 2010). The dataset shown in Table 3.1-5 was compiled using maximum monitored values and should be conservatively representative of the OCS areas, including the COA areas. Therefore, it is expected that this compiled dataset is reasonably representative for the three air quality 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 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 and to be conservative, the data shown in Table 3.1-5 are assumed to represent worst-case 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 relatively 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.

3.1.6 Acoustics

3.1.6.1 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 kiloHertz [kHz]).

Acoustic *intensity* is defined as the acoustical power per unit area. The intensity, power, and energy of a sound wave are proportional to the average of the squared pressure. Measurement instruments and most receivers (humans, animals) sense changes in pressure which is measured in Pascals (Pa). Pressure changes due to sound waves can be measured in Pa but they are more commonly expressed in *decibels* (dB). The decibel is a logarithmic scale that is based on the ratio of the sound pressure relative to a standard reference pressure p_{ref}. Different standard reference pressures are used for airborne sounds and underwater sounds. The airborne standard pressure reference is p_{ref}(air) = 20 microPascals (µPa), where 1 µPa = 0.000001 Pa. The underwater standard reference pressure is p_{ref}(water) = 1 µPa. The formula used to convert a pressure p measured in µPa to sound pressure level P measured in dB is $P = 20 \log_{10}[p/p_{\mathrm{ref}}]$. 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 (0-peak or peak-to-peak), root-mean-square (RMS) sound pressure level (SPL), and sound exposure level (SEL). Figure 3.1-5 shows a representation of a sinusoidal (single-frequency) pressure wave to help illustrate the various metrics. The amplitude of the pressure is shown on the vertical axis, and time is shown on the horizontal axis. The pressure of the wave is shown to fluctuate around the neutral point. The *peak sound pressure* is the absolute value of the maximum variation from the neutral position; therefore, it can result from either compression or a rarefaction. The *peak-to-peak sound pressure* is the difference between the maximum and minimum pressures. The average amplitude is the average of absolute value of pressure over the period of interest. The *RMS amplitude* is a type of average that is determined by squaring all of the amplitudes over the period of interest, determining the mean of the squared values, and then taking the square root of this mean. The RMS amplitude of an impulsive signal could vary significantly depending on the length of the period of interest (DOSITS 2011). SEL is a metric that is related to the sound energy per area received over time, though it does not have energy units. It is proportional to the square of the sound pressure and the time over which a sound is received.

An *audiogram* shows the lowest level of sounds that an animal or human can hear (hearing threshold) at different frequencies (pitch). The y-axis of the audiogram is sound levels expressed in dB (either in-air or in-water) and the x-axis is the frequency of the sound expressed in Hz. A typical audiogram for human hearing is shown on Figure 3.1-6a. In evaluating airborne noise impacts, the method commonly used to quantify environmental sound consists of evaluating all frequencies of a sound according to a weighting system that reflects that human hearing sensitivity varies with sound frequency. The most common frequency weighting to assess human hearing sensitivity and noise impacts is referred to as A-weighting and the decibel level measured is called the A-weighted sound level (dBA). Figure 3.1-6b shows the A-weighting function, with sound levels expressed in dB on the y-axis and frequency on the x-axis. Another human hearing weighting function commonly used includes C-weighting, which is used to address human hearing sensitivity when exposed to loud sound. Common metrics used to for airborne noise include the L_{eq} (equivalent sound level) – the energy-mean A-weighted sound level during a measured time interval and the L_{min} and L_{max} – the RMS minimum and maximum noise levels during the monitoring period.

When evaluating potential noise impacts on wildlife, the A-weighting curve is usually not applied, as it is based on human hearing. Figure 3.1-7 shows hearing thresholds for some terrestrial and marine mammals as compared to the hearing threshold for humans. Figure 3.1-8 illustrates the proposed M-weighting functions for marine mammals by Southall et al. (2007).

Comparisons of underwater and airborne sound levels are difficult for several reasons, primarily due to the differences in the media (especially the characteristic impedance of the media), and it is important to take into account the reference pressure level noted previously (1 µPa for underwater, 20 µPa for airborne). Sound pressure level is derived from the equation SPL = 20 log (p/p_{ref}), where p is the acoustic pressure being measured and p_{ref} is the reference pressure. Thus, 26 dB must be added to the dB level measured in air in order to have the same reference level in water (20 log 20) = 26. Table 3.1-6 shows underwater and airborne sound pressure levels and the relationship with the pressure. While it may be useful to compare the difference in a source sound level or hearing sensitivity of a marine mammal to a terrestrial mammal, this is for comparison purposes only.

O’Neill et al. (2010a and 2010b) provide formulas for calculating underwater levels of impulsive noise used for the purpose of estimating biological impacts, and in particular the peak SPL, the root-mean-square (rms) 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).

Table 3.1-6 Sound Levels of Typical Sources

Pascals	Underwater sound level (dB re 1 µPa)	Airborne sound level (dB re 20 µPa)	Typical underwater sounds	Typical airborne sounds
1,000,000	240	214	1 m from hypothetical airgun array	
100,000	220	194	2 kg high explosive at 100 m	
10,000	200	174		Some military guns at 1 m
1,000	180	154		Sonic booms
100	160	134	Large ship, 100 m	
10	140	114	Fin whale call, 100 m	Discomfort threshold for humans, 500 m from jet takeoff
1	120	94		
0.1	100	74		15 m from auto at 55 km/hr
0.01	80	54	Ambient sound, Sea state 4	Speech in noise at 1 m
0.001	60	34	Ambient sound, Sea state 0	Speech in quiet at 1 m
0.001	40	14		
20 µ	26	0		Human threshold

Notes: dB re 1 Pa = decibels referenced to 1 microPascal; m = meters; km = kilometers; hr = hour
Source: Richardson et al. (1995)

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 hearing 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, as demonstrated in Southall et al. (2007). Southall et al. (2007) also propose peak pressure thresholds for PTS.

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. Sensation levels can be taken into consideration where audiograms are available for a species; however, there are no available measurements of audiograms for mysticetes.

When evaluating acoustic impacts, it is also important to take into account the temporal characteristics of the sound. A sound may be *transient* in nature (a relatively short duration with an obvious start and stop) or *continuous* (no obvious start or stop). NMFS considers transient sound as *pulsed* and continuous sound as *non-pulsed*. Examples of transient sounds include explosions, airguns, impact pile drivers, and sonar. Examples of continuous sounds include an operating drillship or ship underway. However, it is important to note that that source-path-receiver model discussed below will influence how a sound is perceived by the receiver. For example, sound from a ship underway is continuous at the source, but will not be a continuous to a stationary receiver once it has passed by. Another example is that transient sound such as airguns are impulsive at the source, but due to the many factors that influence propagation, may be perceived as non-pulse at a farther distance by a receiver. As described in detail in Southall et al. (2007), pulses are transient sounds with rapid rise-time and high peak pressures and are possibly injurious to mammalian hearing. Non-pulsed sounds may not result in as much damage, but may still cause behavioral changes.

Ambient Noise

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. (2011) report mean spectrum levels in September and October of 80-83 dB re 1 $\mu Pa^2/Hz$ 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 $\mu Pa^2/Hz$ 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 $\mu Pa^2/Hz$ 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. (2011); Delarue et al. (2012) show increasing spectral levels with frequency from ~67 dB re 1 $\mu Pa^2/Hz$ at 20 Hz to 76 dB re 1 $\mu Pa^2/Hz$ 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 (2011) 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 of underwater sound may be physically small, such as the transducers of small positioning sonars, or very large, such as ice-breaking vessels. In both cases acousticians generally characterize their sound emissions using a metric 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 total sound energy produced by all parts of the vessel will be quite large so received sound levels at distance from large vessels are often high. 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; it is common to apply the model separately to smaller frequency bands, and those individual band results are combined later.

Receiver refers to the listening device or animal that experiences the sound at the far end (opposite the source) of 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 (e.g., Richardson et al. 1995, Au and Hastings 2008, Harris 1998). Furthermore, a website with some basic introductions to sound in the sea is located at: http://www.dosits.org/.

Due to the differences in the acoustic environment of the U.S. Beaufort and Chukchi seas (both underwater and airborne), they are discussed separately in the following text. For the purposes of the acoustics section of this EIS only, the region around Barrow will be included in the Chukchi Sea discussion.

3.1.6.2 Beaufort Sea

Airborne Acoustics

The existing airborne noise environment in the coastal areas of the Beaufort Sea is influenced by sounds from natural and anthropogenic sources. Similar to the Chukchi Sea (discussed below in Section 3.1.6.3), the primary natural source of airborne noise on the offshore, nearshore, and onshore regions is wind, although wildlife can produce considerable sound during specific seasons in certain nearshore and onshore regions. Anthropogenic noise levels in the Beaufort Sea region are higher than the Chukchi Sea due to the oil and gas developments of the nearshore and onshore regions of the North Slope, particularly in the vicinity of Prudhoe Bay. Noise sources consist of regular air 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 (e.g., Shepard et al. 2001, EPA 1974). Sound levels farther from equipment are closer to the natural background levels of 45 to 60 dBA (BLM 2004). Noise sources and associated sound levels near the communities of Nuiqsut and Kaktovik will be similar to those described for the Chukchi Sea.

Underwater Acoustics

Underwater noise is comprised of natural and anthropogenic sources. It varies temporally (daily, seasonally, annually) depending on weather conditions and the presence of anthropogenic and biological sources. Natural sound sources in the Arctic Ocean include earthquakes, wind, ice, and sounds from several animal species. Figure 3.1-9 shows the Wenz curves (Wenz 1962), which summarized the range of ocean background noise at different frequencies (as reported in NRC (2003a). Earthquakes and other geologic processes (subduction, spreading, faulting, volcanic, hydrothermal vent activity) typically generate loud, low frequency (<100 Hz) sounds that propagate for long distances. Atmospheric effects, such as wind, lightning, thunder, and rain at the surface have a significant effect on ambient sound levels. Sources of underwater noise in the Beaufort Sea are the same as those described below for the Chukchi Sea (Section 3.1.6.3); however, due to different bathymetry, current, and level of anthropogenic activities, the ambient noise environment is more variable. The Beaufort Sea offshore environment can be divided into three primary acoustic environments: a) shallow bays bounded by barrier islands; b) shelf region with water depths from 10 m to 250 m depth [33 to 820 ft]; and c) basin slope with depths 1,000 to 3,000 m (3,280 to 9,843 ft). The basin floor is 3,000 to 3,500 m (9,843 to 11,483 ft) further offshore but fewer marine mammals are present there, and anthropogenic activities are limited in the very deep ocean region. The shallow bays are less conducive to low frequency sound propagation, and this generally reduces both anthropogenic and natural sound levels relative to the deeper Beaufort Sea environment. However, past oil and gas activities have largely been concentrated in these regions, so anthropogenic noise is more prevalent here. The shelf region has similar depth and acoustic properties to the Chukchi shelf environment. Recent seismic surveys have been performed on the Beaufort Sea shelf in Camden and Harrison Bays that have generated exploration noise footprints similar to those produced by exploration over the Chukchi Sea lease areas. Underwater sound channels form when there is a change in the velocity of the water column. The deeper basin slope and basin include a near-surface sound channel that can support long-range propagation of distant sounds, but at relatively low levels – distant seismic survey sounds are commonly detected here and over deeper parts of the shelf. Those sounds are believed to have propagated from long distances through the sound channel and then with increasing attenuation as they encounter shallower water when propagating over the shelf.

Biological sounds from marine mammals in the Beaufort Sea region are generally lower than those in the Chukchi Sea. This is primarily a result of reduced numbers of the two most vocal species, walrus and bearded seals, in the Beaufort Sea. Bowhead vocalizations will contribute during the spring and fall migrations, but the migration corridor in the Beaufort, and consequently the region exposed to vocalizations, is predominantly along a narrower path that follows approximately 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 (e.g., Blackwell and Greene et al. 2004, Blackwell and Greene 2006, Blackwell et al. 2009) in the Beaufort Sea.

Anthropogenic sounds are primarily in the nearshore and shelf region, and include noise from vessel traffic, primarily in the Prudhoe Bay region, as there are three docks with deep draft capability. During the open water season, there are barges and tugs present with supplies ranging from fuel and food to large modules for oil and gas processing onshore, research vessels, and crew supply vessels from Northstar to West Dock (Blackwell and Greene 2006).

Existing North Slope production operations extend from Alpine in the west to Point Thomson and Badami in the east. Most of the production operations on the North Slope are onshore, but there are a few offshore units that contribute to the underwater noise environment. The Northstar oilfield was discovered in 1983 and developed by BP in 1995. The offshore oilfield is 10 km (6 mi) from Prudhoe Bay in about 10 m (39 ft) of water. Sounds in the near and far shore have been measured from Northstar throughout construction and operation and these measurements continue today (BP 2009) with analysis of potential effects of the island on bowhead migration. Broadband noise from Northstar reaches background noise levels during drilling by 9.4 km (5.8 mi) from the island (Blackwell et al. 2004). The Oooguruk Unit is located adjacent to Kuparuk River Unit in shallow waters of Harrison Bay. Pioneer and its partner, Eni, constructed an offshore drill site and onshore production facilities pad in 2006 on State of Alaska leases, and this unit has been operating since 2008. Studies during construction of Oooguruk showed noise from drilling were not detected outside the barrier islands, and vessels were the primary noise source (Pioneer

2009). The Nikaitchuq Unit is located at Spy Island, north of Oliktok Point and the Kuparuk River unit and northwest of the Milne Point Unit and has been operating since 2010.

3.1.6.3 Chukchi Sea

Airborne Acoustics

The existing airborne environment in the coastal areas of the Chukchi Sea is comprised of natural and anthropogenic sources. The primary natural source of airborne noise on both the offshore, nearshore, and onshore regions is wind, although wildlife will contribute some during specific seasons in the nearshore and onshore regions. For example, shorebirds are often quite loud in the summer season in breeding areas. Walrus produce several types of grunts, snorts, and whistle sounds while on-land haulout sites; these haulout sites are often many thousands of animals. Anthropogenic activity is relatively limited in the Arctic offshore relative to other seas, but occasional vessel traffic from tourism, research, or oil and gas activities and local activity generates some airborne noise. Anthropogenic noise levels in the nearshore and onshore region will be higher in populated areas – the coastal communities of Wainwright, Point Lay, Point Hope, Kivalina, and Barrow – with increasing noise levels associated with the larger communities. Community noise consists of aircraft, vehicular traffic (including all-terrain vehicles and snow machines), construction equipment, people talking/yelling, dogs barking, power plants, skiffs used for hunting, generators, etc. There have been no detailed existing noise surveys in these communities, but overall sound levels associated with smaller communities with smaller roads and relatively few aircraft range from very quiet during periods of low wind (<20 dBA) to 65 to 70 dBA during periods of higher human activity and wind (EPA 1974). Typical community noise levels during the daytime are likely 50-65 dBA, and levels during the nighttime are likely 35 to 45 dBA (EPA 1974).

Noise from offshore vessels will contribute very little to the ambient airborne noise environment as there are no existing ports or docks in any of these communities deep enough for the larger vessels to come within a few miles.

Underwater Acoustics

Sources of underwater noise in the Chukchi Sea are the same as those described above for the Beaufort Sea (Section 3.1.6.2). In the Chukchi Sea, surface wind affects ambient noise levels, causing variations in up to 20 dB in the ambient noise environment (Hannay et al. 2011). The presence of sea ice can dramatically change the ambient noise environment, either by affecting propagation or as a source of noise. Areas with 100 percent sea ice coverage may reduce or eliminate noise from waves or surf (Richardson et al. 1995). As ice forms in shallower waters, sound propagation 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. (2001) also report ice as being a major source of noise throughout the Chukchi Sea.

Biological acoustic sources include marine mammals and fish. During specific seasons, marine mammal calls contribute substantially to the ambient noise levels in the Chukchi Sea. As described in Section 3.2.4, there are a variety of marine mammals that occur in the Chukchi Sea, all of which produce sounds throughout the open water season. Since the late 1970s and early 1980s, seafloor mounted passive acoustic monitoring devices have been deployed near Barrow as part of the bowhead whale acoustic census (e.g., Clark and Johnson 1984). Since 2006, there have been detailed passive acoustic monitoring recorders deployed throughout the Chukchi Sea as part of oil and gas-sponsored environmental studies. The recent recorder locations range from Cape Lisburne to Barrow and from 5 nautical miles (NM) nearshore to more than 100 NM offshore (e.g., Cornell 2010, Hannay et al. 2011). Bowhead whales pass through the region during their spring and fall migrations. They produce a variety of sounds in the 20 to 3,500 Hz frequency range (George et al. 2004, Cornell 2010, Hannay et al. 2011). Walrus are in the Chukchi Sea from late spring through the fall. They produce a variety of sounds ranging from grunts to knocks that are fairly broadband (100 Hz – 10 kHz). In 2008, walrus were detected most frequently in late September (Cornell 2010). In 2009, walrus were detected most frequently in late August to mid-September, particularly between Hanna Shoal and Wainwright (Hannay et al. 2011). Bearded seals are detected throughout the year on recorders throughout the Chukchi Sea, but during the breeding season (May), sounds from the male bearded seals increase the ambient background levels by as much as 20 dB in the 400 Hz range (Hannay et al. 2011). 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 (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 3.3.7 for more details on traffic), some tourism and recreation vessels, icebreakers, and vessels associated with oil and gas exploration activities. As summarized in several acoustic texts (e.g., Richardson et al. 1995, NRC 2003a, Au and Hastings 2008), sounds associated with vessel traffic are primarily generated by cavitation of the propeller, but some sound from on-board machinery is also transmitted through the hull into the water. Source levels for smaller vessels are typically between 120 and 150 dB re 1 µPa at 1 m with most of the energy below 5,000 Hz (Richardson et al. 1995), while source levels for tugs pulling large barges are typically lower frequency (below 1,000 Hz) with greater source levels (~170 dB re 1 µPa at 1 m). In the Chukchi Sea, tugs and barges typically travel approximately 50 NM from shore from the Bering Strait through to Prudhoe Bay or into Canada. Research and oil and gas vessels transit throughout the lease sale area that is more than 50 NM from shore. However, these vessels make occasional transits to within a few miles from shore to change out the research and crew personnel as required.

Sources of anthropogenic sound in the Chukchi Sea associated with oil and gas exploration include all of the activities identified in Chapter 2: deep penetration seismic surveys; high resolution geophysical surveys; and exploratory drilling. The sound levels and associated frequencies were described in Chapter 2. There are no production islands in the Chukchi Sea at this time. There are no ports or docks in the Chukchi Sea, so there has been little introduction of construction noise (such as pile driving or dredging) in this region to date.

Because the Chukchi Sea continental shelf has a highly uniform depth of 30 to 50 m, it strongly supports sound propagation in the 50 Hz to 500 Hz frequency band (Funk et al. 2008). This is of particular interest because most of the industrial sounds from large vessels, seismic sources, and drilling are in this band, and this is likely within the greatest hearing sensitivity of bowhead whales.

3.1.7 Water Quality

Water quality is a term used to describe the physical, chemical, and biological characteristics of water, usually with regard to its ability to perform or support a particular function. Water quality criteria or standards can be generally defined using an established set of parameters that are related to the utility of the water for a particular set of purposes (e.g. protection of marine biota, maintenance of subsistence food resources).

Since drilling of the first OCS exploration well in 1981, a variety of onshore and offshore oil exploration and development projects have been conducted in and adjacent to both the Alaskan Beaufort and Chukchi seas (NRC 2003b). Over 20 discoveries have been made in areas such as Endicott (an offshore field in state waters), Sagavanirktok Delta North (onshore near Prudhoe Bay), and Badami (Beaufort Sea) (Brown et al. 2010). 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 Clean Water Act Section 303(d)) identified within the Arctic Region by the State of Alaska (ADEC 2010).

3.1.7.1 Applicable Regulations

State of Alaska water quality standards for designated uses of marine and fresh water are available in the most recent version of 18 AAC 70, or from the ADEC web site (www.dec.state.ak.us/water/wqsar/).

Pursuant to the Clean Water Act, certain discharges from oil and gas exploration facilities in the Beaufort and Chukchi seas require authorization by the EPA in the form of an NPDES general permit or if in State waters, by the ADEC. To be eligible for permitting, discharges into the ocean may not cause an unreasonable degradation of the marine environment as determined under 40 CFR Part 125 Subpart M.

The Arctic NPDES General Permit AKG-28-0000 for wastewater discharges from Arctic oil and gas facilities expired on June 26, 2011. 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. Changes to the permits include elimination of the authorization to discharge non-aqueous drilling fluids and associated drill cuttings (i.e., only water-based drilling fluids and cuttings are authorized); elimination of the authorization to discharge test fluids; expansion of the scope and requirements of the environmental monitoring program (EMP); increases in the chemical additive inventory and reporting requirements for all discharges, including limitations on chemical additive concentrations; prohibition of the discharge of water-based drilling fluids and drill cuttings during active bowhead whaling activities in the Beaufort Sea, unless the EPA authorizes the discharge after review of the operator's evaluation of the feasibility of drilling facility storage capacity and land-based disposal alternatives; and other changes. A detailed summary of the changes is included in the EPA fact sheet (see pages 11-12 of the fact sheet) for NPDES General Permits for Oil and Gas Exploration Facilities on the Outer Continental Shelf and Contiguous State Waters, available online at http://www.epa.gov/region10/pdf/permits/npdes/ak/arcticgp/Beaufort_and_Chukchi_General_Permits_Fact_Sheet.pdf.

Draft Ocean Discharge Criteria Evaluations (ODCEs) for the Beaufort and Chukchi Permits have also been performed by the EPA (EPA 2012c and EPA 2012d). The final ODCEs are available at http://www.epa.gov/region10/pdf/permits/npdes/ak/arcticgp/beaufort/Beaufort_Final_ODCE_1029012.pdf and http://www.epa.gov/region10/pdf/permits/npdes/ak/arcticgp/chukchi/Chukchi_Final_ODCE_102912.pdf. The 60-day public comment period closed on March 30, 2012. EPA responded to public comments in a "response to comments" document included with the final permits and reissued the permits on October 29, 2012.

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 US Coast Guard 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 three miles of the shore.

3.1.7.2 Water Quality Parameters

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

Temperature and Salinity

Temperature often dictates the ability of water to support a particular biological community and also influences a wide range of other chemical and physical parameters. It is therefore an important variable for establishing baseline water quality of the affected environment. Higher water temperatures decrease the ability of water to hold oxygen, reduce the density of the water, and may also increase the likelihood of an algal bloom. Rapid temperature shifts impact the health of marine species, while long-term temperature changes may have a considerable impact on ecosystems. Increases in water temperature encourage the growth of heat-tolerant organisms, which may include introduced species. Decreases in water temperatures generally slow down biological productivity and may decrease food availability to fish and other grazing animals. Factors that influence water temperature include time of day, season, depth of water, flow rate, tidal influence, nearby cooling water outfalls, and the location of the sampling point.

Salinity influences the density of water and can fluctuate due to ice formation and melting, freshwater influx from rivers, rainfall, evaporation, and tidal cycles. Due to the need to maintain a balance of water and salts within cells (osmoregulation), many organisms have narrow salinity tolerance ranges. The salinity of typical open ocean seawater is usually about 35 ppt (35,000 milligrams per 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 knots) during late summer, turbidity levels are likely to be less than 3 Nephelometric Turbidity Units and under high winds (greater than 25 knots), turbidity may be in excess of 80 Nephelometric Turbidity Units (Figure 3.1-10) (Boehm 2001).

Nearshore waters generally have high concentrations of suspended material during spring and early summer because runoff from the rivers produces very high turbidity adjacent to the river mouths. Maximum values correspond to midseason river-discharge peaks following large rainfall events in the Brooks Range. The highest levels of suspended particles in the discharge are found during breakup; maximum concentrations of total suspended solids ranged from 60 mg/L to 106 mg/L in the Kuparuk River during 2006 and 285 mg/L (2004) to 353 mg/L (2006) in the Sagavanirktok River (Trefry et al. 2009). Turbidity is also affected by natural erosion of organic material along the shorelines. Erosion and flooding associated with autumn and spring storms may increase inputs of organic material from the shorelines and locally increase turbidity (MMS 2008). The resulting turbidity limits light availability and measurably reduces primary productivity of shallow coastal waters (Dunton et al. 2004).

In winter, the turbidity in water under the sea ice is generally lower compared to the summer open water season. As sea ice forms during fall, particulates are removed from the water column by ice crystals and are locked into the ice cover. Formation of surface ice also causes a decrease in waves and currents in response to wind. As a result of decreased wind energy input, the capability of the water to retain particles in suspension diminishes. Settling of particles decreases the turbidity in the water column.

In April 2000, as part of the Arctic Nearshore Impact Monitoring in Development Area (ANIMIDA) project, the turbidity levels at various depths in the water column under about 2 m (6.6 ft) of ice were determined from water samples collected from stations in the vicinity of the Endicott development island, the Northstar Island, and in Foggy Island Bay (Boehm 2001). Turbidity measurements ranged from 0.15 to 1.35 Nephelometric Turbidity Units (Boehm 2001). These levels are 10 to >100 times lower than values obtained during the open-water period of August 1999 (Figure 3.1-10) and provide a good indication of turbidity under the 1.6 to 2.4-m (5.3 to 7.9-ft) thick layers of sea ice (Boehm 2001). The lowest levels of turbidity were observed at the more-offshore stations.

Metals

Concentrations of solid-phase metals in sediment, and dissolved-phase metals in marine waters, help identify spatial and temporal trends in the distribution of potential anthropogenic chemicals (Brown et al. 2010).

In the marine environment, metals are found in the dissolved, solid, and colloidal phases. The distribution of metals among the three phases depends upon the chemical properties of the metal, the properties of other constituents of the seawater, and physical parameters. Current EPA water quality criteria for metals in marine waters are based on dissolved-phase metal concentrations because they most accurately reflect the bioavailable fraction, and hence the potential toxicity of a metal (EPA 2009b). The State of Alaska has adopted these criteria for protection of state waters in 18 AAC 70. EPA also uses these criteria to ensure protection of federal waters (EPA 2006b).

The main inputs of naturally-occurring metals to the Arctic Ocean are derived from terrestrial runoff, riverine inputs, and advection of water into the Arctic Ocean via the Bering Strait inflow and the Atlantic water inflow. Atmospheric inputs of metals to the environment should be relatively small compared to inputs from marine and terrestrial sources (Moore 1981, Yeats and Westerlund 1991). Naturally occurring concentrations of metals are generally higher in the Chukchi Sea relative to those in the Beaufort Sea. The higher concentrations are thought to come from Bering Sea water that passes first through the Chukchi Sea and then through to the Beaufort Sea (Moore 1981, Yeats 1988). Metals from the Bering Sea may be deposited in Chukchi Sea sediments as Bering Sea water flows over the relatively shallow Chukchi Sea Shelf.

Concentrations of dissolved metals were measured in seawater samples from the coastal Beaufort Sea during both the ANIMIDA and Continuation of Arctic Nearshore Impact Monitoring in Development Area (cANIMIDA) projects (Table 3.1-7) (from Neff 2010). Concentrations of dissolved arsenic, chromium, and lead were lower than reported values for surface seawater worldwide. Arsenic concentrations in the low-salinity nearshore samples were below the world average for open ocean waters because dissolved arsenic concentrations in seawater vary concomitant with salinity. In contrast, concentrations of dissolved cadmium, copper, and zinc were higher than in typical surface seawater. Concentrations of dissolved barium were similar to those in typical surface seawater, except during 2000 and 2001, when more nearshore samples were collected (Neff 2010).

Another part of the cANIMIDA program involved measurement of existing concentrations of fourteen metals (Ag, As, Be, Cd, Co, Cr, Cu, Hg, Ni, Pb, Sb, Tl, V, and Zn) in sediment from the nearshore Alaskan Beaufort Sea (Brown et al. 2010). Four other metals (Al, Fe, Ba, and Mn) were included in the study as indicator metals because they provide insight into sediment composition (Al in clays and Fe in iron oxide coatings), the presence of drilling discharges (barium in barite, a common additive in drilling fluids), and sediment redox conditions (manganese, a redox-sensitive metal) (Brown et al. 2010).

Aluminum rarely is introduced into the environment by anthropogenic activities. Normalizing concentrations of other metals to those of aluminum provides a valuable tool for identification of potential sources of contamination. This technique was used by Brown et al. (2010) to identify a total of about 17 minor anomalies in the concentrations of measured metals relative to aluminum (0.9 percent of data points) in the cANIMIDA area. However, the authors concluded that concentrations of potential contaminants in suspended sediments, as well as dissolved and particulate metals and hydrocarbons in the development area, are primarily from terrestrial sources and are nearly always at background levels (Neff 2010).

Hydrocarbons and Organic Contaminants

Hydrocarbons are organic compounds comprised entirely of hydrogen and carbon. Hydrocarbons can be divided into three general categories based on their molecular structures: 1) saturated hydrocarbons (alkanes) contain only single bonds; 2) unsaturated hydrocarbons (alkenes and alkynes) contain one or more double or triple bonds; 3) aromatic hydrocarbons (including polycyclic aromatic hydrocarbons [or PAH]) contain one or more aromatic ring. Because of their nonpolar molecular structures, most hydrocarbon compounds have very low solubility in water, and tend to associate with organic material or solid phase particles (such as sediments) in the environment.

Petroleum is a complex mixture of saturated, unsaturated, and aromatic hydrocarbons, and other related compounds.

Background hydrocarbon concentrations in Beaufort Sea water are present at concentrations of one part per billion or less (Trefry et al. 2004). Whole water samples from three areas of the Beaufort Sea sampled as part of the cANIMIDA study contained 37 to 69 ng/L (parts per trillion) total petroleum hydrocarbons (Neff 2010). Most of the PAH compounds in the whole water samples were associated with the particulate fraction (Neff 2010). Concentrations of dissolved PAH ranged from 13 to 19 ng/L. The low molecular weight 2- and 3-ring PAH were much more abundant than the higher molecular weight 4- through 6-ring PAH in both the particulate and dissolved fractions, indicating that much of the PAH content in surface waters was from a petroleum source (Neff 2010).

Hydrocarbons analyzed in Beaufort Sea sediments include total saturated hydrocarbons (SHC) C9 through C40, PAH, and triterpanes (Brown et al. 2010). An established technique of evaluating the significance of the measured sediment hydrocarbons to overall ecological risk of the region involves comparisons to sediment quality guidelines or benchmarks. Sediment quality guidelines have been developed to assess possible adverse biological effects from metals, polychlorinated biphenyls (PCBs), pesticides, and PAH. The commonly utilized criteria are the Effects Range Low (ERL) and Effects Range Median (ERM) presented by Long et al. (1995). (It should be noted that more recent consensus-based sediment quality guidelines are available (*e.g.*, MacDonald et al. 2000, Buchman 2008)). The general applications of the guidelines have been to state that adverse biological effects are “rarely” observed when PAH levels are less than the ERL, “occasionally” observed when contaminants are present at levels between the ERL and ERM, and “frequently” observed when concentrations exceed the ERM. ERL and ERM values have been developed for 13 individual PAH compounds and three classes of PAH (low- and high-molecular-weight PAH, and Total PAH).

Saturated Hydrocarbons

For most Beaufort Sea stations, the total saturated hydrocarbon concentrations in surficial sediments are low relative to the guideline concentrations, ranging from 0.21 to 16 milligrams per kilogram (mg/kg) (Boehm 2001). These hydrocarbons are a mixture of terrestrial plant waxes with lower levels of petroleum hydrocarbons.

Samples of river sediments and peat have total saturated hydrocarbon values of 5.8 to 36 mg/kg and 21 to 32 mg/kg, respectively (Boehm 2001). Sediments were sampled in the Colville, Kuparuk, and Sagavanirktok rivers. Peat samples came from areas along the Colville and Kuparuk rivers. The compositions of saturated hydrocarbons in the river and peat samples were similar to the composition in Beaufort Sea surficial sediments. This similarity indicates a common source of saturated hydrocarbons for river sediments and nearshore surficial sediments.

The highest total saturated hydrocarbon value, 50 mg/kg, for this suite of samples was found at the station west of West Dock in Prudhoe Bay (Boehm 2001). The sample from this station also contained high concentrations of metals and indicated contamination from an anthropogenic source.

Table 3.1-7 Mean concentrations of dissolved metals and salinity in seawater water collected from the coastal Beaufort Sea and near Northstar Island during the open-water season in 2000 through 2006. All dissolved metal concentrations are µg/L (parts per billion).

Year	Salinity (psu)	As	Ba	Cd	Cr	Cu	Hg	Pb	Zn
2000	22	0.49	26.8	0.02	0.06	0.54	0.0005	0.005	0.20
(n = 49)									
2001	17	0.38	31.9	0.02	0.09	0.64	0.001	0.01	0.16
(n = 34)									
2002	20	0.51	14.2	0.03	0.07	0.47	0.0009	0.07	0.11
(n = 31)									
2004									
Area wide	23	0.72	13	0.04	0.11	0.36	-	0.01	0.16
(n = 42)									
2004 NS	25	0.81	12	0.04	0.10	0.40	-	0.01	0.14
(n =7)									
2005									
Area wide	27	0.93	10.6	0.05	0.09	0.31	0.0007	0.01	0.32
(n = 65)									
2005 NS	25	0.88	11.5	0.04	0.09	0.30	0.0008	0.02	0.28
(n = 9)									
2006									
Area wide	23	0.60	13	0.04	0.09	0.31	-	0.008	0.17
(n = 26)									
2006 NS	21	0.56	14	0.03	0.08	0.31		0.007	0.20
(n =12)									
Average Surface	35	1.2	13	0.01	0.16	0.10	0.0002	0.02	0.1
Seawater[a]									
EPA Marine	Chronic	36	-	8.8	50[c]	3.1	0.94[d]	8.1	81
Water									
Quality Criteria[b]									

Notes:

a Millero (1996); c Criterion for hexavalent chromium Cr (VI);
b EPA (2009); d Criterion for inorganic mercury.

Source:

(Trefry et al. 2009; Neff 2010)

Polycyclic Aromatic Hydrocarbons

PAH concentrations measured during the ANIMIDA project were within the range of values reported from previous studies in the Beaufort Sea and other areas (Boehm 2001). The PAH distributions for most of the surficial sediments sampled during the cANIMIDA project show that the PAHs are primarily of a combined fossil fuel origin (i.e., petroleum and coal) with a biogenic component (perylene), and a smaller fraction of pyrogenic or combustion-related constituents (e.g., 4-, 5-, and 6-ring PAHs) (Brown et al. 2010).

ERL and ERM values have been developed for 13 individual PAH compounds and three classes of PAH (low- and high-molecular-weight PAH, and Total PAH). A comparison of the Total PAH from all ANIMIDA and cANIMIDA sediments from the study region in 1999 through 2006 to the ERL and ERM criteria shows that none of the measured Total PAH concentrations exceed the ERL (Brown et al. 2010). The mean Total PAH values from each study region were generally an order of magnitude lower than the respective ERLs (Brown et al. 2010). Similarly, the individual PAH concentrations did not exceed the ERLs for the individual 13 PAHs (Brown et al. 2010).

Based on sediment quality criteria, the concentrations of PAH found in the cANIMIDA study area sediments are not likely to pose ecological risk to marine organisms (Brown et al. 2010).

Triterpanes

Triterpanes are biogenic organic molecules found in both petroleum and non-petroleum sediment extracts and applied as biomarkers to identify the origins of hydrocarbon mixtures (Waples and Machihara 1990). The structures of triterpane molecules generally include from 19 to 30 carbon atoms, with some exceptions up to 45. Because triterpane molecules are relatively stable in the environment and easily analyzed using widely available instrumentation, the size distribution of triterpane molecules in a sample can be often provide useful information about the source of the sample (Simoneit et al. 1990).

Several surficial sediment samples analyzed from the cANIMIDA study area have triterpane distributions indicative of a petroleum source (Neff 2010). At the site west of West Dock, the triterpane distributions corroborate other organic data indicative of diesel fuel contamination in this area. However, the triterpanedistribution data also indicate the presence of petroleum products “heavier” than diesel, as the distillation process typically removes triterpanes from diesel-range fuels. The cANIMIDA Task 2 final report, “Hydrocarbon and Metal Characterization of Sediments in the cANIMIDA Study Area,” suggests that petroleum contamination at the site west of West dock is comprised of a complex hydrocarbon mixture including diesel and heavier hydrocarbons such as heavy fuel oil or crude oil (Brown et al. 2010). Drilling mud/cutting residues from historical exploratory drilling in the area (i.e., Tern Island) could be the source of this contamination , as the historical standard practices involved disposal of used drill muds on the ice during winter drilling (Brown et al. 2010). At other sampled sites, triterpane distributions are indicative of naturally occurring hydrocarbon inputs to the sediments (e.g. erosional inputs of regional shales, coal, peat, etc.) (Brown et al. 2010).

Other Organic Contaminants

Surface samples were also analyzed for pesticides, polychlorinated biphenyls, semivolatile organic compounds, and selected volatile organic compounds. Concentrations of these substances were within a low range, and were usually below the limits of detection for the analysis (MMS 2008).

3.1.8 Environmental Contaminants and Ecological Processes

This section includes descriptions of ecological processes and ecosystem functions in the affected environment and the environmental contaminants that potentially affect those processes and functions.

Brief descriptions of the ‘ecosystem goods and services’ provided by the U.S. Beaufort and Chukchi seas ecosystem will provide context for subsequent evaluation of potential cumulative impacts on the ecosystem and impacts on the local communities that depend on healthy ecosystems for their social, cultural and subsistence way of life.

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

"Ecosystem functions" refer to properties of the Alaska Arctic region habitat, biological and geochemical systems and the processes facilitated by those systems. Ecosystem goods (such as subsistence foods) and services (such as waste assimilation) represent the benefits that human populations derive, directly or indirectly, from those ecosystem functions (Costanza et al. 1997). Ecosystem services consist of the flows of materials, energy, and information from natural capital stocks (*i.e.* habitats, biological and geochemical systems) that combine with human actions to produce value or welfare for humans (Costanza et al. 1997). A large number of 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 3.1-8.

Table 3.1-8 Examples of Arctic Ecosystem Functions, Goods, and Services.

Ecosystem goods and services	Ecosystem Functions	Examples
Subsistence food	Primary production, nutrient cycling, and trophic processes	Edible animals and plants; fish (subsistence food resources)
Waste treatment; water purification	Recovery of mobile nutrients and or breakdown of contaminants	Pollution control; detoxification
Climate regulation	Regulation of temperature, precipitation, albedo	Climate change mitigation; biogeochemical stability
Raw materials	Provision of raw materials, fuel	Oil and gas
Recreation resources	Provision of opportunities for recreation	Wildlife viewing; recreational boating; tourism
Cultural Resources	Provision of opportunities for non-commercial uses	Aesthetic, spiritual, educational, and scientific values

The values of ecosystem goods and services in the Beaufort and Chukchi seas are usually derived from interplay among various ecosystem components— the physical environment, chemical environment, and biological communities. Ecosystem goods and services are only rarely the product of a single species or component. Therefore, the interactions of various ecosystem components must be considered as important aspects of the affected environment.

3.1.8.2 Identification of Stressors of Potential Concern

A stressor can generally be defined as anything that negatively affects human health and/or ecological processes. Stressors can be physical (e.g. temperature), chemical (i.e. contaminants), or biological (e.g. bacterial contamination). In order to assess potential ecological effects, and related impacts to ecosystem goods and services, stressors potentially resulting from oil and gas exploration activities in the Beaufort and Chukchi seas must be identified. All three types of stressors may be directly or indirectly associated with oil and gas exploration. However, this section will focus on chemical Stressors of Potential Concern (SOPCs) (i.e., contaminants) resulting from oil and gas exploration activities in the Beaufort and Chukchi seas. Particular consideration will be given to levels of anthropogenic chemicals in the environment that may be accessible to organisms for assimilation and possible toxicity (i.e., bioavailable).

Existing development in the project area provides multiple sources of contaminants that may be bioavailable. Chronic discharges of contaminants occur during every breakup from fluids entrained in the ice roads. Entrained contaminants from vehicle exhaust, grease, antifreeze, oil, and other related fluids pass into the Beaufort Sea system. These discharges may involve organic contaminants with high potential for bioaccumulation (Brown et al. 2010). Although drilling fluids and cuttings are usually disposed of through onsite injection into a permitted disposal well, or transported offsite to a permitted disposal location, some drilling fluids are discharged at the sea floor before well casings are in place. Drill cuttings and fluids contain relatively high concentrations of contaminants that have high potential for bioaccumulation, such as dibenzofuran and PAHs (see Table 3.1-9). Historically, drill cuttings and fluids have been discharged from oil and gas drilling in the project area, and residues from historical discharges may be present in the affected environment (Brown et al. 2010).

Table 3.1-9 Water Quality Data for Drill Cuttings

Pollutant	Range of Concentrations Before Washing	After Washing
Conventional Parameters		
pH	5.70 – 8.42	7.00 – 9.20
Specific gravity (kg/L)	1.26 – 2.07	0.98 – 1.59
BOD-5 (mg/kg) (Biological Oxygen Demand)	325 – 4,130	3,890 – 8,950
UOD-20 (mg/kg) (Universal Oxygen Demand)	2,640 – 10,500	12,800 – 26,600
TOC (mg/kg) (Total Organic Carbon)	58,300 – 64,100	23,000 – 27,200
COD (mg/kg) (Chemical Oxygen Demand)	190,000 – 291,000	90,600 – 272,000
Oil & Grease (mg/kg)	54,200 – 130,000	8,290 – 108,000
Metals (mg/kg) (average of duplicate samples on a dry weight basis)		
Zinc	107 – 2,710	114 – 3,200
Beryllium	<1.0	<1.0
Aluminum	6,020 – 10,900	5,160 – 10,500
Barium	34 – 84.8	27.2 - 235
Iron	16,600 – 30,800	17,400 – 20,600
Cadmium	0.402 – 16.4	0.408 – 15.8
Chromium	9.48 – 11.7	10.7 - 12
Copper	20.6 – 55.3	20.4 – 42.6
Nickel	<6 – 12.1	6.2 – 15.9
Lead	21.4 - 298	47.6 - 264
Mercury	0.09333 – 0.4893	0.0920 – 0.944
Silver	0.447 – 0.574	0.222 – 0.568
Arsenic	7.07 – 10.3	7.0 – 10.6

Pollutant	Range of Concentrations Before Washing	After Washing
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 in the screened available data. They were used as the concentration above which effects were frequently or always observed or predicted among most species. Because the ERL and ERM concentrations account for the effects of individual chemical stressors on multiple species from different trophic levels, this approach may provide a basis for predicting the likelihood of ecosystem-level impacts that could result from inputs of chemical contaminants.

Many of the organic contaminants associated with past development in the project area (*e.g.*, PAH) have low solubility in water due to their nonpolar molecular structures. As a result of low aqueous solubility, these compounds tend to associate with organic material or solid-phase particles (such as sediments) in the environment. Similarly, the elemental forms of some potentially toxic metals, such as lead and mercury, have low aqueous solubility. However, these metals may react with other naturally occurring chemical species to form soluble compounds. For example, elemental mercury (Hg) is relatively insoluble in water, while mercuric chloride ($HgCl_2$) and dimethyl mercury (C_2H_6Hg) are considerably more soluble.

The aqueous solubility of a contaminant is an important parameter for determining its behavior in the environment, and the potential pathways through which organisms could be exposed to the contaminant.

The differential solubility of a contaminant between organic and aqueous phases can be expressed as the octanol-water partition ratio. Contaminants with high octanol-water partition ratios are relatively hydrophobic and tend to associate with organic molecules in the environment (*e.g.*, sediments and lipids). Contaminants with lower octanol-water partition ratios are relatively hydrophilic, and elevated concentrations of these soluble contaminants may be found in the water. The behavior of a contaminant in the environment, and the potential pathways for exposure of organisms, depend upon the aqueous solubility of the contaminant as well as the physical, chemical, and biological characteristics of the environment. For these reasons, chemical concentration data from different matrices (*e.g.*, water, sediments, and biota) must be considered in combination with an understanding of the processes that connect ecosystem components in order to meaningfully predict the impacts of chemical contaminants on ecosystem processes.

The relationships between chemical contaminants and ecosystem processes must be considered when assessing the potential for ecological and societal consequences of pollution (Calow and Forbes 2003).

3.1.8.3 Exposure of Biological Communities

The fundamental theoretical basis for assessing the environmental impacts of contaminants is provided by the dose–response model, in which the number of individual organisms in a test population responding to different doses of a chemical is used as a measure of the chemical toxicity (Calow and Forbes 2003). Results of dose-response experiments are often expressed in terms of a fixed percentile (*e.g.*, the LD_{50}, or the dose at which 50 percent of the test population suffers a lethal response). However, it is generally recognized that the dose-response model is an oversimplification of real ecological conditions and fails to take into account the ecosystem-level effects of contaminants (Calow and Forbes 2003). The dose-response model traditionally used in environmental impact assessment only considers the effects of stressors on individuals or populations and does not account for impacts that may occur at the ecosystem level (Figure 3.1-11).

Ecology is rarely concerned only with individuals or populations. Communities (mixed species groups) and ecosystems (communities in interaction with their abiotic surroundings) can persist, within limits, despite losses of individuals or populations. What matters is persistence of ecosystem functions and prevention of irreversible reductions that could lead to extinction (Calow and Forbes 2003). The 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.

3.1.8.4 Oil Spill History

Several studies have reviewed the history of oil industry spills in the U.S. OCS and Canadian Beaufort Sea (Hart Crowser 2000, Anderson and LaBelle 2000, State of Alaska 2007a, b, Nuka Research and Planning Group 2010). The state of knowledge related to Beaufort Sea oil spills, including an extensive literature review, is presented by SL Ross Environmental Research Ltd. et al. (2010). The responses to five spills on the North Slope of Alaska, in particular the March 2006 pipeline release from an infield pipeline onto snow-covered tundra, are described by Majors and McAdams (2008).

Because sufficient historical data on large (greater than or equal to 1,000 barrels) offshore oil spills do not exist for the Alaska Arctic OCS regions, agencies rely upon estimates to represent expected frequency and severity of oil spills in these regions (Holland-Bartels et al. 2011, Bercha International Inc. 2006, 2008 [in OCS Study MMS 2006-033 and OCS Study MMS 2008-O35] and MMS 2007a). Oil spill occurrence estimates have been generated for several expected future oil and gas development scenarios (including exploration, production, and abandonment) in the Beaufort and Chukchi seas (Bercha International Inc. 2006 and 2008 [in OCS Study MMS 2006-033 and OCS Study MMS 2008-035] and MMS 2007a). The above referenced reports describe oil spill occurrence models based on fault-tree analysis. Fault-tree analysis is a method for estimating spill rates resulting from the interactions of other events. Fault trees are logical structures that describe the causal relationship between the basic system components and events resulting in system failure. Fault-tree models are graphical techniques that provide a systematic 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 expected Arctic offshore oil spillage frequencies.

3.1.8.5 Existing Regulatory Control of Discharges

Regulatory control of ocean discharges associated with oil and gas exploration activities in the Alaska Arctic Region OCS is largely under the purview of the EPA. A more detailed discussion of the existing regulatory controls of ocean discharges, including national and regional contingency plans for response to oil and hazardous substance discharges and releases, can be found in Section 2.3.3.

3.2 Biological Environment

3.2.1 Lower Trophic Level Ecology

The following section 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 3.1.7 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 Bloom (2005) found that algal blooms were up to two orders of magnitude lower in ice that had high sedimentation loads. Light appears to be the major factor controlling the distribution, development, and production of the ice algal assemblage. These epontic algal communities provide the sole source of fixed carbon for higher trophic levels in ice covered waters, when other sources 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 (Okkonen et al. 2011, Clarke et al. 2011b, 2011c). Because of this unique biological community, the area has been designated as a special habitat area (see Section 4.5.2.6).

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 and Bering Seas compared to the Arctic due to the high transport rate of water masses northward along the Anadyr current.

Benthic

The shallow continental shelves of the Beaufort and Chukchi seas are among the largest in the world (Grebmeier et al. 2006). Each possess varying substrates such as fine sands, muds, and silts (BOEMRE 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 plants); macroscopic algae (large seaweeds); and benthic invertebrates (organisms that live on the bottom of a water body).

Benthic Microalgae

Benthic-microalgal assemblages, consisting primarily of diatoms, have been studied in the nearshore area off Barrow (Matheke and Horner 1974), off Narwhal Island (Horner and Schrader 1982), and in Stefansson Sound (Horner and Schrader 1982, Dunton 1984). The relationship of the species found in sediments with those found in the ice-algal assemblage is unclear, although some species occur in both assemblages. Primary productivity of the benthic microflora in the Chuckchi Sea in the nearshore area off Barrow, as reported by Matheke and Horner (1974), ranged from less than 0.5 mg C/m^2/hr in winter (when the sampling area was covered with ice), to almost 57.0 mg C/m^2/hr in August. This peak-productivity value was about eight times the peak value for ice-algal production and approximately twice that of the phytoplankton. The productivity of these various assemblages peaked at different times: ice-algal productivity peaked in May; phytoplankton productivity peaked in the first half of June; and productivity of the benthic microalgae peaked during late July and August. Although Matheke and Horner (1974) reported high productivities for benthic microalgae over the summer, Horner and Schrader (1982) and Dunton (1984) estimate that benthic microalgae contribute 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 gC/m2. 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 tototal 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 (Iken 1999, Iken et al. 1997, Dean et al. 2000, Beck et al. 2003) and as such, often increase the number of associated fauna (Taylor 1998). In the Boulder Patch, located in the central Alaskan Beaufort Sea, for example, an important portion of carbon channeling through the food web is derived from macroalgae and approximately 60 percent of the particulate organic matter found in the environment (Dunton and Schell 1987, Dunton 1984).

Kelp beds have been found in the Beaufort Sea in Stefansson Sound, 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. A map of the Boulder Patch shows the location of this habitat in Steffanson Sound between Point Brower and Cross and Narwhal islands (Coastal Marine Institute 2011). The Boulder Patch has been studied extensively, and more than 140 species of invertebrates have been identified including sponges, byrozoans, and hydrozoans with the dominant taxa being red and brown algae (Dunton et al. 2007, MMS 2007c, 2003). The biodiversity and community structure patterns vary among different locations within the Boulder Patch, mainly due to differences in light levels and substrate type. Light limits the growth of kelp in the winter when nutrient levels are high, and, in the summer, nutrients limit the growth when light levels are high (Dunton and Schell 1986). Kelp also has been observed shoreward in an area behind a shoal near Konganevik Point in Camden Bay.

Although 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, *Phvllaria dermatodea*. Two other known algae, *Laminaria saccharina* and *Desmarestia viridis*, also were abundant; and seven species of red algae were sampled. Johnson et al. (1993) reported observing very large quantities of green algae (probably *Ulva* and *Enterornorpha*) which were being utilized as a feeding area by brant. Other macroscopic algae have been noted in Peard Bay, as drift algae and when fouling anchors (Truett 1984). The areal extent and the inherent possibility of variability in areal extent have not been determined.

Benthic Invertebrates

Benthic invertebrates in the Beaufort and Chukchi seas can generally be divided into two main categories: epifauna and infauna, based on their relationship with the substrate. Infaunal organisms live within the substrate and, as a result, are often sedentary. Epifaunal organisms, on the other hand, generally live on or near the surface of the substrate (MMS 1990). Benthic communities offshore can be quite diverse.

Organisms commonly found in surveys include echinoderms, sipunculids, mollusks, polychaetes, copepods, and amphipods (Dunton, Schonberg, and McTigue, 2009; Rand and Logerwell, 2011).

Blanchard et al. (2010) reported that infauna in Burger and Klondike survey areas, associated with the Chukchi Sea Lease Sale 193, are abundant, contain many animals with high biomass, and comprise diverse communities. They found that average abundance, biomass, and number of infauna taxa were significantly 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. Molluscs, 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). 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 water quality, environmental contaminants and ecosystem functions, lower trophic levels, fish and essential fish habitat, and terrestrial mammals.

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 organisms. It has been suggested that the epibenthic (living on the surface of bottom sediments) community is dependent on detritus (Stoker 1981). Both the epifauna and infauna are important components in the diets of higher-order consumers.

In the spring, the melting and retreating ice edge of the Chukchi Sea leads to a highly productive and estuary-like near shore corridor that serves as the base of the food chain for coastal and marine Arctic species. The Chukchi Sea's shallow and highly productive sea floor also allows benthic species such as crustaceans and mollusks to flourish and create an important food source for wildlife specialized to feed at the ocean floor, such as walrus, seals, gray whales, and deep-diving sea birds (Audubon 2011).

The benthic faunal biomass is relatively high in the northeastern Chukchi, compared to the central and western Chukchi and compared to the rest of the Arctic seas (Grebmeier and Dunton 2000). Grebmeier and Dunton (2000) explain that the richness probably is due partly to the inability of Chukchi pelagic fauna to consume all of the primary production, thereby allowing a lot of organic matter to sink to the seafloor. They refer to the situation as weak or loose trophic “coupling,” and the Arctic Climate Impact Assessment (ACIA) refers to such loose coupling as “mismatch” between trophic levels (ACIA 2005).

3.2.1.3 Influence of Climate Change on Lower Trophic Level Ecology

Global climate change is altering the physical environment in the Arctic as described in Section 3.1.4.4. Such changes include warming air (Chapman and Walsh 2003) and sea temperatures, declining sea ice extent and thickness (Levi 2000, Parkinson 2000, Rothrock et al. 1999), salinity changes (Arrigo 2009), rising sea level, increasing precipitation and decreasing snow extent, loss of permafrost, and changes in terrestrial vegetation composition (IPCC 2007a). These changes in the physical environment will 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 CO2-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).

The Beaufort and Chukchi seas are characterized by short, open-water summer periods and long, ice-covered winters. However, the extent of the Arctic sea ice has decreased by approximately three percent over the last decade while the extent of the summer ice has decreased up to nine percent during this time period (IPCC 2007a). The 2007 summer ice extent was 39 percent below long term averages from 1979 to 2000 and changes such as these will likely impact the epontic community, and subsequently, the pelagic and benthic communities (MMS 2007c).

Information on generation times, life spans and doubling times are important in any assessment of effects on primary producers or other planktonic organisms. The doubling time for phytoplankton is short, even in the Arctic. Recent studies have shown that plankton growth rates in the Chukchi Sea range from $0.4d^{-1}$ (equivalent to a doubling in 2.5 days) to $0.16d^{-1}$ (equivalent to a doubling in 6.25 days) which results in doubling times of a few days (Grebmeier et al. 2009). In contrast, many Arctic zooplankton reproduce only once per year resulting in generation times of one year (Hopcroft et al. 2010). However, there are studies showing faster growth rates in warmer water (Feder et al. 2005). Therefore, warming ocean temperatures associated with climate change may increase zooplankton growth rates and generation times in the Beaufort and Chukchi seas.

Atmospheric climate variation and its impact on circulation, heat, salt and nutrient content of shelf waters and sea/shore fast ice formation are central issues in the Arctic seas. It is unlikely that ecosystem change will be understood until more studies examine the Arctic Oscillation-ecosystem interactions (NRC 2004a). Understanding the proximate and ultimate controlling factors of various trophic level standing stocks and production rates is essential for interpreting ecosystem change occurring presently in the Arctic (Aagaard et al. 1999). The impacts of climate change to the ecosystem are commonly thought to be from the bottom up through the nutrient-phytoplankton-zooplankton sequence, while human impacts are top down (Carmack and Macdonald 2002). However, the presence of sea ice as habitat for top-level predators such as polar bears means that climate change will directly affect higher trophic levels. An added element of the ecosystem in Arctic seas is shore-fast ice and its attendant phenomena (turbulence under ice, formation of freshwater pools due to blockage of river inflow).

3.2.2 Fish and Essential Fish Habitat

The following description of fish resources of the Beaufort and Chukchi seas largely adopts the “Fish Resources” section from the Beaufort and Chukchi Sea Planning Area Lease Sale 209, 212, 217, and 221 DEIS (MMS 2008). This section is almost fully incorporated into this document with some modifications, primarily to include the most recent information available since publication.

Over 400 fish species are known to inhabit Arctic seas and adjacent waters, which include marine, migratory (mostly anadromous), and freshwater fish species that enter brackish water (diadromous species). The Alaskan Chukchi and western Beaufort seas support at least 107 fish species, representing 25 families (Mecklenburg et al. 2002, Logerwell and Rand 2010, Love 2005, Harris 1993, Johnson et al. 2010) (see Table 3.2-1). Families and sub-families include lampreys, sleeper sharks, dogfish sharks, herrings, smelts, whitefish, trout and salmon, lanternfish, cods, sticklebacks, greenlings, sculpins, sailfin sculpins, fathead sculpins, poachers, lumpsuckers, snailfish, eelpouts, pricklebacks, gunnels, wolffish, sand lances, and righteye flounders. Forty-nine known species are common to 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 the most recent compilation of marine and anadromous fish resulted in updating the species known to occur in this area (Coad and Reist 2004).

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 Plant (NPFMC 2009) describes the current commercial, subsistence, and recreational fisheries in the Arctic.

Commercial fisheres 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. 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 will 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 3.3-26 and 3.3-27. 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).

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, Arctic grayling, burbot, lake trout, northern pike, capelin, rainbow smelt, Arctic cod, tomcod, and flounder.

There are few recreational fisheries in the area, including no catch and release fishery management programs. Personal use fisheries may occur on a variety of species, occasionally in 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				
Dalatiidae	*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				
Gadidae	*Boreogadus saida*	Arctic cod	MA	MMT
	Arctogadus glacialis	polar cod	MA	MMT

Order/Family	*Species Name*	Common name	Primary Assemblage[1]	Source[2]
	Arctogadus borisovi	toothed cod	MA	MMT
	Eleginus gracilis	saffron cod	MA	MMT
	Theragra chalcogramma	walleye pollock	MA	MMT
	Gadus macrocephalus	Pacific cod	MA	LR
	Gadus ogac	ogac	MA	MMT
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
	Leptagonus decagonus	Atlantic poacher	MA	MMT

Order/Family	*Species Name*	Common name	Primary Assemblage[1]	Source[2]
	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	polar eelpout	MA	MMT
	Lycodes raridens	marbled eelpout	MA	MMT
	Lycodes rossi	threespot eelpout	MA	MMT
	Lycodes sagittarius	archer eelpout	MA	MMT
	Lycodes palearis	wattled eelpout	MA	MMT
	Lycodes pallidus	pale eelpout	MA	MMT
	Lycodes squamiventer	scalebelly eelpout	MA	MMT
	Lycodes eudipleurostictus	doubleline eelpout	MA	MMT
	Lycodes concolor	ebony eelpout	MA	MMT
Stichaeidae	*Eumesogrammus praecisus*	fourline snakeblenny	MA	MMT
	Stichaeus punctatus	Arctic shanny	MA	MMT
	Chirolophis snyderi	bearded warbonnet	MA	MMT
	Leptoclinus maculatus	daubed shanny	MA	MMT
	Anisarchus medius	stout eelblenny	MA	MMT
	Lumpenus fabricii	slender eelblenny	MA	MMT
Pholidae	*Pholis fasciata*	banded gunnel	MA	MMT
Anarhichadidae	*Anarhichas orientalis*	Bering wolffish	MA	MMT
Ammodytidae	*Ammodytes hexapterus*	Pacific sand lance	MA	MMT

Order/Family	*Species Name*	Common name	Primary Assemblage[1]	Source[2]
Pleuronectiformes				
Pleuronectidae	*Hippoglossus stenolepis*	Pacific halibut	MA	MMT
	Hippoglossoides robustus	Bering flounder	MA	MMT
	Reinhardtius hippoglossoides	Greenland turbot	MA	MMT
	Platichthys stellatus	starry flounder	MA	MMT
	Pleuronectes quadrituberculatus	Alaska plaice	MA	MMT
	Pleuronectes glacialis	Arctic flounder	MA	MMT
	Limanda proboscidea	longhead dab	MA	MMT
	Limanda aspera	yellowfin sole	MA	MMT
	Limanda sakhalinensis	Sakhalin sole	MA	MMT

[1]FW = Freshwater; MI = Migratory; MA = Marine
[2]MMT = Mecklenburg, Mecklenburg, and Thorsteinson 2002; LR = Logerwell and Rand 2010

3.2.2.1 Major Surveys of Coastal and Marine Fish Resources and Habitats

MMS (2008) identified the following as some important surveys conducted in the Beaufort and Chukchi seas in the last century.

In 1932 and 1933 Russians A.P. Andriyashev, K.I. Panin, and P.V. Ushakov 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 thirty-five successful otter-trawl tows that were conducted in the northeastern Chukchi and western Beaufort seas in August-September of 1976 and 1977. In 1976, two tows were made in the western Beaufort Sea in water 40 m (131 ft) and 123 m (404 ft) deep. In 1977 (August 2 to September 3), 33 tows were made in the northeastern Chukchi and western Beaufort seas in waters 40 to 400 m (131 to 1,312 ft) deep. 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, 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. More recent survey efforts, such as those by Logerwell and Rand (2010), Norcross et al. (2009) and by Shell Oil and ConocoPhillips (yet to be released) have added, and will add, to this body of knowledge.

A 3-year study (1988, 1990, and 1991) of epipelagic fish inhabiting Beaufort Sea coastal waters in Alaska documented spatial and temporal patterns in fish distribution and abundance and examined their relationships to thermohaline features during summer (Jarvela and Thorsteinson 1999). Significant interannual, seasonal, and geographical differences in surface water temperatures and salinities were observed. In 1990, sea ice was absent and marine conditions prevailed, whereas, in 1988 and 1991, heavy pack ice was present and the dissolution of brackish water along the coast proceeded more slowly. . Arctic cod, capelin, and snailfish were the most abundant marine fish 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 recent BOEM sponsored studies of fish and lower trophic organisms in the Beaufort and Chukchi seas have been completed with final reports expected in 2014 (BOEM 2011f, 2011g, 2011h).

Fish assemblages and populations in other marine ecosystems of Alaska (e.g. Gulf of Alaska, Bering Sea) have undergone observable shifts in diversity, distribution, and abundance during the last 20 to 30 years, and the recent findings of Logerwell and Rand (2010) suggest that a similar trend is occurring in the Arctic. Five species previously not documented in the region were encountered in the Logerwell and Rand (2010) study, so it is possible other existing research no longer accurately and precisely reflects the current distribution, abundance, and habitat-use patterns of fish resources in the northeastern Chukchi and western Beaufort seas. It is also reasonable to suggest that because of the sparseness of data from limited surveys in the past, that 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.

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. (2009) identified 30 demersal fish species within 10 families in a 2004 bottom trawl survey of the 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 3.1-12). The fish of the eastern Chukchi and western Beaufort seas use a range of waters and substrates for spawning, breeding, feeding, or growing to maturity (MMS 2006c).

3.2.2.3 Primary Fish Assemblages

Arctic fish of Alaska have been categorized into assemblages that take into account habitat use and life-history strategies (Craig 1984, Craig 1989, Moulton and George 2000, Gallaway and Fechhelm 2000). A life-history strategy is a set of co-adapted traits designed by natural selection to solve particular ecological problems (Craig 1989 citing Stearns 1976).

The primary assemblages of Arctic fish are:

- Freshwater fish that spend their entire life in freshwater systems (although some also might spend brief periods in nearshore brackish waters);
- Marine fish that spend their entire life in marine waters (some also spend brief periods in nearshore brackish waters along the coast); and
- Migratory fish that move between and are able to use fresh, brackish, and/or marine waters due to various biological stimuli or ecological factors.

While some Arctic fish species are described in the scientific literature and in surveys as being abundant in the region, 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.

3.2.2.3.1 Marine Fish

Most of the surveys/studies of marine fish in the EIS project area have been performed in coastal waters landward of the 200-m (656-ft) isobath (e.g. Logerwell and Rand 2010, Frost and Lowry 1983, Jarvela and Thorsteinson 1999). In areas where coastal surveys have been conducted, seasonal trends in relative abundance of dominant (abundant) fish species are evident (Logerwell and Rand 2010, Jarvela and Thorsteinson 1999). Robust population estimates or trends for marine fish of the region are unavailable. 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 (Logerwell and Rand 2010, Frost and Lowry 1983, Griffiths et al. 1998, Jarvela and Thorsteinson 1999). Detailed information generally is lacking concerning the spread, density, or patchiness of their distribution in either the Beaufort or Chukchi seas, although Logerwell and Rand (2010) made a concerted effort to address this issue by providing a baseline CPUE for future comparison. Data concerning habitat-related densities; growth, reproduction, or survival rates within regional or local habitats; or productivity rates by habitat, essentially are unknown for fish inhabiting waters seaward of the nearshore, brackish-water ecotone. There will be some level of incomplete information on distribution and habitat-related data for marine fish; however, sufficient information is available to support sound scientific judgements and reasoned managerial decisions. Logerwell and Rand (2010) recently reported on the results of a western Beaufort Sea study that used bottom trawls to sample for demersal fish and hydroaccoustics and mid-water trawls to sample for pelagic fish. They found that invertebrates dominated the demersal catch, with arctic cod being the most common fish species caught. Arctic cod were the most prevalent species caught in pelagic habitats. Thirty-two species of fish were identified, and comparison of results with historical data suggests the northward expansion of some species ranges, such as pollock and Pacific cod.

Frost and Lowry (1983) reported anatomical, reproductive, and prey statistics for selected species sampled (arctic cod, polar eelpout, twohorn sculpin, hamecon, arctic alligatorfish, leatherfin lumpsucker, fish doctor, and spatulate sculpin) from 35 otter-trawl tows performed in the northeastern Chukchi and western Beaufort seas in August-September 1976 and 1977. Prey of the summarized species as a group consists of copepods, amphipods, isopods, mysids, euphasiids, polychaete worms, cumaceans, caprellids, shrimp, brittle stars, and arctic cod. Nineteen species of fish were identified; three species (arctic cod, polar eelpout, and twohorn sculpin) accounted for 65 percent of all fish caught.

Marine fish prefer the colder, more saline coastal water seaward of the nearshore brackish-water zone. As summer progresses, the nearshore zone becomes more saline due to decreased freshwater input from rivers and streams. During this time, marine fish often share nearshore brackish waters with diadromous fish (e.g. 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, Buck, and Link 2006). Competition is most likely to occur in the nearshore brackish water ecotone, particularly in or near river deltas. As nearshore ice thickens in winter, marine fish probably continue to feed under the ice but eventually depart the area as ice freezes to the bottom some 2 m (6 ft) thick. Seaward of the bottomfast ice, marine fish continue to feed and reproduce in coastal waters all winter (Craig 1984). Many evidently spawn during winter, some in shallow coastal waters, and others in deeper waters. Arctic cod spawn under the ice between November and February (Craig and Halderson 1981). Snailfish spawn farther offshore by attaching their adhesive eggs to rock or kelp substrate (MMS 2008).

Ecological Groups (secondary Assemblages) of Marine Fish

To better understand fish resources and the potential impacts of disturbances to their populations and habitats, 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 enhancethe 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				
Theragra chalcogramma	walleye pollock	X	X	X	X	
Gadus macrocephalus	Pacific cod	X		X		
Gadus ogac	ogac			X		
Hexagrammos stelleri	whitespotted greenling	X				
Triglops pingelii	ribbed sculpin	X		X		
Hemilepidotus papilio	butterfly sculpin	X		X		
Hemilepidotus jordani	yellow Irish lord	X		X		
Icelus spatula	spatulate sculpin	X		X		
Icelus bicornis	twohorn sculpin	X				
Gymnocanthus tricuspis	Arctic staghorn sculpin	X				
Enophrys diceraus	antlered sculpin	X				
Megalocottus platycephalus	belligerent sculpin	X				
Myoxocephalus quadricornis	fourhorn sculpin	X				
Myoxocephalus scorpius	shorthorn sculpin	X		X		

Species Name	Common name	Secondary Assemblage[2]				
		ND	NP	OD	OP	CP
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				
Liparis bristolensis	Bristol snailfish	X				
Liparis fabricii	gelatinous seasnail	X		X		
Liparis callyodon	spotted snailfish	X				
Careproctus sp. cf. rastrinus	salmon snailfish	X				
Liparis marmoratus	festive snailfish	X				
Gymnelus hemifasciatus	halfbarred pout	X				
Gymnelus viridis	fish doctor	X				
Lycodes seminudus	longear eelpout			X		
Lycodes mucosus	saddled eelpout	X				
Lycodes turneri	estuarine eelpout	X				
Lycodes polaris	polar eelpout	X				
Lycodes raridens	marbled eelpout	X				
Lycodes rossi	threespot eelpout	X		X		
Lycodes sagittarius	archer eelpout			X		

Species Name	Common name	Secondary Assemblage[2]				
		ND	NP	OD	OP	CP
Lycodes palearis	wattled eelpout	X				
Lycodes pallidus	pale eelpout	X		X		
Lycodes squamiventer	scalebelly eelpout			X		
Lycodes eudipleurostictus	doubleline eelpout	X				
Lycodes concolor	ebony eelpout	X		X		
Eumesogrammus praecisus	fourline snakeblenny	X				
Stichaeus punctatus	Arctic shanny	X				
Chirolophis snyderi	bearded warbonnet	X				
Leptoclinus maculatus	daubed shanny	X		X		
Anisarchus medius	stout eelblenny	X				
Lumpenus fabricii	slender eelblenny		X			
Pholis fasciata	banded gunnel	X				
Anarhichas orientalis	Bering wolffish	X				
Ammodytes hexapterus	Pacific sand lance		X		X	X
Hippoglossus stenolepis	Pacific halibut	X		X		
Hippoglossoides robustus	Bering flounder	X				
Reinhardtius hippoglossoides	Greenland turbot	X		X		
Platichthys stellatus	starry flounder	X				
Pleuronectes quadrituberculatus	Alaska plaice	X				
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, polar eelpout, and Arctic flounder (BOEMRE 2011b).

The Nearshore-Pelagic Assemblage

Fish inhabiting the water column over the continental shelf (landward of the 200-m isobath) comprise the nearshore-pelagic assemblage. Some fish of this assemblage utulize 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 ogac, ribbed sculpin, spatulate sculpin, shorthorn sculpin, spinyhook sculpin, archer eelpout, pale eelpout, and daubed shanny are among the fish included in this assemblage (MMS 2008).

The Oceanic-Pelagic Assemblage

Fish inhabiting the water column of oceanic waters seaward of the 200-m isobath comprise this assemblage; most species exhibit some preference of bathymetric stratification. Those species chiefly occurring within the upper 200 m (656 ft) of the water column are called epipelagic fish. Fish inhabiting oceanic waters between 200 m and 1,000 m (656 to 3,281 ft) in depth are termed mesopelagic fish. Bathypelagic fish are those species inhabiting depths >1,000 m (3,281 ft) in depth; as yet, there are no known bathypelagic fish in the Alaskan Beaufort Sea. Several of the epipelagic species include the walleye pollock, Pacific herring, arctic cod, polar cod, and Pacific sand lance (note that several of these species also use nearshore and ice-covered waters).

The Cryopelagic Assemblage

The term "cryopelagic" is used to describe fish that actively swim in nearshore or oceanic waters but, during their lifecycle, are associated in some way or other with drifting or fast ice (Andriyashev 1964). The cryopelagic fish assemblage is further described by Andriyashev (1970) as such:

> *Both young and adult fish can be associated with ice or water immediately below the ice. These relationships are usually trophic in nature, but in some cases ice provides fish with a shelter from predators or even a substratum for sucking. The association of fish with ice can be observed easily and often. The more intimate aspects of their behavior are, however, still little known*….

Andriyashev (1970) described what may be the first known cryopelagic fish species, the arctic cod (*Boreogadus saida*; previously known as polar cod). Arctic cod often occur in ice holes, cracks, hollows, and cavities in the lower surface of the ice and are most common near the ice edge or among broken ice. As the ice thaws at these margins, plankton grow and provide a food source. It is possible that they also feed on the amphipod-diatom ice community inhabiting the lower ice layer. Arctic cod are a common food of ringed seal (*Phoca hispida*), bearded seal (*Erignathus barbatus*), white whale (*Delphinapterus leucas*), narwhal (*Monodon monoceros*) and other marine mammals, many marine birds (including gulls, guillemots, etc.) and fish (citing Klumov 1937, and Andriyashev 1954). The arctic cod is abundant in the region, and their enormous autumn-winter pre-spawning swarms are well known. The species also is very widely distributed and makes distant migrations, not only along the shelf areas in the Arctic Basin, but also in higher latitudes. In addition to the arctic cod, other cryopelagic fish of the Alaskan Arctic Region include polar cod, toothed cod, and Pacific sand lance.

3.2.2.3.2 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 all five Pacific species are found within the project area.

Pacific Salmon

All five species of Pacific salmon occur in the Alaskan Beaufort and Chukchi seas (Craig and Halderson 1986, NMFS 2005): the pink, chum, sockeye, chinook, and coho salmon. A large body of information exists on the life histories and general distribution of salmon in Alaska (NMFS 2005). Pacific salmon life history, general distribution, fisheries background, relevant trophic information, habitat, and biological associations are described by NMFS (2005:Appendix 5) and incorporated herein by reference. More information regarding the biology, ecology, and behavior of Pacific salmon is described in Augerot (2005), Quinn (2005), and Johnson and Daigneault (2008).

Salmon numbers decrease north of the Bering Strait, and they are realtively rare 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). There is little evidence for viable self-sustaining salmon populations occurring in the Beaufort Sea. Salmon are currently not successful at establishing and persisting in this area, probably because only marginal freshwater habitats for overwintering exist (Craig 1989, Fechhelm and Griffiths 2001).

Rivers south of Point Hope support comparatively large runs of chum and pink salmon (Craig and Halderson 1986). Craig and Halderson (1986) noted that only a few pink salmon and, to a lesser degree, chum salmon, occur with any regularity in Arctic waters north of Point Hope and presumably maintain small populations in several of the northern drainages; most occurring in streams along the Chukchi Sea coast west of Barrow.

Chinook, Sockeye, and Coho Salmon

Kotzebue Sound is the northernmostdocumented spawning population of chinook salmonin 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. commun.). Small numbers of chinook salmon reportedly are taken each year in the Barrow domestic fishery, which operates in Elson Lagoon (Fechhelm and Griffiths 2001, citing George, pers. commun.). Strays have been captured in the Kuk River, near Wainwright (Craig and Halderson 1986) 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 Daigneault 2008), and coho salmon have occasionally been captured in marine waters farther east, near Prudhoe Bay (Craig and Halderson 1986). This is particularly important because juvenile fish must overwinter at least one winter in freshwater before entering the marine environment. Overwintering stream habitat may be reduced by as much as 97 to 98 percent by late winter (Craig 1989).

There are no known stocks of sockeye salmon in Arctic waters north of Point Hope (Craig and Halderson 1986). Sockeye salmon northernmost documented spawning population is Kotzebue Sound (Stephenson 2006, citing Burgner 1991).

Pink Salmon

Pink salmon are widely distributed over the northern Pacific Ocean and Bering Sea; they also occur to a lesser degree in Arctic waters (Augerot 2005). Pink salmon are the most abundant salmon species in the Beaufort and Chukchi seas, although their abundance is greatly reduced compared to waters farther south (Craig and Halderson 1986, Fechhelm and Griffiths 2001). Their abundance generally increases from east to west along the Alaskan Beaufort Sea coast. Augerot (2005) depicts pink salmon of limited spawning distribution in the Alaskan Arctic.

Craig and Halderson (1986) proposed that pink salmon spawn successfully and maintain small but viable populations in some Arctic drainages. Small runs of pink salmon occur in nine drainages north of Point Hope (Craig and Halderson 1986, Fechhelm and Griffiths 2001), including the Kuk, Kokolik, Kugrua, and Kukpowruk rivers (Fechhelm et al. 1983 as cited in Kinney 1985). They are reported as present in the Pitmegea and Utukok rivers.

Unlike other nonsalmonid anadromous fish species in Arctic Alaska, the pink salmon is a short-lived species that places all its reproductive effort into a single spawning event and then dies. With its rigid 2-year lifecycle, there is virtually no reproductive overlap between generations; therefore, every spawning event must be successful for the continued survival of the stock (Craig and Halderson 1986).

Run timings are inexact. Along the northeastern Chukchi Sea coast, run times in spawning streams may occur in mid-July; while along the western Beaufort coast, run times appear to commence in late July until the end of August (Craig and Halderson 1986). Occurrence of adult salmon in spawning streams in mid- to late July indicates their presence in marine waters along the Arctic coast as much as several weeks in advance of the runs.

Pink salmon eggs hatch in 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 (Craig and Halderson 1986, Babaluk et al. 2000, Fechhelm and Griffiths 2001). The Pitmegea, Kukpowruk, Kuk, Kukolik, Kuchiak, and Kugrua rivers along the northeastern Chukchi Sea coast are reported to support small populations of chum salmon. They are reported as present in the Utukok and Kuchiak rivers. Individual salmon and small schools have been collected in the Kukpuk River, Kasegaluk Lagoon, and along the Wainwright Coast (Craig and Halderson 1986, Fechhelm and Griffiths 2001).

Generally, chum salmon return to spawn as two to seven year olds (NMFS 2005). In general chum salmon get older from south to north. Seven-year-old chum are rare and occur mostly in the northern areas (e.g. the Arctic). Slow to rapid growth in the ocean can modify the age chum salmon reach maturity. For example, slower growth during the second year at sea causes some chum salmon to mature one to two years later.

Chum salmon fry, like pink salmon, do not overwinter in streams but 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, including invertebrates (including insects) and gelatinous organisms (NMFS 2005).

In late summer, juvenile chum salmon migrate southward toward the Bering Sea, thereby avoiding the cold waters of the Arctic marine environment in winter. Chum salmon eat a variety of foods during their ocean life, e.g. amphipods, euphausiids, pteropods, copepods, fish, and squid larvae.

Amphidromous Fish

Amphidromous fish 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 causeways (West Dock) and that construction of a breach allowed these fish to extend their summer foraging range farther to the east. Similar results were reported by Fechhelm et al. (1999) for Arctic cisco and least cisco suggesting that small fish traveling eastward along the coast failed to bypass a causeway. Most 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 (Gallaway et al. 1983, Fechhelm and Fissel 1988, Fechhelm and Griffiths 1990), although there are reports from fishermen that Arctic cisco in spawning condition have been caught in the upper Colville and Chipp rivers (Moulton et al. 1985 citing Matumeak 1984, pers. commun.). However, the scientific evidence is overwhelming that the vast majority of the Arctic cisco inhabiting the Alaskan Beaufort Sea were carried there from Canada by westerly currents.

During the 3-to-4-month open-water season that follows spring breakup, 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 and Arctic and least cisco) and range farther offshore (Moulton et al. 1985, Thorsteinson et al. 1991). Smaller fish are more abundant in warmer, nearshore waters and the small, freshwater streams draining into the Beaufort Sea (Hemming 1993).

Infaunal prey density in the nearshore substrate is very low and provides little to no food for 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 influence by variability in weather patterns, like the strength of easterly winds (ABR, Inc. et al. 2007).

3.2.2.4 The Influence of Climate Change

Changes in the climate of the Arctic are being documented. While climatic warming is not distributed evenly across the Arctic, the Bering, Chukchi, and Beaufort seas are clearly experiencing a warming trend (ACIA 2005). This warming is altering the distribution and abundance of marine life in the Arctic. The better known fish resources such as capelin, arctic cod, Pacific sand lance, and Bering flounder can exhibit very large interannual fluctuations in distribution, abundance, and biomass. Climate change experienced in the past and apparently accelerating in Arctic Alaska likely is altering the distribution and abundance of their respective populations from what was known from past surveys. For a more detailed discussion of climate change in the Arctic, see Section 3.1.4.4.

Climate change can affect fish production at both the individual and population level through a variety of means (Loeng 2005). Direct effects of temperature on the metabolism, growth, and distribution of fish occur. Food-web effects also occur through changes in lower trophic-level production or in the abundance of predators, but such effects are difficult to predict. Fish-recruitment patterns are strongly influenced by oceanographic processes such as local wind patterns and mixing and by prey availability during early life stages. Recruitment success sometimes is affected by changes in the time of spawning, fecundity rates, survival rate of larvae, and food availability (MMS 2008). An analysis of the Arctic cisco data in the Colville Delta suggests, for example, that survival of certain age classes is reduced during summers with above average temperature and below average ice concentrations (ABR, Inc. et al. 2007).

For example, a climate shift occurred in the Bering Sea in 1977, abruptly changing from a cool to a warm period (ACIA 2004 and 2005). The warming brought about ecosystem shifts that favored herring stocks and enhanced productivity for Pacific cod, skates, flatfish, and noncrustacean invertebrates. The species composition of seafloor organisms changed from being crab dominated to a more diverse assemblage of echinoderms, sponges, and other sea life. Historically high commercial catches of Pacific salmon occurred. The walleye pollock catch, which was at low levels in the 1960s and 1970s (2 to 6 million metric tons), has increased to levels >10 million metric tons for most years since 1980 (ACIA 2005). Additional recent climate-related impacts observed in the Bering Sea LME include significant reductions in seabird and marine mammal populations, unusual algal blooms, abnormally high water temperatures, and low harvests of salmon on their return to spawning areas. While the Bering Sea fishery has become one of the world's largest, numbers of salmon have been far below expected levels, fish have been smaller than average, and their traditional migratory patterns appear to have been altered.

Regarding the Beaufort and Chukchi seas, the Arctic Climate Impact Assessment, published in the mid-2000s (ACIA 2004 and 2005) concluded that the southern limits of distribution for colder water species such as arctic cod, and more southerly species from the Bering Sea, are both anticipated to move northward. Adjustments by one or more fish populations often require adjustments within or among LMEs, influencing the distribution and/or abundance of competitors, prey, and predators. Consequently, it appears reasonable to believe that the composition, distribution, and abundance of fish resources in the Beaufort and Chukchi seas are changing and are now different from that measured in the surveys conducted 16 to 18 years ago or earlier. Pacific cod, herring, walleye pollock, and some flatfish are likely to move northward and become more abundant, while capelin, arctic cod, and Greenland turbot are expected to have a restricted range and decline in abundance. Recent work supports this, with Logerwell and Rand (2010) concluding that climate change may have resulted in northward expansion of some species' ranges, including commercially valuable species such as pollock and Pacific cod (*Gadus macrocephalus*). This survey was also the first to document commercial-sized opilio crab (*Chionoecetes opilio*) in the North American Arctic.

The occurrence of pink and chum salmon in Arctic waters probably is due to their relative tolerance of cold water temperatures and their predominantly marine lifecycle (Craig and Halderson 1986 citing Salonius 1973). The expansion of chinook, sockeye, and coho salmon into the Arctic appears restricted by cold water temperatures, particularly in freshwater environments (Craig and Halderson 1986). Babaluk et al. (2000) noted that significant temperature increases in Arctic areas as a result of climate change may result in greater numbers of Pacific salmon in Arctic regions. The recent range extensions of pink, sockeye, and chum salmon in the Canadian Arctic, as described by Babaluk et al. (2000), indicate that some Pacific salmon may be expanding their distribution and abundance in the proposed project area.

A period of warming in the region between 1990 and 2007, documented and discussed by Moulton (2010) reviewed a number of biological response by freshwater fish in the Teshekpuk Lake region to warming temperatures, mostly relating to growth and condition. Least cisco showed faster growth rates during the warmer period and lake trout distribution may be influenced by the resulting additional prey distribution.

3.2.2.5 Essential Fish Habitat

The Magnuson Fishery Conservation and Management Act of 1976, which has been renamed the Magnuson-Stevens Fishery Conservation and Management Act (MSA), was enacted, along with other goals, to promote the protection of Essential Fish Habitat (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"* (NPFMC 2009). The NMFS and regional Fishery Management Councils (Councils) must describe and identify EFH in fishery management plans (FMPs), minimize to the extent practicable the adverse effects of fishing on EFH, and identify other actions to encourage the conservation and enhancement of EFH. Federal agencies that authorize, fund, or undertake actions that may adversely affect EFH must consult with NMFS, and NMFS must provide conservation recommendations to federal and state agencies regarding actions that would adversely affect EFH. Councils also have the authority to comment on federal or state agency actions that would adversely affect the habitat, including EFH, of managed species.

The 1996 amendments to the MSA 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-nautical mile (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 the Coast of Alaska* (Salmon FMP) (NPFMC 1990) and the *Fishery Management Plan for Fish Resources of the Arctic Management Area* (Arctic FMP) (NPFMC 2009). The Arctic FMP was completed in 2009 and governs commercial harvests of fish resources in U.S. waters of the Beaufort Sea and Chukchi 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 all five species of Pacific salmon, in addition to arctic cod, saffron cod, and opilio (snow) crab (NPFMC 2009). The vastness of Alaska and the large number of individual fish species managed by FMPs make it challenging to describe EFH by text using static boundaries, and descriptions are therefore often vague. Further, species are likely to have EFH described in the future, as conditions and resources require and allow.

EFH is designated based on the best available scientific information (NMFS 2005). The MSA 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.

<u>Coho Salmon</u>

- *Estuarine EFH for juvenile coho salmon* is the general distribution area for this life stage, located in estuarine areas, as identified by the salinity transition zone (ecotone) and the mean higher tide line, within nearshore waters. Juvenile coho salmon require year-round rearing habitat and also migration habitat from April to November to provide access to and from the estuary.
- *Marine EFH for juvenile coho salmon* is the general distribution area for this life stage, located in all marine waters off the coast of Alaska from the mean higher tide line to the 200-nm (230 mi) limit of the EEZ, including the Gulf of Alaska, eastern Bering Sea, Chukchi Sea, and Arctic Ocean.
- *EFH for immature and maturing adult coho salmon* is the general distribution area for this life stage, located in marine waters off the coast of Alaska to 200 m (656 ft) in depth and range from the mean higher tide line to the 200-nm (230 mi) (limit of the EEZ, including the Gulf of Alaska, eastern Bering Sea, Chukchi Sea, and Arctic Ocean.

<u>Pink Salmon</u>

- *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.

<u>Chum Salmon</u>

- *Estuarine EFH for juvenile chum salmon* is the general distribution area for this life stage, located in estuarine areas, as identified by the salinity transition zone (ecotone) and the mean higher tide line, within nearshore waters from late April through June.
- *Marine EFH for juvenile chum salmon* is the general distribution area for this life stage, located in all marine waters off the coast of Alaska to approximately 50 m (164 ft) in depth from the mean higher tide line to the 200-nm (230 mi) limit of the EEZ, including the Gulf of Alaska, eastern Bering Sea, Chukchi Sea, and Arctic Ocean.
- *EFH for immature and maturing adult chum salmon* is the general distribution area for this life stage, located in marine waters off the coast of Alaska to depths of 200 m (656 ft) and ranging from the mean higher tide line to the 200-nm (230 mi) limit of the EEZ, including the Gulf of Alaska, eastern Bering Sea, Chukchi Sea, and Arctic Ocean.

EFH for Arctic species has thus far been limited to 3 species identified in the Arctic FMP (NPFMC 2009). An attempt has been made to be as specific as possible regarding habitat use, but little reliable data exists on which to base these assessments. Therefore, the descriptions are omitted for some life stages and necessarily general for others. The full description of EFH for these species has been included below, taken from the *Essential Fish Habitat 5-Year Review for 2010 Summary Report* (NMFS 2010a):

Arctic Cod

- *Eggs, Larvae, and Early Juveniles* - Insufficient information is available to determine EFH for eggs, larvae, and early juveniles.
- *Late Juveniles* - EFH for late juvenile arctic cod is the general distribution areas for this life stage located in pelagic and epipelagic waters from the nearshore to offshore areas along the entire shelf (0 to 200 m [0 to 656 ft]) and upper slope (200 to 500 m [656 to 1,640 ft]) throughout Arctic waters and often associated with ice floes which may occur in deeper waters.
- *Adults* - EFH for adult arctic cod is the general distribution area for this life stage located in pelagic and epipelagic waters from the nearshore to offshore areas along the entire shelf (0 to 200 m [0 to 656 ft]) and upper slope (200 to 500 m [656 to 1,640 ft]) throughout Arctic waters and often associated with ice floes which may occur in deeper waters.

Saffron Cod

- *Eggs, Larvae, and Early Juveniles* - Insufficient information is available to determine EFH for eggs, larvae, and early juveniles.
- *Late Juveniles* - EFH for late juvenile saffron cod is the general distribution area for this life stage, located in pelagic and epipelagic waters along the coastline, within nearshore bays, and under ice along the inner (0 to 50 m [0 to 164 ft]) shelf throughout Arctic waters and wherever there are substrates consisting of sand and gravel.
- *Adults* - EFH for adult saffron cod is the general distribution area for this life stage, located in pelagic and epipelagic waters along the coastline, within nearshore bays, and under ice along the inner (0 to 50 m [0 to 164 ft]) shelf throughout Arctic waters and wherever there are substrates consisting of sand and gravel.

Snow Crab (*C. opilio*)

- *Eggs* - Essential fish habitat of snow crab eggs is inferred from the general distribution of egg-bearing female crab (see Adults).
- *Larvae and Early Juveniles* - Insufficient information is available to determine EFH for larvae and early juveniles.
- *Late Juveniles* - EFH for late juvenile snow crab is the general distribution area for this life stage, located in bottom habitats along the inner (0 to 50 m [0 to 164 ft]) and middle (50 to 100 m [164 to 328 ft]) shelf in Arctic waters south of Cape Lisburne, wherever there are substrates consisting mainly of mud.
- *Adults* - EFH for adult snow crab is the general distribution area for this life stage, located in bottom habitats along the inner (0 to 50 m [0 to 164 ft]) and middle (50 to 100 m [164 to 328 ft]) shelf in Arctic waters south of Cape Lisburne, wherever there are substrates consisting mainly of mud.

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 will be out of the Beaufort and Chukchi seas by late fall, typically in September or October, to avoid the formation of sea ice (Divoky 1987). The Beaufort and Chukchi seas' coastal lagoons are used by substantial numbers of breeding and post-breeding migratory birds during the short Arctic summer when waters are mostly ice free. Table 3.2-4 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

Common Name	Scientific Name	Iñupiaq Name
Arctic Loon	*Gavia arctica*	
Pacific Loon	*Gavia pacifica*	Qaqsrauq
Common Loon	*Gavia immer*	
Yellow-billed Loon	*Gavia adamsii*	Tuullik
Red-necked Grebe	*Podiceps grisegena*	
Pelagic Cormorant	*Phalacrocorax pelagicus*	
Rough-legged Hawk	*Buteo lagopus*	
Golden Eagle	*Aquila chrysaetos*	
Gyrfalcon	*Falco rusticolus*	
Peregrine Falcon	*Falco peregrinus*	
Sandhill Crane	*Grus canadensis*	Tatirgak
Black-bellied Plover	*Pluvialis squatarola*	
American Golden-Plover	*Pluvialis dominica*	Tuulligouk
Pacific Golden-Plover	*Pluvialis fulva*	
Whimbrel	*Numenius phaeopus*	Siituvuk, Siituvak
Hudsonian Godwit	*Limosa haemastica*	
Bar-tailed Godwit	*Limosa lapponica*	
Ruddy Turnstone	*Arenaria interpres*	Taliqvak, Tuullignaq
Semi-palmated Sandpiper	*Calidris pusilla*	Liva Livaqpauraq, Nivilivilakpak
Western Sandpiper	*Calidris mauri*	
Pectoral Sandpiper	*Calidris melanotos*	Puvviaqtuuq
Sharp-tailed Sandpiper	*Calidris acuminata*	
Rock Sandpiper	*Calidris ptilocnemis*	
Dunlin	*Calidris alpina*	Iooauqtulik, Siggukpaligaraq
Long-billed Dowitcher	*Limnodromus scolopaceus*	
Red-necked Phalarope	*Phalaropus lobatus*	Qayyiubun
Red Phalarope	*Phalaropus fulicarius*	Auksruaq
Black-legged Kittiwake	*Rissa tridactyla*	
Ivory Gull	*Pagophila eburnea*	
Ross' Gull	*Rhodostethia rosea*	
Mew Gull	*Larus canus*	
Herring Gull	*Larus argentatus*	
Glaucous Gull	*Larus hyperboreus*	Nauyyaq, Nauyaq
Aleutian Tern	*Onychoprion aleuticus*	
Arctic Tern	*Sterna paradisaea*	
Pomarine Jaeger	*Stercorarius pomarinus*	
Parasitic Jaeger	*Stercorarius parasiticus*	
Long-tailed Jaeger	*Stercorarius longicaudus*	
Dovekie	*Alle alle*	
Common Murre	*Uria aalge*	Akpa
Thick-billed Murre	*Uria lomvia*	Akpa
Black Guillemot	*Cepphus grylle*	Ifabiq
Pigeon Guillemot	*Cepphus columba*	
Kittlitz's Murrelet	*Brachyramphus brevirostris*	
Parakeet Auklet	*Aethia psittacula*	
Least Auklet	*Aethia pusilla*	
Crested Auklet	*Aethia cristatella*	
Horned Puffin	*Fratercula corniculata*	
Tufted Puffin	*Fratercula cirrhata*	
Snowy Owl	*Bubo scandiacus*	Ukpik
Short-eared Owl	*Asio flammeus*	

Common Name	Scientific Name	Iñupiaq Name
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 (Peterson et al. 2000). Biologists estimate that about 5,000 pairs currently nest on Alaska's Arctic coastal plain and at least 40,000 pairs nest in Arctic Russia. The current worldwide population estimate is between 200,000 and 300,000 birds, which is derived from winter surveys in the Bering Sea and includes non-breeding birds (USGS 2010).

Spectacled eiders are present in the Chukchi Sea during spring migration in May and June. After breeding, male eiders fly to nearshore marine waters in late June where they undergo a complete molt of their flight feathers. Nesting females remain on the coastal tundra until late August to early September and then congregate in molting areas. In Arctic Alaska, the primary molting area is Ledyard Bay, where males occur in the summer and breeding females occur in the fall (MMS 2008). Movement between nesting and molting areas takes several weeks because birds make many stops along the Beaufort and Chukchi coasts. Figure 3.2-7 shows the seasonal distribution of spectacled eiders in the EIS project area.

Spectacled eiders were listed as threatened under the ESA in 1993 as a result of severely declining populations in western Alaska, and possible declining populations in northern Alaska and eastern Russia (58 FR 27474, May 10, 1993). The USFWS published a Recovery Plan for the species in 1996 (USFWS 1996) and designated critical habitat in 2001 (66 FR 9146, February 6, 2001). Critical habitat includes several areas in the Bering Sea and also Ledyard Bay in the Chukchi (Figure 3.2-7).

Steller's Eider

Steller's eiders are the smallest species of eider. They spend most of the year in marine waters and nest in coastal tundra habitats. This species feeds on crustaceans, gastropods, mollusks, and marine worms. There are two geographical populations of Steller's eiders, one that winters in the North Atlantic Ocean and one in the Pacific Ocean. Most of the Pacific population nests in the coastal tundra of northeast Siberia, with less than five percent of the breeding population nesting in Alaska on the Yukon-Kuskokwim Delta and the Arctic coastal plain, especially around Barrow (USFWS 2002).

Steller's eiders return to the Arctic as spring thaw allows, migrating north in May and June. Along open coastline, Steller's eiders usually remain within about 400 m (1,312 ft) of shore in water less than 10 m (33 ft) deep but they can also be found in waters well offshore in shallow bays and lagoons or near reefs (USFWS 2000a). Molting patterns are similar to spectacled eiders, with males returning to molting areas in nearshore marine waters after breeding in late June or July and females molting after nesting season, including substantial use of Izembek Lagoon. Immature birds usually remain at sea until reaching breeding age at two to three years old (Fredrickson 2001). Figure 3.2-8 shows the seasonal distribution of Steller's eiders in the EIS project area.

The Alaska breeding population of Steller's eiders was listed as threatened under the ESA in 1997 due to a decline in breeding in Alaska (62 FR 31748, June 11, 1997). The USFWS designated critical habitat for Steller's eiders in 2001 (66 FR 8850, February 2, 2001), all of which is adjacent to the Bering Sea, and published a Recovery Plan for the species in 2002 (USFWS 2002).

Kittlitz Murrelet

Kittlitz's murrelets are small diving seabirds that eat fish and zooplankton. They occur discontinuously from Southeast Alaska to the eastern edge of the Alaskan Beaufort Sea and east to the Arctic National Wildlife Refuge (Day et al. 2011). They nest in rugged mountains near glaciers or in previously glaciated areas, sometimes up to 45 miles inland. In the EIS project area, the only known nesting habitat is on the Lisburne Peninsula (Figure 3.2-9). Population estimates for Kittlitz's murrelet are difficult to determine and range from 9,000 to 25,000 birds, the great majority of which are in Prince William Sound and Southeast Alaska (Denlinger 2006). There appears to be a great deal of annual variation in their occurrence in the Chukchi Sea (Day et al. 1999).

In response to a petition to list Kittlitz's murrelet under the ESA, the USFWS ruled in 2004 that conservation concerns warrant further investigation and that the species is considered a candidate for listing under the ESA, which was updated in 2011 (76 FR 66370, October 26, 2011). A candidate species is one for which there is enough information to support a proposal to list as endangered or threatened, but for which preparation and publication of a proposal is precluded by higher-priority listing actions. The USFWS has conducted numerous surveys and studies on this species since 2004.

Yellow-billed Loon

The yellow-billed loon is a large diving seabird which spends most of the year in marine waters feeding on fish and invertebrates and nests in Arctic tundra regions. This species migrates from wintering areas in more southern waters, arriving at breeding areas along the Arctic coast between mid-May and mid-June (North 1994). Yellow-billed loons are regular migrants along the coastlines of northern Canada, northern Alaska, and northwestern Alaska, and a rare migrant along the western Alaska coastline (Earnst 2004). Satellite telemetry data indicate that nesting yellow-billed loons have variable movement patterns on their nesting grounds (Rizzolo and Schmutz 2010). Yellow-billed loons that nested on inland lakes (>20 km from marine waters) between Barrow and Teshekpuk Lake did not travel to marine waters to forage but loons that nested nearer to the shore on the Seward Peninsula frequently foraged in marine waters (Rizzolo and Schmutz 2010).

Of the approximately 3,300 yellow-billed loons present on the breeding grounds on the Arctic coast, primarily between the Meade and Colville rivers in the National Petroleum Reserve-Alaska (NPR-A), it is likely that there are fewer than 1,000 nesting pairs, because some birds are non-breeders (Earnst et al. 2005). Additionally, there are approximately 1,500 yellow-billed loons, presumably immatures and non-breeding adults, which remain in near shore marine waters or in large rivers during the breeding season. In total, there are fewer than 5,000 yellow-billed loons on the Arctic coast breeding grounds and near shore marine habitat (Earnst et al. 2005). In addition, approximately 8,000 yellow-billed loons that nest in the Canadian Arctic (Fair 2002, as cited in Earnst et al. 2005) also must travel through the Beaufort and Chukchi seas during spring and fall migration between Canada and wintering grounds in eastern Asia (Schmutz et al. 2010). Figure 3.2-10 shows the seasonal distribution of yellow-billed loons in the EIS project area.

In response to a petition to list yellow-billed loons under the ESA, the USFWS determined in 2009 that listing the yellow-billed loon is warranted but precluded by other higher priority listing actions and that the species should be considered a candidate for listing (74 FR 12932, March 25, 2009). The USFWS has not made any additional determinations on the petition to list the species under the ESA.

3.2.3.2 Seabirds

There are many species of seabirds that occur in both the Beaufort and Chukchi seas, including representatives from several orders of birds, all of which are adapted for spending the majority of their time at sea. Most only come near land during the breeding season. Some species feed at or near the surface of the water while others dive deep to feed in the benthic environment.

Loons

There are five species of loons in the Arctic, including the yellow-billed loon described above, Arctic and common loons which are rare in the Beaufort and Chukchi seas, and the Pacific and red-throated loons which are common nesters. Loons are extremely good swimmers and divers but awkward on land, therefore they nest within one meter of water, near large, deep, tundra lakes and wetlands. Loons eat invertebrates, aquatic insects, and small fish (USFWS 2009a).

The majority of loons migrate along coastal routes, although some migrate using inland routes (Johnson and Herter 1989). Most of the loon's fall migration takes place in September, and they are commonly observed in flight as they migrate to southern locations for the winter (Divoky 1987). In a survey of bird density and distribution at the Burger and Klondike lease areas in the Chukchi Sea (Gall and Day 2009). Pacific loons were one of the eight most abundant species observed. Most of the observations occurred in mid-September to early October, and none were observed in late summer. Both red-throated and yellow-billed loons were rare during these surveys. USFWS surveys indicate the Pacific loon population on the North Slope has been growing substantially over the past ten years and has totaled about 27,000 birds the past few years (Larned et al. 2010).

The red-throated loon is the smallest of the loon species. USFWS surveys indicate the red-throated loon population on the North Slope has been relatively stable over the last 10 years and has totaled about 2,600 birds the past few years (Larned et al. 2010).

Short-tailed Shearwaters

Short-tailed shearwaters breed in the southern hemisphere and occur in the Bering Sea and Arctic waters during their non-breeding season, eating primarily crustaceans, fish and squid.

Short-tailed shearwaters are most common in the southern portion of the Chukchi Sea but are often found in the central and northern portions from late August to late September. They have been reported as far north as Barrow depending on the presence of sea ice. An estimated 100,000 passed Point Barrow in one day in mid-September 1984 (Divoky 1987). At the Burger and Klondike lease areas, Short-tailed shearwaters were observed in most seasons but were most abundant in early fall when they were by far the most common species seen (Gall and Day 2009).

Northern Fulmars

The northern fulmar is abundant in the offshore waters of the Chukchi Sea. There are approximately 1.4 million fulmars in Alaska, almost all of which breed in colonies in the Bering Sea (Denlinger 2006). Northern fulmars do not breed in the Chukchi Sea (Divoky 1987). Fulmars observed in the Chukchi, estimated at 45,000, from late August to mid-September are non-breeders or failed breeders (Divoky 1987). Reproduction rate is low, and breeding does not occur until they are 8 to 10 years old (Hatch and Nettleship 1998). Northern fulmars eat a wide variety of fish, squid, and zooplankton (especially copepods and amphipods) from near the sea surface and also commonly scavenge offal generated by commercial fishing and whaling operations (Hatch and Nettleship 1998). At the Burger and Klondike lease areas, northern fulmars were observed in all seasons but were most abundant in early fall at Klondike when they were the second most abundant species seen (Gall and Day 2009).

Ross' Gull

Ross' gull is a small Arctic species which is rare in the Beaufort Sea during the summer time because most breed in coastal areas in the Russian Arctic. If they are in the Beaufort during the summer, they are found in close association with the ice edge (Divoky et al. 1988). Ross' gulls were rarely observed at Burger in late fall (Gall and Day 2009). However, they are common migrants in the Beaufort and Chukchi seas around Point Barrow in the fall (Divoky et al. 1988). Up to 16,000 birds have been observed migrating east past Point Barrow in late September, presumably from their breeding grounds in the Russian Chukchi, and westward back into the Chukchi in mid-October. Ross' gulls are commonly seen during these fall migrations along the coast from Wainwright to Cape Halkett, approximately 100 miles (160 km) west of Point Barrow (Divoky et al. 1988).

Ivory Gull

The ivory gull breeds in areas of the high Arctic outside of Alaska and move to the Bering Sea in the winter (Mallory et al. 2008). They are present in the Beaufort and Chukchi seas in limited numbers during the spring and fall migrations and are uncommon to rare in the summer (Divoky 1987). These gulls eat invertebrates and ice-associated fish (walleye pollock and arctic cod). These birds tend to concentrate at the ice edge and at polynyas (recurring areas of open water), and may occasionally stop along the shores of Kasegaluk Lagoon, of Peard Bay, and near Barrow (Mallory et al. 2008). Ivory gulls were rarely observed at Burger in late fall (Gall and Day 2009).

Glaucous Gull

Glaucous gulls occur in low densities in the offshore areas of the Chukchi Sea but commonly congregate at food sources (Divoky 1987). These birds are found in higher densities along the coasts of both the Beaufort and Chukchi seas. They breed inland near freshwater but sometimes breed within coastal seabird colonies. Glaucous gulls nest in many habitats including: barrier islands; sea cliffs; open tundra; ice edges; freshwater lakes and ponds; and islets on river deltas (Denlinger 2006). An adjusted population for Alaska, including those that nest inland, is approximately 100,000 individuals (Denlinger 2006). Glaucous gulls are most common in the Chukchi Sea from late July to late September within 70 km (43.5 mi) of shore between Icy Cape and Barrow (Divoky 1987). They were observed in all seasons at Burger and Klondike but were most common in early fall (Gall and Day 2009).

Black-Legged Kittiwake

Black-legged kittiwakes nest on narrow cliff ledges in colonies that range from a few nests to several thousand (Denlinger 2006). They breed in colonies along the coast of the Chukchi Sea from Cape Thompson to Cape Lisburne, which are at the northern limit of the species range in Alaska (Denlinger 2006). Their diet consists of mostly fish including capelin, pollock, and herring. They are common in the Chukchi Sea north of Cape Thompson from mid-July until late September. From late August to late September, the population density for the central and southern portion of the Chukchi Sea is 2.3 birds/km^2 or an estimated population in excess of 400,000 birds in the pelagic Chukchi Sea (Divoky 1987). They were one of the most commonly observed species in all seasons at Burger and Klondike but were most common in early fall (Gall and Day 2009).

Jaegers

Pomarine jaegers, parasitic jaegers, and long-tailed jaegers are common in the Chukchi Sea in the summer until late September. Jaeger densities at sea tend to be higher in years when there is low breeding on the tundra (Divoky 1987). Breeding occurs along the Arctic coast and on the Yukon Delta. Jaegers are found sporadically at any one site, but sometimes are in large numbers near Barrow. They primarily feed by scavenging, predation on small birds, bird eggs, and young birds, and stealing food from other birds (Denlinger 2006). Pomarine and parasitic jaegers were observed in low numbers at Burger and Klondike and were most common at Burger in early fall (Gall and Day 2009).

Arctic Terns

Arctic terns nest near fresh or marine waters in open, treeless environments and are distributed widely along the Arctic coastal plain of the Beaufort and Chukchi seas. Population estimates in Alaska show that there may be several hundred thousand, most nesting inland (Denlinger 2006). They are rare in the pelagic waters of the Beaufort and Chukchi seas but congregate in nearshore areas to feed on zooplankton. Studies have found concentrations of arctic terns in Kasegaluk Lagoon and between Omalik Lagoon and Point Barrow (Dau and Larned 2005). Most leave the Arctic by mid-September, following a coastal route out of the Chukchi Sea in the fall (Divoky 1987). A few arctic terns were observed at Burger and Klondike, primarily in early fall (Gall and Day 2009).

Phalaropes

Red phalaropes and red-necked phalaropes are closely related to other shorebirds but are often considered to be seabirds because they spend most of the year at sea and nest in coastal tundra. Both species are common in the Chukchi Sea during open-water periods but few are found further north than Point Barrow (Divoky 1987). There is a minimum of one million phalaropes in the Chukchi Sea during the summer. These seabirds are found in pelagic waters and also within a few meters of shore due to zooplankton abundance; therefore, their distribution tends to be patchy (Divoky 1987). Red phalaropes are considered more common than red-necked phalaropes in Peard Bay (important for migrating juvenile red phalaropes) and Kasegaluk Lagoon (ASWG 2008). Small numbers of both species were observed in mixed-species flocks at Burger and Klondike, primarily in September (Gall and Day 2009).

Murres

Murres have a unique breeding strategy with high nesting density, colony departure in synchrony, and the majority of chick development taking place at sea with the male parent (Ainley et al. 2002). The flightless period for juvenile murres at sea lasts from early September to mid-November when they, along with attendant adult males (part of this period males will be flightless and molting), move quickly from the Chukchi Sea to winter locations in the Bering Sea (Hatch et al. 2000). Murres use their wings to propel themselves underwater and can dive as deep as 210 m (689 ft) to catch fish and invertebrate prey (Ainley et al. 2002).

There are two main breeding colonies of common murres and thick-billed murres along the Chukchi Sea coast (Hatch et al. 2000). Approximately 100,000 murres nest at Cape Lisburne, with about 70,000 being common murres. At Cape Thompson, there are about 390,000 nesting murres, of which 75 percent are thick-billed. The foraging ranges of these two breeding colonies are almost completely separate. The Cape Lisburne colony forages primarily northwest to northeast of Point Hope, while the Cape Thompson colony forages primarily southwest to southeast of Point Hope (Hatch et al. 2000). Thick-billed murres were one of the most common species observed at Klondike in the summer and early fall but were rare or absent at Burger and during other seasons (Gall and Day 2009). Common murres were also observed at Klondike in fair numbers, primarily in late summer and early fall.

Puffins

Tufted puffins nest in beach habitat by digging burrows or hiding under large pieces of driftwood or debris. They dive deep for fish and invertebrate prey. Around 18,000 horned puffins breed at colonies at Cape Lisburne and Cape Thompson. Only 100 breeding tufted puffins occur in these areas (USFWS 2006). Horned puffins are commonly observed in the Chukchi Sea by Cape Lisburne after the breeding season in September. They have also been seen near Barrow and are now breeding on Cooper Island in the western Beaufort Sea (USFWS 2006). Both species were observed at Klondike in low numbers, primarily in summer (Gall and Day 2009).

Black Guillemots

Black guillemots have a small breeding population in Alaska, with a combined total of fewer than 2,000 birds in both the Beaufort and Chukchi seas. Their breeding range is from Cape Thompson northward. Black guillemots nest in driftwood piles and manmade structures due to the low coastal tundra bluffs and gravel beaches lacking fissures or spaces that are suitable for breeding (Denlinger 2006). These birds tend to stay close to sea ice throughout their lifetime to feed on arctic cod. If the sea ice is beyond their foraging range, they will switch prey to other fish species as necessary (Divoky 1987). The black guillemots that breed on Cooper Island (between late June and early September), in the Beaufort Sea, also are found in the Chukchi Sea by Point Barrow during the early part of the breeding season (Divoky 1987). Black guillemots were also observed at Klondike in low numbers, primarily in summer (Gall and Day 2009).

Auklets

Parakeet auklets, least auklets, and crested auklets breed as far north as the Bering Strait, but move north into the Chukchi Sea from late August through early October where they feed on small zooplankton, often far from shore where strong vertical mixing carries the prey to the surface (Denlinger 2006). Based on limited data, crested auklets appear to be the most numerous auklet species in the Chukchi Sea during this time period (Divoky 1987). Perhaps a total of 100,000 auklets are present in the Chukchi Sea when combining all three species (Divoky 1987). Least and crested auklets were two of the most common species observed at Klondike, especially in fall, but were much less common at Burger (Gall and Day 2009).

3.2.3.3 Waterfowl

Many ducks, geese, and swans migrate to the Arctic for the summer to nest on the tundra. Some species, such as long-tailed ducks and eiders, spend most of their non-breeding seasons on marine waters and are often considered as seabirds. Other species are not often associated with marine waters but nest in coastal areas in the EIS project area and may be affected by associated onshore activities identified in this EIS.

Long-tailed Ducks

The long-tailed duck is a small sea duck that nests on marshy grass tundra, especially around polygon ponds, lakes, bogs, slow rivers, and barrier islands (Robertson and Savard 2002). They feed on crustaceans, shrimp, amphipods, clams and fish in marine waters and will eat freshwater insects, fish eggs, and plant material on their breeding grounds. Alaska is home to about 20 percent of the North American population of one million (Kirchhoff and Padula 2010). This species breeds in the Arctic and western Alaska and winters along the southern coast of Alaska south to Washington state. Long-tailed ducks migrate north along the Chukchi Sea coast and east along the Beaufort Sea coast from wintering areas to breeding areas in Arctic Alaska and Canada (Lysne et al. 2004). During the open-water period in the Beaufort Sea, long-tailed ducks are abundant in and near lagoons, but they also molt in Kasegaluk Lagoon on the Chukchi Sea coast (Flint et al. 2003). Kasegaluk Lagoon and Peard Bay are major long-tailed duck molting and pre-migratory areas (Lysne et al. 2004). In late June and early July, most male and nonbreeding females assemble in massive flocks in lagoons along the Beaufort Sea to molt, while a smaller number molt on large, freshwater lakes (Flint et al. 2003). Females and immature birds leave in August to October. Long-tailed ducks were the most common waterfowl observed at Burger and Klondike, but numbers were still relatively low. They were observed at both sites and in all seasons (Gall and Day 2009).

USFWS surveys indicate the long-tailed duck population on the North Slope has been above the 18 year mean but below the 20 year mean and has totaled about 34,000 birds the past few years (Larned et al. 2010).

Eiders

King and common eiders are two of the four world eider species (spectacled and Steller's eiders are discussed above). These large sea ducks breed in the Arctic and winter in marine waters along the southern coast of Alaska. They are always found near water and nest on Arctic tundra near lakes, bogs, and streams near the coast and up to 50 km (31.1 mi) inland. They eat mostly benthic organisms while at sea, and mollusks, aquatic insects, and plants on breeding grounds (Suydam 2000). Both eider species begin migration in April and arrive at their breeding grounds in May to early June; males leave breeding areas in late June and July to migrate to molting areas, while females and immature birds follow later.

The population status of king eiders is in question because of migration counts at Point Barrow, which declined 56 percent between 1976 and 1996, from 802,556 birds to about 350,835 birds, as well as a significant decrease in birds in the Northwest Territories (Suydam 2000). An estimated 499,423 king and 174,063 common eiders passed Point Barrow in the summer/fall migrations of 2002. In 2003, the summer/fall surveys estimated 365,680 king and 132,404 common eiders had passed Point Barrow. In the spring migrations, 304,966 king and 114,998 common eiders passed Point Barrow in 2003 while 591,961 king and 110,561 common eiders passed in 2004. This study indicated that, since 1996, the numbers of king eiders passing Point Barrow remained stable while common eiders have increased (Quakenbush et al. 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 delta but smaller colonies exist from the Seward Peninsula to Kasegaluk Lagoon (about 200 birds) and along the Beaufort coast east to the Canning River (about 3,000 birds) (Pacific Flyway Council 2002). The USFWS conducts waterfowl surveys along the Alaska Arctic coast every year and found a significant increase in the brant breeding population between 2001 and 2004 followed by stability at the higher level through 2009 (Larned et al. 2010). However, the USFWS survey design may not be the most appropriate to track population trends and more focused surveys have indicated a stable number of nests (346 to 386 nests total) at small colonies between Barrow and the Coleville Delta (Ritchie et al. 2002 and 2007, as cited in Larned et al. 2010). The largest concentrations of colonies and nests have been located in the Sagavinirktok River Delta, Prudhoe Bay, and Kuparuk areas (Stickney and Ritchie 1996). Kasegaluk Lagoon and Peard Bay are important stopover locations during the post breeding migration of this species.

Greater white-fronted geese breed along the coasts of the Bering, Chukchi, and Beaufort seas. The first week of June and the last week of August are peak migration times out of Kasegaluk lagoon. They typically breed on the tundra, within 30 km (18.6 mi) of the coast (Johnson and Herter 1989). USFWS surveys indicate the white-fronted goose population on the North Slope has been growing substantially over the past ten years and has totaled about 160,000 birds the past few years (Larned et al. 2010).

Lesser snow geese use Kasegaluk lagoon, an island in the Kukpowruk River delta (about 60 km [37.3 mi] south of Point Lay), and the Ikpikpuk River delta near Prudhoe Bay on the Arctic coast to nest (Ritchie and Rose 2009). Recent brood rearing monitoring surveys on sites east of Barrow found increases in populations on the Ikpikpuk River and growth in the colonies on both the Colville River delta and the Sagavanirktok River delta. Based on a combination of group sizes from points north and south of Point Lay at least 2,315 snow geese summered in Kasegaluk lagoon in 2008 (Ritchie and Rose 2009). USFWS surveys indicate the snow goose population on the North Slope has been growing substantially over the past ten years and has totaled about 28,000 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, USSCP 2004, Powell et al. 2010). Shorebird chicks leave their nests within 24 hours of hatching and never return but are protected by both parents until they are able to fly. Juvenile birds often group together in flocks, typically along the coast, to feed and prepare for their migration (Weiser 2008).

Dunlin are one of the main species of shorebirds that use Kasegaluk Lagoon for staging during migration. They are listed as a species of concern because of declining populations (USSCP 2004).

Semipalmated sandpipers nest on flat marshy tundra and raise their young in just a few weeks of Arctic summer. This species appears on the breeding territories in the first few weeks of June (Hicklin and Trevor 2010).

Pectoral sandpipers arrive on the breeding grounds in late May or early June. In Barrow, egg laying begins as early as the first week of June but most laying occurs from mid-June to the beginning of July. In the breeding areas, they feed on larvae and adult arthropods (Holmes and Pitelka 1998).

Bar-tailed godwits breed in sub-Arctic and Arctic tundra in western and northern Alaska. In September and early October, nearly 100,000 post breeding birds move along the Bering Sea Coast at staging grounds before flying nonstop to New Zealand. Both breeding and non-breeding sites show a rapid population decline (McCaffery and Gill 2001).

Buff-breasted sandpipers are rare breeders and visitors in northwestern Alaska and are considered highly imperiled due to threats in their winter habitat in South America (Brown et al. 2001).

American golden-plovers breed in dwarf shrub habitats and stage in dwarf-shrub and salt-grass meadows. The North American population is of conservation concern due to a decreasing population trend and threats during the non-breeding season in South America (USSCP 2004).

3.2.3.5 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. Six species – bowhead whale, humpback whale, fin whale, ringed seal, the Beringia Distinct Population Segment of bearded seal, and polar bear – are listed as either threatened or endangered under the ESA. The Pacific walrus is a candidate species for listing. The remaining species are neither listed nor currently proposed for listing under the ESA. The USFWS has jurisdiction over Pacific walrus and polar bears. The remainder is under the jurisdiction of NMFS.

This section includes information on population status and trends; distribution, migration and habitat use; reproduction and growth; survival; mortality; disease; hearing and other senses; and climate change. Information is derived from peer-reviewed papers, published and unpublished reports, and recent summary documents available for several species of concern, such as stock assessment reports (e.g. Allen and Angliss 2010, 2012a, 2012b) and status reviews (e.g. Boveng et al. 2008, Boveng et al. 2009, Cameron et al. 2010, Garlich-Miller et al. 2011, and Kelly et al. 2010a).

Table 3.2-5 Marine Mammal Species Found in the Beaufort and Chukchi Seas EIS Project Areas

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

[a] **Source:** Bacon, Joshua and Robert Akpik, Jr. List of subsistence resources utilized by residents of the NSB (revised by L. Pierce, May 2010). NSB Department of Wildlife Management, Barrow, AK

3.2.4.2 Cetaceans

Bowhead Whale: Western Arctic Stock

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-Beaufort-Chukchi seas) stock. The current working hypothesis is that the Davis Strait and Hudson Bay bowhead whales comprise a single Eastern Arctic stock. Confirmation of stock structure awaits further scientific analyses (IWC 2011). The Western Arctic stock is the largest remnant population and the only stock within U.S. waters (Allen and Angliss 2011). 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 Eskimo whalers pointed out shortcomings in these early counts, such as not accounting for and correcting for whales that continued to migrate under the ice of closed leads or that migrate farther offshore. As a result, an acoustic component was added to the census, allowing for the detection of whales not detectable by visual observers and for the development of correction factors (Huntington 2000). The whalers' traditional knowledge proved accurate and invaluable in advancing the accuracy of census estimates.

The most recent estimate of abundance derived from an ice-based census in 2001 was 10,470 bowhead whales in the Western Arctic stock (George et al. 2004). The estimated annual rate of increase from 1978 to 2001 was 3.4 percent. The 2001 estimate was subsequently revised to 10,545 bowhead whales (Zeh and Punt 2004 cited in Allen and Angliss 2011). Attempts to count bowheads migrating near Point Barrow in 2009 and 2010 were unsuccessful due to sea ice conditions (George et al. 2011). An ice-based count was successful in 2011; the data are currently being analyzed, with a new estimate antipacted by 2013 (Allen and Angliss 2012a, R. Suydam pers. comm 2012b). The population may be approaching carrying capacity despite showing no sign of a slowing in the population growth rate (Brandon and Wade 2006).

Capture-recapture analysis based on aerial photographs of individually identified bowhead whales provided alternative, and comparable, estimates of abundance. Schweder et al. (2009) calculated an estimate for 2001 of 8,250 whales and a yearly growth rate of 3.2 percent. Results based on images from 2003 through 2005 provided an estimated population abundance in 2004 of 12,631 whales, excluding calves (Koski et al. 2010). The abundance estimates calculated from photographic data were consistent with expected abundance and trend estimates from ice-based surveys (Koski et al. 2010).

The Western Arctic stock of bowhead whales remains listed as endangered under the ESA and is considered depleted under the MMPA.

Distribution, Migration and Habitat Use

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 ADF&G tagged bowhead whale tracking data show a tagged bowhead wintering south of 59°N latitude in the SW 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 2012a). 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.-11). Some animals remain in the eastern Chukchi and western Beaufort seas during the summer (Clarke et al. 2011a, 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. 2011) 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).

The spring migration from April to June follows leads in the sea ice through the Bering Strait to the Chukchi Sea and past Barrow and into the Beaufort Sea (Figure 3.2.-12). Tagged whales began migrating north in early April, passed into the Chukchi Sea by mid-April, on average, and all passed Barrow by May 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 polyna (Quakenbush et al. 2010a) (Figure 3.2-13).

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).

Aerial surveys of bowhead whale distribution in the Beaufort Sea during summer-fall are conducted annually by the National Marine Mammal Laboratory (NMML). BWASP surveys were previously flown by the Minerals Management Service (now BOEM). In 2011, an Interagency Agreement between the BOEM and NMML combined BWASP with the Chukchi Offshore Monitoring in Drilling Area survey (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 2011) were light ice years. Median distance of bowhead whales from shore ranged from as close as 6.6 to 16.9 km (4.1 to 10.5 mi) in 2009 to 34.3 to 39.2 km (21.3 to 24.4 mi) in 2006. The latter was significantly farther from shore than during other light ice years, possibly due to grounded ice near the coastline, locations of prey concentrations, or nearshore shallow hazards work. Median depth of sightings was relatively shallow all years, ranging from 15 to 44 m (49 to 144 ft) (Clarke et al. 2011b, 2011c). Bowhead distribution in 2011 was not noticeably different than that of other low ice years (Clarke et al. 2012). Behaviors included milling, swimming, and feeding, to a lesser degree. Highest numbers of sightings were in the central Beaufort and east of Point Barrow.

During the summer, most of the population is in the southern and eastern Beaufort Sea and Amundsen Gulf although recent tagging studies and aerial surveys indicate summer movements to areas outside the Canadian Beaufort. These include the central Alaskan Beaufort and Barrow, and as far as the northern coast of Chukotka, Russia (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 September to mid-October bowheads begin their western migration out of the Canadian Beaufort Sea to the Chukchi Sea (Figure 3.2-15). 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, b, c, Koski and Miller 2009, Quakenbush et al. 2010a).

The Barrow area is used as a feeding area during spring and fall. A higher proportion of photographed individuals showed evidence of feeding in fall than in spring (Mocklin 2009). 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 appears to be one of the areas important to bowhead whales primarily during the fall (NMFS 2010b). BOEM-funded BWASP surveys show areas off Kaktovik as areas that are sometimes of high use by bowhead whales (Clarke et al. 2011b, NMFS 2010b). 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 (BWASP, ASAMM, BOWFEST, 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 3.2-15) (Quakenbush et al. 2010b, Quakenbush et al. 2012). 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 of 52 whales were in the Burger study area and along the Burger to Wainwright transect in early October (Aerts et al. 2011).

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). Most tagged whales were crossing the Chukchi Sea in September heading to Wrangel Island and Chukotka (Figure 3.2-14). The Chukchi Sea Lease Sale Area was most commonly used by tagged whales in September. However, the areas with the highest probability of use were in the northeastern section of the Lease Area, not in the area of the leased blocks. Leased blocks contained only two percent of the total probability of use by bowhead whales (Quakenbush et al. 2010a). Bowhead whales increased in the 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 excellent survey effort (Clarke et al. 2012).

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).

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). 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).

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).

Reproduction and Growth

Bowheads likely mate in late winter or early spring, although mating behavior has been observed at other times of the year. Gestation is about 13 to 14 months, and calves are usually born between April and June, during the spring migration. The calving interval is about three to four years. Juvenile growth is relatively slow. Bowheads reach sexual maturity at about 15 years of age (12 to 14 m [39 to 46 ft] long) (Nerini et al. 1984). Growth for both sexes slows markedly at about 40 to 50 years of age (George et al. 1999).

Survival and Mortality

Bowhead whales are long-lived animals, likely living longer than any other mammals. Based on aspartic racemization of eye lenses, George et al. (1999) calculated ages greater than 150 years. Discoveries of traditional stone, ivory, and metal whale-hunting tools recovered from several harvested whales further corroborated longevity beyond 150 years.

Pelagic commercial whaling was the single greatest historical source of mortality for bowhead whales. The Bering Sea fishery primarily operated from 1848 to 1919. By 1870, 60 percent of the pre-whaling population was estimated to have been taken (Braham 1984). The estimated catch of 18,684 western Arctic bowhead whales by pelagic whalers (Woodby and Botkin 1993) was likely an underestimate due, in part, to under-reporting of Soviet catches (Yablokov 1994). Bowhead whales are an important subsistence resource for Alaska natives (see Section 3.3.2, Subsistence) and have been hunted by Eskimos for at least 2,000 years. Takes are regulated by quotas established under the authority of the IWC and average about 40 to 50 strikes per year (NMFS 2008b).

Incidental mortality or injury from entanglement in commercial fishing gear is known to occur. Scarring attributed to ropes or entanglements have been observed on approximately 10 percent of whales harvested from 1988 to 2008 (Reeves et al. 2012). Stranding reports document entanglements between 2001 and 2005, including a bowhead whale observed near Point Barrow with fishing net and line around the head (Allen and Angliss 2010). A dead bowhead whale found floating in Kotzebue Sound in July 2010 was entangled in crab pot gear similar to that used in the Bering Sea crab fishery. The entanglement through the mouth and around the tail stock may have been the cause of death (Suydam et al. 2011a).

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 2008b).

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 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 1 minute to hours. Pulsive vocalizations range between 25 and 3500 Hz and last

0.3 to 7.2 seconds (Clark and Johnson 1984, Würsig and Clark 1993; Cummings and Holliday 1987 in Erbe 2002).

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).

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). Trend data were unreliable for this stock (Allen and Angliss 2010). The estimated abundance for the Aleutian Islands, Bering Sea, and Gulf of Alaska combined ranged from 6,000 to 19,000 (Allen and Angliss 2010, 2012a).

The humpback whale is listed as endangered under the ESA and designated as depleted under the MMPA.

Distribution, Migration and Habitat Use

Humpback whales occur in all oceans of the world from the tropics to sub-polar regions (Perry et al. 1999). They undertake extensive seasonal migrations between low-latitude breeding and calving areas and high latitude feeding grounds (Perry et al. 1999). The summer feeding range of humpback whales in the North Pacific includes coastal and inland waters of California, the Gulf of Alaska, and Bering Sea, along the Aleutian Islands to the Kamchatka Peninsula and into the Sea of Okhotsk, and north of the Bering Strait. Wintering areas include Japan, the Phillipines, Hawaii, Mexico, and Central America (Allen and Angliss 2010, 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). Additionally, Ireland et al. (2008) reported three humpback sightings in 2007 and one in 2008 during surveys of the eastern Chukchi Sea. A single humpback was observed between Icy Cape and Wainwright feeding near a group of gray whales during aerial surveys of the northeastern Chukchi Sea in July 2009 as part of COMIDA (Clarke et al. 2011a). This may be a recent phenomenon as no humpback whales were sighted during the previous COMIDA surveys in the Chukchi Sea from 1982 through 1991 (Clarke et al. 2011a). Additional sightings of four humpback whales occurred in 2009 south of Point Hope, while transiting to Nome (Brueggeman 2010). Aerts et al. (2011) observed one humpback whale during the Nome transit in 2010. The COMIDA surveys conducted in 2012 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 feed on euphausiids (krill) and various schooling fishes, including herring, capelin, sand lance, and mackerel (Krieger and Wing 1986, Nemoto 1957, 1959, Witteveen et al. 2008). They are considered “lunge feeders” that predate dense prey patches by engulfing the patch and distending the ventral grooves of the throat area. They also blow nets, or curtains, of bubbles around or below prey patches to concentrate the prey in one area, and then lunge with mouths open through the middle (Clapham 2009).

Reproduction and Growth

Humpbacks give birth and presumably mate on low-latitude wintering grounds in January to March in the Northern Hemisphere. Females attain sexual maturity at 5 years in some populations and exhibit a mean calving interval of approximately two years (Barlow and Clapham 1997, Clapham 1992). Gestation is about 12 months, and calves probably are weaned by the end of their first year (Perry et al. 1999).

Survival and Mortality

The greatest source of mortality of humpback whales was commercial whaling. An estimated 28,000 humpbacks were reportedly removed from the North Pacific during the 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).

Mortality or injury due to interactions with commercial fisheries is possible. Incidental mortality of one Western North Pacific humpback whale was reported in the Bering Sea/Aleutian Islands flatfish trawl fishery and one was reported in the Bering Sea/Aleutian Islands pollock trawl fishery between 2007 and 2010. The estimated annual mortality rate incidental to US commerical fisheries was calculated as 0.62 humpbacks from this stock. The estimated fishery-related minimum mortality and serious injury rate incidental to commercial fisheries for the northern part of the central North Pacific stock is 1.0 humpback whales per year (Allen and Angliss 2012a).

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. 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 (Winn et al. 1970; Richardson et al. 1995; Frazer and Mercado 2000; Au et al. 2000, 2006); (2) Social sounds in the breeding areas that extend from 50Hz – more than 10 kHz with most energy below 3kHz (Tyack and Whitehead 1983, Richardson et al. 1995); 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 (Thompson et al. 1986; Richardson et al. 1995).

<u>Fin Whale: Northeast Pacific Stock</u>

Species Description

Fin whales are baleen whales of the family Balaenopteridae. They are the second largest whale in the world reaching lengths of about 22 m (72 ft) in the northern hemisphere (Aguilar 2009). Females are larger than males (Gambell 1985). Fin whales are slender, with a narrow rostrum and prominent falcate dorsal fin. The pigmentation is uniquely asymmetrical. The right lower jaw and right side baleen plates are white to yellow-white, while the corresponding left side is dark gray, as are the upper body, flippers and flukes. They are considered “gulp” feeders and have a series of ventral groves that expand during feeding, enabling the whale to engulf large quantities of water and prey (Aguilar 2009).

Population Status and Trends

The IWC recognizes one stock of fin whales in the North Pacific, but NMFS recognizes three stocks in U.S. Pacific waters for management purposes: Alaska (Northeast Pacific); California/ Oregon/Washington; and Hawaii (NMFS 2010b, Allen and Angliss 2010, 2012a). The Northeast Pacific stock is the only one that may occur in the EIS project area.

There are currently no reliable estimates of abundance for the entire Northeast Pacific stock of fin whales. Surveys in the Bering Sea and coastal waters from southcentral Alaska to the central Aleutian Islands provide the only data from which estimates could be derived. The estimate of 5,700 whales is considered a minimum for this stock, since surveys only covered a small part of the range (Allen and Angliss 2010). Zerbini et al. (2006) estimated an annual rate of increase of 4.8 percent from 1987 through 2003 for fin whales in coastal waters south of the Alaska Peninsula.

For fin whales, the pre-commercial whaling population for the entire North Pacific was estimated to be 42,000 to 45,000, with the "American population" east of 180° W longitude estimated as 25,000 to 27,000 whales (Ohsumi and Wada 1974). By the early 1970s, there may have been as few as 8,000 to 11,000 remaining in the eastern North Pacific (Ohsumi and Wada 1974).

The fin whale is listed as endangered under the ESA and as depleted under the MMPA.

Distribution, Migration and Habitat Use

Fin whales occur throughout the North Pacific from Central Baja California to the Chukchi Sea (Mizroch et al. 2009, Nasu 1974, Rice 1974). Occurrence in Alaskan waters in summer and fall has been documented primarily in the Gulf of Alaska and Bering Sea (Mizroch et al. 2009). There are no reports of fin whales in the Beaufort Sea. In 2010, fin whales were among the species commonly detected acoustically in the Chukchi Sea during August and September (Crance et al. 2011, Hannay et al. 2011). Visual observations are rare. One fin whale was observed north of Cape Lisburne during COMIDA aerial surveys in July 2008 (Clarke et al. 2011a). Also in 2008, there were two sightings of four fin whales recorded by Marine Mammal Observers during Chukchi Sea seismic surveys (Funk et al. 2010). Observations made during the 2012 ASAAM surveys in the Chukchi Sea observed a total of five fin whales (including two calves) on September 11. Three individuals were observed lunge feeding (Sims et al. 2013).

Little is known of their migratory movements. 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 (Nemoto 1970, Kawamura 1982).

Reproduction and Growth

Age at sexual maturity is between 5 and 15 years (Perry et al. 1999). Mating and calving occur primarily during winter (November to March, with a peak in December to January). Gestation is probably less than a year. Calves nurse for six to seven months, and the average calving interval is two to three years (Agler et al. 1993).

Survival and Mortality

Fin whales were heavily targeted by 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 incidentally killed in the Bering Sea/Aleutian Islands pollock trawl fishery between 2002 and 2006 (Allen and Angliss 2010, 2012a). There were no observed mortalities incidental to commercial fisheries in Alaska between 2007 and 2010 (Allen and Angliss 2012a). Ship strikes have, however, resulted in fin whale mortalities in Alaskan waters, with three reported between 2006 and 2010 (Allen and Angliss 2012a).

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 (Watkins 1981; Watkins et al. 1987; Edds 1988; Thompson et al. 1992). 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 (Patterson and Hamilton 1964; Watkins et al. 1987; Thompson et al. 1992; McDonald et al. 1995; Clark and Gagnon 2004).

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).

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). There will be some level of incomplete information on population status of minke whales in Alaska waters. However, sufficient information is available to support sound scientific judgments and reasoned managerial decisions. More accurate counts are not essential for a reasoned choice among alternatives. Furthermore, the missing information pertains to impacts that are common to all alternatives, limiting the utility of this information to the decision maker.

Minke whales are not listed as depleted under the MMPA or listed as threatened or endangered under the ESA.

Distribution, Migration and Habitat Use

Minke whales are common and the most numerous baleen whales found throughout the world. In the Northeast Pacific Ocean, minke whales range from the Chukchi Sea south to Baja California (Perrin and Brownell 2009). 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 3 in 2006, 3 in 2007, and 8 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). 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. They are rare in the Beaufort Sea, with only one observation in 2007 during vessel surveys in the region (Funk et al. 2010).

Minke whales in the North Pacific typically consume euphausiids, anchovies, Pacific saury, walleye pollock, small fish, and squid (Perrin and Brownell 2009).

Reproduction and Growth

Little is known of the natural history of minke whales. They presumably breed in winter in warm, low latitude waters, give birth to a single calf every other year, and reach sexual maturity when 7 to 9 m (23 to 30 ft) long (Perrin and Brownell 2009).

Survival and Mortality

Minke whales were never targeted by the modern shore-based whale fishery in the eastern North Pacific (Rice 1974). Subsistence takes by Alaska Natives are rare, but have occurred, with seven minke whales reported taken for subsistence between 1930 and 1987 (C. Allison, International Whaling Commission, United Kingdom, pers. comm. cited in Allen and Angliss 2010).

Incidental mortality in commercial fisheries is known to occur at a low level. There was one mortality of a minke whale reported in the Bering Sea/Aleutian Islands groundfish trawl fishery in 2000 (Allen and Angliss 2010). The total estimated mortality and serious injury due to interactions with U.S. commercial fisheries was zero for 2006 to 2010 (Allen and Angliss 2012a).

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). Minke whales produce a variety of calls ranging from 60 Hz to 20 kHz (DoN 2011). Common sounds include clicks, tonals, and FM signals that range in frequency from 80 to 800 Hz. North Pacific minke whales were recently discovered to be the source of the "boing" sound that has been recorded since the 1950s (Frankel 2009, Rankin and Barlow 2005).

Gray Whale: Eastern North Pacific Stock

Species Description

The gray whale is a robust, slow-moving baleen whale recognized by a mottled gray color with numerous light patches scattered along the body and lack of a dorsal fin (Jones and Swartz 2009). They have more external parasites than other cetaceans (Jones and Swartz 2009). Instead of a dorsal fin, they have a low hump, followed by a series of 10 or 12 knobs along the dorsal ridge of the tail. Adults are 10 to 15 m (33 to 49 ft) long and weigh between 16 and 45 tons (Jones and Swartz 2009).

Population Status and Trends

There are two populations of gray whales in the North Pacific. The eastern North Pacific population migrates along the coasts of eastern Siberia, North America, and Mexico (Allen and Angliss 2010, Weller et al. 2002). The western North Pacific population migrates primarily between the South China Sea and the Okhotsk Sea. Some members of the western North Pacific stock may occasionally migrate to the eastern Pacific. A 13 year old male from the western population satellite-tagged off Sakhalin Island, Russia in 2010 departed Russia in mid-December, traveled across the Okhotsk Sea, the Bering Sea and Gulf of Alaska to the coast of Oregon by early February 2011. The last location overlapped in time and space with the end of the typical eastern North Pacific population's southbound migration. Photo-identification and genetics studies revealed that this individual and others from the western population 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). 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.

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, and 19,126 in 2006/07 (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 3.2-17). Feeding also occurs near Kodiak Island, Southeast Alaska, British Columbia, Washington, Oregon, and California (Calambokidis et al. 2002, Darling 1984, Moore et al. 2007, Nerini 1984, Rice and Wolman 1971, Rice et al. 1984). Those remaining throughout the summer and fall along the

Canadian/Washington/Oregon coast are known as the Pacific Coast Feeding Aggregation (Allen and Angliss 2010, 2012a).

Sightings of gray whales in the Beaufort Sea near Point Barrow increased in recent years. Native hunters observed growing numbers of gray whales during late summer and autumn (Moore et al. 2006). Gray whales were observed in all survey months and years (2008 through 2011) during COMIDA and ASAMM aerial surveys of the northeastern Chukchi Sea (Clarke et al. 2011a, 2012). They were consistently observed within 50 km (31.1 mi) of shore between Wainwright and Barrow. (Clarke et al. 2011a, 2012). 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, while they were observed 50 to 100 km (31 to 60 mi) offshore between Point Franklin and Icy Cape (Clarke et al. 2012). Similar to 2008 to 2010, gray whales were absent from Hanna Shoal during all survey months in 2011. This differed markedly from surveys of 1982 through 1991 when gray whales frequented Hanna Shoal (Clarke et al. 2011a, 2012). 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). In 2011, there were no sightings of gray whales east of Point Barrow during ASAMM aerial surveys (Clarke et al. 2012). 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). Calls recorded by moored autonomous acoustic recorders northeast of Barrow throughout the winter of 2003/2004 provide evidence of gray whales overwintering in the Beaufort Sea (Stafford et al. 2007b). Increasing population size and habitat changes associated with decreased sea ice may be contributing to the northward shift in distribution.

Gray whales are the most coastal of all the large whales and inhabit primarily inshore or shallow, offshore continental shelf waters (Jones and Swartz 2009). They prefer shoal areas (<60 m [197 ft] deep) with low (<7 percent) ice cover (Moore and DeMaster 1997). These areas provide habitat rich in gray whale prey. Gray whales are suction-feeders and prey upon a variety of benthic amphipods, decapods, and other invertebrates in the Bering and Chukchi Seas. Ampeliscid amphipods were the predominant prey targeted in Chirikov Basin in the northern Bering Sea (Moore et al. 2003). There are indications that this resource was being stressed by overgrazing and that gray whales may be expanding their summer range in search of alternative feeding grounds (Rugh et al. 1999).

Reproduction and Growth

Female gray whales usually breed once every two years. The breeding season is limited primarily to a three-week period in late November and early December during the southbound migration (Jones and Swartz 2009). Gestation lasts approximately 13.5 months (Rice et al. 1984), with an estimated median calving date of January 13 (Perryman and Lynn 2002). Weaning occurs approximately seven months later on the feeding grounds (Rice et al. 1984).

Calf production indices (calf estimate/total population estimate) fluctuated broadly between 1994 and 2000, from a high of 5.8 percent in 1997 to a low of 1.1 percent in 2000. These fluctuations positively correlated with how long the primary feeding area was free of seasonal ice during the previous year (Perryman et al. 2002). More calves were observed during the 2012 ASAMM surveys than anytime 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 3.3 gray whales died annually from interactions with commercial fishing gear between 2003 and 2007 (Allen and Angliss 2012b). From 2005 to 2009, stranding data indicate a minimum annual mean of 2.4 gray whale mortalities resulting from interactions with commercial fishing gear. This includes the entire U.S. west coast from California to Alaska and is a minimum estimate due to lack of observer coverage for most Alaska gillnet fisheries known to interact with gray whales (Allen and Angliss 2012b).

Russian and Alaskan subsistence hunters traditionally harvested whales from this stock. Most are taken by Russian hunters. Alaska Natives reportedly took two gray whales in 1995 (IWC 1997). In 1997, the IWC approved a five-year quota (1998 through 2002) of 620 gray whales, with an annual limit of 140 whales. The U.S. and Russia share the quota, with an average annual allowable take of 120 whales by the Russian Chukotka people and four whales by the Makah Indian Tribe of Washington State (U.S.) (IWC 1998). The annual subsistence take averaged 121 whales from 2003 to 2007; all were taken in Russia (Allen and Angliss 2012b).

The coastal habitat use and migrations of gray whales leaves them vulnerable to ship strikes, although this is not currently a major source of mortality. In 1997, one fatal ship strike of a gray whale was reported in Alaska (B. Fadely, AFSC-NMML, pers. comm., cited in Allen and Angliss 2010).

Predation by killer whales has been well documented and is the primary natural, non-human cause of mortality in gray whales (Rice et al. 1984). Iñupiat Eskimo hunters have observed killer whale attacks on gray whales off Point Hope and between Point Franklin and Barrow. In addition, several young gray whales stranded along the Chukchi Sea coast have had injuries indicative of killer whale attacks (George and Suydam 1998). Weller et al. (2002) observed that at least 1/3 of identified western gray whales bore killer whale tooth rake marks on their bodies.

Hearing and Other Senses

Gray whales are in the low-frequency cetacean functional hearing group, with an estimated auditory bandwidth of 7 Hz to 22 kHz (Southall et al. 2007). Gray whales produce broadband signals ranging from 100 Hz to 4 kHz (and up to 12 kHz). The most common sounds on the breeding and feeding grounds are knocks, which are broadband pulses from about 100 Hz to 2 kHz and most energy at 327 to 825 Hz. The source level for knocks is approximately 142 dB re 1 μPa-m (Jones and Swartz 2009, Richardson et al. 1995).

Beluga Whale: Beaufort Sea and Eastern Chukchi Sea Stocks

Species Description

The beluga whale is a toothed whale of the family Monodontidae. The white coloring and lack of dorsal fin are two distinguishing characteristics for which the scientific name derives ("…apterus" means without a fin and "leucas," from the Greek leukos, means white). Unlike other toothed whales, beluga neck vertebrae do not fuse, allowing for flexibility of the head and neck (O'Corry-Crowe 2009). They are medium sized, growing to 3.5 to 4.5 m (11 to 15 ft) in length and weigh up to 1,500 kg (3,307 lbs) (Burns and Seaman 1986). Calves are dark gray when born and grow progressively lighter with age, until they are pure white at about age 14 for females and 18 for males (O'Corry-Crowe 2009). In northwest Alaska, age at which animals become all white is highly variable. For males, it ranged from 9 to 38 years and from 6 to 33 years for females (Burns and Seaman 1986).

Population Status and Trends

There are five stocks of beluga whales recognized in U.S. waters: Cook Inlet; Bristol Bay; eastern Bering Sea; eastern Chukchi Sea; and Beaufort Sea (Allen and Angliss 2010, 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). Telemetry data from 1993 and 1995 showed belugas ranging well beyond the aerial survey area, suggesting the 1992 abundance may have been greatly underestimated (Richard et al. 2001).

Survey data are also outdated for the eastern Chukchi stock. It was not possible to estimate abundance from the most recent survey in 1998, but, in 2012, efforts to estimate abundance of this stock took place. Data are currently being analyzed. 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 (Allen and Angliss 2010, 2012a).

Neither the Beaufort Sea beluga whale stock nor the eastern Chukchi Sea stock is listed as depleted under the MMPA or threatened or endangered under the ESA.

Distribution, Migration and Habitat Use

Beluga whales closely associate with open leads and polynyas in ice-covered regions throughout Arctic and sub-Arctic waters of the Northern Hemisphere. Distribution varies seasonally. Whales from both the Beaufort Sea and eastern Chukchi Sea stocks overwinter in the Bering Sea. Belugas of the eastern Chukchi may 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 3.2-16) (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 are regularly sighted during the September-October BWASP aerial surveys of the Alaska Beaufort Sea coast. In 2006, distribution offshore along the shelf-break and slope overlapped with that observed in previous years. Sighting rates were much lower in 2007 and 2008 (117 and 15, respectively, compared to 525 in 2006), possibly because of the absence of sea ice in the area or survey effort offshore. Sighting rates in 2009 were similar to years prior to 2007, with distribution highest in Barrow Canyon and offshore shelf break and slope areas (Clarke et al. 2011b, 2011c). 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. Distribution patterns of belugas in the Alaskan Beaufort Sea have remained relatively consistent for the past 30 years (Clarke et al. 2012). Belugas seen during these surveys could be from either the Beaufort Sea or Chukchi Sea stocks.

In fall, most belugas migrate to the Bering Sea where they spend the winter. Satellite tag transmissions from one male suggest that the area northwest of St. Lawrence Island is used as an overwintering area for the Chukchi Sea stock (Suydam et al. 2005, Robert Suydam, Department of Wildlife Management, NSB, Barrow, AK, pers. comm.), although determining what a population does from a sample of one should be done cautiously.

Acoustic detections of beluga whales provide additional insight into distribution and movements of belugas in the northeastern Chukchi Sea. Belugas were detected during every month from April to November in 2007 and 2008 (Delarue et al. 2011). Detections were more restricted in summer and ranged more broadly in the spring. Calls in July and August were concentrated near Barrow Canyon. Calls were detected between mid-April and June 2008 over a large area 90 to 150 km (60.0 to 93.2 mi) off Point Lay and Wainwright. These spring detections of belugas may have included whales from both the eastern Beaufort and Chukchi Sea stocks (Delarue et al. 2011). Calls were also detected in November 2007 off Point Lay (Delarue et al. 2011). It is not clear from which stock those animals originated. Most acoustic detections of belugas from late-October to late-November 2008 were at stations located 56.3 km (35 mi) and 80.5 km (50 mi) off Wainwright (Hannay et al. 2011). Detections in spring 2009 began in mid-April 177 km (110 mi) off Point Lay, suggesting that migrating belugas may travel in offshore leads that form southwest of Hanna Shoal before inshore leads form (Hannay et al. 2011). High call counts shifted from the southwest to the northeast from April to June, as belugas migrated to the Beaufort Sea. Spring detections ended mid-June 144.8 km (90 mi) off Wainwright. Belugas were only detected on 4 occasions during summer 2009 (Hannay et al. 2011). There were no recorders deployed inshore.

Despite being acoustically detected in the Chukchi Sea, no beluga whales were visually detected by observers aboard vessels surveying the Burger and Klondike prospects from July to October 2008 and August to October 2009 (Brueggeman 2009, 2010), 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 sightability 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). More beluga whales (127 sightings) were seen near Barrow during the summer of 2010 than in previous years. They were observed feeding inside and near to Elson Lagoon in July through August and September, with over 500 belugas reported on July 25 (George et al. 2011).

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).

Reproduction and Growth

Females become sexually mature at 9 to 12 years old; males at a later age (O'Corry-Crowe 2009), although this varies by population. Heide-Jøregensen and Teilmann (1994) estimated age of sexual maturity at 6 to 7 years for males and 4 to 7 years for females off West Greenland. Suydam (2009) estimated that 50 percent of females were sexually mature at age 8.25 and the average age at first birth was 8.27 years for belugas sampled near Point Lay.

The gestation period calculated for the eastern Chukchi stock is 14.9 months, and the calving interval is 2 to 3 years. The pregnancy rate of 0.41 for females harvested at Point Lay is consistent with this interval (Suydam 2009). Pregnancy rates decline after females reach 25 years old (Suydam 2009). A single calf is born in late spring to mid-summer and may remain with its mother until 2 years old (Brodie 1971, Suydam 2009). Most births occur from mid-June to mid-July (Burns and Seaman 1986). Length at birth for eastern Chukchi belugas was estimated to be 1.57 m (5.15 ft) and length at separation from mothers was estimated as 2.46 m (8.07 ft) (Suydam 2009). Mating is thought to occur from late-February to June, with a peak in March. Some breeding may occur in late-June to early-July (Burns and Seaman 1986, Suydam2009).

Survival and Mortality

The primary sources of human caused mortality in beluga whales are subsistence hunting and, possibly, interactions with commercial fisheries. The average annual subsistence take from the Beaufort Sea beluga stock by Alaska Natives was 41 during 1987 to 2006. For the eastern Chukchi Stock, annual subsistence take by Alaska Natives averaged 62 belugas during 1987 to 2006 (Frost and Suydam 2010). These annual harvests represent 0.1 percent and 1.7 percent of the estimated stock sizes for the Beaufort Sea stock and eastern Chukchi Sea stock, respectively (Frost and Suydam 2010). Subsistence is further discussed in Section 3.3.2.

The total commercial fishery mortality and serious injury is estimated to be zero for both the Beaufort Sea and eastern Chukchi Sea stocks (Allen and Angliss 2010, 2012a). 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). Belugas create a diverse repertoire of sounds, earning them the name "sea canary." Sounds are divided into whistles and pulsed calls, typically at frequencies between 0.1 and 12 kHz. Nearly 50 different call types have been recognized, including groans, whistles, buzzes, trills, and roars (Bel'kovitch and Sh'ekotov 1990). Call types recorded in the Chukchi Sea include low and high whistles, buzzes, chirps, and clicks (Hannay et al. 2011).

Narwhal

Species Description

The narwhal is a toothed whale in the family Monodontidae, along with beluga whales. This species was given its scientific name for its most unique feature -- the up to 3 m (9.8 ft) long spiraled tusk. Adult narwhals only have two teeth, and, in males, the left tooth develops into a tusk. Some females grow tusks, some males lack tusks, and some grow double tusks. The tusk is likely a secondary sexual characteristic (Heide-Jørgensen 2009).

Narwhals lack dorsal fins. Calves are uniformly dark in coloration, while adults are mottled in appearance. Adult females are approximately 400 cm (157.5 in) long and weigh 1,000 kg (2,205 lbs), and males are 450 cm (177.2 in) and 1,600 kg (3,527 lbs) (Garde et al. 2007).

Population Status and Trends

Abundance surveys of narwhals in the Canadian High Arctic (Prince Regent Inlet, Barrow Strait, and Peel Sound) were conducted during summer 1996. The resulting estimated total abundance for that area was 45,358 (Innes et al. 2002).

Distribution, Migration and Habitat Use

Narwhals predominantly inhabit Arctic waters of the Atlantic Ocean—the Canadian high Arctic, northern Hudson Bay, Davis Strait, Baffin Bay and the Greenland Sea, and the Arctic Ocean between Svalbard and Franz Josef Land. There are a few records of sightings in the Pacific side of the Arctic (Heide-Jørgensen 2009).

Occurrence of narwhals in the Alaskan Beaufort and Chukchi seas is rare and, likely, extralimital. The NSB Department of Wildlife Management collected about a dozen incidental observations of narwhals made by Alaska Native hunters. Two were sighted in the spring leads off of Barrow with a group of belugas in 1989. Between 2001 and 2006, there were nine narwhal sighted in July and August from Wainwright to off Point Barrow. In 2008, a narwhal tusk was found on Cape Sabine. Most of the narwhals sighted live were associated with beluga whales (JC George pers. comm.). Incidental sightings of narwhals in the Beaufort and Chukchi seas are thought to be from the Baffin Bay population that are known to move into the Canadian Arctic Archipelago and as far north and west as ice conditions will permit (COSEWIC 2005).

Reproduction and Growth

Age at sexual maturity is estimated as six to seven years for females and nine years for males (Garde et al. 2007). Mating likely occurs in April through May, and, at least in Greenland and Canada, calving occurs from June through August, suggesting a gestation of 13 to 16 months. Lactation lasts one to two years, and females are thought to calve every three years (Heide-Jørgensen 2009).

Survival and Mortality

Recent studies using aspartic racemization suggest that female narwhals can reach 115 years of age (Garde et al. 2007).

Killer whales and polar bears are the only non-human predators of narwhals (Heide-Jørgensen 2009).

Narwhals are hunted for their tusks and skin in Greenland and Canada, with 433 taken during 2000 to 2004 in Canada. Narwhals appear susceptible to ice entrapment, particularly in areas of unpredictable ice conditions, such as Disko Bay in West Greenland (Heide-Jørgensen 2009).

Hearing and Other Senses

Narwhals are in the mid-frequency hearing group with an estimated auditory bandwidth of 150 Hz to 160 kHz (Southall et al. 2007). Narwhals produce a variety of sounds. Echolocation clicks have been measured at maximum amplitudes of 48 kHz. Whistles have also been recorded with frequencies of 300 Hz to 18 kHz (Ford and Fisher 1978, Miller et al. 1995).

Narwhals are called “unicorns” of the sea because of the tooth, or tusk, that emerges from its upper jaw. Researchers have come up with several explanations over the decades as to its function. A recent theory proposed by Nweeia et al. (2009) that it may in fact be a chemoreceptor capable of reacting and responding to varying salinity gradients. Being able to detect salinity gradients could help these animals survive in the Arctic environment. Additionally, it could also allow the animals to detect water particles characteristic of the fish upon which they prey (Science Daily 2005).

Killer Whale: Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock

Species Description

Killer whales are toothed whales and the largest member of the dolphin family. Adults are sexually dimorphic. Males reach a maximum body length of 9 m (30 ft) and a maximum weight of 6,600 (14,550 lbs). Females reach lengths of 7.7 m (25.5 ft), with a maximum measured weight of 4,700 kg (10,361 lbs) (Ford 2009, Yamada et al. 2007). In addition to being overall larger than females, the prominent dorsal fin on males can be as tall as 1.8 m. Directly behind the dorsal fin is a gray area of variable shape called the saddle patch. Killer whales are strikingly black and white in coloration with a conspicuous elliptically shaped white patch behind the eye. Individuals can be identified using variation in the shape and color of the eye patch, saddle patch, and the size and shape of the dorsal fin (Ford 2009).

Population Status and Trends

The three recognized ecotypes of killer whales—resident, transient, and offshore—are distinguished based on morphology, ecology (including prey preferences), genetics, acoustics, and behavior (Baird and Stacey 1988, Baird et al. 1992, Ford and Fisher 1982, Hoelzel and Dover 1991, Hoelzel et al. 1998, 2002).

Within these three ecotypes, there are six putative stocks of killer whales in Alaska: the Alaska Resident stock, occurring from southeastern Alaska to the Aleutian Islands and Bering Sea; the Northern Resident stock, occurring from British Columbia through part of southeastern Alaska; the Gulf of Alaska, Aleutian Islands, and Bering Sea Transient stock, occurring mainly from Prince William Sound through the Aleutian Islands and Bering Sea; the AT1 transient stock, occurring in Alaska from Prince William Sound through the Kenai Fjords; the West Coast transient stock, occurring from California through southeastern

Alaska; and the Offshore stock, occurring from California through Alaska (Allen and Angliss 2010, 2012a).

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 552, based on photographic identification of individuals (Allen and Angliss 2012a). Data are currently not available for determining trends in abundance.

The Gulf of Alaska, Aleutian Islands, and Bering Sea transient stock of killer whales is not listed as threatened or endangered under the ESA or considered depleted under the MMPA.

Distribution, Migration and Habitat Use

Killer whales are a cosmopolitan species found in all oceans and most seas. They are most commonly found in coastal and temperate waters of high productivity (Forney and Wade 2006). Killer whales range throughout the North Pacific. Along the west coast of North America, they occur from Alaska to California. Seasonal and year-round occurrence has been noted for killer whales throughout Alaska (Barlow 1995, Bigg et al. 1990, Braham and Dahlheim 1982, Forney et al. 1995).

Killer whales are occasionally reported in the northeastern Chukchi and western Beaufort Seas. Iñupiat Eskimo hunters reported observing killer whale attacks on gray whales in Peard Bay, northwest of Barrow and Point Hope. Other observations include attacks on beluga whales and bearded seals and possible foraging on whitefish and chum salmon near Peard Bay (George and Suydam 1998). 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, Reiser et al. 2011). In August 2011, two large groups of killer whales were sighted during marine mammal surveys. A group of 13 whales was sighted during an ASAMM aerial survey northeast of Barrow, followed five days later by a sighting of 25 to 30 whales by a CSESP survey vessel near Hanna Shoal (Joling 2012).

Killer whales were acoustically detected throughout the 2007 and 2009 Chukchi Sea open water season (Hannay et al. 2011). They were detected primarily off Cape Lisburne and Point Lay, with a few detections off Wainwright, plus one off Barrow in fall 2007. Analysis of the 2007 data indicated that the sounds were produced by transient killer whales (Hannay et al. 2011).

The killer whale is an apex marine predator with a diverse prey base. Transient killer whales are mammal-hunters whose prey includes various seal species. They are also known to attack minke whales and gray whale calves, as well as other large whale species, as evidenced by scars incurred during attacks (Ford 2009, George et al. 1994).

Reproduction and Growth

Births may occur in any month but most are in October through March. Females become reproductively mature between 11 and 16 years of age with a 5-year interval between births. Gestation is 15 to 18 months (Ford 2009) and weaning is about 1 to 2 years after birth. Females typically give birth for the first time at about 12 to 14 years of age (Olesiuk et al. 2005). Males attain sexual maturity at about 15 years of age (Ford 2009).

Killer whales are very social. The basic social unit is based on matriline relationships and linked by maternal decent. A typical matriline is composed of a female, her sons and daughters, and the offspring of her daughters (Ford 2009).

Survival and Mortality

Killer whales are long-lived. Life expectancy for females is about 50 years with a maximum of 80 to 90; males typically live to about 29 years of age (Ford 2009).

Sources of human-caused mortality include entanglement in fishing gear and ship strikes. Mortality has been reported in the Bering Sea/Aleutian Islands flatfish 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 2009 is 1.5 per year (Allen and Angliss 2012a). One ship strike of a killer whale was reported in the Bering Sea groundfish trawl fishery in 1998 (Allen and Angliss 2010). Killer whales have no known predators other than humans.

There is no subsistence harvest of killer whales in Alaska.

Hearing and Other Senses

Killer whales are highly vocal and use sound for social communication and to find and capture prey. The sounds include a variety of clicks, whistles, and pulsed calls (Ford 2009). Most of the pulsed sound frequencies range from 0.5 to 25 kHz. Source levels for echolocation clicks range from 195 to 224 dB re 1 μPa-m, with dominant frequencies from 20 to 60 kHz. Source levels associated with social sounds range from 131 to 168 dB re 1 μPa-m (DoN 2011). Acoustic studies of resident killer whales in British Columbia have found there to be dialects, which are likely used to maintain group identity and cohesion, and may serve as indicators of relatedness (Ford 1989, 1991). The vocal behavior of transient killer whales differs from residents, which is likely related to the hearing capabilities of their prey. They remain silent much of the time and communicate less frequently than residents (Barrett-Lennard et al. 1996, Saulitis et al. 2005). The killer whale has the lowest frequency of maximum sensitivity and one of the lowest high frequency hearing limits known among toothed whales. The frequency range of hearing is 1 to 100 kHz, with highest sensitivity at 20 kHz (DoN 2011).

Harbor Porpoise: Bering Sea Stock

Species Description

Harbor porpoise are toothed whales of the family Phocoenidae. They are one of the smaller porpoises in the world and the smallest cetacean in Arctic waters. They are characterized by a short, stocky body and a small, triangular dorsal fin. Females average 1.6 m (5.2 ft) in length and 60 kg (132.3 lbs), while males reach 1.4 m (4.6 ft) and 50 kg (110 lbs) (Bjørge and Tolley 2009). They have dark gray backs and light undersides. Harbor porpoise tend to avoid ships and rarely bow ride (Bjørge and Tolley 2009).

Population Status and Trends

There are currently three stocks of harbor porpoise recognized in Alaska: the Southeast Alaska stock; the Gulf of Alaska stock; and the Bering Sea stock (Allen and Angliss 2010). The latter occurs throughout the Aleutian Islands and all waters north of Unimak Pass.

The 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).

Harbor porpoise are not listed as depleted under the MMPA or listed as threatened or endangered under the ESA.

Distribution, Migration and Habitat Use

Harbor porpoise in the eastern North Pacific range from Point Barrow and along the west coast of North America from Alaska to Point Conception, California (Gaskin 1984). The harbor porpoise are primarily coastal and most commonly occur in waters less than 100 m (328 ft) deep (Hobbs and Waite 2010). Harbor porpoise often feed on bottom-dwelling fishes and small pelagic schooling fishes with high lipid content; herring and anchovy are common prey (Bjørge and Tolley 2002, Leatherwood et al. 1982).

Harbor porpoise are seen in both the Beaufort and Chukchi seas. Incidences of entanglement in subsistence nets, beached carcasses, and live sightings near Point Barrow suggest regular use of, at least, the northeast Chukchi and far western Beaufort Seas (Suydam and George 1992). They are also occasionally seen during the fall BWASP aerial surveys (Clarke et al. 2011c). Harbor porpoise were sighted during vessel surveys of the Chukchi Sea in 2006 through 2010 (Aerts et al. 2011, 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 Iñupiaq 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 mortality was observed in 2007 in the Bering Sea/Aleutian Islands flatfish trawl fishery; this is the only harbor porpoise mortality observed from 2007 to 2010. The estimated minimum annual mortality rate for the Bering Sea stock of harbor porpoise incidental to commercial fisheries is, therefore, 0.53 (Allen and Angliss 2012a). That estimate is, however, unreliable due to lack of observers on several gillnet fisheries in Alaska (Allen and Angliss 2010, 2012a).

Subsistence fishermen in Barrow occasionally catch harbor porpoise in their nets during the summer (Suydam & George 1992).

Hearing and Other Senses

Harbor porpoise are in the high-frequency functional hearing group, whose estimated auditory bandwidth is 200 Hz to 180 kHz (Southall et al. 2007). Their vocalizations range from 110 to 150 kHz, and echolocation signals are in the 1.4 to 2.5 kHz range (DoN 2011).

3.2.4.3 Ice Seals

<u>Ringed Seal</u>

Species Description

Ringed seals are one of the smallest of the true seals (family Phocidae). Adults reach 1.5 m (4.9 ft) in length and 70 kg (154 lbs) in weight. They have a small head, short cat-like snout, and a plump body. Ringed seal pelage can be either light or dark phase, and they have silver rings on their back and sides with a silver belly (McLaren 1966, Murdoch 1885, Ognev 1935).

Population Status and Trends

The five recognized subspecies of ringed seals are the Arctic ringed seal (*Phoca hispida hispida*), the Baltic ringed seal (*Phoca hispida botnica*), the Okhotsk ringed seal (*Phoca hispida ochotensis*), the Ladoga ringed seal (*Phoca hispida ladogensis*), and the Saimaa ringed seal (*Phoca hispida saimensis*).

The Arctic ringed seal is the most abundant of the subspecies and is further subdivided by geographical region: Greenland Sea and Baffin Bay; Hudson Bay; Beaufort and Chukchi seas; and the White, Barents and Kara Seas. Arctic ringed seals of the Beaufort and Chukchi seas will be discussed here, as they are the only ones anticipated to occur in the EIS project area.

Several factors—from the seals' distribution and ecology to cross political boundaries--make assessing the population difficult. Recent surveys estimated a population of at least 300,000 ringed seals in the Alaskan Beaufort and Chukchi seas, although this was likely an underestimate (Bengtson et al. 2005, Frost et al. 2004). Accounting for seals inhabiting the pack ice and the eastern Beaufort and Amundson Gulf areas, the total population of ringed seals in the Beaufort and Chukchi seas was estimated to be 1 million (Bengtson et al. 2005, Frost et al. 2004). Kelly et al. (2010a) estimates that over 1,000,000 ringed seals inhabit the Beaufort, Chukchi, and Bering Seas based on information from existing surveys and studies. Kelly et al. (2010) placed their maximum density estimate of ringed seals at Prudhoe Bay and along the coast south of Kivalina at 1.62 seals/km^2. A minimum population estimate could not be determined as current reliable estimates of abundance are not available (Allen and Angliss 2012a).

On December 10, 2010, NMFS announced a proposed rule and a 12-month finding on a petition to list the ringed seal as a threatened or endangered species in the *Federal Register* (75 FR 77476). In this *Federal Register* notice, NMFS determined that all of the subspecies, except for the Saimaa ringed seal, are likely to become endangered throughout all or a significant portion of their range in the foreseeable future and therefore proposed to list them as threatened under the ESA. The basis for the determination was the likelihood of sea-ice habitat modification due to climate change and marine habitat modification due to ocean acidification. On December 28, 2012, NMFS published the final rule in the *Federal Register* (77 FR 76706) listing the Arctic subspecies of ringed seal as threatened.

Distribution, Migration and Habitat Use

Ringed seals are circumpolar and occur in all seasonally ice-covered seas of the northern hemisphere (King 1983) (Figure 3.2-18). Ringed seals are strongly ice-associated, and the seasonality of ice cover dictates their movements, feeding, and reproductive behavior. The ringed seal year consists of three distinct periods: the "foraging period" during the open water season when foraging is most intensive; the "subnivean period" from early winter through late May or early June when seals are using subnivean lairs on the ice; and the "basking period" between the time seals leave their lairs in May or June and the ice breaks up in June or July (Kelly et al. 2010b).

Ringed seals 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 100s to 1,000s of kilometers (Kelly et al. 2010b). Adult Arctic ringed seals return to the previously used subnivean site after the foraging period ends. Movements are limited during the subnivean period.

The Arctic subspecies typically hauls out exclusively on sea ice for resting, pupping, and molting. In the Beaufort and Chukchi seas, time spent on the ice increased from 12 percent in March to 43 percent in early June to more than 60 percent while molting in June (Kelly and Quakenbush 1990, Kelly et al. 2010b). After molting, and, as the sea ice breaks up in summer, ringed seals spend less time on the ice and more time in the water foraging. Time on the ice was 10 percent or less from August to November and remained less than 20 percent from December to March (Kelly et al. 2010b).

Ringed seals are able to remain in areas of dense ice cover throughout the fall, winter, and spring by maintaining breathing holes in the ice. They excavate lairs in the snow (subnivean) over their breathing holes as pupping season approaches (Helle et al. 1984). 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 coast and Admiralty Bay/Dease Inlet along the western Beaufort Sea east of Barrow during summer and fall (NSB 2012a)

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 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 1958a, Smith and Stirling 1975, Tikhomirov 1968). Pups nurse for 5 to 9 weeks and, when weaned, are four times their birth weights. Ringed seal pups are more aquatic than other ice seal pups and spend roughly half their time in the water during the nursing period (Lydersen and Hammill 1993b).

Survival and Mortality

Survival rates are not well known. The average life span is 15 to 28 years (Holst et al. 1999), but ringed seals can live longer than 40 years (Lydersen and Gjertz 1987, McLaren 1958a).

Sources of mortality include commercial fisheries, subsistence harvests, and predation. Mortality incidental to commercial fishing operations is low, with one report during 2002 to 2006 (Allen and Angliss 2010).

Ringed seals are hunted for subsistence by Alaska Natives from communities along the coasts of the northern Bering, Beaufort, and Chukchi seas. See Section 3.3.2, Subsistence Resources and Uses, for further discussion.

Common predators of ringed seals are polar bears and Arctic foxes, and, occasionally, other terrestrial carnivores, sharks, walrus and killer whales (Stirling and McEwan 1975, Stirling and Øritslsand 1995, Burns and Eley 1976, Heptner et al. 1976a, Sipila 2003). Ringed seals constitute 98 percent of the polar bear diet in the Beaufort Sea (Iverson et al. 2006). Gulls and ravens will prey on newborn pups, but concealment in subnivean lairs usually prevents that from occurring (Kelly et al. 2010a).

Ringed seals co-evolved with numerous parasites and diseases, and distemper virus has been reported in Arctic ringed seals. There is currently no evidence of impacts of disease or pathogen on ringed seal populations (Kelly et al. 2010a).

In 2011, over 60 dead and 75 diseased seals (mostly ringed seals) were reported in the Arctic (Chukchi and Beaufort seas) and Bering Straits regions of Alaska (NOAA 2011c). Characteristics of the disease include 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 have documented over 40 seals with clinical signs of the disease (NOAA 2012b).

The underlying cause 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, VES, 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).

Hearing and Other Senses

The estimated auditory bandwidth of ringed seals is 75 Hz to 75 kHz in water and 75 Hz to 30 kHz in air (Southall et al. 2007). Ringed seals produce at least six types of underwater calls. These include clicks (2 to 6 kHz), burst pulses, knocks (150 Hz to 2 kHz), chirps (500 to 1000 Hz), yelps (modulate around 1 kHz), and other low-frequency sounds (as summarized in Frankel 2009). Call activity varies seasonally in the Arctic. Most noises produced by ringed seals consist of sounds from scratching ice to maintain their breathing holes in the ice, otherwise they produce much less noise than other seal species (Cummings and Holliday 1984). Seals do not echolocate; however they can hear low-frequency sounds. Foraging by seals is believed to integrate vision and tactile senses such that they can see in almost total darkness, having the ability to track moving prey from as far as 100+ ft (30+ m) away using their vibrissae (Schusterman et al. 2004, Riedman 1990, Wieskotten et al. 2010, Dehnhardt et al. 2001, Schulte-Pelkum et al. 2007).

Spotted Seal

Species Description

Spotted seals, also called largha seals, are true seals of the family Phocidae. Males and females are similar in size and appearance. Adult females in the Bering Sea and Sea of Okhotsk typically weigh 65 to 115 kg (143.3 to 253.5 lbs) and are 151 to 169 cm (59.4 to 66.5 in) long. Adult males typically weigh 85 to 110 kg (187.4 to 242.5 lbs) and are 161 to 176 cm (63.4 to 69.3 in) long. They are generally light-colored with densely scattered dark grey and black spots (Heptner et al. 1976b, Wilke 1954).

Population Status and Trends

Spotted seals are divided into three Distinct Population Segments (DPSs) based on genetics, geography and breeding groups: the Bering DPS; the Okhotsk DPS; and the Southern DPS (Boveng et al. 2009). The Southern DPS includes spotted seals breeding in the Yellow Sea and Peter the Great Bay in the Sea of Japan.

There are no accurate abundance estimates for spotted seals across their entire range or for the Bering DPS, specifically. Data from 2007 and 2008 surveys are being analyzed to estimate abundance for the central and eastern Bering Sea. A provisional estimate of 101,568 spotted seals was provided in the interim by the National Marine Mammal Laboratory (Goodman 1960, Ver Hoef et al. 2010). Population trend assessments are currently unavailable.

In response to a petition to list the spotted seal as threatened or endangered under the ESA due to concerns over impacts of habitat loss due to climate change, NMFS conducted a status review of the species (Boveng et al. 2009). NMFS determined that only the Southern DPS is likely to become endangered throughout all or a significant portion of its range in the foreseeable future and should be listed as threatened. A proposed rule to list the Southern DPS of the spotted seal as a threatened species was published in the *Federal Register* on October 20, 2009 (74 FR 53683). NMFS published the final rule for the listing in the *Federal Register* on October 22, 2010 (75 FR 65239).

No listing action was proposed for the Okhotsk and Bering Sea DPSs (74 FR 53683, October 20, 2009). The Okhotsk and Bering Sea DPSs are not considered in danger of extinction or likely to become endangered in the foreseeable future.

Distribution, Migration and Habitat Use

Spotted seals are widely distributed on continental shelf areas of the Beaufort, Chukchi, southeastern East Siberian, Bering, and Okhotsk Seas, and south through the Sea of Japan and the northern Yellow Sea. This encompasses more than 40 degrees of latitude from Point Barrow in Alaska to the Yangtze River in China (Burns and Fay 1972, Lowry 1985, Naito and Konno 1979, Naito and Nishiwaki 1972).

Habitat use and distribution are closely linked to seasonal sea ice from late fall through spring (November/December to March in the Bering Sea). The seals haul out on the ice during the whelping, nursing, breeding, and molting periods. Before whelping and breeding, spotted seals are scattered among drifting ice floes (Heptner et al. 1976b).

Spotted seals congregate in herds on ice floes as the ice begins to disappear in late spring. Adults molt, and pups are weaned during this time. Adult spotted seals in the Bering Sea molt over a 2 to 2.5 month period from late April or early May to mid-July (Boveng et al. 2009). In summer, when the usable sea ice disappears, herds disperse, and seals move toward the ice-free coastal waters (Heptner et al. 1976a).

Spotted seals in the eastern Bering Sea use coastal haul-out sites from Kuskokwim Bay to the Bering Strait from May to July. Primary haul-outs in the eastern Chukchi Sea are along the coast of Kotzebue Sound and in Kasegaluk Lagoon (near Point Lay) during summer and fall (Figure 3.2-19) (Frost et al. 1982, Frost et al. 1983). 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 3.2-19) (Frost et al. 1982, Frost et al. 1983).

Based on satellite tagging studies, spotted seals in the Chukchi Sea migrated south to breeding and whelping areas in the Bering Seas in October, passing through the Bering Strait in November. In summer, the seals either traveled to nearshore areas of the Bering Sea or headed north into the Beaufort and Chukchi seas. Tagged seals undertook foraging trips from haul-out sites in Kasegaluk Lagoon that averaged 9 days in length and ranged over 1,000 km (621 mi) towards the Bering Strait, Beaufort Sea, or the Russian coast (Lowry et al. 1998).

Spotted seals are generalists that eat a broad array of fish, crustaceans and cephalopods from continental shelf and shelf break waters (Dehn et al. 2007). Among the fish commonly consumed are Pacific herring, smelt, Arctic cod, and saffron cod. Arctic cod were consumed more often by spotted seals in the Bering Sea than in the Chukchi Sea and saffron cod was more common in stomachs of harvested seals taken in the Chukchi Sea than in the Bering 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. The Bering Sea/Aleutian Islands flatfish trawl fishery is the only observed commercial fishery known to have taken spotted seals, averaging 1.0 seals per year from 2007 to 2009 (Allen and Angliss 2012a).

Spotted seals are an important species for Alaskan subsistence hunters, primarily in the Bering Strait and Yukon-Kuskokwim regions (see Section 3.3.2, Subsistence Resources and Uses).

There is little evidence of predation on spotted seals, and they are not considered primary prey of any predators. Predators include polar bears, brown bears, walrus, killer whales, Pacific sleeper sharks, foxes, wolves, sea lions, eagles, and gulls (Quakenbush 1988).

A variety of pathogens, diseases, helminthes, cestodes, and nematodes have been found in spotted seals, yet the prevalence is not unusual for seals (Boveng et al. 2009). 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; 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). Spotted seals in captivity produced six underwater sounds, including growls, clicks, snorts, and “cranky door U.” Frequencies ranged from 500 Hz to 3.5 kHz (summarized in Frankel

2009). Additional information on hearing and other senses for seals in general can be found in the ringed seal description above.

Ribbon Seal: Alaska Stock

Species Description

Ribbon seals are one of the most strikingly marked and easily recognizable seals in the world. The distinctive ribbon pattern consists of four light-colored bands on a background of darker pelage. One band encircles the neck and nape, another the trunk around the lower back and hips, and two ovals encircle each front flipper. Adult males are more brightly patterned than adult females (Boveng et al. 2008).

Ribbon seals are medium-sized seals. Adults reach lengths of 150 to 175 cm (59.0 to 68.9 in) and weights of about 70 to 90 kg (154 to 198.4 lbs) (Burns 1981, Lowry and Boveng 2009).

Population Status and Trends

The two main breeding areas for ribbon seals are in the Sea of Okhotsk and the Bering Sea. They are not separated into DPSs.

Data from aerial surveys in the eastern Bering Sea in 2003, 2007, and 2008 are currently being analyzed to develop abundance estimates for that region. An interim provisional population estimate of ribbon seals in the eastern and central Bering Sea (i.e. the EEZ) is 49,000 individuals (Boveng et al. 2008).

NMFS received a petition to list ribbon seals under the ESA in December 2007 due to loss of sea ice habitat caused by climate change in the Arctic. NMFS published a notice in the *Federal Register* on March 28, 2008 (73 FR 16617) indicating that there were sufficient data to warrant a status review of the species (Boveng et al. 2008). Findings of the review were published in the *Federal Register* on December 30, 2008 (73 FR 79822), wherein it was determined that listing of the ribbon seal was not warranted at the time, as it is not in danger of extinction or likely to become an endangered species within the foreseeable future. In response to new information and ongoing litigation regarding ribbon seals, NMFS published a notice of intitiation of a new status review in the *Federal Register* on December 13, 2011 (76 FR 77467). The findings of the new review are expected to be announced in June 2013.

Distribution, Migration and Habitat Use

Ribbon seals occur in the northern North Pacific Ocean and adjoining sub-Arctic and Arctic seas, primarily the Sea of Okhotsk and Bering Sea. They are strongly associated with sea ice during whelping, mating, and molting from mid-March through June (Burns 1970). The rest of the year is mostly spent at sea. Ribbon seals are rarely observed on land or near land and appear to prefer the continental shelf slope (Heptner et al. 1976c).

In Alaska, ribbon seals are found in the open sea, on pack ice, and only rarely on shorefast ice. They range from Bristol Bay in the Bering Sea to the Chukchi and western Beaufort Seas (Figure 3.2-20). From late March to early May, they inhabit the Bering Sea ice front (Braham et al. 1984, Burns 1970). During May and June, ribbon seals haul out on ice floes where weaned pups become self–sufficient and adults molt. As summer progresses and ice melts, at least part of the Bering Sea population migrates into the Bering Strait and Chukchi Sea (Fay 1974, Lowry 1985).

Research from the 1970s through 1980s, including observations by 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 moved south of the Bering Strait before ice reformed in the Chukchi Sea. Most of the seals tagged in the central Bering Sea did not travel north of the Bering Strait (Boveng et al. 2008).

Ribbon seals primarily consume pelagic and nektobenthic prey, including demersal fishes and cephalopods. Arctic cod were important prey in the northern Bering Sea (Ziel et al. 2008).

Reproduction and Growth

Ribbon seals reach sexual maturity at one to five years of age, depending on environmental conditions. Adult females annually give birth to a single pup (Boveng et al. 2008). Whelping in the Bering Sea occurs from late March to mid-May, with a peak in early to mid-April (Burns 1981). Pups are nursed for three to four weeks, during which time their weight may triple from about 9.5 to 28.5 kg (20.9 to 62.8 lbs) (Burns 1981). Breeding takes place after weaning, at the end of April to early May (Boveng et al. 2008).

Survival and Mortality

Very little is known about survival rates, but ribbon seals may live 20 to 30 years. An estimated 25 percent of ribbon seals survive to reach sexual maturity at age five. Mortality for pups in their first year was estimated to be 45 percent; this decreased to 8 to 10 percent for adults annually (Boveng et al. 2008).

Ribbon seals were commercially harvested by the Soviet Union beginning in the Sea of Okhotsk in the 1930s. Catches increased to approximately 20,000 ribbon seals annually during the 1960s (Heptner et al. 1976c).

Commercial sealing expanded to the Bering and Chukchi Seas in 1961. Due to overharvest, the Bering Sea ribbon seals declined (Burns 1981) from an estimated 80,000 to 90,000 in 1963 through 1964 (Fedoseev 2000) to about 60,000 to 70,000 in 1969. Harvest restrictions were imposed in 1969 (Fedoseev 2000).

Ribbon seals are harvested by Alaska Native subsistence hunters, primarily from villages along the Bering Strait and to a lesser extent at villages along the Chukchi Sea coast (See Section 3.3.2, Subsistence Resources and Uses).

Incidental mortality in commercial fisheries is minimal. There 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 2007 and 2009, for an estimated annual mortality rate of 2.25 seals (Allen and Angliss 2012b).

There is little evidence of predation on ribbon seals, and they are not considered primary prey of any predators. Polar bears and killer whales are the most likely opportunistic predators (Boveng et al. 2008).

A variety of pathogens, diseases, helminthes, cestodes, and nematodes have been found in ribbon seals, yet the prevalence is not unusual for seals (Boveng et al. 2008).

Hearing and Other Senses

The estimated auditory bandwidth of ribbon seals is 75 Hz to 75 kHz in water and 75 Hz to 30 kHz in air (Southall et al. 2007). There is some information available about the vocalizations of ribbon seals. The only recordings of underwater sounds were off St. Lawrence Island in the 1970s (Watkins and Ray 1977 cited in Frankel 2009). The two recorded sounds were described as “intense downward frequency sweeps” and a “broadband puffing” sound. The downsweeps were of three types: long (from 7100 to 200 Hz); medium (from 5300 to 100 Hz); and short (from 2000 to 300 Hz). The puffing sounds were below 5 kHz (Frankel 2009). Additional information on hearing and other senses for seals in general can be found in the ringed seal description above.

Bearded Seal: Alaska Stock (Beringia Distinct Population Segment)

Species Description

Bearded seals are the largest of the true seals, or phocids. They are distinguished by their girth; small head in proportion to body size; unpatterned gray to brown pelage; long, mustache-like whiskers; and square-shaped front flippers. Some individuals have a rust-colored head and fore flippers (Lydersen et al. 2001). Adults are 2 to 2.5 m (6.5 to 8.2 ft) long, with an average weight of 250 to 300 kg (551.1 to 661.4 lbs). Sexes are generally indistinguishable, although females may be larger than males and weigh more than 425 kg (937.0 lbs) in the spring (Kovacs 2009).

Population Status and Trends

The two subspecies of bearded seals are *E. b. barbatus* in the Atlantic and *E. b. nauticus* in the Pacific. *E. b. nauticus* was further divided into an Okhotsk DPS and a Beringia DPS (Heptner et al. 1976c, Ognev 1935). The Beringia DPS was named for the land bridge—Beringia--that was exposed during the last glaciation and over which the range of bearded seals in the Bering, Chukchi, Beaufort, and East Siberian lies (Cameron et al. 2010).

Aerial surveys were flown along the Chukchi Sea coastal regions from Shishmaref to Barrow during May to June 1999 and 2000. The average density of bearded seals was 0.07 seals/km^2 in 1999 and 0.14 seals/km^2 in 2000. Highest densities were along the coast south of Kivalina (Bengtson et al. 2005). Accurate abundance estimates were not calculated due to lack of correction factors. A rough estimate, based on the densities, was 13,600 bearded seals for the U.S. coastal portion for the Chukchi Sea. If the Russian portion of the Chukchi Sea has similar numbers of bearded seals, a combined total would then be roughly 27,000 seals (Cameron et al. 2010).

Estimates for the Beaufort Sea, extrapolated from surveys in the eastern Beaufort in the 1970s and not corrected for seals in the water, was 3,150 seals (Stirling et el. 1982). This is likely a gross underestimate (Cameron et al. 2010).

On December 10, 2010, NMFS announced a 12-month finding on a petition to list the bearded seal as a threatened or endangered species in the *Federal Register* (75 FR 77496). In the *Federal Register* notice NMFS determined the Beringia DPS and the Okhotsk DPS are likely to become endangered throughout all or a significant portion of their ranges in the foreseeable future, but that such a determination is not warranted for *E. b. barbatus*. This announcement issued the proposed rule to list the Beringia DPS and the Okhotsk DPS of the bearded seal as threatened species; no listing action was proposed for *E. b. barbatus*. The basis for the determination was the likelihood of current and future sea-ice habitat modification due to climate change and marine habitat modification due to ocean acidification. On December 28, 2012, NMFS published the final rule in the *Federal Register* (77 FR 76740) listing the Beringia DPS and Okhotsk DPS of the bearded seal as threatened.

Distribution, Migration and Habitat Use

Bearded seal distribution is circumpolar (Burns 1967, Burns and Frost 1979, Kelly 1988) and extends from the Arctic Ocean (85°N) to Sakhalin Island (45°N) in the Pacific (Allen 1880, Ognev 1935). Distribution and seasonal movements are closely associated with seasonal changes in sea ice. Sea ice provides an important platform on which bearded seals haul out to give birth, nurse pups, rest, and molt. Bearded seals prefer ice in constant motion, with natural openings and areas of open water, such as leads, fractures, and polynyas (Heptner et al. 1976d). Bearded seals in the Beaufort Sea were most abundant where drifting pack ice interacts with fast ice, creating leads and other openings (Burns and Frost 1979).

Most adult bearded seals move north from the Bering Sea into the Bering Strait and Beaufort and Chukchi seas in spring as the ice retreats. From summer to early fall, they occur along the southern edge of the Beaufort and Chukchi Sea pack ice (Heptner et al. 1976d). Most bearded seals migrate south through the Bering Strait to the Bering Sea ahead of the advancing ice in the fall and winter. During late winter and early spring, bearded seals are widely distributed in the broken, drifting pack ice from the Chukchi Sea to the ice front in the Bering Sea (Figure 3.2-21) (Cameron et al. 2010).

Recent acoustic data indicate that bearded seals are present in the Chukchi Sea throughout the year. Acoustic detections of calls were highest off Wainwright and Barrow during the breeding season in May and June (Hannay et al. 2011). Bearded seals were visually detected during June to November COMIDA 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. 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 2011 ASAMM (formerly COMIDA and BWASP) surveys. Five were hauled out on ice; the rest were in open water (Clarke et al. 2012).

Pregnant females generally overwinter on drifting ice in the Bering Sea where they whelp and wean before migrating north. Wintering and whelping bearded seals are also found in coastal leads of the Bering and Chukchi Seas, including Bristol and Kuskokwim Bays, Norton and Kotzebue Sounds, the Gulf of Karaginskiy, the Gulf of Anadyr, and near Point Hope (Coffing et al. 1998, Georgette et al. 1998).

It is unusual for bearded seals in the Bering, Beaufort and Chukchi seas to haul out on land. Younger bearded seals have, however, been seen hauled out on land in lagoons and up rivers near Wainwright and on sandy islands near Barrow (Nelson 1981).

Since bearded seals feed benthically (on the ocean bottom), they generally associate with seasonal sea ice over shallow water of less than 200 m (656 ft). In the Beaufort Sea, bearded seals prefer areas of open ice cover and water depths of 25 to 75 m (82 to 246 ft) (Stirling et al. 1982). In the eastern Chukchi Sea, highest densities in May and June were in the offshore pack ice where benthic productivity is high (Bengtson et al. 2005). The shallow continental shelf area of the Bering and Chukchi Seas includes about half of the Bering Sea, the Bering Strait, and most of the Chukchi Sea. Bearded seals can dive to the bottom all along the shallow shelf, making it a favorable foraging habitat (Burns 1967).

Bearded seals primarily prey on benthic organisms, such as epifaunal and infaunal invertebrates and demersal fishes. Crabs, shrimp, and clams are major prey for bearded seals in the Bering, Beaufort, and Chukchi seas. Tanner crabs are important in the southern Bering Sea, and spider crabs are important in the northern Bering, Beaufort, and Chukchi seas. Sculpins, Arctic cod,, and saffron cod can also be important prey (Allen 1880, Antonelis et al. 1994, Dehn et al. 2007, Finley and Evans 1983, Heptner et al. 1976d, Kenyon 1962, Lowry et al. 1980, Ognev 1935, Quakenbush et al. 2011a, Wilke 1954). Prey preferences apparently changed over time. The consumption of fish and diversity of fish consumed increased while crustacean (primarily decapod) consumption 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, and males become sexually mature at six to seven years. Most adult female bearded seals annually produce a single pup. Pupping takes place from mid-March to early-May in the central Bering Sea. The peak pupping in the Bering Strait and central Chukchi Sea occurs in late April (Heptner et al. 1976d).

Newborn bearded seals in the Bering and Chukchi Seas weigh an average of 33.6 kg (74.1 lbs) and are 131.6 cm (51.8 in) long. Pups grow rapidly and gain an estimated 2.8 to 3.6 kg (6.2 to 7.9 lbs) per day (Kovacs and Lavigne 1986, Lydersen and Kovacs 1999). Weight increases to about 85 kg (187.4 lbs) by the time of weaning at 12 to 18 days. The pups are able to enter the water within hours of birth and begin to forage while still nursing (Cameron et al. 2010).

Survival and Mortality

Bearded seals typically live 20 to 25 years (Kovacs 2009), with a maximum of around 30 years (Cameron et al. 2010).

Sources of mortality include subsistence hunting, fisheries interactions, and predation. Bearded seals have been an important subsistence species for Alaska Natives for thousands of years and continue to be so today. See Section 3.3.2, Subsistence Resources and Uses, for details on the subsistence harvest of bearded seals.

Mortality incidental to the Bering Sea/Aleutian Islands pollock trawl fisheries is rare but known to occur.

Between 2007 and 2009, there were incidental serious injuries and mortalities of bearded seals in the Bering Sea/Aleutian Islands pollock trawl and the Bering Sea/Aleutian Islands flatfish trawl fisheries, resulting in an estimated minimum annual mortality rate of 2.7 bearded seals (Allen and Angliss 2012a).

Mortalities incidental to permitted marine mammal research activities may occasionally occur. One mortality, resulting from research on the Alaska stock of bearded seals, was reported between 2003 to 2007 (Tammy Adams, Permits, Conservation, and Education Division, Office of Protected Resources, NMFS, cited in Allen and Angliss 2010).

Polar bears are the primary predators of bearded seals. Other predators include brown bears, killer whales, sharks, and walrus (Cameron et al. 2010).

Relatively little is known about diseases and causes of natural mortality in bearded seals, other than predation by polar bears. A variety of diseases and parasites, with which the seals likely co-evolved, have been documented in bearded seals. The observed prevalence is not unusual (Cameron et al. 2010). 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. They produce four basic call types: trill; moan; sweep; and ascent. Trills, the predominant call during the breeding season, are one of the more distinctive calls of any marine mammals. The frequency modulated vocalizations with long downsweeps that begin between 3 and 6 kHz, can propagate up to 30 km (18.6 mi), and last up to 60 s (Cameron et al. 2010, Frankel 2009). The sounds of bearded seals during their breeding season (May) increases the ambient noise level by as much as 20 dB (Hannay et al. 2011).

Another sensory adaptation of bearded seals is that for which they were named—their well-developed facial whiskers. Theirs are among the most sensitive in the animal world with 1,300 nerve endings associated with each whisker. This extreme sensitivity is thought to be an adaptation to benthic feeding (Kovacs 2009). Additional information on hearing and other senses for seals in general can be found in the ringed seal description above.

Pacific Walrus

Species Description

The walrus is the only living member of the pinniped family Odobenidae. The species' Latin name *Odobenus rosmarus* means "tooth walking sea horse" (Kastelein 2009), in honor of one of their more distinguishing characteristics. The upper canine teeth are enlarged to form prominent tusks, which are longer and thicker in males than in females (Garlich-Miller et al. 2011).

The walrus is the largest pinniped species in the Arctic. Males are larger than females, with an average body length of 230 cm (90.5 in) and weight of 1,200 to 1,500 kg (2,646 to 3,307 lbs), compared to 270 cm (106.3 in) and 600 to 850 kg (1,323 to 1,874 lbs) for females (Kastlein 2009). Females attain maximum size by about 10 years old and males at about 15 to 16 years (Fay 1982).

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

Population Status and Trends

The three modern subspecies of walrus are the Atlantic walrus (*O. r. rosmarus*), the Pacific walrus (*O. r. divergens*), and the Laptev walrus (*O. r. laptevi*) (ITIS 2010). The Pacific walrus is represented by a single population that inhabits continental shelf waters of the Bering and Chukchi Seas (Fay 1982), and is the only subspecies expected to occur in the EIS project area (Quakenbush 2010).

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 walrus within the area of the Bering Sea pack ice that was surveyed was estimated at 129,000 individuals (Speckman et al. 2010). This represents only a partial population estimate, since only about half of the potential walrus habitat was surveyed (Speckman et al. 2010).

On February 10, 2011, the USFWS published a notice of a 12-month finding in the *Federal Register* (76 FR 7634 [2011a]) on a petition to list the Pacific walrus as threatened or endangered under the ESA. It was determined that listing the Pacific walrus was warranted but precluded by higher priority actions. 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. Upon publication of the notice, the Pacific walrus was added to the USFWS list of candidate species.

Distribution, Migration and Habitat Use

Pacific walrus range across continental shelf waters of the northern Bering Sea and southern Chukchi Sea (Figure 3.2-22). Adult males remain in the Bering Sea to forage from coastal haul outs during the ice free season. The rest of the population migrates seasonally in conjunction with seasonal advance and retreat of sea ice (Garlich-Miller et al. 2011).

Walrus congregate in the Bering Sea pack-ice adjacent to areas with open water, such as leads and polynyas, during the breeding season from January to March (Fay et al. 1984b). Breeding aggregations are common southwest of St. Lawrence Island, south of Nunivak Island and south of the Chukotka Peninsula in the Gulf of Anadyr (Speckman et al. 2010).

Most of the population migrates north through the Bering Strait to summer feeding areas over the continental shelf in the Chukchi Sea when the ice in the Bering Sea breaks up in spring. Summer distribution in the Chukchi Sea depends on sea ice distribution and extent. Walrus form patchy aggregations across the continental shelf when loose pack ice is abundant. Aggregations range in size from less than 10 to more than 1,000 individuals (Gilbert 1999, Ray et al. 2006). Walrus concentrate in loose pack ice off the northwest coast of Alaska between Icy Cape and Point Barrow and along the coast of Chukotka, Russia, to Wrangel Island (Belikov et al. 1996, Gilbert et al. 1992). The return southbound migration to the Bering Sea wintering areas occurs in September and October in advance of sea ice formation in the Chukchi Sea. Large herds may gather to rest during migration at haul outs in the southern Chukchi Sea (Belikov et al. 1996).

Walrus were observed in June to October 2008 through 2011 during aerial surveys of the northeastern Chukchi Sea (Clarke et al. 2011a, 2012). Distribution was broad and associated with sea ice in June to early August. It then shifted to nearshore open water and coastal habitat in late August and September. Few were seen in the area in October 2008 to 2010 (Clarke et al. 2011a). Walrus 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 walrus (Blanchard et al. 2011). Walrus detected during fall BWASP surveys in 2006 and 2007 were north and east of Barrow (Clarke et al. 2011b, 2011c). No walrus were observed in the Alaskan Beaufort Sea in 2011 (Clarke et al. 2012).

Acoustic detections indicate that walrus are present in the Chukchi Sea from early June through December. Calls peaked in August and September, with the highest level of detections occurring off Wainwright (Hannay et al. 2011).

Walrus 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). Walrus satellite-tagged in 2010, 2011, and 2012 regularly frequented Hanna Shoal during July through mid-September. This was particularly true in 2012 when tracking showed nearly all of the tagged walrus on or near Hanna Shoal from August into September (USGS 2011, 2012) where grounded ice remained later than in surrounding areas. Walrus 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).

Sea ice serves as a platform for resting between feeding bouts, breeding, calving, and care of dependent young (Fay et al. 1984b, Kelly 2001). Walrus may haul out on land when sea ice is not available, which has occurred during several years since the mid-1990s. Females avoid using terrestrial haul outs, when possible, possibly because calves are more vulnerable to trampling (Fishbach et al. 2009).

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

Recent use of coastal haul outs along the northwestern Alaska coast is influenced by the availability of sea ice. In 2006 and 2008 walrus remained with the ice pack throughout the summer and fall, but in 2007, 2009, and 2010, the pack-ice retreated beyond the continental shelf and walrus hauled out on land at several locations between Point Barrow and Cape Lisburne (Clark et al. 2011a, Thomas et al. 2009). Between 2 and 13 September 2009, approximately 2,500 walrus were observed hauled out on Icy Cape. In 2010, walrus were distributed throughout the northeast Chukchi Sea in the water and on scattered ice floes in early August. In late August, most shifted nearshore between Point Lay and Barrow. On 30 August 2009, several large coastal haul outs with 2,500, 1,000, and 200 animals were documented east of Cape Lisburne. A coastal haul out near Point Lay had approximately 4,000 animals. The Point Lay haul out persisted through much of September, with counts ranging from <1,000 to >15,000 animals (Clarke et al. 2011a). 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).

Walrus are benthic feeders, specializing in invertebrates. Prevalent prey in both the Bering and Chukchi Seas includes bivalves, gastropods, and polychaete worms. Bivalves were more common in walrus stomachs from the Bering Sea and polychaete worms were more common in the Chukchi Sea (Sheffield and Grebmeier 2009). Sheffield and Grebmeier (2009) suggest that walrus exploit different benthic prey throughout their range depending on biomass availability and not just species.

Reproduction and Growth

Males reach sexual maturity at 6 to 7 years old, but are not likely to successfully compete for females until they are at least 15 years old (Fay 1982, Fay et al. 1984a). Females reach sexual maturity at 4 to 7 years old (Garlich-Miller et al. 2006). Mating takes place from January through March, and a single calf is born in May of the following year (Fay 1982). Newborn calves weigh 65 kg (143.3 lbs) and are 113 cm (44.5 in) long on average (Fay 1982).

Walrus have the lowest birth rate of any pinniped species. This is offset by a high level of maternal investment and the resulting high rates of calf survival. Females and newborn calves remain on ice floes until calves develop enough energy reserves to thermoregulate properly. The calf remains with its mother for at least two years. The prolonged nursing period of 1 to 2 years may suppress ovulation so that the birth interval is 3 or more years (Garlich-Miller and Stewart 1999). Young female walrus generally remain with groups of adult females after weaning, whereas young males associate with groups of other males (Fay 1982).

Survival and Mortality

Walrus may live to be 40 to 45 years old. Estimated survival rates for the first year of life are between 0.5 and 0.9. Survival rates may be as high as 0.96 to 0.99 for juveniles and adults (4 to 20 years old) (DeMaster 1984, Fay et al. 1997).

Walrus were historically harvested commercially. American whalers in the Bering Sea intensified hunts in the mid- to late-1880s. An estimated 15,000 to 20,000 were harvested annually between 1860 and 1880, with 60,000 reportedly taken between 1868 and 1872 (Fay 1957). The population decreased dramatically as a result, as did harvest levels. Annual harvests of 5,000 to 7,000 continued from 1910 to 1950 (Fay 1957). In 1960 and 1961, the State of Alaska imposed restrictions on subsistence takes in order to promote recovery of the population, which, by the 1980s appeared to be recovered to its pre-exploitation level (Fay et al. 1989).

The Pacific walrus is an important subsistence resource in many coastal communities along the Bering and Chukchi Sea coasts of Alaska (U.S.) and Chukotka (Russia). See Section 3.3.2, Subsistence Resources and Uses, for further details.

Incidental mortality of Pacific walrus in commercial fisheries is insignificant. Observed mortality in the Bering Sea/Aleutian Islands flatfish fishery averaged 1.8 walrus per year between 2002 and 2006 (Allen and Angliss 2010).

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

Pacific walrus are one of the largest animals of the Bering and Chukchi Seas. As such, they have relatively few natural predators. The principal natural predators of Pacific walrus are polar bears and killer whales.

Diseases and predation are not currently posing significant threats to the Pacific walrus population (Garlich-Miller et al. 2011).

In August and September 2011, approximately six percent of Pacific walrus hauled out at Point Lay had skin ulcers or sores similar to that characteristic of the disease outbreak reported for ringed seals. Most 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; 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).

The underlying cause is still unknown and it is not known if the seal and walrus diseases are related. 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, VES, 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).

Hearing and Other Senses

As with other pinnipeds, the estimated auditory bandwidth of walrus is 75 Hz to 75 kHz in water and 75 Hz to 30 kHz in air (Southall et al. 2007).

Walrus produce a variety of sounds in and out of water. Acoustic threats when hauled out include roars, grunts, and guttural sounds, ranging in frequency from 13 Hz to 4 kHz. Males sing on the mating grounds and at summer seasonal haulouts. Songs include sequences of pulsed sounds and bell-like sounds. Pulsed sounds include intense “knocks” of 0.2 to 8 kHz and “taps” produced more rapidly at 0.2 to 4 kHz. Males also produce gong-like sounds (Frankel 2009).

3.2.4.4 Fissipeds

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

Species Description

Polar bears are the largest of the living bear species and have a longer neck and proportionately smaller head than other bears (DeMaster and Stirling 1981). Adult males are larger than adult females. Males can be 230 to 285 cm (90.5 to 112.2 in) long and weigh over 650 kg (1,433.0 lbs). Females range in size from 180 to 240 cm (70.8 to 94.5 in) in length and 181 to 317 kg (399.0 to 698.9 lbs) in weight (Amstrup 2003). The fur ranges in color from white, to yellow, to grey, to almost brown. The nose, lips, and skin are black (Amstrup 2003, DeMaster and Stirling 1981).

Adaptations to living on sea ice include white fur with water repellent guard hairs and a dense under-coat; a short snout; small ears; teeth specialized for eating meat; and hair on the soles of the feet. The large, paddle-like feet help disperse weight when walking on thin ice and aid in swimming (Stirling 1988).

Population Status and Trends

The two stocks of polar bears in Alaska are the Southern Beaufort Sea stock and the Chukchi/Bering Seas stock. Low population densities, inaccessible habitat, cross-boundary politics and budget constraints have made estimating abundance of 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 estimated a population of approximately 2,000 animals by extrapolating multiple years of aerial den survey data. However, the estimate is imprecise and not useful for evaluating status and trends for this population (Lunn et al. 2002). Sufficient information is available to support sound scientific judgments and reasoned managerial decisions. More accurate counts are not essential for a reasoned choice among alternatives. Furthermore, the missing information pertains to impacts that are common to all alternatives, limiting the utility of this information to the decision maker.

The southern Beaufort Sea population has been studied since 1967. The most current and valid population estimate (1,526 bears) was based on data collected from 2001 to 2006. The area to which this applies extends from Point Barrow east to the Baillie Islands in Canada (Regehr et al. 2006). The overall population growth rate declined by approximately 0.3 percent per year for the years 2001 to 2006 (Hunter et al. 2007).

A determination of threatened species status for the polar bear throughout its range was published by the USFWS in the *Federal Register* on May 15, 2008 (73 FR 28212). This determination was based on declining sea ice habitat throughout the species range and the anticipated continued decline in the foreseeable future. This loss of sea ice habitat was considered a sufficient threat that polar bears were considered likely to become an endangered species in the foreseeable future throughout all of its range.

Distribution, Migration and Habitat Use

Polar bears are distributed across ice-covered waters of the circumpolar Arctic. Sea ice is their primary habitat upon which they depend for most life functions, including hunting and feeding, breeding, travel, maternity denning areas, and resting (Stirling and Derocher 1993). Distribution and movements are intricately tied to seasonal sea ice dynamics and the polar bears range is limited to areas covered in sea ice for much of the year (Stirling et al. 1999, Quakenbush et al. 2009b).

Pack ice is the primary summer habitat for Alaska polar bears that use it for traveling, feeding, and denning in fall and winter. In the Beaufort Sea and to a lesser extent in the Chukchi Sea females may den and give birth to their young on the drifting pack ice (Amstrup and Gardner 1994). During the summer months when the sea-ice disappears from the Bering Sea and becomes reduced in the Chukchi Sea polar bears that occupy these areas can migrate as much as 1000 km (620 mi) to stay with the pack ice (Garner et al. 1990, 1994). During the summer months polar bears tend to concentrate along the edge or into the adjacent persistent pack ice. Distribution patterns for some populations during the open water and early fall seasons have changed over the last decade. Shorefast ice is important in the spring for preying on seal pups, traveling, and occasional denning. Leads that open and close between the active pack ice and shore-fast ice are important during winter and spring for feeding and travel (Schliebe et al. 2006a).

The Chukchi/Bering stock is widely distributed on pack ice in the Chukchi Sea, northern Bering Sea, and adjacent coastal areas in Alaska and Russia (Figure 3.2-23). The range extends to the northeast near the Colville Delta in the central Beaufort Sea and to the west near Chauniskaya Bay in the Eastern Siberian Sea. The southern boundary is determined by the annual extent of pack ice (Amstrup et al. 2005, Garner et al. 1990).

The Southern Beaufort Sea stock ranges east to south of Banks Island and east of the Baillie Islands, Canada (Amstrup et al. 2000). The western boundary is near Point Hope (Figure 3.2-23). Adult female polar bears from this stock occasionally move into an area that overlaps with the range of the Chukchi/Bering stock between Point Hope and Colville Delta, centered near Point Lay (Amstrup et al. 2000, Garner et al. 1990, Garner et al. 1994). Telemetry data showed that adult female polar bears from the Southern Beaufort Sea spend about 25 percent of their time in the northeastern Chukchi Sea, whereas females tagged in the Chukchi Sea spend only six percent of their time in the Southern Beaufort Sea (Amstrup 1995).

Polar bears do not disperse evenly throughout their range. Polar bears in the Southern Beaufort Sea concentrate in waters less that 300 m (984 ft) deep over the continental shelf and in areas with >50 percent ice cover in order to access ringed and bearded seals (Durner et al. 2004, Durner et al. 2006a, Durner et al. 2009, Stirling et al. 1999).

Polar bears from the Southern Beaufort Sea population historically denned on both the sea ice and in snow drifts on land. The number denning on sea ice declined from 62 percent (1985 to 1994) to 37 percent (1998 to 2004) in response to thinning of the sea ice (Fischbach et al. 2007). 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, Durner et al. 2006b, Durner et al. 2010). Polar bear denning occurs along the 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).

Distribution patterns have changed in recent years. In the Beaufort Sea more polar bears (up to 200) occurred on shore between 2000 and 2005 than at any previous time (Schliebe et al. 2006b). The reason for this is unclear, but a statistically significant relationship exists between the number of bears using the coast and the distance of the pack ice from shore. Telemetry data and habitat use data from the southern Beaufort Sea indicate shifting distribution during summer and fall, apparently in response to ice retreating farther offshore than in the past (Schliebe et al. 2006b). The number of bears on land increased when sea-ice retreated farthest from shore, but distribution was also related to the availability of subsistence harvested bowhead whale carcasses and the density of ringed seals offshore (Schliebe et al. 2008).

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 ASAMM surveys (Clarke et al. 2012).

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 (87.0 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).

Polar bears are apex predators in the Arctic marine ecosystem. Unlike other bear species that are generally omnivorous, polar bears are carnivores (Stirling 1988). Seals are their primary prey – particularly ringed seals and, in some areas, bearded seals or other ice seal species. Polar bears may occasionally prey on walrus, narwhals, and beluga whales (Calvert and Stirling 1990, Smith and Sjare 1990). Polar bears in the Beaufort Sea (e.g. at Barter Island, Cross Island, Barrow) gather to feed at the butchering sites of harvested bowhead whales. Bears observed feeding on these carcasses in the fall are generally large and healthy (Miller et al. 2006).

On December 7, 2010, the USFWS published a Final Rule in the *Federal Register* (75 FR 76086) designating critical habitat for U.S. populations of polar bears. This rule designated critical habitat in Alaska and adjacent territorial and U.S. waters and encompasses 484,734 km^2 (187,157 mi^2) (Figure 3.2-24). Excluded from designation 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 (Figure 3.2-24). 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. On January 11, 2013, the U.S. District Court for the District of Alaska vacated the Final Rule, which designated critical habitat for the polar bear and remanded the matter back to the USFWS.

Reproduction and Growth

Polar bears have a low reproductive rate characterized by small litter sizes and extended parental investment (Angliss and Lodge 2004). Females come into estrus between March and June when breeding occurs. Mating induces ovulation (Ramsay and Dunbrack 1986).

In most areas, pregnant females come ashore in the fall (September to November) to excavate dens in snow drifts (Amstrup and Gardner 1994, Lentfer and Hensel 1980, Ramsay and Stirling 1990). Many pregnant females in the Beaufort Sea do not enter dens until late November or early December (Amstrup and Gardner 1994). In the Beaufort Sea and, to a lesser extent, the Chukchi Sea, females may den and give birth to their young on drifting pack ice (Schliebe et al. 2006a). As noted above, the use of pack ice for denning appears to be decreasing in recent years in the southern Beaufort Sea.

Females and cubs leave the dens in the spring (February through April) when their cubs are able to survive in the outside environment. They return to the sea ice soon thereafter (Amstrup 1995).

Newborn polar bears are helpless, blind, and weigh only 0.6 kg (1.3 lbs). Growth is rapid, and cubs may weigh 10 to 12 kg (22 to 26.5 lbs) when they emerge from the den. Weaning typically occurs in the spring when cubs are about 2 years old. Young bears remain with their mothers until then. Adult females can breed again once the cubs are weaned, resulting in a typical birth interval of 3 years (Schliebe et al. 2006a).

Survival and Mortality

Polar bears are long-lived. The oldest recorded age in the wild was 32 for a female and 28 for a male (Stirling 1990). The low reproductive rates of polar bears necessitate a high survival rate to maintain population levels (Schliebe et al. 2006a).

Polar bears have been harvested both commercially and for subsistence. Russia prohibited all hunting of polar bears in 1956 as populations declined (Uspenski 1986). Illegal hunting of polar bears in the Russian Arctic began to increase in 1992. As many as 150 to 250 bears may be illegally harvested from the Chukchi/Bering stock each year (Kochnev 2006). Subsistence hunting by Alaska Natives is discussed in Section 3.3.2, Subsistence Resources and Uses.

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

Mortality related to industrial activities has occurred in the Southern Beaufort Sea. One incident was at an offshore drilling site in the Canadian Beaufort Sea in 1968. One bear died at the Stinson site in the Alaska Beaufort Sea in 1990, and another died after ingesting ethylene glycol stored at an offshore island in the Alaska Beaufort Sea in 1988. A polar bear was killed in self-defense at a remote radar defense site in 1993 after it severely mauled a worker (Allen and Angliss 2010). More recently (August 2011), a female polar bear was shot and killed by a security guard near employee housing at the Endicott oil field (Reuters 2011).

Polar bears are not known to be particularly susceptible to disease, parasites, or injury. *Trichinella* is commonly observed in polar bears throughout their range, but infections are not normally fatal (Rogers and Rogers 1976).

Hearing and Other Senses

There is limited information on the hearing of polar bears. Polar bears are not known to communicate underwater. Nachtigall et al. (2007) measured the in-air hearing of three polar bears using evoked auditory potentials. Measurements were not obtainable at 1 kHz, and best sensitivity was found in the 11.2 to 22.5 kHz range. Preliminary behavioral testing of hearing indicates that they can hear down to at least 14 Hz and up to 25 kHz (Bowles personal communication 2008 cited in URS 2009). Information on the hearing of polar bears is not relevant to reasonably foreseeable adverse effects, as the under water seismic activity would not interfere with their communication.

3.2.4.5 Influence of Climate Change on Marine Mammals

Climate change impacts on the Arctic are of growing concern. Changes to the physical environment in the Arctic are described in more detail in Sections 3.1.2.6 and 3.1.4.4. Increased temperatures, longer periods of open water with an earlier onset of melting and later onset of freeze-up, increased rain-on-snow events, warm water intrusion into the Arctic, and changing atmospheric wind patterns, are contributing to overall reduction and changes in sea ice and polar ecosystems (Allen and Angliss 2010). Loss of sea-ice is one of the most pronounced changes currently occurring and projected to continue into the future. Arctic sea ice is changing in extent, thickness, distribution, age, and timing of melt. Analysis of long-term data sets show substantial decreases in both extent (area of ocean covered by ice) and thickness of sea ice cover during the past 30 years (Perovich et al. 2010).

The impacts of climate change on marine mammals in the Arctic will likely be profound, but exactly what form these impacts will take is not easy to determine (ACIA 2005). Direct loss of habitat for feeding, breeding, pupping, and resting is likely, as are changes in prey composition and availability. Ice-obligate species, such as walrus, ringed seals, ribbon seals, bearded seals, spotted seals, and polar bears, are intricately tied to and heavily dependent upon sea ice and particularly vulnerable to changes. Concern over habitat degradation and loss due to climate change prompted petitions to list all of these species as either threatened or endangered under the ESA. Polar bears, ringed seals, and the Beringia Distinct Population Segment of bearded seals are now listed as threatened and walrus are a candidate species for listing (73 FR 79822; 73 FR 28212; 74 FR 53683;; 75 FR 65239;; 76 FR 7634; 77 FR 76706; 77 FR 76740). Detailed analyses of potential impacts of climate change on these species are available in the respective *Federal Register* notices and status reviews (see Boveng et al. 2008, Boveng et al. 2009, Cameron et al. 2010, Garlich-Miller et al. 2011, and Kelly et al. 2010a).

Recent shifts in distribution and habitat use by polar bears and walrus in the Beaufort and Chukchi seas are likely attributable to loss of sea ice habitat. Durner et al. (2009) predict that the greatest declines in twenty-first century optimal polar bear habitat will occur in these areas and, although the exact relationship between habitat loss and polar bear demographics is not known, reduced total optimal habitat will likely reduce polar bear populations. 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 will 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). Over the past decade, the number of walrus coming to shore along the coastline of the Chukchi Sea in Russia has increased, and recent use of coastal haul outs along the northwestern Alaska coast was influenced by the loss of sea ice over the Chukchi Sea continental shelf (Clarke et al. 2011a, Clarke et al. 2012, Allen and Angliss 2010, Fischbach et al. 2009). Use of shore-based haul outs may leave walrus, particularly calves and juveniles, vulnerable to disturbance related stampedes and trampling mortalities (Fischbach et al. 2009).

Loss of sea ice habitat and associated ecosystems will impact access to prey, prey availability, and species composition. Predictions for biotic change include increased primary and secondary production, particularly in the central Arctic, during summer open-water conditions; reduced benthic and pelagic biomass in coastal/shelf areas (due to increased river runoff and changes in salinity and turbidity); and increased pelagic grazing and recycling in open-water as opposed to the current tight benthic–pelagic coupling in ice-covered shelf areas (Bluhm and Gradinger 2008). If this holds true, the feeding range for ice dependent, benthic shelf–feeding Arctic marine mammals, such as walrus and bearded seals, would decrease and nearshore areas may become less productive. This could prove advantageous to pelagic-feeding or generalist marine mammals species (Bluhm and Gradinger 2008).

Bowhead whales may be sensitive to changes in Arctic weather, sea-surface temperatures, or ice extent, and resulting impacts on prey availability. It is not, however, currently possible to make reliable predictions of the effects of climate change on the species. Research by George et al. (2006, cited in Allen and Angliss 2010) showed that the body condition of bowheads harvested by Iñupiat Eskimos was better during years of light ice cover. Thus far, it appears that the Western stock of bowhead whales is tolerating the recent ice loss in the Arctic (Allen and Angliss 2010).

Range expansion of sub-Arctic and temperate species into the Beaufort and Chukchi seas has been observed in recent years and could continue with changing Arctic conditions. Humpback whales and fin whales in the northeastern Chukchi Sea appears a relatively recent phenomenon (Clarke et al. 2011a). Thus far, potential range expansion into the Beaufort Sea is limited to one humpback whale sighting just east of Barrow in 2007. This was, incidentally, a low ice year (Hashagen et al. 2009). Along with range expansion of the more temperate species comes the possibility for competition for resources with Arctic species (ACIA 2005).

Other risks to Arctic marine mammals induced by climate change include increased risk of infection and disease with improved growing conditions for disease vectors and from contact with non-native species, increased pollution through increased precipitation transporting river borne pollution northward, and increased human activity through shipping and offshore development (ACIA 2005, Huntington 2009).

3.2.5 Terrestrial Mammals

There are approximately 30 species of terrestrial mammals within the vicinity of the EIS project area (Table 3.2-6). Among these species, it is expected that only barrenground caribou (*Rangifer tarandus granti*) may experience interactions with oil and gas exploration activities during critical periods of their life cycle; therefore, this 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 erminea*	Itibiaq
Least weasel	*Mustela nivalis*	Itibiaq
Moose	*Alces americanus*	Tuttuvak
Barrenground caribou	*Rangifer tarandus granti*	Tuttu
Muskox	*Ovibos moschatus*	Umifmak
Dall's sheep	*Ovis dalli*	Imnaiq

3.2.5.1 Caribou

Four caribou (also known as "*Tuttu*" to local Iñupiat residents) herds utilize habitats along Alaska's North Slope: the Western Arctic, the Porcupine, the Central Arctic, and the Teshekpuk herds (MMS 2008, ADFG 2010a). Of those, the Western Arctic and Porcupine herds make up approximately half of the total caribou population in Alaska (ADFG 2008). Barrenground caribou generally have large home ranges throughout this treeless tundra region often migrating long distances between winter ranges, calving grounds, and summer feeding areas. Calving areas are usually located in mountain foothills or on open

[2] Nomenclature according to MacDonald and Cook 2009
[3] Bacon and Akpik 2010
[3] Interactive Inupiaq Dictionary 2011

coastal tundra (ADFG 2008). North Slope caribou tend to calve in the same general areas year after year followed by movements to insect relief areas 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 3.2-2) (Dau 2005, ADFG 2009). 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 are dispersed in the fall as they move southwest toward their wintering grounds. In winter, the range extends south as far as the Seward Peninsula and Nulato Hills, and east as far as the Sagavanirktok River north of the Brooks Range and the Koyukuk River south of the Brooks Range. Since 1996, much of the WAH has shifted its winter range from the Nulato Hills to the eastern half of the Seward Peninsula and has generally been more dispersed than prior to that time (Dau 2005).

The WAH is the largest caribou herd in Alaska. In 1970, the WAH numbered approximately 242,000, and, by 1976, it had declined to approximately 75,000 animals. From 1976 to 1990, the WAH grew 13 percent annually, and from 1990 to 2003, it grew 1 to 3 percent annually. In 2003 the WAH numbered more than 490,000. As of July 2011, the population is reported to be about 325,000, which represents an estimated four to six percent annual decline since its peak in 2003 (Woodford 2012). 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 2009b). The CAH range extends from the Itkillik River east to the Canning River and south from the Beaufort coast into the south slopes of the Brooks Range (Figure 3.2-3). CAH's summer range extends from Fish Creek, just west of the Colville River, eastward along the coast, and slightly inland, to the Katakturuk River. The CAH winters in the foothills and mountains of the Brooks Range; often overlapping with the Porcupine Caribou Herd (PCH) during the summer and winter and overlapping with the WAH and Teshekpuk Caribou Herd (TCH) in the summer and winter (Lenart 2005, MMS 2007a). The CAH has grown from an estimated 5,000 animals in 1975 to approximately 31,857 animals in 2002 (Lenart 2005, Cameron and Whitten 1979, ADFG 2009). 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 2009b). The female caribou of the CAH calve across a broad swath of the Arctic coastal plain from the Canning River drainage of ANWR west to the Colville River. Most calves are born in areas on either side of the Prudhoe Bay oil complex (USFWS 2009b). Soon after calving season, CAH move outward both east and west to 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 2009b).

Although the CAH traditionally calved between the Colville and Kuparuk rivers on the west side of the Sagavanirktok River and between the Sagavanirktok and the Canning rivers on the east side, the greatest concentration of caribou calving has shifted southwest. (Lawhead and Prichard 2002, Lenart 2007).

The Porcupine Caribou Herd

The Porcupine Caribou Herd (PCH) ranges through eastern portions of the Arctic Slope, the Brooks Range, northeastern Interior Alaska, and Canada's Northwest Territories (Figure 3.2-4). Named for the major river within its range, the Porcupine herd uses an area roughly the size of Wyoming in the Refuge, Yukon, and Northwest Territories. A July 2010 photographic census shows the PCH has grown to an estimated 169,000 animals. The herd peaked in size in 1989 at 178,000 caribou, and the four surveys that followed over the period of 1992–2001 documented a decline in the herd to 123,000 caribou. The 2010 effort is the first successful photographic census on the PCH since 2001, due to factors such as weather, poor aggregation, and herd movements (ADFG 2010a).

The calving grounds of the PCH include the northern foothills of the Brooks Range and the Arctic coastal plain from the Tamayariak River in Alaska to the Babbage River in Canada. The most often used calving area, however, is the Refuge coastal plain between the Katakturuk and Kongakut Rivers. Commonly, one-half to three quarters or more of the calves are born within this area (USFWS 2009b, ADFG 2010a). The PCH winters in the southern portion of its range, including the Refuge, where they are an important resource for the Gwich'in people (USFWS 2009b).

The Teshekpuk Caribou Herd

The Teshekpuk Caribou Herd (TCH) is distributed primarily within the NPR-A, with its summer range extending between Barrow and the Colville River (see Figure 3.2-5). 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 (MMS 2007a, ADFG 2010a). In 1984, the herd only numbered 11,800 animals but has grown rapidly since then (ADFG 2010a). The TCH calve on the east side of Teshekpuk Lake (this herd is also sometimes called the Teshekpuk Lake Herd based on their calving area) and near Cape Halkett, adjacent to Harrison Bay (MMS 2007a).

Management

Alaska has a dual system for the management of fish and wildlife resources, as both state and federal harvest regulations apply to much of the state. The federal land management agencies regulate subsistence harvest on federal public lands, while the State of Alaska provides harvest opportunities for both recreational and subsistence purposes through the Alaska Board of Game's authorities. Subsistence harvest of caribou is discussed in more detail in Section 3.3.2, Subsistence Resources and Uses, but the foundation for the state's ungulate harvest regulations are described below.

The Alaska Legislature passed the Intensive Management Law in 1994 [Alaska Statute 16.05.255(e)-(g)]. This law requires the Alaska Board of Game to identify moose, caribou, and deer populations that are especially important food sources for Alaskan residents and to insure that these populations remain large enough to allow for adequate and sustained harvest (ADFG 2010a). Intensive management is a process that starts with investigating the causes of low ungulate numbers and then identifying steps to increase those numbers. This can include restricting hunting seasons and bag limits, evaluating and improving habitat, liberalizing the harvest of predators, and predator control. For purposes of implementing the Intensive Management Law, the Board of Game has determined that the Central Arctic, Teshekpuk, Western Arctic, and Porcupine caribou herds are important for providing high levels of harvest for human consumptive use and has established the following population and harvest objectives (AAC 2011) (Table 3.2-7).

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 parturient female caribou from the overwintering areas to the calving grounds starts in late March (Hemming 1971). Often the most direct routes are used; however, certain drainages and routes are theorized to be used during calving migrations because they tend to be corridors free of or with shallow snow (Lent 1980). Bulls and nonparturient females generally migrate later. Severe weather and deep snow can delay spring migration, with some calving occurring en route (Carroll et al. 2005). Cows calving en route usually proceed to their traditional calving grounds after giving birth (Hemming 1971, MMS 2007a).

The evolutionary significance of the establishment of the calving grounds may relate directly to the avoidance of predation on the caribou calves, particularly predation by wolves (Bergerud, 1974, 1987). Caribou calves are very vulnerable to wolf predation, as indicated by the documented account of surplus predation by wolves on newborn calves (Miller et al. 1985). By migrating north of the tree line, caribou leave the range of the wolf packs, which generally remain on the caribou winter range or in the mountain foothills or along the tree line during the wolf-pupping season (Heard and Williams 1991, Bergerud 1987). By calving on the open tundra, the cow caribou also avoid ambush by predators. The selection of snow-free patches of tundra on the calving grounds also helps to camouflage the newborn calf from other predators such as golden eagles (Bergerud 1987). It is also believed that the sequential spring migration, first by cows and later by bulls and the rest of the herd, is a strategy for optimizing the quality of forage as it becomes available with snowmelt on the Arctic tundra (Whitten and Cameron 1980, Griffith et al. 2002).

The timing of snow melt and plant “green up” on the coastal plain coincides with the caribou calving period. Traditional calving grounds consistently provide high nutritional forage to lactating females during calving and nursing periods, which is critical for the health of the cow and the growth and survival of newborn calves (USFWS 2009b). The ANWR coastal plain provides an abundance of plant species preferred by caribou, *Eriophorum*-tussock sedge buds (tussock cotton grass) appear to be very important in the diet of lactating caribou cows during the calving season (Lent 1966, Thompson and McCourt 1981, Eastland et al. 1989), while orthophyll shrubs (especially willows) are the predominant forage during the postcalving period (Thompson and McCourt 1981). The availability of sedges during spring, which is thought to be dependent on temperature and snow cover, probably affects specific calving locations and calving success. Finally, the earlier migration of parturient cow caribou to the calving grounds could also serve to reduce forage competition with the rest of the herd during the calving season (MMS 2007a).

The WAH calving area is inland on the NPR-A, outside of the EIS project area (Figures 3.2-2 and 3.2-6). Typically, most pregnant cows reach the calving grounds by late May. Most give birth in the Utukok uplands during late May through early June. By mid-June large post calving aggregations begin forming as cows with neonates move west toward the Lisburne Hills (Dau 2005). The TCH's central calving area 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 2009b).

During the postcalving period in July through August, caribou generally attain their highest degree of aggregation with continuous masses of animals in herds, sometimes in excess of tens of thousands. Cow/calf groups are most sensitive to human disturbance during this period. However, during this time, most of the PCH has moved or is relocating to the Brooks Range foothills; therefore, most of this herd is no longer near the coast.

Summer Distribution/Insect Relief Areas

After calving, caribou collect in large "postcalving aggregations" to avoid predators and 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 TCH generally aggregate close to the coast for insect relief. Some small groups, however, gather in other cool, windy areas such as the Pik Dunes located about 30 km south of Teshekpuk Lake (Hemming 1971, Philo et al. 1993). Caribou aggregations move frequently from insect-relief areas along the Arctic coast (the CAH, WAH, and especially the TCH) and in the mountain foothills (PCH and some aggregations of the WAH) to and from green foraging areas (MMS 2007a).

Winter range use and distribution

The WAH caribou generally reach their winter ranges in early to late November and remain on the range through March (Hemming 1971, Henshaw 1968). The primary winter range of the WAH is located south of the Brooks Range along the northern fringe of the boreal forest (Figure 3.2-2). Since 1996, much of the WAH has shifted its winter range from the Nulato Hills to the eastern half of the Seward Peninsula and has generally been more dispersed than prior to that time (Dau 2005). However, in recent winters, >30,000 WAH caribou have wintered in the northwest portion of their range. During two of these winters (1994 to 1995 and 1999 to 2000), caribou wintering along the Chukchi Sea coast between Cape Lisburne and Cape Krusenstern experienced high, localized mortality; the investigation indicated that caribou in this area were malnourished (Dau 2005). During winters of heavy snowfall or severe ice crusting, caribou may overwinter within the mountains or on the Arctic Slope (Hemming 1971). Even during normal winters, some caribou of the WAH overwinter on the Arctic Coastal Plain. The majority of the PCH often winter on the south side of the Arctic National Wildlife Refuge or in Canada (Figure 3.2-4). The CAH overwinters primarily in the northern foothills of the Brooks Range (Figure 3.2-3) (Roby 1980) (MMS 2007a). The TCH was 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 (Henshaw 1968, Bergerud 1974, Bergerud and Elliot 1986). The numbers of caribou using a particular portion of the winter range are highly variable from year to year (Davis et al. 1982; Fancy et al. 1990, as cited in Whitten 1990). Range condition, distribution of preferred winter forage (particularly lichens), and predation pressure all affect winter distribution and movements (Roby 1980, Bergerud 1974, MMS 2007a).

3.3 Social and Economic Environment

3.3.1 Socioeconomics

Economic activity, broadly defined, is a basic determinant of socioeconomic change and therefore the starting point in assessing change for the affected communities. BOEM NEPA documents define a sociocultural system as encompassing social organization, cultural values, and institutional organization of communities (MMS 2007a, MMS 2007c, Impact Assessment Inc. 2011). The discussion of subsistence and cultural values associated with this economic activity can be found in Section 3.3.2. This description will be 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 project area, followed by a description of the source and relative amounts of public revenue and expenditures budgeted by these communities.

<u>**Economic Sectors and Activity**</u>

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, generate contracts for service providers within the NSB and the state, and provide royalty and tax revenue to local, state and federal government. Extensive oil and gas exploration activities have occurred on Alaska's North Slope since 1940, with large-scale development and production beginning at the Prudhoe Bay field in the 1970s Also in the late 1970s and early 1980s, exploration for oil and gas was initiated offshore into the Beaufort and Chukchi seas. Nearshore Beaufort Sea development and production began in the 1980s (MMS 2008); no development and production has occurred to date in the Chukchi Sea. Offshore lease sale environmental documents by BOEM and ADNR Division of Oil and Gas provide a more detailed description of the history of oil and gas development and production. These studies are available on the BOEM and ADNR websites: http://www.gomr.boemre.gov/homepg/lsesale/lsesale.html and http://www.dog.dnr.state.ak.us/oil/. The State of Alaska has held oil and gas lease sales on the North Slope and Beaufort Sea since 1964. The state leases offshore acreage for exploration (up to three miles offshore, including off of barrier islands). The 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 February 1, 2013, there were 183 active leases in the Beaufort Sea OCS where exploration activity could occur (BOEM 2013). Thirty exploratory wells have been drilled, and there is production from a joint federal/state unit of over 23 million barrels of oil since 2001 (MMS 2009a).

Federal OCS lease sales in the Chukchi Sea have only been offered since 1988. Two-dimensional seismic data collected starting in 1969 and five large prospects drilled between 1989 and 1991 resulted in no commercial development of oil or gas on the 483 leased tracts (MMS 2009a). All 483 leases have now expired. 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, and exploratory drilling in 2012 on two lease tracts. In December 2012, 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.

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 (ADCCED 2011a). Government bodies are also the largest employer with 1,973 employees in the NSB (58.1 percent) and Northwest Arctic Borough (NAB) employs 1,245 workers (39.2 percent) (ADLWD 2005, NSB 2005; ADCCED 2011a). Major local government employers include borough and other municipal government and school districts. Government funding also influences construction employment for capital projects in the NSB and NAB.

Transportation

Trade, transportation, and utilities are the largest non-government sector employers in the State of Alaska (ADCCED 2011a). Nome, Kotzebue, Barrow, and Prudhoe/Deadhorse are regional transportation and utility hubs for surrounding villages and for oil and gas and mining support activities. Transportation services are a key economic sector and source of employment for the region.

Mining

Mining is a major economic sector in the NAB, and has occasionally resulted in economic activity in the NSB. The Red Dog Mine creates local and statewide employment, generates contracts for service providers within the borough and the state, and provides payment in lieu of tax (PILT) revenue to local and state government.

Public Revenue and Expenditures

The state and local governments levy taxes on the oil and gas industry for onshore and offshore exploration and production on state and private lands and in state waters. Lease sales and production on state lands and waters also generates state royalty payment. Production on federal lands and waters generates federal royalty and tax revenue; however, revenue sharing is limited from activities in the federal OCS. Though federal revenue sharing is limited, any offshore development would require billions of dollars of onshore facilities that would likely be subject to borough and state taxes (NEI and ISER 2011). Offshore oil production would also add to the thru put of the Trans-Alaska Pipeline System, paying tariff, 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 2011, NSB 2010). Communities within the NSB are allowed to set sales tax and other special taxes, but the Borough property tax mill rate is set at a ceiling of 18.5 (Table 3.3-1).

Northwest Arctic Borough – NAB generates revenue from activities related to government, mining, health care, transportation, services, and construction. The NAB FY 2011 budget is $11.6 million (NAB 2011). The Red Dog Mine, 90 miles north of Kotzebue, is the world's largest zinc and lead mine. Owned by NANA Regional Corporation and operated by Teck, Red Dog provides 370 direct year-round jobs and over a quarter of the borough's wage and salary payroll (ADCCED 2011b). NAB received $972,000 in PILT and $6.73 million from Teck in 2010 (NAB 2010). The Red Dog Mine Extension (Aqqaluk Project) EIS explains that without PILT funds from the Red Dog Mine, the NAB would be much more reliant on state and federal funds. These funds are not only important logistically but give the region a degree of self-reliance and self-determination (EPA 2009).

City of Nome – The Nome FY 2011 budget is $10.8 million (City of Nome 2011a). Government services provide the majority of employment, and the largest revenue source in 2010 was capital grants and contributions ($6.71 million). Property taxes generated $1.69 million, and general sales tax generated $4.43 million (City of Nome 2010). Retail services, transportation, mining, medical, and other businesses provide year-round income. Several small gold mines continue to provide some employment, and NovaGold Resources, Inc., a large gold mining operation, is developing a mine eight miles north of Nome. In 2009, 42 residents held commercial fishing permits.

State of Alaska Revenue and Expenditures

The main source of Alaska's revenue comes from tax and royalty revenue from oil and gas production. Depending on the tax structure and price and volume of oil produced, state revenue can vary significantly. Tax revenue totaled $4.2 billion in FY 2009 (a decline from FY 2008 when $8.5 billion was collected). Approximately 90 percent of all state tax revenue is paid by the oil and gas industry ($3.8 billion, see Figure 3.3-1). Investments held by the Alaska Permanent Fund and other investment accounts, were $2.5 billion in FY 2009. Oil and gas contributed $6.1 billion through tax and royalty payments (ADCCED 2011a). State revenue peaked in FY 2008 at $13.1 billion as a result of record oil prices and changes in the state oil and gas tax structure.

For future oil and gas activities in the NSB, the state would collect $20 million in property tax and return $18.5 million to the NSB (see Table 3.3-1 for the local tax structure).

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%

Note:

a) Definitions of city and borough powers and responsibilities are defined in the AK Constitution, Article X, Section 3, 5 and 7 and AS 29.04.020

b) Unalaska/Dutch Harbor is not part of the EIS project area, but it is discussed in Section 4.5.3.1

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

Federal Revenue and Expenditures

Overall, federal revenue from personal income tax, corporate tax, and other types was $2.11 trillion in 2009 (OMB 2011). Oil and gas lease sales and production in federal lands and waters generate federal royalty revenue. For example, the recent Chukchi Seas lease sale has generated $2.66 billion in bonus bids (NEI and ISER 2011).

Federal spending for the State of Alaska totaled $14.2 billion, ranking Alaska first in the U.S., based on per capita federal spending (ADCCED 2011a). Federal spending has a significant impact on Alaska's economy through annual contributions to retirement and disability ($1.5 billion), other direct payments ($875 million), grants ($3.7 billion), procurement ($4.97 billion), and salaries and wages (military and government employment; $3.1 billion) (Census 2010). In many cases, state dollars are able to match federal funds for in-state community programs and projects.

3.3.1.2 Employment and Personal Income

Employment and income statistics for the State of Alaska mirror important economic sectors to some degree in the NSB and NAB. The government sector is a major employer, particularly in the NSB and NAB. The oil and mining industry generate high income jobs and service contracts for local businesses and the construction industry. Transportation and utilities also provide substantial levels of employment.

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 only modest direct economic benefit in the form of jobs, household income, business purchases, and public revenue for most residents (Goldsmith 2007). At the scale of Figure 3.3-3, the value of local wages generated from these industries cannot be seen on the bar chart.

Oil Industry Employment and Residency

North Slope oil field operations provide employment to over 5,000 people who are not residents of the NSB. These employees arrive from Anchorage, other areas of the state, and the lower 48 (ADCCED 2011b) and rotate in and out of work sites. This transient population is not reflected in the Census numbers until 2010 as shown in Table 3.3-4.

The 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. 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 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

	2000[a]		2010[b]	
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***

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) 2006-2010 American Community Survey, 5-Year Estimates
c) Population aged 16+
d) Unemployed and seeking work

Alaska Economic Trends special issue on the northern region of Alaska explains that Alaska has naturally higher unemployment rates because of the nature of the state's economy rather than relative economic health (ADLWD 2005). The state's economists theorize that more jobs are temporary or seasonal, and there are greater rates of geographic mismatches between employment opportunities and available/skilled workers.

Rural communities in general have a large number of discouraged workers who are involuntarily unemployed because they have stopped attempting to find work and/or they have exhausted their employment security benefits. In addition, underemployment is a common condition where an individual involuntarily worked less than 40 weeks in the previous year and/or did not make full use of their education, skill, or abilities (NSB 2005). Employment and race data in Section 3.3.10, Environmental Justice, show that unemployment and poverty disproportionately affects Alaska Native people.

North Slope Borough Employment

Oil and gas exploration and development on Alaska's North Slope is the principal industry in the NSB; however, the oil and gas industry provides a limited amount of direct employment to NSB residents. Residents with vocational or college degrees may be hired for professional and technical work in Prudhoe Bay and Anchorage. Temporary employment opportunities include subsistence and protected species observers or village liaisons. Previous MMS lease sale EIS documents include descriptions of a historic lack of Alaska Native employment in and near Prudhoe Bay (MMS 2008, MMS 2007a). Indirect employment is provided through service contracts with Alaska Native corporations and other providers. However, while a limited percentage of the direct oil and gas jobs are taken by local residents, a much larger share of the indirect jobs in other sectors of the economy that provide goods and services to support OCS exploration, development, and production are obtained by local residents from support contracts for North Slope and OCS projects (Northern Economics Inc. and ISER 2010). It is estimated that for each direct job created by future OCS activity in the oil and gas sector (and the revenues associated with production) an additional 4.8 indirect jobs are created in the Alaskan economy in the form of infrastructure, support, and state and local government employment (Northern Economics and ISER 2010).

The major employers are the NSB, North Slope School District, and the Alaska Native corporations and tribal organizations. Although dated, Figure 3.3-4a, Top Employers in the NSB, was produced from supplemental surveys to the U.S. Census. Figures 3.3-4a and 3.3-4b demonstrate that the majority of residents employed in the NSB work for the NSB and other local governments in an administrative, educational, or social service capacity. In 2009, approximately 60 percent of resident workers by industry worked for local government (ADLWD 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 ANCSA village corporation), and NANA Corporation (ADCCED 2011b). With the exception of KIC, all of NANA Region's ANCSA village corporations have merged with NANA Corporation, which makes it the area's largest corporation in the private sector (ADLWD 2005). Figure 3.3-4c demonstrates that the "education, health and social services" are the largest employment sector, similar to the NSB. However, the "transportation, warehousing and utilities" is a larger employment sector for the NAB than it is for the NSB, as well as a large "agriculture, forestry, fishing & hunting, mining" sector that does not rank as high for NSB. In 2009, local government accounted for 39 percent of resident employment (ADLWD 2011a).

City of Nome

The City of Nome is the supply, service, and transportation center of the Bering Strait region. Government services provide the majority of employment. Retail services, transportation, mining, medical, and other businesses provide year-round income. Several small gold mines continue to provide some employment, and NovaGold Resources is developing a mine 8 miles north of Nome. In 2009, 42 residents held commercial fishing permits (ADCCED 2011b). The top employers in Nome include Bering Strait School District, Kawerak (the regional Native non-profit corporation), and Norton Sound Health Corporation (ADLWD 2011a).

Personal Income

Wage Income

Average monthly wages in Alaska total $3,886 per month per household, but the oil and gas extraction industry has the highest monthly wages at $13,924. Mining support was second at $8,164 per month (ADCCED 2011a). The most common employer is the government, where the average monthly wages were $4,293 in 2010. All industries combined produced $4.05 billion in total wages (including commission, bonuses, and other gratuities) in the state in the third quarter of 2010 (ADLWD 2011c). Table 3.3-3 shows 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 (US Census Bureau 2010).

Figure 3.3-5 demonstrates the proportion of workers making under $20,000 per year. This is likely due to a lack of opportunities with local governments, school districts, construction camps, and support facilities for both the oil and gas and mining industries.

Transfers and Dividends

Transfer payments and dividends can provide a substantial contribution to household income in rural Alaska. Transfer payments can represent the value of services to individuals in government programs like Medicaid/Medicare, food stamps, housing assistance, and Social Security payments (a more detailed description of the distribution of transfer payments in Alaska can be found in Goldsmith 2007). Dividends come in the form of Alaska Permanent Dividend Fund and shareholder dividends from Alaska Native Corporations. In 2010, the Alaska Permanent Dividend Fund was $1,281 per qualified Alaska resident. Depending on financial performance, dividends to shareholders may be paid by regional and village Alaska Native Corporations. Table 3.3-5 provides 2009 dividend per share for each of the three regional corporations in the project area: Arctic Slope Regional Corporation (ASRC); NANA Regional Corporation (NANA); and Bering Straits Regional Corporation. As an example of the higher end of dividend payments, ASRC has distributed over $423.8 million in dividends to shareholders since its incorporation (ADCCED 2011a, Stricker 2010).

Contribution of Subsistence

Subsistence is the customary and traditional uses of wild, renewable resources for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation. It is a critical component of the project area's economy. Under NMFS' MMPA implementing regulations, subsistence is defined as "the use of marine mammals taken by Alaskan Natives for food, clothing, shelter, heating, transportation, and other uses necessary to maintain the life of the taker or those who depend upon the taker to provide them with such subsistence" (50 CFR Part 216.3). Subsistence activity is inseparable from the Alaska Native cultures, including the Iñupiat Eskimo 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 3.3.2.

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 (US Census 2011a). Population growth is a result of natural increases (births minus deaths) and positive net migration as a result of assignment of military personnel (ADCCED 2011a). The State of Alaska's Alaska Native population was 13 percent statewide, but the rural Arctic communities are predominantly Alaska Native. The Institute of Social and Economic Research conducted a study on the special socioeconomic features of remote rural Alaska and found that this region has more children and fewer middle-aged adults. The non-Native population is composed primarily of working age adults. Men outnumber women, particularly among young adults (Goldsmith 2007). Complete race and poverty tables can be found in Section 3.3.10, Environmental Justice.

Regional Demographics

Table 3.3-3 provides a snapshot of regional demographics showing numerous similarities across the northern regions in terms of populations, racial composition and educational attainment.

North Slope Borough Demographics

There are eight communities within the NSB, all of which occur in the EIS project area. The population of the NSB is estimated at 9,430 (ADLWD 2005, U.S. Census Bureau American Community Survey). The vast majority the borough's population is Alaska Native. There have been short-term population spikes in the last thirty years which have been attributed to the construction of major infrastructure and resource development projects (Shepro et al. 2003). The median age of the borough is estimated at 26 years, which is substantially younger than the state median age (32.9 years) (Table 3.3-3). An estimated 60 percent of NSB residents have educational attainment of a high school diploma or less; 40 percent of the borough residents have attended some college, or attained a college diploma (Table 3.3-3).

Northwest Arctic Borough Demographics

There are 11 communities within the NAB (of these Kivalina and Kotzebue occur in the EIS project area). The population of the NAB is estimated at 35,862 (ADLWD 2005, US Census Bureau 2006-2010 5-Year American Community Survey). The vast majority of the NAB population is Alaska Native (Table 3.3-3). The median age of the borough is estimated at 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 occurs in the EIS project area. The majority of the Nome Census Area is Alaska Native (75.8 percent), although slightly lower than the NAB. 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. 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**

North Slope Borough Communities

Kaktovik is located on the northern shore of Barter Island in the eastern Beaufort Sea and has a long history as an Iñupiat meeting and trading place (Shepro et al. 2003). The City of Kaktovik was established in 1923 as a fur trading post and was moved three times, partly in response to Department of Defense Distant Early Warning (DEW) facilities. It was incorporated as a city in 1971. Kaktovik has a population of 239 residents (2010 Census), and like other North Slope communities is a highly active subsistence community for marine and terrestrial mammals. The borough provides electricity, water and sewer, and a health clinic, as well as a school that serves students from kindergarten through grade 12.

Prudhoe Bay is an industrial site and oil field, not a community. As described in Section 3.3.1.1, exploration activities began in the 1940s. An industry-support community and airfield was developed at Deadhorse in the 1970s. Prudhoe Bay's inter-connected, industrial infrastructure includes roadways, pipelines, production and processing facilities, gravel mines, and docks (MMS 2008).

The ***Nuiqsut*** area on the Colville River was used for centuries for subsistence activities, but the Iñupiat village of Nuiqsut was abandoned until it was resettled in 1973 by 27 Barrow families (NSB 2005). The current population is 402 (2010 Census), and the residents participate in a high level of subsistence activity and subsistence resource use (NSB 2005). The borough provides electricity, water and sewer, and a health clinic, as well as a school that serves students from kindergarten through grade 12. The Alpine oil field and satellite infrastructure are nearby.

Barrow is located at a point that is the dividing line between the Beaufort and Chukchi seas. The area was historically a hunting and fishing area for Iñupiat Eskimos with archaeological sites indicating habitation from 500-900 A.D (ADCCED 2011b). Commercial whaling and trading was established officially at the turn of the nineteenth century (NSB 2005). The City of Barrow was incorporated in 1958. It is the largest community within the NSB with 4,212 residents and only about 55 percent identified as Alaska Native (2010 Census). The population increases through the 1980s to today were stimulated by a boom in Barrow's economy and an influx of non-Alaska Natives into the community (MMS 2008). Like Kaktovik, the military had a large influence on the community before it was incorporated into a city due to the construction and operation of military installations, including the Naval Arctic Research Laboratory and DEW Line Station. Barrow's unemployment rate (21.4 percent estimated in 2010) is still high despite having a more diverse economy than smaller NSB communities. The borough provides electricity, water and sewer, as well as a school that serves students from kindergarten through grade 12. Advanced education is available as well through Ilisagvik College. The primary healthcare facility for the North Slope region is the Samuel Simmonds Memorial Hospital, operated by Arctic Slope Native Association, the regional Native non-profit corporation.

Wainwright is located on the Chukchi Sea within the region that has become the NPR-A. It is a community with 556 residents (2010 Census) that is growing slowly and steadily. The City of Wainwright was incorporated in 1962, but the construction of a school and health clinic dates back to 1904. Numerous historic and contemporary hunting and fishing camps are in the area; indigenous residents refer to themselves as the Tagiumiut or "people of the sea." Reindeer herding, oil and gas exploration, and military activities in recent history have greatly influenced the community (NSB 2005). The borough provides electricity, water and sewer, and a health clinic, as well as a school that serves students from kindergarten through grade 12.

Point Lay is located on the Chukchi Sea and was established as a trading post in the 1920s after small hunting and fishing groups from the area congregated south of the Kokolik River mouth. The village has been moved a few times before its current location on the Chukchi Sea coast (NSB 2005). Point Lay has not been incorporated as a city, but the Native Village of Point Lay is a federally recognized tribe, and Cully Corporation is the ANCSA village corporation. A DEW line site just southwest of the community was removed in 2005 (ADCCED 2011b). The borough provides electricity, water and sewer, and a health clinic, as well as a school that serves students from kindergarten through grade 12. Water from a lake is treated for residents to haul to tanks at their homes. The 2010 Census estimated the population to be 189, a loss of about 58 people since the 2000 Census. This 31 percent population loss is the largest relative population loss for all the NSB communities since 2000. About 783 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). The Point Hope peninsula is one of the oldest continuously occupied "Tikeraqmuit" Iñupiat Eskimo areas in Alaska with different settlement names over the past 2,500 years. Commercial whalers brought an influx of Westerners by 1848 who disappeared by the early 1900s. Strong influences included commercial whaling, trading, reindeer herding, the introduction of alcohol and diseases, missionaries, and federal agencies. The City of Point Hope was incorporated in 1966 and moved to its present location after a storm surge in 1978 (NSB 2005). The borough provides electricity, water and sewer, and a health clinic, as well as a school that serves students from kindergarten through grade 12.

Northwest Arctic Borough Communities

Kivalina is located on the northern tip of a barrier reef between the Chukchi Sea and Kivalina River. Kivalina is the only village in the NAB region that hunts bowhead whale, and it is a member of the Alaska Eskimo Whaling Commission. Historically, it was a stopping-off place for seasoned travelers between Arctic coastal areas and Kotzebue Sound communities (ADCCED 2011b). The community has been subject to severe erosion and wind-driven ice damage to the current site. Storm surges and erosion have been a concern since the community was first established (City of Kivalina 2010). The City of Kivalina was incorporated in 1969. The economy is dependent on subsistence activities, and the infrastructure is modest; water is treated and stored in a community water tank where the public hauls it to their homes. Most residents haul their own honey buckets (sewage containers) to an open disposal site and a washeteria (public laundromat) provides showers (NSB 2005). The NAB provides kindergarten through grade 12 education.

Kotzebue, originally named Kikiktagruk or "place that is almost an island" has been occupied by Iñupiat Eskimos for at least 600 years (City of Kotzebue 2000). The city was formed in 1958 as a service and transportation center for all villages in the northwest region. Kotzebue has a healthy cash economy, a growing private sector, and a stable public sector. Due to its location at the confluence of three river drainages, Kotzebue is the transfer point between ocean and inland shipping. It is also the air transport center for the region. Activities related to oil and minerals exploration and development have contributed to the economy. The majority of income is directly or indirectly related to government employment, such as the school district, Maniilaq Association, the city, and the borough. The Teck Alaska Red Dog Mine is a significant regional employer. Commercial fishing for chum salmon provides some seasonal employment. In 2009, 115 residents held commercial fishing permits. Most residents rely on a combination of subsistence activities and cash income (ADLWD 2011b).

Nome Census Area Unorganized Borough

Nome was established as a gold mining town in 1901, but Malemiut, Kauweramiut, and Unalikmuiut Eskimos occupied the Seward Peninsula historically. All former villagers from King Island were moved to Nome by 1970. The town site was built along the Bering Sea and acts as the supply, service, and transportation center of the Bering Strait region. . It has provided support for offshore activities in the Chukchi Sea. The Nome 2010 population was 3,598, which was a modest increase from 3,505 in 2000 (U.S. Census). Nome has the largest white population in the 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 project areas (see Table 3.3-51 in Section 3.3.10, Environmental Justice), however nearly all of the individuals living in poverty are Alaska Natives by ethnicity.

Complete community profiles can be found in other publications (e.g. 2005 NSB Comprehensive Plan, individual community comprehensive plans), and updated online profiles at the Alaska Department of Commerce, Community, and Economic Development (ADCCED) Division of Community and Regional Affairs (DCRA) *Alaska Community Database* website: http://www.commerce.state.ak.us/dca/commdb/CIS.cfm.

3.3.1.4 Social Organizations and Institutions

The following represents a brief overview of social and governmental organizations in the project area and their roles among communities. Cultural values are incorporated into governmental and tribal (governmental) bodies in the project area (see Table 3.3-6) to ensure that economic development and social services address the needs of local communities appropriately.

Village/Tribal Governments

All communities described in this section, except for Prudhoe Bay, 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 necessaity 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 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 municipal governments as representing all residents, while tribal governments represent the interests of the tribal membership. Cities within the NSB and NAB receive public education from the boroughs and can exercise their power to enforce special taxes, but they do not set property taxes. The classification of project area cities can be found in Table 3.3-1.

North Slope Borough is Alaska's largest borough, encompassing 88,000 square miles of land and 5,900 square miles of water. It was incorporated in 1972 and adopted its Home Rule Charter in 1974 allowing it to exercise any legal governmental power in addition to its mandatory powers of taxation, property assessment, education, and planning and zoning services. The borough provides a full range of services, including police and fire protection, search and rescue, construction and maintenance of roads and other infrastructure, water and wastewater treatment, light, power and heat, health and clinic services, fuel storage, solid waste collection and disposal (FY2009 Report). NSB is also financially accountable for a legally separate school district. In addition, there are seven incorporated municipal governments within the NSB. The borough's administrative center, Barrow, has operated as a city since 1958. Barrow is the largest community which acts as the hub of government, transportation, communications, education, and economic development (ADCCED 2011b).

Northwest Arctic Borough is the second largest borough in Alaska, encompassing 35,800 square miles. It was incorporated in 1986 and adopted its Home Rule Charter in 1987, allowing it to exercise any legal governmental power in addition to its mandatory powers of taxation, property assessment, education, and planning and zoning services. NAB does not levy taxes on its residents, although Kivalina and Kotzebue do. Many local services are provided by the cities, but education is the responsibility of the borough (ADCCED 2011b). In addition, there are 11 incorporated communities with municipal governments within the NAB (of these Kivalina and Kotzebue occur in the EIS project area). Kotzebue is the largest community in the borough and serves as the hub of government, transportation, communications, education, and economic development. Kotzebue is also the gateway to four major National Park units.

The ***City of Nome*** was formed in 1901 after gold was found in the area. The region in which Nome is situated is does not have an incorporated borough; statistics are gathered for the Nome Census Area. Nome is a first class city that manages a school district, contains the offices of Bering Straits Native Corporation, Kawerak, and hosts the Norton Sound Regional Hospital. Nome is the supply, service, and transportation center of the Bering Straits region (ADCCED 2011b).

Alaska Native Regional and Village Corporations

Alaska Native Corporations were created as a result of the 1971 Alaska Native Claims Settlement Act that 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 Arctic Slope Regional Corporation (ASRC), NANA, and Bering Straits Regional Corporation (listed in Table 3.3-5). These ANCSA corporations reflect a mix of traditional and Western values (Braund and Kruse 2009).

The 2009 dividend per shareholder is shown in Table 3.3-5. ASRC generated 1.94 billion in revenue in 2009, the highest for the 12 Alaska regional corporations, but down from its record $2.3 billion in 2008. Since its incorporation, ASRC has distributed over $423.8 million in dividends to shareholders (ADCCED 2011a, Stricker 2010).

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

ANCSA Corporation	Region	Money from ANCSA (mil)	2009 Revenue (mil)	Net Income (mil)	Shareholders	Dividend Per Share (2009)
Arctic Slope Regional Corporation	North Slope	$22.5	$1,945	$169.3	9,616	$57.12
NANA Regional Corporation	Northwest Alaska	$44.0	$1,259	$17.1	12,044	$12.00
Bering Straits Regional Corporation	Nome and Seward Peninsula	$38.2	$162	$8.1	6,334	$1.00

Source: 2009 Alaska Economic Performance Report (ADCCED 2011a)

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 a small amount of employment opportunities for North Slope and NANA regional and village corporation shareholders because many of these jobs are in Anchorage, the lower 48, or require travel to Prudhoe Bay. (Data on the numbers of shareholders that find employment with Native Corporations and their subsidiaries are unavailable.)

Along with ASRC and NANA, many North Slope Village Corporations have subsidiaries that provide oil field services (a list of village corporations can be found in Table 3.3-6). Like regional corporations, village corporations also provide services throughout the state and the world. Administrative offices are not always in their respective villages.

Regional Non-Governmental Organizations

Native regional non-profits (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).

AEWC was established in 1977 to protect the subsistence practice of bowhead whaling that the International Whaling Commission attempted to ban. AEWC has helped contribute to the management of the bowhead whale and provided traditional knowledge to the oil and gas industry regarding potential impacts and mitigation. More can be found on 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 project area, member entities include North Slope Borough, Kawerak, and NANA Regional Corporation.

The Alaska Nanuuq Commission was established in 1994 to "represent the villages in North and Northwest Alaska on matters concerning the conservation and sustainable subsistence use of polar bear" (Alaska Nanuuq Commission 2011). Committee membership includes representatives from fifteen tribal councils; communities within the project area that participate include: Kaktovik; Nuiqsut; Barrow; Wainwright; Point Lay; Point Hope; Kivalina; and Kotzebue. Additional information is available on the commission website, http://www.nanuuq.info/index.html.

Understanding that ice seals are important food sources for polar bears and coastal subsistence communities, the Alaska Nanuuq Commission established the Ice Seal Committee. The purpose of the committee is to "preserve and enhance the marine resources of ice seals including the habitat; to protect and enhance Alaska Native culture, traditions, and especially activities associated with subsistence uses of ice seals; to undertake education and research related to ice seals" (Ice Seal Committee 2005). Committee membership includes representatives from five entities located within the Alaska coastal regions with polar sea ice, including: NSB; Maniilaq; Kawerak; Association of Village Council Presidents; and Bristol Bay Native Association. Additional information may be found on the Nanuuq Commission website, http://www.nanuuq.info/iceseal.html.

Table 3.3-6 Institutions in the EIS Project Area

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

Note: * The Alaska and Inuvialuit Beluga Whale Committee serves the entire project area; the Alaska Nanuuq Commission serves the North Slope Borough and Northwest Arctic Borough regions.

Sources:
"Indian Entities Recognized and Eligible to Receive Services from the United States Bureau of Indian Affairs' (75 *Federal Register* 60810, October 1, 2010)
Alaska Department of Community and Economic Development Community Database Online Available from: http://www.commerce.state.ak.us/dca/commdb/CF_BLOCK.htm

3.3.2 Subsistence Resources and Uses

3.3.2.1 Introduction

This section describes the subsistence harvest patterns of the Iñupiat communities in the EIS project area: Kaktovik; Nuiqsut; Barrow; Wainwright; Point Lay; Point Hope; Kivalina; and Kotzebue. This community-by-community description provides general information on harvest information by resource, seasonal subsistence harvest patterns, including community, timing of the subsistence harvest cycles, and harvest-area participation rates by community.

3.3.2.2 Definition of Subsistence and Cultural Importance

<u>Definition of Subsistence for this EIS</u>

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)).*

<u>The Cultural Importance of Subsistence</u>

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 2010).

Subsistence production is also linked to the market economy. Subsistence harvest byproducts are used by many households to earn cash from crafting whale baleen and walrus ivory and from harvesting furbearing mammals. 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 (See also Davidson 1974, Arnold 1978, Lewis 1978, Lonner 1980, Langdon and Worl 1981, Kelso 1981, 1982, Case 1984, 1989, Ellanna and Sherrod 1984, Berger 1985, Caulfield and Brelsford 1991, Bryner 1995, Naiman 1996, ADNR 1997). Communities express and reproduce their unique identities based on the enduring connections between current residents, those who used harvest areas in the past, and the wild resources of the land. Elder's conferences, spirit camps, and other information exchange and gathering events serve to solidify these cultural connections between generations and between the people and the land and its resources.

Subsistence activities and wage economic opportunities are highly developed and highly interdependent (Kruse et al. 1981, Kruse 1981 and 1982). Subsistence activities are dependent upon cash for equipment and operating costs, but at the same time these activities are very cash efficient, in that relatively modest investments of cash produce large quantities of fresh, nutritious food. Moreover, households that are most active in subsistence activities tend also to be those highly involved in the wage economy. Monetary resources are necessary to assist in the harvest of subsistence resources, both as they affect individual harvesters (such as to purchase a boat, snow machine, all-terrain vehicle, fuel, and guns and ammunition) and as they affect the head of a whaling crew. The heads of the whaling crews traditionally occupy positions of authority and respect within their communities (EDAW-AECOM 2007). Whaling captains' are responsible for the readying of supplies, weapons, boats and gear for the hunt, distribution and storage of the meat and decisions on when and where to locate hunting camps. Full-time employment is also limiting as it affects the time a subsistence hunter can spend harvesting. In summer, extensive hunting and fishing can be pursued after work and without any daylight limitations, but, during midwinter and winter, daylight is a limiting factor (MMS 2008).

As one North Slope hunter observed:

> *The best mix is half and half. If it was all subsistence, then we would have no money for snowmachines and ammunition. If it was all work, we would have no Native foods. Both work well together.* (ACI et al. 1984 in MMS 2008)

Cultural Importance of Subsistence Hunt of Bowhead Whales and Other Marine Mammals

Iñupiat and Siberian Yupik Eskimos have hunted bowhead whales continuously for over 2,000 years (Stoker and Krupnik 1993). Hunting bowhead whales in Arctic Alaskan waters remains a communal activity that supplies important meat and maktak (the skin and a layer of blubber used for food) for entire communities, as well as for feasts and during annual celebrations. Formalized patterns of hunting, sharing, and consumption characterize the modern bowhead harvest. In addition, whaling captains are highly respected and carry the burden of the hunts within their communities for their traditional knowledge of ice, weather, and whale behavior, which is necessary to hunt successfully, for their generosity in supporting their whaling crews, and for their stewardship of traditions of sharing and distributing maktak throughout the community (NMFS 2008b). As one whaling captain expressed:

> *We have to go 93 miles from here to go hunt, do our subsistence fall hunt and be out there until we meet our -- until we meet our quota. That's taking away from our families and very costly. It's a burden to the captain just to try and provide the needs of what we depend on; a subsistence lifestyle.* (Nuiqsut Public Scoping Meeting, March 11, 2010)

The bowhead whale hunt represents one of the greatest concentrations of community-wide effort and time. It is highly productive, accounting for a substantial percentage of the food consumed in the Beaufort communities and to a lesser extent in several of the Chukchi Sea communities. As the principal activity through which traditional skills for survival in the Arctic are passed from elders to younger generations, the bowhead hunt provides ongoing reinforcement of the traditional social structure. Thus, the bowhead subsistence hunt is a large part of the cultural tradition and modern cultural identity (Worl 1980, Braund et al. 1997). Spiritual and moral values, beliefs, and cultural identity are expressed and recreated through subsistence harvest activities. The great gifts of food from bowheads are recognized in the ceremonies of the Nalukataq festival at the conclusion of spring whaling (NMFS 2008b).

In addition to this high reliance on bowhead whales, Iñupiat and Siberian Yupik communities harvest many species throughout an intricate annual cycle of subsistence activities (NMFS 2008). The species composition of subsistence harvests provides an indication of the flexible adaptation of subsistence patterns to ecological patterns of abundance and access to various resources. For example, while bowhead, caribou, and fish make up the majority of subsistence foods in most of the Iñupiat communities, the Chukchi Sea communities rely more heavily on beluga whales, walrus, and seal than do the Beaufort Sea communities. The Beaufort Sea communities of Kaktovik, Nuiqsut, and Barrow have high proportions of total subsistence food derived from the bowhead harvest and lower proportions from other marine mammals. The communities of Wainwright, Point Lay, Point Hope, Kivalina, and Kotzebue harvest greater numbers of marine mammals and fish (NMFS 2008b).

Additional comprehensive descriptions of subsistence harvest patterns and uses are found in BOEM, BLM, and U.S. Army Corps of Engineers (USACE) EIS and EA documents and are incorporated by reference: the Liberty Development and Production Plan final EIS (MMS 2002); the Beaufort Sea Multiple Sale Final EIS (MMS 2003); the Northwest NPR-A Final IAP/EIS (BLM and MMS 2003); the Beaufort Sea Sale 195 EA (MMS 2004); the Alpine Satellite Development Plan Final EIS for potential expansion of Alpine field production near Nuiqsut (BLM 2004); the Northeast NPR-A Amendment IAP/EIS (BLM 2005) and the final supplemental IAP/EIS (BLM 2008a); the USACE Delong Mountain Terminal Project Draft EIS (USACE 2005); the Kobuk-Seward Peninsula Resource Management Plan (BLM 2006); the MMS seismic-survey PEA (MMS 2006b);; the 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 2012-2017 Five Year Oil and Gas Leasing Program Final EIS (BOEM 2012); and USGS (2011).

Additional information is included in: ACI et al. 1984; ADFG 1995; Alaska Natives Commission 1994; Braund and Burnham 1984; Braund and Associates 1989a, 1989b; Braund and Associates and UAA, ISER 1993a, 1993b; Braund and Associates 1996; Braund and Associates 2010; Besse 1983; Brower et al. 2000; Brower and Opie 1997; Burch 1998; City of Nuiqsut 1995; Craig 1987; Fuller and George 1997; George and Kovalsky 1986; George and Nageak 1986; Hall 1983; Harcharek 1995; Hoffman et al. 1988; Huntington and Quakenbush 2009; Impact Assessment 1989, 1990a, 1990b; Huntington et al. 1999; Jacobson and Wentworth 1982; Kassam and Wainwright Traditional Council 2001; Kruse et al. 1983a, 1983b; Lowenstein 1994; Lutton 1985; Minn 1982; Moulton 1997; Nelson 1982; NMFS 2004; NSB Contract Staff 1979; NSB 1998; Northern Economics, Inc. 2006; Quakenbush and Huntington 2010; Schneider et al. 1980; Shapiro et al. 1979; Stephensen et al. 1994; Suydam et al. 1994, 2005, 2006, 2007, 2008, 2009 and 2010; and Wolfe 2004.

3.3.2.3 Subsistence Resources

This section describes the primary subsistence resources harvested by the Beaufort Sea and Chukchi Sea communities of Kaktovik, Nuiqsut, Barrow, Wainwright, Point Lay, Point Hope, Kivalina, and Kotzebue. A general description of the resource in relation to subsistence harvests is included in this section. Marine mammal species are discussed first, followed by fish, waterfowl, and caribou. More detailed ecological accounts of the species, including population abundance and distribution are found in Section 3.2.4, Marine Mammals.

Important subsistence resources in the EIS project area include the bowhead whale, beluga whale, seal (ringed and bearded), walrus, polar bear, fish, migratory waterfowl (including their eggs), and caribou. It is important to note that the species composition of community subsistence harvests vary from one region to another, depending largely on the ecological setting. While residents of the NSB and NAB tend to concentrate harvests on the highest value species and those species groups it should be noted that subsistence harvests are diverse (USGS 2011). For instance, walrus and belugas are harvested less in Kaktovik where their occurrence and distribution is lower in comparison to Point Lay where these two species are more prevalent in seasonal abundance. Communities which have higher rates of harvest for bowhead whales are less likely to harvest seals. Table 3.3-7 provides an overview of Community Subsistence Harvest by Species Group (percent total harvest by species, total harvest and pounds per capita). Specific harvest patterns by seasonal round and areas of use by community are described in

Section 3.3.2.4. Maps of subsistence harvest areas for subsistence resources are presented as Figure 3.3-18 through Figure3.3-27.

Table 3.3-7 Community Subsistence Harvest by Species Group
(percent total harvest by species, total harvest and pounds per capita)

Species	Kaktovik (1992 – 1993)	Nuiqsut (1993)	Barrow (1987 – 1989)	Wainwright (1988 - 1989)	Point Lay (1987)	Point Hope (1992)	Kivalina (2007)	Kotzebue (1986)
Bowhead whale	63%	29%	38%	35%	-	6.9%	5.1%	-
Beluga whale	-	-	-	1%	64%	40.3%	3.8%	1.9%
Seals	3%	3%	6%	6%	6%	8.3%	24%	24%
Walrus	-	-	9%	27%	4%	16.4%	8.1%	1.1%
Fish	13%	34%	11%	5%	3%	9%	33%	40.5%
Polar bear	1%	-	2%	2%	<1%	-	<1%	<1%
Waterfowl	2%	2%	4%	2%	5%	2.8%	1.4%	1.3%
Caribou	11%	31%	27%	23%	16%	7.7%	18.2%	24.4%
Other terrestrial mammals and vegetation	6%	2%	3%	<1%	2%	-	3.5%	4%
Total Harvest in pounds	170,939	267,818	872,092	351,580	107,321	304,383	255,344	1,067,280
Per capita Harvest in pounds	886	742	289	751	890	487	594	398

Sources:
ADFG 1986, 1988, 1989, 1992, 1993, 2007 accessed on April 28, 2011; Braund and Kruse 2009; MMS 2008

Bowhead whale (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 3.3-19). In the autumn they return to the Bering Sea to overwinter. Eleven Alaskan coastal communities along this migratory route participate in traditional subsistence hunts of these whales: Gambell, Savoonga, Little Diomede, and Wales (on the Bering Sea coast); Kivalina, Point Lay, Point Hope, Wainwright, and Barrow (on the coast of the Chukchi Sea); and Nuiqsut and Kaktovik (on the coast of the Beaufort Sea). The eight communities which are the focus of this EIS and harvest areas are shown on Figure 3.3-19. As noted, the bowhead whale hunt constitutes an important subsistence activity for these communities, providing substantial quantities of food, as well as reinforcing the traditional skills and social structure of Iñupiat culture. Partly as a result of concerns about sustainability, such hunts have been regulated by a quota system under the authority of the IWC since 1977, with Alaska Native subsistence hunters from northern Alaskan communities taking less than one percent of the stock of bowhead whales per year (NMFS 2008b). The stock has reported to continue to grow at a rate of 3.4 percent per year since 1978 (NMFS 2008b). A total of 832 whales were landed by subsistence hunters between 1974 and 2003, with Barrow landing the most whales during this time period (418 whales) (Suydam and George 2004).

The IWC is the authority which sets the quota for bowhead subsistence hunts and the Alaska Eskimo Whaling Commission allocates that quota among the whaling communities in multi-year periods. At present there are 280 strikes allocated over the current five year period (2008 through 2012) with no more than 67 whales struck in any year (up to 15 unused strikes may be carried over each year). 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. As the strikes may be carried over and at the end of the 2010 harvest 15 strikes that were not used were available for carry-forward. The combined strike quota for 2011 is 82 (67 plus the 15) (Federal Register 2011b). An agreement between the U.S. and the Russian Federation gives the Russian natives no more than 7 of these strikes and Alaskan Natives may use no more than 75 strikes (Federal Register 2011b). In 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 2012). The IWC catch limits are implemented by NMFS, which released a Draft EIS in June 2012, with a Final EIS anticipated in early 2013. The preferred alternative in the Draft EIS corresponds to the catch limits adopted by the IWC. The AEWC noted that annual limits adopted are the same as they have been for the past 15 years and anticipates that the same allocations will be agreed for 2013 (AEWC 2012).

Under a Cooperative Agreement between NOAA and the AEWC, the AEWC allocates the strikes and catch limit for landed whales among 11 Alaska Eskimo 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 2011 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) 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 2011.

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

Year	Barrow	Wainwright	Point Hope	Kivalina
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
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

Source: BOEM 2011b; Suydam et al. 2005, 2006, 2007, 2008, 2009 , 2010 and 2011
Note: Summarized in these references by the authors from data provided by AECW to NSB.
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Note: 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 2010 complied from NMFS (2012) is described in Table 3.3-9. Additional harvest data is provided in Table 3.3-10 for the years 2005 to 2011. 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 2010.

	Gambell	Savoonga	Wales	Little Diomede	Kivalina	Point Hope	Point Lay	Wainwright	Barrow	Nuiqsut	Kaktovik	Total
Total Landed	23	33	1	1	0	26	1	32	219	32	31	399
Annual Average	2.3	3.3	0.1	0.1	0	2.6	0.1	3.2	21.9	3.2	3.1	39.9

Source: AEWC and NSB, 2010

Table 3.3-10 Summary of bowhead whales landed, struck and lost, and total struck 2005 to 2011.

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

Village	Landed	Struck and Lost	Total Struck
Barrow	19	3	22
Wainwright	1	-	1
Point Lay	1	-	1
Point Hope	1	-	1
2010			
Kaktovik	3	-	3
Nuiqsut	4	-	4
Barrow	22	15	37
Wainwright	3	2	5
Point Hope	2	7	9
2011			
Kaktovik	3	-	3
Nuiqsut	3	-	3
Barrow	18	6	24
Wainwright	4	1	5
Point Lay	1	-	1
Point Hope	3	3	6

Source: Suydam et al. 2005, 2006, 2007, 2008, 2009 , 2010 and 2011
Note: Summarized in these references by the authors from data provided by AECW to NSB.

Barrow, Wainwright and Point Lay are the only communities within the EIS project area that hunt bowhead whales in the spring and fall. Kivalina, Wainwright, Point Hope, and (beginning recently in 2009) Point Lay hunt bowhead whales during the spring season. Kivalina and Kotzebue residents join bowhead whaling crews out of Point Hope. The communities of Kaktovik and Nuiqsut bowhead whale only during the fall season, although some Nuiqsut hunters join Barrow whaling crews during the spring whaling season (NSB 1998, Alaska Consultants Inc. and S.R. Braund and Assocs. 1984). Bowhead whale harvest areas for Kaktovik, Nuiqsut and Barrow have been extensively mapped by S.R. Braund and Associates (2010). Bowhead whale subsistence harvest areas for the Beaufort and Chukchi seas are provided on Figures 3.3-20 and 3.3-21. Harvest areas for the recently resumed bowhead whale hunt near Point Lay are unavailable and are not depicted on Figure 3.3-21. Descriptions of the bowhead whale hunts and their management are provided in NMFS (2008b) and are incorporated by reference. There are also many reports on subsistence patterns available from BOEM 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 3.3-23.

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 in NMFS 2012). In Bristol Bay, about 20 beluga whales are harvested per year, with a total of approximately 350 beluga whales then taken annually in western and northern Alaska although this number does not include struck and lost beluga whales (Suydam in NMFS 2012). 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 in NMFS 2012).

Ice Seals

Harvest areas for seals are described on Figures 3.3-24 and 3.3-25

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).

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).

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 (Johnson et al. 1966; Burns and Harbo 1972; Frost et al. 1988, 1997, 1998, 1999 in NMFS 2008b). Ringed seals are an important species for Alaska Native subsistence hunters. The most recent annual subsistence harvest in Alaska is estimated to be 9,567 (Allen and Angliss 2010).

Ribbon Seal (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).

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). When harvested walrus meat may be eaten and its ivory used in the manufacture of traditional arts and crafts. Harvest areas are described on Figures 3.3-22 and 3.3-23.

Polar Bear *(Nanuq)*

Polar bears (*Ursus maritimus*) are harvested primarily during the winter months on ocean ice and along ocean leads. The 1995-2000 mean U.S. harvest from the Beaufort Sea stock was 32.2 animals per year (NMFS 2008b). The Alaska Nanuuq Commission was formed in 1994 and represents 15 coastal villages from Kaktovik to the villages of Gambell and Savoonga on St. Lawrence Island (Alaska Nanuuq Commission 2012). This commission is recognized in federal legislation as the co-management authority, along with the U.S. Fish and Wildlife Service, in the management of the U.S.' shared polar bear populations. The Alaska Nanuuq Commission is directed by commissioners that are 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 that intends to ensure that levels of polar bear harvest are sustainable (Alaska Nanuuq Commission 2012). The Alaska Nanuuq Commission noted that the quota harvest will be phased in during 2013 and then is expected to be officially implemented beginning in 2014 with 58 bears to be taken each year – 29 per country (Smith 2012). Polar bear fur is used to manufacture cold-weather gear such as boots, mitts, and coats. These sewn items are bartered, sold, and given as gifts to relatives and friends. Harvest areas for the Chukchi Sea are described on Figure 3.3-25.

Fish

Both marine and anadromous fish inhabit coastal Arctic waters. Marine fish include Arctic cod (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 3.3-26 and 3.3-27.

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 3.3-26 and 3.3-27.

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 3.3-26 and 3.3-27.

3.3.2.4 Community Subsistence Harvest Patterns – Seasons and Use Areas

This section describes annual subsistence cycles and harvest use areas by community. The timing of subsistence harvests is depicted in Tables 3.3-11 through 3.3-18 for the communities of Kaktovik, Nuiqsut, Barrow, Wainwright, Point Lay, Point Hope, Kivalina, and Kotzebue.

Subsistence harvest patterns are seasonal, responding to biological cycles, the proximity of resources, environmental conditions, and ease of travel. These patterns have a long historical basis and have been modified with the establishment of permanent settlements. It is important to note that the seasonal movement of subsistence resources to hunting sites and camps involves travel over and use of the extensive areas around each of the communities. Each community relies on specific subsistence resources to varying degrees, depending on their abundance, seasonal distribution, and proximity to the community. Many studies have been conducted to identify traditional subsistence use areas and are incorporated by reference throughout this section. They include studies by: NSB 1979; Pederson 1979; MMS 2007a, 2007b, 2007c; MMS 2008; Galginaitis 2009; Braund and Kruse 2009; EDAW-AECOM 2007; and Braund 2010. Seasonal descriptions of harvest are reported from the NSB's Coastal Management Plan (2007) and the NAB's Coastal Management Plan (2006). Extensive marine and terrestrial subsistence map efforts were conducted by Stephen R. Braund & Associates (2010) for the communities of Kaktovik, Nuiqsut, and Barrow in an effort to develop a GIS system that depicts regional subsistence patterns and measuring changes in these patterns over time.

Subsistence harvests tend to occur within traditional use areas, for which hunters have accumulated detailed knowledge of the physical geography of landscape and waters, the social geography of place names and the associated stories, and the wildlife ecology of likely animal distributions by seasons and under varying weather conditions. Hunters have a repertoire of effective harvest strategies to draw upon as they hunt throughout these traditional harvest areas. For example, bowhead subsistence whaling occurs in U.S. waters primarily during the spring and autumn migrations as the bowhead whales move north and east through near shore leads in the spring, and then west and south as ice forms in the autumn (Figures 3.3-19 through 3.3-21). The bowhead migration patterns are conducive to spring harvests for the Chukchi Sea communities, while Barrow's (and now Wainwright's) location provides for successful spring and fall hunts, the communities of Nuiqsut and Kaktovik on the Beaufort Sea participate in the fall hunt (NMFS 2008b).

<u>Beaufort Sea Communities</u>

Kaktovik

The subsistence patterns of Kaktovik are influenced not only by the seasonality of the resources but by the community's geographical position and periodic access limitations. Along this portion of the Beaufort Sea coast there is shorefast ice for at least 10 months of the year due to the currents. During the winter, marine mammals such as seals and walrus are not as numerous in the Beaufort Sea as in the Chukchi Sea, and they are not present as long in the summer. Some species such as walrus rarely occur near Kaktovik. Belugas are harvested opportunistically during the bowhead hunt. The majority of summer activities are coastal oriented, as Kaktovik lacks direct access to a navigable river because the waters are too shallow for boating. Hunters will go out along the coast for seals throughout the year.

Kaktovik has winter access to resources such as Dall sheep in the Brooks Range and to the Porcupine and Central Arctic caribou herds. Caribou hunting also occurs along the coast from June through September. These two resources make up for the lessened availability of marine mammals. Kaktovik's primary subsistence resources are caribou, sheep, bowhead whale, fish, and waterfowl, with seal, polar bear, and furbearers also being important. Main subsistence areas include a summer coastal zone extending from Foggy Island to Demarcation Bay and inland areas, such as along the Hula Hula River and into the Brooks Range, used when snow cover permits access by snowmachine (NSB 2007)

Winter: Sheep and caribou hunting declines during December due to the lack of daylight. Some limited trapping occurs and wolves and wolverines are taken in the mountains. Foxes are trapped along the coast, and polar bears are hunted near the community. During late January hunters begin returning to the mountains with trips becoming more frequent in March with increasing daylight. Winter fishing reported at the Hula Hula camps occurs during late February to April. Some caribou remain on the coast and are taken in late winter; and moose may be taken if they are needed and available (NSB 2007). Some sheep hunting may also be done in late winter. Lake trout are taken at places in the mountains, and ling cod can be obtained along inland portions of rivers (Wentworth 1979).

Spring: The long daylight hours of April and May and sufficient snow cover are good conditions for snow machine travel. Fishing at favored locations on the Hula Hula and other rivers continues until early April. Sheep might be taken until May (NSB 2007). Furbearer hunting continues until then also. Ground squirrels and marmots are hunted from early April when they come out of their holes. Often, the last trips to the mountains for the season are used to hunt them. Ptarmigan, though hunted all year, are most easily taken when they congregate in large flocks in the spring. Upon returning from the mountains, the first migratory waterfowl are taken along the coast in late spring/early summer, especially at traditional sites like Nuvuaq where seals, caribou, fox, and fish can be taken in various seasons (Wentworth 1979).

Summer: Waterfowl arrive as soon as there is open water. Tent camps are then set up in the Camden Bay area. As the season progresses and snow machine travel diminishes, hunting is done closer to the community, such as on the mainland or the historic area of Arey Island. Eggs are gathered on several of the barrier islands. Seals may also be taken, particularly for the oil and hides, but are hunted less than they were previously when they were needed for dog food. Towards the end of June, subsistence activities can come to a standstill as there is no snow for snow machine travel, and the frozen waters prohibit boat travel. Later, summer use areas are confined mainly to coastal and river delta regions due to shallow water. Griffin Point is a primary summer subsistence area; caribou, seals, and fish are taken there by people who may stay there for up to two months (Wentworth 1979).

In early July, boat travel is possible, and nets are set in Kaktovik Lagoon and other sites from Camden Bay to Jago Spit for Arctic char, which are harvested until August. Cisco and pink salmon are caught in the nets later in the summer; and, occasionally, beluga whales are taken. Beluga whales usually are harvested in August through November, incidental to the bowhead harvest. Caribou season occurs in about July, and they are taken along the coast and especially along the lower seven miles of the Canning River, where boating is possible (NSB 2007). A particularly good caribou hunting area has been identified at Konganevik Point. Grayling and whitefish are taken in the Canning Delta, which is one of the most important fishing areas for Kaktovik.

Fall: In late August, bowhead migration begins as the whales move westward, and crews may travel 20 miles out to sea at the beginning of the season, though later in the season, the whales migrate closer to shore and can be taken nearer the community during early September(Huntington and Quakenbush 2009). Kaktovik whalers have noticed patterns in the size of the whales during their migration and speculate that the larger whales are further offshore (more than 20 miles [32.2 km]) than they usually hunt (Huntington and Quakenbush 2009). Whaling may continue for several weeks, and butchering and transporting the whale can take another week. Peak sealing occurs during the whaling season. After whaling and freeze-up, inland travel is possible, and trips are frequently made along the Hula Hula River and into the mountains. Various camps along the Hula Hula are good spots for ice fishing for grayling and Dolly Varden/ char and provide a base of operations for caribou and sheep hunting in late October/early November. Kongakut River fishing sites produce Dolly Varden/char. Grayling fishing is done in nearly all the major rivers and especially along the Canning, where whitefish and ling cod are also taken, and along the Kuparuk (Jacobson 1979).

Many studies document the customary and traditional use of subsistence resources by Kaktovik residents. These studies are herein incorporated by reference: Brower and Hepa 2000; Caufield and Pedersen 1981;

Chance 1966; Chance 1997; Coffing and Pedersen 1985; Craig 1987; George and Fuller 1997; ADFG 2000; Haynes and Pedersen 1989; Impact Assessment, Inc. 1990; Jacobson and Wentworth 1982; MMS 2003; MMS 2001; MMS 1998; MMS 1996b; MMS 1990; MMS 1986; MMS 1983; MMS 1998; MMS 1996;; MMS 1986;; Nielson 1977; NSB 1979; Oldham n.d.; Patterson 1974; Pedersen 1995; Pedersen 1990; Pedersen 1984; Pedersen 1979; Pedersen and Linn 2005; Pedersen and Coffing 1984; Pedersen and Coffing 1985; Pedersen et al. 1991; Pedersen et al. 2000; Huntington and Quakenbush 2009; Wentworth 1979.

Table 3.3-11 Kaktovik Seasonal Subsistence Cycle

Subsistence Resource	Inupiaq Name	Winter			Spring		Summer		Fall			Winter	
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bowhead whale	Agviq								■	■	■		
Beluga whale	Quilalugaq								■	■	■		
Bearded, ringed and spotted seals	Ugruk, Qasigiaq, Qaigulik	■	■	■	■	■	■	■	■	■	■	■	■
Walrus	Aiviq						■	■					
Polar Bear	Nanuq	■	■	■	■	■	■		■	■	■	■	■
Birds/eggs	Mannik (eggs)	■	■	■	■	■	■	■	■	■	■	■	■
Caribou	Tuttu	■	■	■	■	■							
Moose	Tuttuvak	■	■	■	■	■	■	■	■	■	■	■	■
Brown Bear	Aklaq					■	■						
Furbearer Hunt/trap	*	■	■	■	■					■	■	■	■
Small mammals	*			■	■	■	■	■	■				
Sheep	Imnaiq	■	■	■	■	■				■	■	■	■
Freshwater fish	*	■	■	■	■	■	■		■	■	■	■	■
Marine and Migratory fish	*							■	■	■	■	■	

Source: NSB 1979, MMS 2007a and 2007c, MMS 2008, Braund and Kruse 2009, Braund, 2010 *many Inupiaq names for these resources

Nuiqsut

Marine mammals harvested by Nuiqsut hunters include bowhead whales, beluga whales, bearded seals, ringed seals, spotted seals, and polar bears. Bowhead whales are hunted from Cross Island.. The barrier island and Thetis Island are also reported as important seal hunting areas:

> *Thetis Island is one of the most important areas for seal hunt during -- when you have access to go out to the ocean or you have access closer to the shore. Once that ice goes out, it goes out, it doesn't come back. And we depend on these islands for subsistence.* – Nuiqsut Public Scoping Meeting March 11, 2010.

Nuiqsut hunters report caribou and moose as their most important subsistence land mammals, but also harvest wolf, wolverine, and fox. Fish harvests include Arctic cisco, whitefish, least cisco, grayling, humpback whitefish, burbot, northern pike, pink salmon, and Arctic char. The general area of terrestrial subsistence activities extends from the community east to the Sagavanirktok River, south to the middle Colville, west to Teshekpuk Lake, and along the coast to Pitt Point to the mouth of the Canning River. Hunters also join Barrow hunts for sea mammals and occasionally go to Kaktovik and Wainwright (NSB 2007).

Winter: Activities slow down during the coldest and darkest part of winter. Trapping for foxes and hunting of wolves and wolverines are accomplished during this season. Caribou and moose have traditionally been taken during winter. Seals are hunted on sea ice when open leads appear. As weather and light improve, trapping, caribou hunting, and fishing for cod, grayling, and lake trout increase (NSB 2007).

Spring: Spring whaling on the coast draws some men to Barrow to participate as crew members or whaling captains. No spring whaling occurs from Nuiqsut or Cross Island. Seals are taken on the sea ice during April and May. Furbearer hunting in the foothills and on the coastal plain is an important activity as the daylight and weather improves and continues until the snow is gone in May. Grayling, cod, and lake trout are taken with hook and line during the warmer weather. Long snow machine trips may be taken to Barrow or Kaktovik or even farther to visit friends and relatives before the snow melts and some caribou may be taken in conjunction with these trips (NSB 2007).

Summer: In the summer, ringed and spotted seals are hunted near the Colville River as far south as Ocean Point (EDAW-AECOM 2009). Following breakup in early summer, whitefish are taken in nets in the Colville River when the water clears in June. As this season progresses, fishing is conducted farther up river and on Fish Creek. Waterfowl begin to appear and are taken periodically until their fall migration. In late summer, char and salmon begin running up the Colville River, followed by spotted seals. Some coastal fishing occurs for whitefish and cisco. Children set traps for ground squirrels and fish for grayling with nets and rod/reel. Caribou hunting then becomes the primary activity in late summer (NSB 2007).

Fall: Caribou hunting, fishing, and bowhead whaling are the most important subsistence activities that occur in the fall. Bowhead whaling begins in mid-September along the coast as far east as the Canning River. The base for fall whaling is Cross Island which is 90 to 100 miles from the community by boat (EDAW-AECOM 2009). As indicated by Nuiqsut whalers:

> *Thetis Island, on to Cross Island and beyond Cross Island to Camden Bay. Those are our very important areas for feeding, resting for the bowhead whales while they're migrating west during fall time.* – March 11, 2010 Nuiqsut Scoping Meeting.

Seals are also hunted near the Colville Delta and along the coast from Cape Halkett to Foggy Island (EDAW-AECOM 2009). Caribou migrate south from their respective calving grounds, though some remain in the area throughout the winter near Fish Creek. Moose are a newer species to the region and are becoming an important resource, especially during times of restricted hunting of caribou and are taken along the middle Colville River. Fishing for cisco and whitefish is done with nets before freeze-up in the rivers and continues after freeze-up at fish camps on the Colville and Fish Creek. Grayling and ling cod are taken through the ice in later fall. Berries are picked during fishing and hunting trips, and sometimes driftwood and coal are collected. Seals, ducks, caribou, and sometimes polar bear are taken concurrent with bowhead whaling activites (NSB 2007).

Whaling activities of Nuiqsut have been extensively studied in cooperation with participating whaling captains for more than a decade. BOEM (and previously MMS) has conducted long-term environmental monitoring around the Northstar development, which is near the Nuiqsut subsistence-whaling area at Cross Island. As part of this monitoring effort, BOEM conducted a multiple-year collaborative project with Nuiqsut whalers that describes present-day subsistence whaling practices at Cross Island to verify any changes to whaling due to weather, ice conditions, or oil and gas activities. The project findings were summarized during the 2005 MMS Information Transfer Meeting (MMS 2005) and specifically through Galginaitis (various studies through 2009). These observations and narrative annual reports were performed in participation with whaling captains from Nuiqsut that depict geospatial information from the sharing of GPS data. This data reflects the extensive use of the area for bowhead hunts from whaling camps at Cross Island (specifically see Galginaitis 2009).

The customary and traditional use of subsistence resources by Nuiqsut residents and the effects of oil development is documented in many studies, which are herein incorporated by reference: ADFG 2000; ADF&G 2003; Brower and Opie 1998; Brown 1979; Burns 1990; Craig 1987; Galginaitis and Funk 2005; Galginaitis et al. 1984; George and Fuller 1997; George and Nageak 1986; George and Kovalsky 1986; Hall 1983; Hoffman et al. 1978; Impact Assessment, Inc. 1990; Kruse 1982; Kruse et al. 1982; Kruse et al. 1981; Moulton and Field 1988; MMS 2003; MMS 2001; MMS 1998; MMS 1996a and 1996b; MMS 1990; MMS 1986; MMS 1983; Nielson 1977; NSB 2003; NSB 1979; NSB 1978; NSB 1975; Patterson 1974; Pedersen 2001; Pedersen 1995; Pedersen 1988; Pedersen 1986; Pedersen 1979; Pedersen et al. 2000; USACE 1997; U.S. Department of the Interior 1998.

Table 3.3-12 Nuiqsut Seasonal Subsistence Cycle

Subsistence Resource	Inupiaq Name	Winter			Spring		Summer		Fall			Winter	
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bowhead whale	**Agviq**								■	■	■		
Beluga whale	**Quilalugaq**								■	■	■		
Bearded, ringed and spotted seals	**Ugruk, Qasigiaq, Qaigulik**			■	■	■			■	■	■		■
Walrus	**Aiviq**						■	■					
Polar Bear	**Nanuq**	■	■	■							■	■	■
Birds/eggs	**Mannik (eggs)**	■	■	■	■	■	■	■	■	■	■	■	■
Caribou	**Tuttu**	■	■	■	■	■	■	■	■	■	■	■	■
Moose	**Tuttuvak**								■	■	■		
Brown Bear	**Aklaq**						■	■	■	■	■		
Furbearer Hunt/trap	*	■	■	■	■	■	■					■	■
Small mammals	*					■	■	■	■	■	■		
Freshwater fish	*	■	■	■	■	■	■	■	■	■	■	■	■
Berries/roots/ plants	*						■	■	■	■			

Source: NSB 1979, MMS 2007a and 2007c, MMS 2008, Braund and Kruse 2009, Braund, 2010 * many Inupiaq names for these resources

Barrow

Barrow is 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 2010).

Boats are used for travel in the open water season and in open water leads. Outboard motors and all-terrain vehicles now enable hunters to travel much farther in a day than in the past. Aircraft are used by some to access fish camps or special hunting areas far from the community. Barrow hunters use the sea-ice/ocean environment at all times of the year, in the areas ranging from Peard Bay to Pitt Point for marine mammals, waterfowl, and fox. Spring whaling is based from camps on the ice shelf northwest of the community. The coastal zone is used for hunting ducks, seals, and walrus, fishing (spring/summer), and, in the fall, for whaling (especially at Pigniq). The coast is also used for collecting eggs, driftwood, and occasionally plants and invertebrates, also for picnics and camping. Inland areas are used in pursuit of caribou, fish, and fur-bearers (Schneider et al. 1980).

Winter: During the coldest and darkest of the winter months, subsistence activities progressively decrease. Sealing occurs on the west side of Barrow, and polar bears are harvested if they are encountered along the coast. Polar bear are hunted during the fall and winter – October to June – in the same areas where walrus are hunted from west of Barrow southwestward to Peard Bay. Inland travel is lessened with river and lake fishing ceasing by midwinter. Light trapping occurs, but the hunting of furbearers is conducted by use of snow machine. Trap lines are set on nearshore pack ice off Barrow and inland about one hour from the community. Trap lines are extended much farther in all directions from Barrow when the weather warms beginning in late winter (March). The historic site of Pulayaaq on the Meade River is used for trapping in late winter and for taking waterfowl in the spring, as well as for summer fishing and hunting. Nearby, Pulayatchiaq is also noted as a current and historical area for trapping and spring waterfowl. Some trap lines extend for a hundred miles with many loops and follow the rivers, ridges, or other easily traversed features. Furbearer hunting by snow machine is also done when people are out hunting caribou or trapping. Foxes are trapped or shot incidental to other hunting trips. The local demand for wolf and wolverine far exceeds the supply (NSB 2007).

Midwinter is also a time for socializing and celebrations at which subsistence foods, particularly bowhead whale, play an important role. As winter progresses and daylight hours lengthen, subsistence activities and travel increases. Trap lines are extended, and caribou hunting becomes of increased importance as food supplies become generally low. Sealing and polar bear hunting continue along the coast in each direction from Barrow. In late winter, preparations begin throughout the community for spring whaling (NPR-A Task Force 1978, Schneider et al. 1980).

Spring: The spring bowhead hunt occurs west and east of Point Barrow (Braund 2010). Barrow residents have reported hunting bowhead whales almost as far as Smith Bay to the east and as far as Skull Cliff to the west where there is an area of overlap with Wainwright whaling areas (Braund 2010). The location of Barrow allows access for whalers from April to June in offshore leads from historic areas such as Nuvuk. Spring whaling areas depend on the location of the open lead. Huntington and Quakenbush (2009) reported that whalers have noticed an increase in the numbers of bowheads over the last few decades and that changes in ice in conditions and have influenced the spring migration pattern near Barrow with fewer whales migrating next to the edge of the shorefast ice and fewer seen southwest of Barrow.

The spring hunt for beluga whale occurs from April to June in the spring leads between Point Barrow and Skull Cliff. Later in the spring, whalers in Barrow hunt belugas in open water around the barrier islands off Elson Lagoon.

With the increase of daylight hours, other subsistence activities increase, and migratory animals return to the coast. Ducks, some walrus, and bearded seals may become available offshore west and north of Point Barrow in April. Trapping ends at about this time, though furbearer hunting continues at places, such as Qaviarat on the Meade River (where geese can be taken later on), and Kalayauk, which is also noted for its geese and ducks. While caribou may be hunted, whaling takes precedence unless the quota is met early, in which case all of the above resources are then pursued (NSB 2007). Ptarmigan are available year round but are taken in greater numbers in the spring when they flock. By June, when spring whaling is over, seal and duck hunting camps are set up along the coast southwest to Peard Bay. One especially popular camp is at the historic site of Pigniq, north of Barrow (NSB 2007).

Summer: In late spring/early summer, gathering of coastal and inland birds including eggs commences. When the rivers become free of ice, nets are set at fish camps for harvest of whitefish, char, and salmon. When the shore ice retreats in about early July, boat travel becomes more frequent, and trips are taken to Wainwright, Nuiqsut, Beechey Point, and inland fish camps, such as Qaviarat, where other year round activities take place as well. As the ice recedes, ringed sealing decreases though bearded and harbor seals become more common in abundance. Bearded seal hunting is a communal effort, and hunts are conducted west of Barrow or from Pigniq (NSB 2007).

After the shore ice breaks up, walrus are also hunted cooperatively. Barrow residents harvest walrus for their meat, hides, and ivory tusks. The walrus supplies food and material for clothing and arts and crafts. Residents hunt walrus in early summer to early fall, June to September, from west of Barrow southwestward to Peard Bay. Barrow residents hunt seals for their meat, oil, and skins. The meat and oil serve as dietary supplements. Seal skin is used in clothing, as wells as for boats.

Coastal fishing with nets for salmon, and char occurs at traditional sites along Elson Lagoon and west of Point Barrow, where tending nets may be combined with duck and marine mammal hunting. Whitefish and grayling are taken with gill nets during mid to late summer. Inland fishing becomes intensified. Payugvik, on the Meade River, is a noted traditional site used for more than a hundred years as a summer and winter fishing spot. The area is a common rest stop for people traveling the trail between Barrow and the community of Atqasuk further inland.

In conjunction with other activities on the coast and at inland lakes and rivers, berries and plants are collected when in season. The major fish effort for the Barrow area takes place at inland sites. Sealing and walrus hunting begins to decrease in late summer. Caribou skins are considered to be in prime condition in late summer when the main hunting effort begins. The majority of caribou hunting occurs by boat during the summer and fall months along the coast and inland along various rivers; whereas caribou are taken as needed throughout the winter months (Braund 2010). A few grizzly bears are taken if the opportunity presents, usually while conducting other subsistence activities along rivers. Duck hunting can continue into September as the southward migration begins, especially at Pigniq where some fishing is also done (Schneider et al. 1980).

Fall: Intensive caribou hunting, fishing, and whaling occur during the fall. Barrow residents have reported that fall hunting areas depend on the location of the migrating whales, weather, and ice conditions, and hunters generally indicated that the primary fall hunting area is east or northeast of Cape Simpson on Smith Bay (Braund 2010). Fall bowhead whaling occurs from August to October in an area that extends 16 km (10 mi) west of Barrow to 48 km (30 mi) north of Barrow, and southeast 48 km (30 mi) off Cooper Island with an eastern boundary on the east side of Dease Inlet. Occasionally, bowhead whale hunting may extend east as far as Smith Bay and Cape Halkett or Harrison Bay. In a 2009 study (Braund 2010), respondents noted that the whaling captains set the timing of the fall hunt with some hunters preferring to hunt in October after the larger whales have migrated through.

Caribou are still numerous near Barrow in September. Inland fishing is considered to be most productive in the fall, and this activity increases especially at such historic places as Iviksuk on the Inaru River and Nauyalik on the Meade, where a landing strip provides easy access for the community. As during the summer months, fishing is often combined with caribou hunting and berry picking and later with furbearer hunting. Permanent (cabins) and temporary camps are set up at favorite spots to conduct these subsistence activities for extended periods of time. Food storage is another function of these camps, as ice cellars store excess food which can be transported to the community later. They are not, however, as commonly used today as in the past. The camps are like small tent cities, especially after freeze-up, and are heavily used on weekends. Distant camps as far away as Teshekpuk Lake are used by Barrow residents, either because their past history includes personal familiarity or because nearer camps may be overcrowded (NSB 2007).

During the fall, coastal areas such as Pigniq continue to produce ducks while they are available, and seals and walrus may also still be available. When the ice begins to form on inland waters, fishing continues for whitefish, grayling, and burbot with nets and by jigging (NSB 2007). Ringed seals will begin to appear on the coast. Moose, which have recently extended their range northward, can sometimes be available in the Colville drainage, but the number taken by Barrow residents is considered low.

Table 3.3-13 Barrow Seasonal Subsistence Cycle

Subsistence Resource	Inupiaq Name	Winter			Spring		Summer		Fall			Winter	
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bowhead whale	Agviq				■	■	■		■	■	■		
Beluga whale	Quilalugaq												
Bearded, ringed and spotted seals	Ugruk, Qasigiaq, Qaigulik	■			■	■	■	■				■	■
Walrus	Aiviq						■	■	■				
Polar Bear	Nanuq	■	■	■	■	■					■	■	■
Birds/eggs	Mannik (eggs)					■	■	■	■	■	■		
Caribou	Tuttu	■	■	■	■	■	■	■	■	■	■	■	■
Moose	Tuttuvak								■	■			
Brown Bear	Aklaq					■	■	■	■	■			
Furbearer Hunt/trap	*	■	■	■								■	■
Freshwater, migratory and marine fish	*	■	■		■	■	■	■	■	■	■	■	
Berries/roots/plants	*					■	■	■	■	■			

Source: Braund 2003, MMS 2007a and 2007c, MMS 2008, Braund and Kruse 2009, Braund 2010 * many Inupiaq names for these resources

Chukchi Sea Communities

Wainwright

Wainwright is situated close to several different environments, each of which provides the community with diverse wildlife resources for subsistence harvest. Bowheads, belugas, walrus, and seals are taken from the ocean/sea ice environments. The lagoon system inside of the barrier islands provides habitat for waterfowl, seals, and other marine mammals. Subsistence hunts for bowhead whales occur in the spring and fall. Beluga whales comprise a main portion of the subsistence economy of Wainwright (NSB 2007). Beluga subsistence hunters conduct annual hunts for cultural and nutritional reasons, and, in Wainwright, up to forty belugas per year are harvested (Willie Goodwin - ABWC 2007). Seals are also harvested, with bearded seal being the most sought after species, and ringed seal is not considered as important. Bearded seals are considered a mainstay subsistence resource and are prized for their fat and meat. Bearded seals are harvested from spring through fall. Smaller bearded seals are preferred for their meat, and the larger ones are considered best for rendering oil (MMS 2008). The Kuk River is an area where fish and other predators attracted to them are taken. The Kuk River estuary provides habitat for fish, especially smelt. Terrestrial resources such as caribou, furbearers, plants/berries, bear, and ptarmigan are also harvested. Subsistence activities are concentrated along coastal areas from Point Franklin to Icy Cape and inland along the Kuk and Utukok river drainages. The sea and sea/ice environments are used for many miles out from the shore. Avid hunters may extend their operations to the Meade and Colville rivers or along the coast to Point Lay and Peard Bay (Ivie and Schneider 1979) overlapping with subsistence user areas of other communities.

Winter: Wainwright residents hunt polar bear for their meat and pelts. Polar bear subsistence hunts occur in the fall and winter around Icy Cape, at the headland from Point Belcher to Point Franklin, and at Seahorse Island. In the winter, furbearers are taken during late winter when there is increased daylight and weather improves. Fox are harvested along major rivers and at coastal sites, while wolf and wolverine are trapped or shot on the coast or at inland locations. Throughout the winter, ringed seals are taken along leads in the ice. Caribou and polar bear may occasionally also be taken. Wainwright is noted throughout the North Slope for its smelt, and much fishing is done in January through March in the Kuk Lagoon.

Spring: Whaling is the most important subsistence activity in spring. Bowhead whaling occurs beginning in April, and these whales are taken in open leads in the offshore ice as they pass close to shore near Point Belcher and Icy Cape. More recently is has been reported that bowheads are appearing in early April and sometimes even in March, with movements being determined by ice conditions (Quakenbush and Huntington 2010). Wainwright residents will travel up the coast as far as Peard Bay to hunt bowheads in the spring. Whaling camps are sometimes located 10 to 15 mi (16 to 24 km) from shore (MMS 2009b). Hunters report that the bowhead whales reach the Wainwright area approximately a week after passing Point Hope (Quakenbush and Huntington, 2010). The beluga whale hunt takes place in the spring lead system from April to June. The beluga whales arrive about the same time as bowheads. Belugas are hunted from the ice along leads or driven into inlets in summer and harvested. Belugas are hunted from late June through mid-July and sometimes later into the summer. Walrus and harbor and bearded seals also may be taken but are more commonly hunted in summer; ringed seals, however, are taken during the spring. Migratory waterfowl harvest occurs along the coast and along rivers beginning in May. Squirrels and marmots are sometimes harvested in conjunction with furbearer hunting trips inland toward the mountains.

Summer: Bearded seals are hunted in early summer southwest of the community, and spotted seals, which migrate south in fall, are harvested in late summer when they will float after being shot. Walrus become prevalent during July and August and are taken from drifting ice floes near Wainwright and along the coast to Peard Bay. From August to September, Wainwright residents may hunt walrus at local haulouts, with the main area being from Milliktagvik north to Point Franklin. Icy Cape is a known walrus haulout location (NSB 2007).

Subsistence activities occur on the coast and at rivers as overland tundra travel becomes more difficult in summer. Families occupy traditional camping sites along the coastline for sealing, waterfowl hunting, and other activities up until the midsummer, and then fishing activities intensify. Waterfowl are harvested in early summer until nesting and some egg collecting occurs along Kasegaluk Lagoon or Seahorse Island (NSB 2007).

Caribou migrate to the coast during summer and are harvested from Icy Cape to Peard Bay beginning in late August and into the fall. Berries are collected during the late summer near the community and along the Kuk River. Fishing is a major subsistence activity that occurs all year, and, during midsummer, nets are set up in front of the community for salmon, trout, and whitefish. Fishing activities then move to streams and rivers as the migratory fish work their way upstream (NSB 2007).

Fall: Fishing and caribou hunting are the main subsistence harvest activities in the fall. Caribou skins are considered the best at this time of year, and they are hunted on the coast from Icy Cape to Peard Bay and along major rivers (NSB 2007). Migratory waterfowl are also harvested at areas including Icy Cape and Point Belcher. While caribou is not a coastal resource, access is closely tied to the waterways as they travel along the drainages and beaches, and the waterways provide an avenue for transportation for locating the caribou and hauling the harvest home. Wainwright residents recently resumed a fall bowhead hunt and landed a whale in the fall of 2010 for the first time since 1974 and possible 50 years (Suydam et al. 2010, Brower 2010) 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; ADFG 2000; Ivie and Schneider 1988; Jorgensen 1990; Kassam and Wainwright Traditional Council 2001; Lutton 1985; Nelson 1981; Nelson 1969; NSB 2002; NSB 1979; Patterson 1974; Pedersen 1979. A particularly important collaborative effort to document traditional use areas and potential impacts of oil and gas development is found in Wainwright Traditional Council and the Nature Conservancy, n.d. [est 2007].

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: Kassam 2001 in MMS 2008, Braund 2009
* 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 will harvest approximately 30 to 50 belugas each year (Willie Goodwin – in MMS 2008). Frost and Suydam (2010) estimated that up to sixty percent of the eastern Chukchi Sea harvest occurred at Point Lay and noted that the hunt usually occurs in very shallow water, less than two meters near the town. Point Lay hunts belugas from late June through mid-July. It is estimated that up to two-thirds of the annual subsistence production by weight is beluga whale (ADFG 2011) with the majority of the harvest being taken in one or two cooperative hunts in the early summer. Point Lay hunters take belugas near the community, usually herding them from the south to the shallows inside Kasegaluk Lagoon. Hunters are most familiar with belugas in the area between Omalik Lagoon and Point Lay, although they also have hunted belugas as far north of the community as Icy Cape (Huntington et al. 1999).

There are several overlapping areas of subsistence usage between the communities of Point Lay and Wainwright such as in the Beaufort and Raven basins up the Kukpowruk River where hunters from both communities harvest furbearers. Icy Cape is another area that each community uses for hunting waterfowl. Caribou hunting areas in the western Brooks Range in the southeast corner of the NPR-A are used by Point Lay and Wainwright hunters (NSB 2007). In March and April, both communities may hunt for wolf and wolverine in the Amatusuk Hills. A seasonal description of current subsistence activities of Point Lay follows.

Winter: Some ice fishing continues in early winter, and occasional caribou hunting trips are taken. Trapping occurs throughout the winter primarily at coastal areas, though winter storms may prevent the checking of traps at regular intervals. Wolf, wolverine, and caribou hunting may be combined in areas towards the mountains. Coastal traps are often set next to washed up marine mammal carcasses which attract fox and wolverine. Polar bears are also taken at these trapping sites as they are attracted because of the bait or foxes. Polar bears are not as actively hunted as in former years. Some sealing is attempted. In late winter, some people travel to other communities to participate in the bowhead whaling activities (NPR-A Task Force 1978, Schneider and Bennett 1979 in NSB 2007).

Spring: During the spring, Point Lay residents gather eggs and hunt terrestrial mammals and marine mammals. Migratory waterfowl and eggs are harvested during May and June at coastal sites and along inland rivers. Large quantities of eggs are harvested at specific areas, such as the islands in Kasegaluk Lagoon north of the community and along the barrier islands. Ground squirrels are harvested by the community and hoary marmots are hunted in the Amatusuk Hills. Ringed and bearded seals are available year-round. Ringed and bearded seals are hunted 20 mi (32 km) and 30 mi (48 km) north of Point Lay, respectively, with bearded seals concentrated in the Solivik Island area and up to three miles north off the island (NSB 2007, MMS 2009b). Bearded seals are also hunted from south of Point Lay to the southern end of Kasegaluk Lagoon. Snow machines are used to hunt caribou as they move toward the coast for the summer or in the Amatusuk and Kiklupiklak hills (Schneider and Bennett 1979 in NSB, 2007). While Point Lay hunts mostly beluga whales, in the spring of 2009, a bowhead whale was landed for the first time since 1937 and in May 2011 a whaling crew again landed a bowhead whale (Arctic Sounder 2011).

Summer: Many different subsistence activities occur during the summer, and boats are used for access to subsistence resources. In early June, the open lead allows for sealing, and later the annual walrus hunt occurs near Icy Cape. As the sea ice retreats in June, the walrus migrate north past Point Lay, and the community conducts their annual hunt. Walrus are hunted from June to August – depending on favorable ice conditions – along the entire length of Kasegaluk Lagoon, south of Icy Cape, and as far as 20 mi (32 km) offshore (NSB 2007, MMS 2009b).

Beluga whales are harvested from the middle of June to the middle of July. The hunting area is concentrated in Naokak and Kukpowruk Passes south of Point Lay. Hunters use boats to herd the whales into the shallow waters of Kasegaluk Lagoon where the belugas are harvested. If the July beluga hunt is unsuccessful, Point Lay hunters may travel as far north as Utukok Pass and as far south as Cape Beaufort in search of beluga whales. Like the walrus hunt, all available hunters participate. Boats are used to herd whales into shallow water where they can easily be retrieved after being stuck. Occasionally, belugas can be taken in August as well. Data from satellite tagging and aerial surveys in the eastern Chukchi Sea indicate that belugas make extensive use of the coastal waters within 50 miles of the coast in June and July, and more than 1,000 belugas have been observed at Kukpowruk, Akunik, and Utukok passes along Kasegaluk Lagoon during these months (Willie Goodwin – ABWC in MMS 2008; Suydam et al. 2000).

Caribou are taken along the coast and around Icy Cape, and waterfowl and eggs continue to be taken in early summer. Fishing using gill nets occurs near river mouths (except Kokolik), at ocean passes, in Kasegaluk Lagoon, and at Sitkik Point. The season lasts from early July to late September. The nets are moved about 15 miles up the Kukpowruk River in September for grayling fishing. A variety of salmon, whitefish, flounder, smelt, herring, bullhead, and an occasional char are taken. A majority of residents of the community are engaged in fishing during the summer months (NSB 2007). Berries and other edible plants are collected along the coast, inland along rivers and near the historic site of Cully. As fall approaches, preparations are made for ice fishing. Snow machines are taken by boat up the Kukpowruk River and left to be used after freeze-up (Schneider and Bennett 1979 in NSB 2007).

Fall: Point Lay residents hunt for polar bears from September to April along the coast with the hunting area rarely extending more than two miles offshore. The fall migration of waterfowl attracts hunters to the area near Icy Cape. Caribou hunting is actively pursued from late August to October at inland locations. Whole families will engage in fall grayling fishing up the Kukpowruk River, even after the school year has begun. Nets are used until freeze-up, when hook and line methods are then used for ice fishing at traditional ice fishing sites. Berry picking is combined with fishing trips, and coal is sometimes brought back to the community after freeze-up by snow machine from the mine on the Kukpowruk. Residents hunt moose, which is considered a new species to the area. Spotted seals are hunted in early fall when they are fat and do not sink (Schneider and Bennett 1979 in NSB 2007). Point Lay has been recently conducting fall hunts as changing sea ice conditions have been more dangerous in the spring (Comstock 2011).

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 utilized (Foote and Williamson 1966).

Summer: Open water by late June allows for boat travel. Some bearded and harbor sealing may occur in late spring/early summer (Pedersen 1971). Beluga whaling also occurs again in July, and some may be taken with nets from the beach (Burch 1981). The second beluga hunt occurs later in the summer from July to August. During this second hunt, Point Hope residents hunt beluga whales in the open water near the southern shore of Point Hope close to the beaches, as well as north of Point Hope as far as Cape Dyer (MMS 2007c).

Bird nesting sites at Cape Thompson and Cape Lisburne are visited by boat to collect eggs and harvest birds (Maclean 1971 in NSB 2007). Marine fishing for char and salmon is conducted with beach seines and nets along the north and south shores, and lagoons yield whitefish. Caribou are also harvested at several places inland along the coast, including the Kukpuk River area or towards the Pitmegea River (Lowenstein 1980). Salmon and grayling are caught at the mouth of the Kukpuk River and at other fishing areas along the river. Berries and edible plants are collected and, if not used immediately, are stored in oil or frozen.

Fall: Subsistence activities in the fall are conducted from about mid-September to early November and are characterized by intensive fishing along the Kukpuk River. About three fourths of the total fish harvest is obtained in the fall (Pedersen 1971). Fishing is combined with caribou and moose hunting up to the mouth of the Ipewik River. Gill nets and hook and line are used for fishing before freeze up and afterwards through holes in the ice. Grayling, char, whitefish, and Dolly Varden are harvested. Cod are harvested in the fall when storms throw them up on the beaches (Lowenstein 1980). Caribou are hunted along the Kukpuk River and at coastal and inland areas around Cape Thompson. Migratory waterfowl are harvested again in the fall. As the sea ice forms, seals begin to reappear, and some are hunted by boat while residents collect driftwood. Sealing becomes more intense as the ice thickens. In early November, the trapping season begins. The area of greatest fall subsistence usage extends from the south shore inland to an area beyond the Kukpuk River and part of the north coast. Point Hope has recently been conducting fall hunts to meet their allocated quota and provide for their community as changing sea ice conditions have been more dangerous in the spring hunt (Comstock 2011).

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 Stephen R. Braund & Associates (2008) and are found in Appendix D of the Red Dog Supplemental EIS prepared for the EPA in 2009 (Braund and Associates 2009).

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 ADFG Subsistence Division subsistence harvest database. Table 3.3-19 (Rates of Participation in Subsistence Activities – All Resources) describes rates of participation of communities within the EIS project area. Data included in this table were gathered from ADF&G's Community Subsistence Harvest Records and reflect years where the most comprehensive resource inventory was completed. Complete data are not available for each community.

Participation on the harvesting and sharing of subsistence foods goes beyond the family and the community. There is an extensive network of exchange that occurs between communities of the Beaufort and Chukchi seas and further to relatives in larger towns such as Anchorage and Fairbanks. For instance, the shares of bowhead whale that each crew member receives after whaling are involved in a secondary redistribution among local relatives and those in other communities. Social and cultural identity is strengthened by serving subsistence foods at home and at feasts and sharing subsistence foods, particularly with elders. The foods that are exchanged strengthen family and regional ties.

Some subsistence foods are exchanged between communities, each noted for its special resources. Point Hope and Barrow are the major suppliers of bowhead whale, with Point Lay contributing beluga whale. Kaktovik is recognized for its sheep and Wainwright its smelt. Nuiqsut is noted for its whitefish and pelts (NSB 2007). As noted by Bill Tracey at the Point Lay February 22, 2010 public scoping meeting for this EIS:

> *It has to do with sharing. If Point Lay catches a beluga whale, that beluga whale is shared with people as far away as Anchorage, Kotzebue, Nuiqsut, it just goes all over the place. So if we get 30 belugas, I wouldn't be surprised if that showed up in 30 villages. So when something affects Point Lay, little old Point Lay in the middle of north nowhere, it's felt in Anchorage in some way, in some fashion. So yes, if there is something big that happens offshore at Point Lay and it contaminates, say, our lagoon system, we're not catching the belugas anymore, people in the whole state of Alaska are going to feel that.*

Kin-based groups form the basis for most harvest and distribution activities. Spring bowhead whaling remains the dominant activity for expressing culturally relevant values of cooperation and sharing in the communities of Point Hope, Wainwright, and Barrow. The nature of the hunt, the size of the whale, and severe weather conditions encountered require cooperation of nearly everyone in the community for success (Worl 1980). Before the season begins, the equipment must be prepared and checked, ice cellars prepared, and the bearded seal skins necessary for covering the whaling boat obtained and sewn by the women (NSB 2007). More recently freezers are being used for storage of subsistence foods (EDAW-AECOM 2007).

Table 3.3-19 Rates of Participation in Subsistence Activities – All Resources

Community	Percentage (%) of Households					
	Using	Trying to Harvest	Harvesting	Receiving	Giving	Average pounds harvested per household – all resources
Kaktovik (1992)	95.7	89.4	89.4	91.5	83	2,713
Nuiqsut (1993)	100	93.5	90.3	98.4	91.9	2,943.1
Barrow (1989)	-	-	61	-	-	930.73
Wainwright (1989)	-	-	66	-	-	2,954.46
Point Lay (1987)	100	83.1	83.1	100	88.7	2,495.83
Point Hope (1992)	-	-	-	-	-	2,182
Kivalina (2007)	100	95.2	95.2	100	90.5	3,152
Kotzebue (1986)	100	78.4	78.4	96.3	71.6	1,395.14

Source: ADFG 1986, 1988, 1989; NSB 1993, 2007 accessed on April 28, 2011; MMS 2008; Braund and Kruse 2009

Beaufort Sea Communities

Kaktovik

ADF&G (2011) estimated that in 1992 the approximate per capita consumption of subsistence food for Kaktovik was 886 pounds. Approximately 93 percent of the Iñupiat households in Kaktovik participate in the local subsistence economy, while approximately 80 percent of other residents use wild resources obtained from hunting, fishing, or gathering. In 2003, 68 percent of all Kaktovik residents reported that half or more of their diet consisted of local subsistence resources (Shepro et al. 2003).

Levels of harvest change from year to year, depending on species population dynamics, weather, and hunting conditions, among other factors. However, subsistence users adapt. For example, when fewer whales (or smaller whales) are harvested, it is likely that the lower percentage for these species is offset by increases in the use of other resources (EDAW-AECOM 2007). Kaktovik subsistence harvest data is described in Table 3.3-20.

Table 3.3-20 Kaktovik Subsistence Harvest Data

Kaktovik Subsistence Harvest Data (by weight) ADFG (1992)	
Resource	**Percentage (%) of Harvest**
Bowhead Whale	64
Fish	13
Caribou	11
Birds	1
Other	11
Kaktovik Mean Per Capita Subsistence Harvest (lbs per person), ADFG (1992)	
Salmon	1
Fish	118
Land Mammals	150
Marine Mammals	599
Birds and Eggs	17
Shellfish	0
Plants	1
All Resources	886
Kaktovik Subsistence Harvest Summary, ADFG (1992)	
Estimated Pounds Harvested	170,940.00
Mean Household Pounds	2,713.33
Harvested Per Capita Pounds Harvested	885.60

Source: ADFG 2011

Between the 1998 and 2003 surveys, there have been some changes in household consumption of subsistence resources (Shepro et al. 2003). The percentage of households who used very little local foods increased, while the number of households that identified the “more than half” category decreased. The percentage of households that were heavily reliant on subsistence resources (those who consumed all or nearly all of their food from local resources) increased from 35 percent in 1998 to approximately 41 percent in 2003 (Shepro et al. 2003).

Table 3.3-21 Kaktovik's Usage of Local Subsistence Resources in 1998 and 2003

Amount	Households 2003	Percentage (%) 2003	Households 1998	Percentage (%) 1998
None	0	0	1	2
Very little	8	15	1	2
Less than half	9	17	8	13
Half	11	20	11	18
More than half	4	7	18	30
Nearly all	13	24	12	20
All	9	17	9	1
Total	**54**	**100**	**60**	**100**

Source: Shepro et al. 2003

The average expenditure for the 49 households who reported subsistence expenditures was $4,788; the community spent approximately 10 percent of its total income on subsistence activities (Shepro et al. 2003). This includes expenses such as fuel, ammunition, and other supplies needed to participate in subsistence activities.

Nuiqsut

ADF&G (2011) estimated that in 1993 the approximate per capita consumption of subsistence food for Nuiqsut was 742 pounds. Fish (mainly freshwater white fish), terrestrial mammals (caribou and moose), and marine mammals (whales and seals) are harvested in roughly the same amounts (EDAW-AECOM 2007). Other resources harvested in lesser amounts include furbearers and birds. There is no "average" year so that in some years one of the resource components may comprise much more than a third of the actual subsistence resource use (especially in years when few or no whales are taken) (Galginaitis 1990 in EDAW-AECOM 2007).

Table 3.3-22 Nuiqsut Subsistence Harvest Data

Nuiqsut Subsistence Harvest (by weight), ADFG (1993)	
Resource	**Percentage (%) of Harvest**
Bowhead Whale	29
Fish	34
Caribou	30
Birds	2
Other	5
Nuiqsut Subsistence Harvest Summary, ADFG (1993)	
Estimated Pounds Harvested	267,818.00
Mean Household Pounds	2,943.05
Harvested Per Capita Pounds Harvested	741.75

Source: ADFG 2011a

Approximately 81 percent of the households in Nuiqsut participate in the local subsistence economy; the participation rate for Iñupiat residents was recorded at approximately 95 percent (Shepro et al. 2003).

Another study of subsistence practices in Nuiqsut (Brower and Opie 1997 in NSB 2005) indicated that of 259 harvest instances, 226 (87 percent) resulted in sharing with others. Sharing harvest resources is known to be one of the most important traditions in the local subsistence lifestyle. The subsistence lifestyle remains a primary cultural choice for Native households. In 2003, approximately 63 percent of local residents said that half or more of their diet consisted of local subsistence resources (Shepro et al. 2003). Table 3.3-23 describes usage of local subsistence resources for Nuiqsut.

Table 3.3-23 Nuiqsut Usage of Local Subsistence Resources in 1998 and 2003

Amount	Householder 1998	Percentage (%) 1998	Householder 2003	Percentage (%) 2003
None	0	0	0	0
Very little	8	13	14	18
Less than half	9	14	16	20
Half	20	31	18	23
More than half	15	23	14	18
Nearly all	7	11	13	17
All	5	8	4	5
Total	**64**	**100**	**79**	**100**

Source: Shepro et al. 2003

The average expenditure for the 50 households who reported subsistence expenditures was over $6,700. Together, these 50 households spent approximately $335,000 on subsistence in 2003, representing about 20 percent of the gross incomes of these families (Shepro et al. 2003).

Barrow

A 2003 survey found that 91 percent of Iñupiat households participated in the local subsistence economy, and 66 percent of the households indicated that half or more of their diet consisted of local subsistence resources (Circumpolar Research Associates 2004 in EDAW-AECOM 2007). In contrast, two-thirds of Barrow's non-Iñupiat households do not use wild resources obtained from hunting, fishing, or gathering. This is likely a result of the high non-Iñupiat population in Barrow and a reason for the lower harvest of subsistence resources on a per capita and per household basis in comparison to Nuiqsut and Kaktovik rates (EDAW-AECOM 2007).

In 1992, from subsistence fish and wildlife harvests in Barrow, 349 pounds per capita of wild resources were harvested (BLM 2005 in EDAW-AECOM 2007). Marine mammals composed approximately 55 percent of the total resources harvested, and land mammals composed 30 percent of the total. In 1992, the total harvest of marine mammals (bowhead whale, walrus, and ringed and bearded seals) accounted for approximately 72 percent of the total village harvest of all species, and bowhead whale provided the single greatest contribution of food to the community at 54 percent of the total harvest. Land mammals (caribou, moose, and Dall sheep) contributed approximately 19 percent of Barrow's total harvest in 1992, and caribou was the principal terrestrial resource (17 percent of the total harvest). Close to half (45 percent) of Barrow households participated in caribou hunting in 1992; caribou is one of the most consistently eaten subsistence resources in Barrow. In 1992, fish constituted approximately seven percent of the total harvest in Barrow, and broad whitefish was the most important fish resource (four percent of the total harvest). Birds, such as eiders and geese, contributed less than two percent of the total harvest by weight; however, participation in bird hunting was high (EDAW-AECOM 2007). ADF&G harvest data for Barrow from 1989 is described in Table 3.3-24.

Table 3.3-24 Barrow Subsistence Harvest Data - 1989

Barrow Per Capita Subsistence Harvest (per capita pounds), ADFG (1989)	
Salmon	4.06
Fish	35.22
Land Mammals	71.18
Marine Mammals	168.5
Birds and Eggs	9.76
Plants	0.44
Barrow Harvest Summary, ADFG (1989)	
Estimated Pounds Harvested by community – all resources	872,092
Average pounds per household - all resources	930.73
Harvested Per Capita Pounds	289.16

Source: ADFG 2011

The average expenditure for the 492 households who reported subsistence expenditures was $3,787, while the median expenditure was $925. Fifty-nine percent of the households that were interviewed reported spending less than $2,000 per year on subsistence (Shepro et al. 2003).

Many studies document the customary and traditional use of subsistence resources by Barrow residents including: ADFG 2000; BOEM 2011b and 2011c; Braund 1993; Braund 1989; Chance 1966; Craig 1987; EDAW-AECOM, 2007; George and Fuller 1997; George et al. 1993; Hess 1999; MMS 2003; MMS 2001; MMS 1998; MMS 1996a and 1996b; MMS 1990; MMS 1986; MMS 1983; MMS 2006b and 2006c, MMS 2007a and 2007c; MMS 2008; MMS 2009a and 2009b Nielson 1977; NSB 2002; NSB 1979; Patterson 1974; Pedersen 1979; Pedersen et al. 1979; Philo et al. 1994; Sonnenfeld 1956; SRB&A 2010; and Wolfe et al. 1986.

Chukchi Sea Communities

Wainwright

Wainwright subsistence users have opportunities for hunting terrestrial, riverine, and marine species, including bowhead whales, though they tend to harvest mostly from the ocean (Fuller and George 1997). Their data indicate that Wainwright residents primarily utilize marine mammals, caribou, and fish in terms of pounds per person harvested. Other resources are also harvested but at lower rates.

Table 3.3-25 Wainwright Subsistence Harvest Data, 1989

Resource	Estimated Number	Estimated pounds	Average pounds	Per Capita pounds
All Resources	-	351,581	2,954.46	751.24
Fish	64,567	17,385.00	146.09	37.15
Salmon	180	1,044.00	8.77	2.23
Non-Salmon Fish	64,387	16,341.00	137.32	34.92
Land Mammals	760	83,389.00	700.75	178.18
Large land mammals	713	83,387.00	700.73	178.18
Small land mammals	47	2.00	0.02	0.00
Marine mammals	-	243,594.00	2,047.01	520.50
Natures and eggs	2,735	7,211.00	60.60	15.41

Source: ADFG 2011

Approximately 92 percent of the households in Wainwright participate in the local subsistence economy; the participation rate for Iñupiat residents was recorded at approximately 99 percent (Shepro et al. 2003). In 2003, approximately 73 percent of all Wainwright residents said that half or more of their diet consisted of local subsistence resources, while 83 percent of Iñupiat residents were heavily reliant on subsistence resources (half or more of their diet comes from local foods) (Shepro et al. 2003).

The average household expenditure for subsistence activities in Wainwright in 2002 was $4,504, and the median expenditure was $2,500 (Shepro et al. 2003). Subsistence expenses include items such as fuel, ammunition, and other supplies needed to participate in subsistence activities.

Table 3.3-26 Wainwright Household Use of Subsistence Resources by Ethnicity

Level of Use	1998 Total	Iñupiat in 2003	Other in 2003	Total in 2003
None	0	1	8	9
Very little	12	5	6	11
Less than half	29	12	1	13
Half	32	30	1	31
More than half	16	22	0	22
Nearly all	29	30	1	31
All	4	5	0	5
Total	**122**	**105**	**17**	**122**

Source: Shepro et al. 2003 (authors noted that results were only of those households responding to the survey)

Point Lay

Caribou, fish, and beluga whale comprise the most significant subsistence resources of Point Lay residents. The reestablished bowhead hunt was successful in 2009 though poor ice conditions in 2010 prevented Point Lay hunters from striking a whale (ADN 2009, AEWC 2011). Seals and walrus are not as intensively used as in the past due to the reduction in dog teams and the present adequate supply of caribou. Other resources are also utilized by the community but at lower harvest levels in terms of pounds per person.

Table 3.3-27 Point Lay Subsistence Harvest Data, 1987

Resource	Estimated Number	Estimated pounds	Average pounds	Per Capita pounds
All Resources	-	107,321.00	2,495.83	890.11
Fish	2,807	2,983.00	69.38	24.74
Salmon	147	425.00	9.88	3.52
Non-Salmon Fish	2,660	2,559.00	59.50	21.22
Land Mammals	458	21,426.00	498.27	177.71
Large land mammals	167	21,309.00	495.56	176.74
Small land mammals	292	117.00	2.72	0.97
Marine mammals	-	76,853.00	1787.27	637.41
Birds and eggs	3,531	5,836.00	135.73	48.40
Plants	-	223.00	5.19	1.85

Source: ADFG 2011

Approximately 77 percent of the households in Point Lay participate in the local subsistence economy (Shepro et al. 2003). Of those households, 75 percent are heavily reliant on subsistence resources, where half or more of household diets consisted of local resources.

Table 3.3-28 Point Lay Usage of Local Subsistence Resources in 1998 and 2003

Amount	Households 1998	Percentage (%) 1998	Households 2003	Percentage (%) 2003
None	2	4.50	2	4.5
Very little	4	9.10	7	15.90
Less than half	5	11.40	2	4.50
Half	9	20.50	11	25.00
More than half	14	31.80	6	13.60
Nearly all	4	9.10	8	18.20
All	6	13.60	8	18.20
Total	**44**	**100**	**44**	**100**

Source: Shepro et al. 2003 – Authors noted that results include only households participating in the census survey and responding to the question "How much of the meat, fish and birds you and your household ate came from local food sources (fishing and hunting)?"

Thirty percent of the Point Lay households spent less than $500 on subsistence activities. Approximately 40 percent of the households spent $3,100 to $9,500 on subsistence activities (Shepro et al. 2003). Many sources document the customary and traditional use of subsistence resources by residents of this community, and are hereby incorporated by reference: Ahmaogak 1989; Alaska Consultants 1983; Alaska Consultants 1983; Bockstoce et al. 1979; Braund et al. 1988; MMS 2001; MMS 2009; NSB 1979; Suydam et al. n.d.; Suydam et al. 1994; and Worl 1980.

Point Hope

At Point Hope, marine mammals comprised over three-quarters of the harvest by weight (77 percent), including belugas, bowheads, walrus and seals (Fuller and George 1997). Caribou have historically been, and remain, an important subsistence resource for the community; in the 1997 study, caribou were the only non-marine mammal species in the top five species harvested for the year (NSB 2005).

Table 3.3-29 Main Subsistence Resources Harvested at Point Hope, 1992

Resource	Edible Pounds Harvested	Number Harvested	Pounds per household	Pounds per capita	Percent (%) of Total Harvest
Beluga whale	137,172	98	879	196	40.3
Walrus	55,797	72	358	80	16.4
Bearded seal	28,242	160	181	40	8.3
Caribou	26,303	225	169	38	7.7
Bowhead whale	23,365	3	150	33	6.9

Source: Fuller and George 1997

In 2003, approximately two-thirds of all Point Hope residents said that half or more of their diet consisted of local subsistence resources, while three-quarters of all Iñupiat residents were heavily reliant on subsistence resources (half or more of their diet comes from local foods) (Shepro et al. 2003). Approximately 93 percent of the households in Point Hope participate in the local subsistence economy; the participation rate for Iñupiat residents was recorded at approximately 99 percent (Shepro et al. 2003).

Nearly half of Point Hope residents (47.5 percent) spent less than $1,200 on subsistence activities; however 15 percent of residents spent between $9,600 and $20,000 (Shepro et al. 2003). Customary and traditional use of subsistence resources is documented in many sources that are incorporated into this document by reference: ADFG 2000; Foote and Williamson 1966; Foote and Williamson 1961; George and Fuller 1997; Heller 1966; Lowenstein 1980; NSB 1979; Patterson 1974; Pedersen 1979; and Pedersen 1971.

Table 3.3-30 Point Hope Usage of Local Subsistence Resources in 1998 and 2003

Amount	Households 1998	Percentage (%) 1998	Households 2003	Percentage (%) 2003
None	4	2.9	10	7.0
Very little	11	8.2	16	11.3
Less than half	23	17.2	23	16.2
Half	34	25.4	28	19.7
More than half	34	25.4	30	21.1
Nearly all	19	14.2	15	10.6
All	9	6.7	20	14.1
Total	**134**	**100**	**142**	**100**

Source: Shepro et al. 2003 Authors noted that results include only those households responding to the census survey, and the query about the amount of subsistence harvested by the household.

Kivalina

Subsistence harvest data for Kivalina, from 1992 and 2007, show 100 percent of households using subsistence resources during each year with 761 per capita pounds of subsistence resources in 1992 and 594 per capita pounds in 2007 (Braund 2008). The main species harvested tend to be Dolly Varden char, bearded seal, and caribou. Kivalina’s harvest numbers have been extensively studied by Braund (2008) who noted that Kivalina’s recent harvests, compared to pre-mine harvest levels, appear to have steadily decreased from 1,838 usable pounds per person in 1959–1960 to 594 pounds in 2007. This was attributed to less harvest needed to feed to dogs with the shift from sled-dogs to snowmachines as the primary mode of transportation. While Kivalina did not harvest a bowhead during 2004, data from that period indicate that rates of receiving from other communities were high at 64 percent of households receiving bowhead (Braund 2008).

Table 3.3-31 Kivalina Estimated Harvest by Resources, 2007

Resource	Total Pounds	Mean Households pounds	Per Capita pounds	Percent (%) of Total Harvest
All resources	255,344	3,152	594	100
Caribou	36,458	450	85	14.3
Moose	2,075	26	5	0.8
Other large land mammals	201	2	0	0.1
Bowhead	0	0	0	0.0
Beluga	21,890	270	51	8.6
Bearded seal	96,188	1,188	224	37.7
Other seals	5,830	72	14	2.3
Walrus	1,350	17	3	0.5

Resource	Total Pounds	Mean Households pounds	Per Capita pounds	Percent (%) of Total Harvest
Furbearers – small land mammals	39	0	0	0.0
Waterfowl	3,319	41	8	1.3
Eggs	839	10	2	0.3
Upland birds	233	3	1	0.1
Dolly Varden char	67,739	836	158	26.5
Other non-salmon fish	7,596	94	18	3.0
Salmon	3,445	43	8	1.3
Berries	7,398	91	17	2.9
Plants	654	8	2	0.3

Source: Braund 2008

Kotzebue

The 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, namelycaribou, 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 (Braund 2008). The composition of the subsistence harvests of Kotzebue are similar to comprehensive subsistence harvest information from seven nearby communities (based on 97 surveys) in the Kotzebue Sound area where caribou comprises 30 percent of the subsistence foods harvested (Magdanz et al. 2010).

Table 3.3-32 Kotzebue Estimated Harvest by Resources, 2004

Resource	Percent of Households Harvesting	Total Pounds	Mean Households pounds	Percent of Total Harvest
All resources	-	1,022,847	3,237	100%
Caribou	76	260,459	743	25.5%
Moose	22	51,215	135	5.0%
Other large land mammals	-	472	4	0%
Beluga	5	7,960	74	0.8%
Bearded seal	40	204,272	638	20.0%
Other seals	-	31,113	106	3.0%
Walrus	3	12,320	114	1.2%
Polar bear	1	0	0	0.0%
Waterfowl	-	12,864	33	1.3%
Eggs	-	605	2	0.1%
Dolly Varden char	56	18,287	45	1.8%
Other non-salmon fish	63	245,352	799	24.0%
Salmon	68	164,689	499	16.1%

Source: Braund 2008

3.3.2.6 Influence of Climate Change on Subsistence Resources and Uses

While the potential impacts of climate change on subsistence resources and harvests are 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 of sea-ice; increased snowfall; drier summers and falls; forest decline; reduced river and lake ice; permafrost degradation; increased storms and coastal erosion; cooling in the Labrador Sea (associated with increased sea-ice melt); and ozone depletion (MMS 2008).

The communities of the Beaufort and Chukchi seas have voiced increasing concern about the potential for adverse effects on subsistence harvest patterns and subsistence resources from habitat and alterations due to the effects of global climate change. Indigenous peoples have settled in particular locations because of their proximity to important subsistence resources and dependable sources of water, shelter, and fuel. As voiced by Edna Ahmaogk at the March 9, 2010 public scoping meeting in Wainwright for this EIS:

> *[T]here is nowhere else in the world where people are still living as lively as we are, subsistence-wise, and we're not exploiting our natural resources as in most countries. You know, we're doing it for our living. And I don't want to lose that.*

MMS (2008) described how the indigenous communities and their traditional subsistence practices will be stressed to the extent that the following observed changes continue:

- villages and settlements are threatened by sea-ice melt, permafrost loss, and sea-level rise;
- traditional hunting locations are altered;
- traditional storage practices are altered due to melting in ice cellars;
- subsistence travel and access difficulties increase on land and on water; and
- resource patterns shift and their seasonal availability changes.

Changes in sea ice could have dramatic effects on sea mammal-migration routes which could impact the harvest patterns of coastal subsistence communities and increase the danger of hunting on sea ice (Callaway et al. 1999, Bielawski 1997).

Subsistence hunters have already noted such changes:

> *We realize the ecosystem we are in is very healthy and productive. However, the access, due to changing patterns in ice and weather, has affected our ability to access resources. The changes aren't all bad, because in 1990 Savoonga and Gambell started harvesting bowheads in the dead of winter. As a consequence, 40 percent of our harvests are now occurring in winter (November/December timeframe). We have begun to take steps to conduct spring whaling activities earlier so we can adjust to the changes that are now occurring in migration patterns of marine mammals, specifically the bowhead whales.* - George Noongwook, AEWC Vice Chair and representing Savoonga/St Lawrence March 2011 - Open Water Meeting, Anchorage, AK.

In addition changes in ice conditions have influenced the spring bowhead hunt in the Chukchi sea communities. The AEWC noted that *"worsening ice conditionshave 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 will continue to threaten and change important subsistence habitats and species. The reduction of sea ice would result in the loss of habitat for marine mammals, including polar bear, ringed and bearded seals, walrus, and beluga whales.

Every community in the Arctic potentially is affected by the anticipated climactic shift (MMS 2008). It is likely that the reduction, regulation, and/or loss of subsistence resources would have severe effects on the way of life for residents of coastal communities in the Beaufort and Chukchi seas who depend on subsistence resources. Shore erosion in communities such as Shishmaref, Kivalina, Wainwright, Barrow, Kaktovik, the Yukon-Kuskokwim Delta in Alaska, and in Tuktoyaktuk at the mouth of the Mackenzie River in Canada has become increasingly severe in recent years, as sea-ice formation occurs later, allowing wave action from storms to cause greater damage to the shoreline and change the usage pattern of local and regional subsistence use areas (MMS 2008).

3.3.3 Public Health

3.3.3.1 Introduction

This section presents an overview of public health in the areas that comprise the affected environment for this EIS. As described below, the affected environment for public health consists of the eight communities in the NSB and one community of the NAB whose residents may be affected by the proposed oil and gas offshore exploration activities in the Beaufort and Chukchi seas.

The description of health conditions presented in this section is considerably broader than what has, until recently, typically been included in EISs to describe the health of affected populations. This wider scope is driven by two reasons. The first reason relates to changing expectations for what constitutes a sufficient examination of human health within the regulatory process. North Slope residents, the NSB municipality, the Alaska Inter-Tribal Council, the Iñupiat Community of the Arctic Slope, the EPA, and the National Research Council (NRC) have all advocated strongly for the inclusion of a more systematic and broad-based appraisal of human health concerns in planning processes and the BLM on the national level is reassessing public health analysis in planning (MMS 2008, NRC 2003b).

The second reason has to do with data availability. Data have only recently become available that allow the health of the affected environment to be described explicitly; previously, most relevant health indicators were available only at the state level, for all rural Alaska populations, or for all Alaska Natives as a group.

In depicting health conditions in the affected environment, this section begins with a description of biomedical health outcomes—rates of disease, injury, and other indicators of ill health—and follows with a description of health determinants—the environmental and social conditions that cause or contribute to biomedical health outcomes. By including both health conditions and health determinants, this section attempts to elucidate the specific pathways through which public health may be affected, as well as the outcomes that may result.

The main health conditions that burden the population in the affected environment are the same ones that are seen elsewhere in Alaska and the U.S.: cancer; heart disease; respiratory diseases and intentional and unintentional injury; overweight/obesity; and diabetes. Overall, the rates of these conditions are parallel to that seen elsewhere in Alaska, although the rates of some conditions are higher in the affected environment.

These diseases and health conditions are multifactorial – that is, they arise from a complex combination of factors that affect populations and the individuals within them. These factors include individual behaviors, environmental conditions, institutional supports, and social and economic circumstances. What is important to note in the context of this EIS is that the factors that are most relevant for disease generation in this population are not necessarily the same as those that apply to populations elsewhere. The unique physical, cultural, and social environments of northern Alaska determine the level of health of the population and of individuals. The health determinants described in this section—such as income and employment and subsistence participation and diet—play a critical role in supporting or undermining the health of the population.

3.3.3.2 Data Sources

Although the data presented in this section derive from a large number of sources, there are three sources in particular that are important to note and that have been used extensively throughout this section. The first of these is the Public Health section of the Affected Environment chapter of the Northeast NPR-A Final Supplemental Integrated Activity Plan/Environmental Impact Statement (IAP/EIS), authored by Dr. Aaron Wernham (BLM 2008a).

The second source of note is a report that 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.*
>
> *After mapping all the occupied structures in each community the 2010 NSB census takers conducted face-to-face interviews, attempting to reach every household in each NSB community. Sampling proportions ranged from 65 percent in Barrow to nearly 90 percent in some of the smaller communities. The total potential households for each community were determined by analyzing utility (primarily electricity) hookup data provided by the Borough. Given such high sampling fractions and absent any reasonable expectation of sampling bias this survey provides an extremely representative picture of the population. Standard errors of the proportion range from 1.9 percent to 7.5 percent depending on the community. For the North Slope Borough as a whole with 1,604 households interviewed out of total of 2,271 the standard error is 1.4 percent.*
>
> *For each household, an attempt was made to interview the adult who identified themselves as the "household head," a household member who was available and likely to have the greatest familiarity with household economics, health of household members, level of subsistence participation, etc. The respondents, or "household heads" were asked all the questions as they pertained to themselves and then a smaller subset of questions as they pertained to all other household members, acting as a proxy. Household heads participating in the census were 48 percent male and 52 percent female.*
>
> *Household heads participating in the census were 69 percent Iñupiat, 19 percent Caucasian, and 12 percent of other ethnic groups* (Circumpolar Research Associates 2011).

Two last points are important to note about the data presented in this section. First, the population of the affected communities is relatively small, and when de-aggregated into individual villages, it is smaller still. Small populations mean small numbers of cases on an annual basis, with potentially large fluctuations from year to year. For example, two cases of cancer one year and three cases of cancer the next may appear as a 50 percent increase, although the difference between two and three is unlikely to be statistically significant. For this reason, rates of uncommon diseases or health conditions in the affected environment must be interpreted with caution.

Second, the tables often contain data that have been obtained from different sources. In this case, the original questions or methods used to obtain the data may vary between sources, and thus comparisons between these data sets should be made cautiously.

3.3.3.3 Study Area and Population Demographics

The affected environment for the Public Health section of this EIS comprises the communities whose residents may be affected by social or environmental changes that result from the proposed oil and gas offshore exploration activities in the Beaufort and Chukchi seas. This includes the communities of Kaktovik, Nuiqsut, Anaktuvuk Pass, Atqasuk, Barrow, Wainwright, Point Lay, Point Hope, and Kivalina. Anaktuvuk Pass and Atqasuk are not on the coast of either the Beaufort or Chukchi seas and are not included in the affected environment of many other sections of this EIS. However, residents of these two communities use the seas for subsistence activities, a key health determinant, and therefore these communities are included in the affected environment for public health. Kotzebue is not included in this assessment as there are no proposed offshore exploration activities occurring in this area.

The population of the communities in the affected environment is described in Table 3.3-33 below. There is one larger community: Barrow, but the majority of communities are small, with populations fewer than 1,000 residents. The majority of residents in all communities (roughly 90 percent except in Barrow) are Iñupiat or Alaska Natives. The population is very young, with the median age between 20 and 25 years old and children comprising 34 percent of the population in the NSB. This age structure influences the health conditions likely to be observed in the affected environment, since younger populations are more likely to experience higher rates of infectious diseases, injuries, and some mental illnesses. Older populations, in contrast, tend to exhibit higher rates of chronic disease such as heart disease, diabetes, arthritis, and cancer.

Table 3.3-33 Population Demographics in Affected Environment Communities

Community	Population size	Percent (%) Iñupiat/Alaska Natives	Median Age	Proportion of residents over the age of 65	Proportion of residents under the age of 18
North Slope Borough (NSB) Communities					
Anaktuvuk Pass	346	88	25.7	4%	36%
Atqasuk	250	91	26.3	6%	39%
Barrow	4,429	61	28.8	5%	32%
Kaktovik	286	88	32.1	10%	30%
Nuiqsut	416	92	23.8	6%	31%
Point Hope	764	91	21.8	8%	37%
Point Lay	260	86	20.8	5%	40%
Wainwright	556	94	24.5	8%	35%
Northwest Arctic Borough (NAB) Community					
Kivalina	388	97	20.8	n/a	n/a

Data: NSB 2011a, ADCCED 2010, Advameg, Inc. 2009. Note that these data are derived from the 2000 and 2003 census.

The focus of the analysis of impacts in Chapter 4 will consider the entire affected environment to the degree to which effects are predicted for each community. In this chapter, current health conditions are described more intensively for the eight communities of the NSB than for Kivalina in the NAB. This is primarily because more specific and fine-grained data about health conditions exists for the NSB communities, as described in Section 3.3.3.2 (Data Sources). However, Kivalina shares many common features with the NSB communities, including many lifestyle, environmental, social, economic, and cultural conditions that determine health outcomes, such as reliance on subsistence resources, including the Western Arctic Caribou Herd, remote location, small population comprised mainly of Iñupiat people, limited infrastructure, housing type, and availability and limited economic opportunities. In addition, many of the health outcome indicators described in this chapter indicate that biophysical health outcome measures are likely to be similar for the populations in NSB and NAB communities. As a result, the impact pathways between proposed alternatives and human health outcomes are likely to be similar for NSB communities and Kivalina, as are the effects that will be experienced. The additional fine-grain of detail available for NSB communities therefore provides an extra source of information that will help in the analysis of impacts; but the lack of this same level of detail for Kivalina will not preclude a full assessment of impacts for that location.

3.3.3.4 Biomedical Health Outcomes

This section presents an overview of biomedical health outcomes and diseases experienced by the population in the affected environment. Biomedical health refers to illnesses, diseases, injuries, and other health states experienced by individuals.

General Health Indicators

General health indicators provide a picture of the overall health status of the population. The health indicators presented in this section reflect important measures of population health and wellness that can be compared across time and across different regions to understand how the health of one population compares with the health of others.

Table 3.3-34 General Health Indicators in the NSB

	Anaktuvuk Pass	Atqasuk	Barrow	Kaktovik	Nuiqsut	Point Hope	Point Lay	Wainwright	All NSB	All Alaska
Reported health status, adults										
"Very good" or "excellent" general health	32%	21%	53%	38%	39%	36%	52%	35%	46%	56%[a]
"Fair" to "Poor" general health	4%	34%	13%	19%	22%	21%	10%	21%	16%	14%[a]
Reported health status, children										
"Very good" or "excellent" general health	41%	38%	68%	66%	55%	66%	70%	54%	63%	89%[b]
"Fair" to "Poor" general health	4%	9%	4%	10%	16%	7%	1%	7%	6%	

Source: [a] CDC 2008 [b] CAHMI 2007
Source: Circumpolar Research Associates 2010,

Table 3.3-35 Leading Causes of Death in the EIS Project Area

	North Slope Borough 2006-2008			Northwest Arctic Borough 1999-2003			Alaska 2006-2008	
	Rank	Number of Deaths	Rate (age-adjusted)	Rank	Number of Deaths	Rate (age-adjusted)	Rank	Rate (age-adjusted)
Cancer	2	29	272.9	1	39	347.8	1	181.3
Heart Disease	1	26	274.8	2	28	321.3	2	154.8
Unintentional injuries	4	17	125.2	3	38	133.6	3	54.8
Chronic Lower Respiratory Diseases	3	10	144.3	n/a	n/a	n/a	5	42.5
Suicide	5	10	53.3	4	30	79.5	6	22.7

Notes: Rates are per 100,000 persons, age-adjusted to U.S. year 2000 standard population. Ranks are based on age-adjusted rates.
Source: State of Alaska Department of Health and Social Services 2008, AN Epicenter 2008

As can be seen from the data in Table 3.3-34, residents of the NSB report lower rates of excellent/very good health and higher rates of fair/poor health than residents of Alaska as a whole, both for children and for adults, with considerable diversity among the different NSB communities. Self-rated health is one of the strongest, most consistent predictors of illness, premature death, health care utilization, and hospitalization (Idler and Benyamini 1997). The observation that NSB residents experience poorer overall health than other Alaskan residents is supported by data that show the NSB ranking 17th out of 22 Alaskan census areas for overall health outcomes, based on a combination of standard health indicators (MATCH 2010).

Life expectancy and mortality are also commonly used to evaluate and compare the health of populations. Between 1999 and 2008, the life expectancy at birth for a resident of the NSB was estimated as 71.9 years, approximately four years shorter than for Alaskans overall (75.6 years), although the estimate was similar to that for Alaska Natives statewide (State of Alaska Department of Health and Social Services 2008). However, rates of adult and infant mortality have declined in the NSB over the past three decades, representing overall health improvements in the area.

Since the early 1990s, the leading causes of death in the NSB have been fairly constant. Cancer is the leading cause of death in both the NSB and across Alaska, followed by heart disease and respiratory disease (Table 3.3-35). In the NAB, the leading causes of death in Alaska Natives, which make up 97 percent of the population are cancer, heart disease, and unintentional injuries (Table 3.3-35) (AN Epicenter 2008). Rates of death for all leading causes of death are much higher in the affected environment than in the State of Alaska.

Chronic Diseases

Table 3.3-36 Chronic Disease in the NSB

	All NSB	All Alaska
Proportion of adults who report a health professional diagnosis of:		
High blood Pressure	20%	26%[a]
Heart disease	5%	3%[b]
Thyroid problems	4%	9% (U.S.)[c]
In the past 12 months, percent who experienced:		
Chronic breathing problems (adults)	8%	10%[d]
Chronic breathing problems (children under 18))	5%	5-6%[d]
Daily pain or arthritis that limits activities or requires prescription pain medicine	21%	22%[a]

Notes:
[a] CDC 2009
[b] CDC 2008 (Heart disease: Alaska estimate includes only diagnoses of angina, heart attack, coronary heart disease. NSB estimate may include other types of heart disease such as congestive heart failure, heart rhythm problems, or valvular heart disease)
[c] Melzer 2010
[d] Based on CDC 2004, Gessner and Utermohle 2006, CAHMI 2007
Source: Circumpolar Research Associates 2010, with the exception of those noted here

Important chronic diseases in the affected environment include chronic respiratory disease, cancer, and cardiovascular conditions. The leading causes of self-reported health problems among Iñupiat adults (over age 16) participating in a 2004 survey were high blood pressure (reported in 29 percent of respondents), arthritis/rheumatism (21 percent), asthma (21 percent), stomach problems or intestinal ulcers (15 percent), chronic bronchitis, emphysema, or shortness of breath (12 percent), and heart problems (9 percent) (Poppel et al. 2007).

Chronic lower respiratory disease (CLRD) is one of the most frequently cited health concerns among community members in the NSB and has been the fifth leading cause of death in the Borough for most years since 1990. Mortality rates from CLRD in the NSB remain almost twice statewide rates and nearly three times the mortality rate for the U.S. (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.

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, 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 (DiGirolamo et al. 2007, Baggett et al. 2006) and possibly with stomach cancer among adults. Unusually high rates of *H. pylori* have been found among Alaska Natives. Based on a sample of approximately 2,000 stored blood samples taken between 1980 and 1986, rates of *H. pylori* infection were estimated to be about 75 percent among Alaska Natives (Parkinson 2000). While the reasons for these high rates are not clear, the strain of the bacteria is unusually resistant to treatment (Centers for Disease Control 2011).

Few parasitic diseases have been reported in the literature as presenting a significant medical problem in Alaska. The parasitic diseases most likely to cause problems in humans in the area are giardia, brucellosis, and trichinella. However, concern has been raised that changing of the landscape, water supply, and subsistence food practices (including food harvesting, preparation and storage) caused by climate change, development activities, or other causes, could cause an increase in the rates of parasitic diseases experienced by humans (Brubaker et al. 2011).

Nutritional Outcomes

Diet and nutrition play an important part in health. Healthy diets prevent disease and are important to maintain at community and individual levels. Native populations in Alaska and elsewhere have experienced marked changes in disease patterns stemming from the rapid transition from a healthy subsistence diet to a more Western diet and lifestyle, resulting in drastic increases in obesity, diabetes, and other chronic diseases (Kuhnlein and Receveur 1996).

Table 3.3-37 Nutritional Outcomes Among Adults in the NSB

	Anaktuvuk Pass	Atqasuk	Barrow	Kaktovik	Nuiqsut	Point Hope	Point Lay	Wainwright	All NSB	All Alaska
Diabetes									6%	6%[a]
Overweight (BMI 25-29.9 kg/m^2, based on self-reported height and weight)^2									33%	37%[a]
Obese (BMI 30 kg/m^2 or higher, based on self-reported height and weight)^2									39%	28%[a]
Percent of households that found it difficult to get the foods they needed to eat healthy meals in the past year	57%	59%	28%	40%	38%	36%	51%	46%	35%	
Percent with household members who at times did not have enough to eat	40%	20%	14%	19%	25%	24%	22%	30%	19%	

Notes: [a] CDC 2009
Source: Circumpolar Research Associates 2010, with the exception of that noted here

Table 3.3-38 Nutritional Outcomes Across Alaska

Indicator	All Alaska	American Indian / Alaska Native	All Rural Alaska
Proportion of Alaskan adults with pre-diabetes or borderline diabetes	8.1% (95% confidence interval: 7.0% - 9.4%)	10.1% (95% confidence interval: 7.4% -13.6%)	6.5% (95% confidence interval: 4.9% - 8.6%)
Proportion of Alaskan adults with non-gestational diabetes	6.7% (95% confidence interval: 5.7% - 7.8%)	8.2% (95% confidence interval: 5.7% - 11.6%)	5.7% (95% confidence interval: 3.9% - 8.1%)

Source: Parnell et al. 2008

Overweight, obesity, and diabetes present significant health burdens to NSB (Parnell et al. 2008). This constellation of disorders is linked with increased risk of developing a number of other chronic health problems, including high blood pressure, heart disease, arthritis, certain cancers, and some types of respiratory problems.

As shown in Table 3.3-37, in 2006 to 2008 the NSB had substantially higher estimated adult obesity rates than the Alaska average, with almost two-thirds of residents self-reporting as overweight or obese. One-half of children in the NSB are overweight or obese, making rates of childhood obesity in the NSB well above the state average for Alaska. Between 1990 and 2005, the prevalence of diabetes in the Barrow service unit increased by roughly 130 percent, or by nearly three times the overall U.S. rate (ANMC

2010). Across all of Alaska, rates of overweight individuals are similar in Natives compared to non-Natives, although rates of obesity are significantly higher in Alaska Natives (38.1 percent vs. 26.1 percent) (Parnell et al. 2008).

Rates of diabetes among adults in the NSB vary substantially depending on the data source. The NSB census data show rates very similar to those of adults across Alaska, and this similarity has also been found in the Behavioral Risk Factor Surveillance Survey telephone survey data (Tables 3.3-37 and 3.3-38). However, the Alaska Native Medical Center's diabetes program that maintains a statewide diabetes registry found the age-adjusted diabetes prevalence for the Barrow service area to be the second lowest in the state, estimated at only 2.8 percent (ANMC 2010). As has been happening across the country and state, rates of diabetes have risen rapidly in the NSB over the last several decades. Between 1985 and 2005, the crude prevalence of diabetes seen in the 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 et al. 2006, Bersamin and Luick 2007, Bersamin et al. 2008). This is often because processed or packaged foods are cheaper and more readily available in rural/remote areas than fruits and vegetables, often because of their longer shelf life. Rates of food insecurity are high in the NSB with 19 to 40 percent of households reporting not having enough food to eat at times (Table 3.3-37). Food availability from subsistence foods is discussed further in Section 3.3.2.5, Community Subsistence Harvest Rates.

Injuries

Injuries are an important health outcome that can lead to lost worker productivity and income, increased health care costs over the short and long term, disability, and even death (McAninch 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: 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	All Alaska
In the past 12 months, felt a household member had been hurt by drugs or alcohol[1]	30%	n/a
In the past 12 months, felt the health of their community had been hurt by drugs or alcohol		
Often	57%	n/a
Sometimes	35%	n/a

Notes: [1] Includes all head of households (survey respondents)
Source: Circumpolar Research Associates 2010

Table 3.3-42 Mental Health Across Alaska

Indicator	All Alaska	American Indian / Alaska Native	All Rural Alaska
Proportion of Alaskan adults with current moderate-to-severe depression	7.6% (95% confidence interval: 5.9% - 9.7%)	9% (95% confidence interval: 6% - 15%)	8% (95% confidence interval: 5% - 11%)

Source: Parnell et al. 2008

Alcohol and drug misuse, which usually comprise a significant component of and contributor to social pathologies. As shown in Table 3.3-41, a large proportion of NSB residents feel that their families and communities have been hurt by drug or alcohol use.

In 2006 to 2008, suicide was the fourth leading cause of death in the NSB. Since 1990, age-adjusted suicide mortality rates in the NSB have averaged twice the statewide average and four times the national average. Alaska Natives are at particular risk of suicide, comprising 39 percent of all suicides in the state (AIPC et al. 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 (CDC 2006). Within the NSB, there can be considerable variation among communities; in Barrow in 2003, rates of reported domestic violence were six times higher than reported in the rest of the state (ANDVSA 2004). Across the state, Alaska Natives suffer disproportionately higher rates of domestic violence than non-Alaska Natives (Rivera 2010).

Maternal and Child Health

Indicators of maternal and child health provide insight into overall health status and social wellbeing at a societal level, since they are highly sensitive to changing social and environmental conditions. The infant mortality rate for the NSB was reported as 9.2 per 1,000 live births between 1998 and 2007. Although this rate has been steadily declining in the NSB since 1977, this rate is still higher than the state rate of approximately 6.5 deaths per 1,000 live births and is above the state target of 4.5 per 1,000 live births (Pearson 2002). However, the NSB has the lowest 10-year average infant mortality rate of all the northern, southwest, and interior rural Alaskan regions (ABVS 2007).

Child mortality among all Alaska Natives is higher than among Alaska non-Natives, and this health disparity has persisted over many years. Between 2003 and 2005, child mortality among children ages 1 to 4 was 103.4 per 100,000 population in Alaska Native children vs. 23.7 per 100,000 for non-Native children (Schoellhorn et al. 2008). The proportion of deaths due to unintentional injuries among all Alaska Natives increases from young children to adolescents to teenagers. While homicide is the second leading cause of death in children aged 0 to 9, suicide becomes the second leading cause of death for youth and teens (Schoellhorn et al. 2008).

Mortality is not the only indicator of child health. Of particular relevance to the NSB is tooth decay, a health issue that is predominant in Native populations across the country. Rates of untreated tooth decay in Alaska Native and American Indian children have been two to five times the rates for non-Native children (IHS 1999, Riedy 2010), and high intakes of sugar-sweetened beverages appear to be a causative factor. As discussed earlier in the section titled Nutritional Outcomes, diabetes and obesity also greatly impact youth of the NSB and represent serious public health concerns.

Health Disparities

Although population-level health data are usually presented in a way that aggregates individual experience and shows the "average" experience of health, it is important to note that significant health disparities exist among individuals, and also among subsets of the population. While some people and some groups will always be healthier than others, systematic health disparities—also termed *health inequities*—generally arise along predictable lines. Groups that experience some areas of disadvantage, such as economic disadvantage, environmental injustice, or social dysfunction, are usually those that experience health disparities.

In Alaska, these health inequities can generally be found when looking at differences between rural and urban populations, and among racial and socioeconomic groups. Alaska Natives, people living in rural areas, and the poor are generally worse off in terms of almost all measurable health outcomes.

Examples of health disparities between Alaska Natives and non-Natives can be seen in a large number of health outcome indicators. In the year 2000, the life expectancy for Alaska Natives was 69.5 years, lagging the life expectancy of 76.5 years for the general U.S. population (Parkinson 2006). Rates of unintentional injury are higher in Natives, as is cancer mortality, social pathologies (including suicide, homicide, family and intimate partner violence), smoking-related illness such as lung cancer, and CLRD (Day et al. 2006, Lanier et al. 2006). Indicators of maternal and child health are also worse for this group.

Disparities are neither fixed nor uniform. While patterns may be observed in the population at large, the health of individuals within any group will vary widely. And regardless of disparities, many disadvantaged groups in Alaska have seen substantial improvements across a wide range of health indicators over the last several decades.

3.3.3.5 Health Determinants

To a large extent, health is determined by where we live, the state of our environment, our income and education levels, our jobs, and our relationships with friends, family, and the larger community. These critical factors are often called *health determinants* (or determinants of health) because of their roles in shaping health in individuals and communities. Some health determinants are under the direct control of individuals, for example, the choice to use alcohol or to smoke, to eat healthy foods, or to use snow machines or four-wheeler helmets. Other health determinants are more closely tied to the physical environment (e.g. air and water quality; subsistence resources); activities under the control of governments (public utilities, land use, access to alcohol and tobacco); working conditions (jobs, income); or the social environment (social, emotional, and religious supports).

The biomedical health outcomes described in Section 3.3.3.4 share the fact that rates of disease incidence, prevalence, and mortality are driven in large part by these determinants, although other factors, such as genetic factors, also play a role. The effects of individual health determinants on disease rates often persist even after controlling for standard risk factors such as smoking rates, cholesterol and blood pressure levels, and overall poverty.

The following sections describe a number of health determinants that are relevant for the affected population and to potential development that may stem from the proposed oil and gas offshore exploration activities in the Beaufort and Chukchi seas.

Table 3.3-43 shows where there is an evidence-based interaction between the health determinants presented below and the biomedical health outcomes presented above, especially those that may be applicable for the affected population (Driscoll 2009).

Table 3.3-43 Interaction Between Health Determinants and Health Outcomes in the EIS Project Area

	Chronic diseases	Infectious diseases	Nutritional outcomes	Injuries	Social pathologies and mental health	Maternal and child health
Income and employment	•	•	•	•	•	•
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 utilized 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 3.3.2, Socioeconomics.

Subsistence Participation and Diet

Table 3.3-44 Food and Nutrition in the NSB

	Anaktuvuk Pass	Atqasuk	Barrow	Kaktovik	Nuiqsut	Point Hope	Point Lay	Wainwright	All NSB
Times last year when household found it difficult to get the foods they needed to eat healthy meals[1]	57%	59%	28%	40%	38%	36%	51%	46%	35%
If yes, because not able to get enough subsistence foods	71%	34%	34%	44%	53%	59%	48%	36%	43%
If yes, because not able to get enough store foods	80%	100%	90%	88%	87%	86%	96%	95%	90%
Households that get at least half of their meals from subsistence sources	67%	58%	44%	67%	67%	64%	61%	67%	54%

Notes: [1]Includes all head of households (survey respondents)
Source: Circumpolar Research Associates 2010

Diets in the NSB include both traditional, or subsistence foods, and non-traditional, or store foods. Traditional diets are associated with numerous health benefits and reduced risk of many chronic diseases including diabetes, high blood pressure, high cholesterol, heart disease, stroke, arthritis, depression, and some cancers (Reynolds et al. 2006; Murphy et al. 1995; Adler et al. 1994, 1996; Ebbesson et al. 1999, Bjerregaard et al. 2004).

While evidence of dietary habits in the NSB is limited, subsistence sources are an important food source to NSB residents. Subsistence foods include fish, seal, walrus, beluga and bowhead whale from the Beaufort and Chukchi seas, as well as land-based animals and certain migratory birds and eggs. In the 2010 NSB census, 54 percent of households indicated that they get at least half of their meals from subsistence sources. Data from the 2003 NSB census show that virtually all Iñupiat households reported relying on subsistence resources to some extent and that subsistence foods make up a large proportion of healthy meals (Table 3.3-44) (Circumpolar Research Associates 2010). The NSB also has among the highest per capita harvests of subsistence food in Alaska (McAninch 2012).

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 (Nobmann et al. 2005, Bersamin and Luick 2007). The NSB communities are similar to many other Arctic communities in this respect: people across the circumpolar regions are increasingly replacing traditional subsistence foods, which are associated with numerous health benefits, with store-bought foods that are often high in sugar, calories, and unhealthy types of fat. NSB residents are also consuming high levels of sodas and other sugared beverages (Circumpolar Research Associates 2010).

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 Services

Table 3.3-45 Health Insurance in the NSB

	All NSB	All Alaska
Have health insurance, including IHS eligibility	97%	82%[a]
Have health insurance, other than IHS eligibility	64%	

Notes: Includes all head of households (survey respondents)
[a] CDC 2009
Source: Circumpolar Research Associates 2010, with the exception of that noted here

Table 3.3-46 Health Insurance across Alaska

Indicator	All Alaska	American Indian / Alaska Native	All Rural Alaska
Proportion of Alaskan adults with health care coverage	83.2% (95% confidence interval: 81.4% - 84.8%)	84.3% (95% confidence interval: 80.9% - 87.2%)	78.9% (95% confidence interval: 75.4% - 82.0%)

Source: Parnell et al. 2008

Health care resources play a specific role in prevention—and a widespread role in treatment—of disease and illness. The adequacy of health care resources is dependent on both universality of access and availability of resources. The provision of health care services may be limited, especially in rural areas, by the unavailability of health care providers. Rural areas often have problems with both recruitment and retention of medical personnel, and some areas are chronically understaffed and underserved. Access to specialist care (and some of the allied health professions, such as mental or nutritional health) is also quite limited in rural areas, unless the patient travels to a major population center.

Provision of health care in the NSB is the joint responsibility of the NSB and the Arctic Slope Native Association (ASNA). Other than Barrow, all NSB communities of the NSB maintain a clinic that is staffed by Community Health Aide/Practitioners. None of these communities have a physician or physician's assistant in residence. Barrow houses the Samuel Simmonds Memorial Hospital, a 14-bed hospital with an outpatient unit that consists of a six-room clinic and a two-bed emergency room (ASNA 2010). The hospital in Barrow offers an ambulatory care clinic, dental and eye clinics, pharmacy, and a specialty clinic. Barrow acts as the tertiary care center for the NSB communities, with cases referred to Fairbanks or Anchorage if they cannot be taken in Barrow. Barrow also offers outpatient behavioral or mental health services. A wellness center in Barrow houses both NSB and ASNA services. NSB services include a public health nurse, an eye clinic, and an allied health program, while the ASNA has a "Screening for Life" program that includes screening for STIs and, breast and colon cancers.

Health services in and near the NAB are provided through the Maniilaq Association, which is responsible for the provision of extensive health, tribal, and social services to residents of rural Northwest Alaska. Kotzebue houses the Maniilaq Health Center, a primary health care facility that offers an emergency room, an ambulatory care clinic, dental and eye care clinics, a pharmacy, a specialty clinic, and an inpatient wing with 24 beds. In Kivalina, the Community Health Aide/Practitioner program operates a village clinic staffed by two to four Health Aides. The clinic is supported by electronic access to the Maniilaq Health Center in Kotzebue. Several times a year, specialized doctors, dentists, and eye doctors make regularly scheduled visits to the clinic to provide specialized care not usually offered in the area (Maniilaq Association 2010).

Alaska Native Health Service provides health insurance to all Alaska Natives, and over 97 percent of adult NSB residents have health insurance compared to 82 percent of adults statewide (Table 3.3-45). Rural Alaskans also have lower rates of insurance coverage than the overall population, although the rates remain high (Table 4.4-43). While insurance coverage is very good, access to services is severely inhibited by the remote location of the communities and severity of the climate. The costs and inconvenience of travel necessary for many services is cited as a barrier (McAninch 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.

The Alaska Native Tribal Health Consortium has supported the development of telehealth technologies to support health-related communications in Alaska, through the Alaska Federal Health Care Access Network. Although NSB Health and Community Health Aides/Practitioners have been trained in using telehealth, challenges in staff turnover at the Samuel Simmons Memorial Hospital have prevented its full implementation.

Emergency medical services are also considered a part of health care services in the affected community. The NSB maintains a centralized headquarters to coordinate the provision of fire, rescue, and emergency medical services and oversees nine fire rescue stations, all of which house, at a minimum, an ambulance, engine, and tanker to provide Emergency Medical Services (EMS) response and fire protection to the community (NSB 2011b). Following considerable investment by the Borough, an estimated 94 percent of NSB households have modern water and sewer service as of 2008, compared with an average of 76 percent for Tribal Health Regions statewide (AN EpiCenter 2009, Circumpolar Research Associates 2010, McAninch 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 will strengthen public services in all communities, and is in the process of revising their Emergency Preparedness Plan (NAB 2010).

Alcohol and Drug Misuse

Table 3.3-47 Alcohol Misuse Across Alaska

Indicator	All Alaska	American Indian / Alaska Native	All Rural Alaska
Binge drinking: Proportion of males having 5 or more drinks or females having 4 or more drinks on at least one occasion in the past 30 days.	15.1% (95% confidence interval: 13.6% - 16.7%)	18.3% (95% confidence interval: 14.8% - 22.4%)	14.4% (95% confidence interval: 12.1% - 17.0%)
Excessive drinking: Proportion of males having more than 2 drinks per day or females having more than 1 drink per day in the past 30 days.	6.2% (95% confidence interval: 5.1% - 7.5%)	5.8% (95% confidence interval: 3.5% - 9.2%)	5.1% (95% confidence interval: 3.6% - 7.2%)

Source: CDC 2008

Alcohol abuse is linked to chronic disease, interpersonal violence, injuries, disintegration of family structure and well-being, and adverse home environments for children. Within the NSB, alcohol is involved in an estimated 40 percent of snow machine-related injury hospitalizations, 70 percent of assault injuries, 57 percent of suicide attempts, and 45 percent of motor vehicle-related injury hospitalizations. Many incidents of interpersonal violence or injury in particular are associated with "binge," or episodic, heavy drinking.

In the NSB, the sale and importation of alcohol is prohibited in all communities but Barrow, which prohibits the sale but not the importation of alcohol. Restrictive alcohol policies in rural Alaskan communities are associated with decreased incidence of alcohol-related injuries and other health problems (Chiu et al. 1997, Landon et al. 1997), and the NSB's laws appear to be moderately effective: binge drinking and prenatal drinking in the NSB seem to have decreased since the 1990s. Currently, there does not appear to be a significant difference in self-reported periodic heavy, or "binge," alcohol consumption compared to the state of Alaska or the nation. In 2005 to 2007 the rate of binge drinking among adults in the NSB was estimated at 17 percent (McAninch 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.

In the NAB, a 2010 vote allowed the selling of liquor in the community of Kotzebue via a city-run package store and distribution center.

Culture and Language

Culture and ethnicity are important determinants of health, as they influence almost all aspects of how we live. Culture and language provide the framework in which we understand and interpret our surroundings and provide a set of "ready-made" choices about lifestyle and behavior (e.g. eating and physical activity patterns, use of tobacco, risk-taking behavior, interaction with health care alternatives, etc.).

The NSB has made several efforts towards strengthening culture and language among the Iñupiat peoples. The school curriculum in the NSB now includes Alaska Native culture, history, and language (Circumpolar Research Associates 2010), and language ability among NSB Iñupiat compares very well to neighboring regions of Bering Straits and the NAB. The NAB has a Rosetta Stone Language program in place for the Northwest Iñupiaq language, and the NSB is finalizing plans for its own Iñupiat Eskimo Rosetta Stone Language program.

However, there are several threats to culture and language in the NSB. Younger residents do not have the fluency of older residents with Iñupiaq language (Circumpolar Research Associates 2010; et al. 2007).

Subsistence foods—believed by many Iñupiat and other Alaska Natives to be the very foundation of health and well-being—are increasingly viewed as threatened in terms of both availability and potential contamination, and this may impact participation in subsistence activities and food sharing social networks (McAninch 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 (CEAA 2010, Joyce 2008, Loring et al. 2010), with potential changes in nutrition-related diseases as a result. It is important to note that these health results arise regardless of whether or not there is any "real" contamination at a level that could induce toxicologic effects in humans; the effects are linked to the perception of contamination, rather than to measured levels.

The issue of exposure to environmental contaminants is contentious, and few data exist to support or deny resident concerns regarding degradation of environmental quality and local health impacts. In general, the field of public health addresses this concern through efforts to control exposure to environmental contaminants, rather than through responding to specific increases in disease rates related to a known exposure. Other sections of this chapter, including those related to air quality (Section 3.1.5), water quality (Section 3.1.7), and environmental contaminants and ecological processes (Section 3.1.8) discuss some of the media through which humans could be exposed to contamination.

Public Health and Climate Change

Rural Arctic communities are particularly vulnerable to the health effects of climate change, and global warming is increasingly becoming recognized as a determinant of health in the Arctic (ICIA 2005). Changing weather and ice patterns have the potential to affect a wide range of health-related outcomes. Climate change may affect both subsistence food availability and storage and may increase risks associated with subsistence activities, which in turn may lead to dietary and cultural change. Climate change can also affect water, sanitation, housing, transportation infrastructure, cultural continuity, community stress levels, the spread of infection, and even the types of diseases and infections to which the population is susceptible (ACIA 2004, Brubaker et al. 2010, Brubaker et al. 2011).

Communities in the NSB are already experiencing some effects of climate change: erosion problems; thawing ice cellars; less reliable ice conditions; and subsequent higher risk to hunters and spring whalers. Several communities south of the Brooks Range (Kivalina, Shishmaref, and Newtok) are actively planning to relocate due to climate-induced erosion problems. Climate change will likely result in rapidly changing physical environment and health conditions for this population in the coming years.

Other Determinants of Health

The health determinants discussed above are thought to be relevant for the assessment of public health impacts potentially resulting from offshore oil and gas exploration activities in the Beaufort and Chukchi seas. There are, however, other health determinants that impact upon population health in the affected population. These include education, smoking, physical activity, and motor vehicle safety. Although each of these determinants plays an important role in determining the health of the population in the affected area, they are not discussed because of their irrelevance to the proposed activities.

3.3.3.6 Summary

The population in the affected area is experiencing health trends similar to that of the rest of Alaska and the U.S.; however, health outcomes in the affected area tend to be worse off, especially for health outcomes like diabetes, obesity, respiratory illness, and injury. The health determinants that play a role in altering the impacts of these health outcomes comprise of those similar to all populations, as well as ones unique to the environment and culture in northern Alaska. A consideration of this local health data and accepted determinants of health will allow for recognition of important risks associated with a project and the eventual development of effective mitigation strategies.

3.3.4 Cultural Resources

3.3.4.1 Introduction

Cultural resources include archaeological sites and historic structures and features that are protected under the National Historic Preservation Act of 1966, as amended. Cultural resources also include traditional cultural properties (TCPs) that are important to a community's practices and beliefs and that maintain a community's cultural identity. Cultural resources that meet the eligibility criteria for listing on the National Register of Historic Places (NRHP) are considered significant resources and, when present, must be taken into consideration during the planning of federal projects. Federal agencies also are required to consider the effects of their actions on sites, areas, and other resources (e.g., plants) that are of religious significance to Native Americans and Alaska Natives, as established under the American Indian Religious Freedom Act. Native American and Alaska Native graves, burial grounds, and associated funerary objects are protected by the Native American Graves Protection and Repatriation Act.

Pursuant to Section 106 of the National Historic Preservation Act (*16 U.S.C. 470f*), and its implementing regulations (36 CFR 800), the alternative identified in this EIS may have the potential to cause effects to offshore prehistoric and historic resources, including submerged prehistoric sites and historic shipwrecks, as well as onshore prehistoric and historic resources, including camps, village sites, artifact scatters, historic structures, and World War II and Cold War era facilities. Offshore impacts may be incurred throughout the project area in conjunction with seismic testing activities. Onshore impacts would be restricted to areas of shore-based activities, including Prudhoe Bay, Barrow, Wainwright, and Nome.

3.3.4.2 Cultural Setting

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 BP, 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 BP (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 BP (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 BP 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 current 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 Eskimo culture. While the prehistory of the region is not well understood, over 1,200 archaeological sites have been recorded in the Alaska Heritage Resource (AHRS) files of the Alaska Office of History and Archaeology. As currently interpreted, regional prehistory has been divided into five periods that reflect significant changes in culture and habitat: full-time tundra hunting, from earlier than 11,000 years ago to about 8,000 years ago; adaptation to taiga-tundra hunting and fishing, from 8,000 to 4,200 years ago; development of seasonal and year-round coastal hunting and fishing, from 4,200 to 1,500 years ago; prehistoric Eskimo culture, from 1,500 years ago to 1778; and historic Eskimo culture, from 1778 to the present (Anderson 1984). There is abundant evidence of human presence in North America soon after 11,500 years ago, while at least one site, Monte Verde, in Chile, gives secure evidence of a still-earlier presence. This site, and its distance from the presumed Beringian entryway to North America, indicates people arrived in the New World at least 12,500 years ago (Meltzer 2009:192. Two finds were reported in early 2011 that support the early presence of humans in North America. One of these is a child cremation associated with the remains of a semi-subterranean house in central Alaska, dated to 11,500 years ago (AAAS 2011). The second is an even older site located in central Texas, where a pre-Clovis archaeological assemblage has been identified and dated to between 13,200 and 15,500 years ago (Waters et al. 2011). Closer to the area in question are the Broken Mammoth site on the Tanana River in central Alaska, dated to 11,800 years ago; the Mesa Site on Alaska’s North Slope, dated to near 12,000 years ago; and the Nenana Complex sites of the Nenana and Tanana river valleys of interior Alaska (Meltzer 2009:190, 217, 304-305; West 1996: 537-549). Evidence from these and other sites in interior and coastal North America and elsewhere have led some archaeologists to postulate alternative models to the traditional Bering land bridge explanation of the populating of North America, including coastal migration with later inland movement and settlement (Dixon 1999:243-256).

The earliest well-documented archaeological tradition in the northwestern Arctic, representative of the tundra-hunting era, is the American Paleo-Arctic tradition, identified from the coast of the Arctic Ocean to both shores of the Bering Strait, south along the Alaska coast to the Alaska Peninsula, as well as into interior areas. Sites of this tradition are known for containing wedge-shaped microblade cores, microblades, blades and blade cores, bifacial cores, and slotted antler arrows with microblades. These sites are known to be located in both coastal and interior regions and extend from western Alaska to the northern Yukon Territory; providing a well-defined indication of a Pleistocene population migrating south from Alaska (Anderson 1984:81-82; Meltzer 2009:193-194).

By 8,000 years ago, as a result of the post-Pleistocene warming trend and the melting of glacial ice, sea level had risen to between 25 and 40 feet below its present height and for the most part, the Arctic coastline was within one mile of its current position. Archaeological cultures of this time, identified as part of the Northern Archaic Tradition, begin to resemble those of the North American boreal woodlands. Diagnostic artifacts include side-notched projectile points and half-rounded lithic artifacts worked on both surfaces, (semilunar bifaces), bifacial knives, end scrapers, notched pebbles, microblades, and cobble choppers. The oldest site of this tradition is the Tuktu site in Anaktuvuk Pass, in the Brooks Range. In addition to open camps, sites from this tradition include semi-subterranean houses and stone-lined tent rings; the latter two types are known from sites both on the North Slope and in the Brooks Range (Anderson 1984). Anderson (1984:82) proposes that beginning about 6,000 years ago, the North Alaskan cultures shifted from a nearly exclusive land-based, hunting subsistence-base to taiga-tundra hunting and fishing.

Between 4,500 and 4,200 years ago, as sea levels stabilized, evidence for coastal habitation in the Arctic becomes plentiful. Sites of this era reflect the characteristics of the Arctic Small Tool tradition, known for the presence of small, finely flaked stone tools. 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 1984:82-84).

By about 1,500 years ago, Prehistoric Eskimo cultural phases emerged along the north coast of Alaska, reflecting a substantial change from the preceding cultures. These ancestral Iñupiat or Iñupiaq cultures resulted either from movement of people from Siberia or the transfer of new sea mammal hunting technology. In either case, there were significant changes in the material culture, especially related to food acquisition and processing (Anderson 1984:90-93). The Birnirk cultural phase, documented at the Point Barrow type site, indicates a return to whale hunting after a 500-year hiatus. Their primary food supply included seals, fish, caribou, and birds hunted with a variety of hunting implements. Material used to make artifacts include ground slate, chipped stone, antler, bone, ivory, clay, wood, and baleen.

The Western Thule phase developed out of the Birnirk phase along the north coast of Alaska between 1,000 and 750 years ago. Western Thule material culture appears to be an elaborate combination of Birnirk artifacts with specialized tools with whale, caribou, and seal hunting being the major subsistence activities. Houses were similar to Birnirk, with large settlements developed around the group sizes required for whale hunting. However, settlement size also decreased in response to declining whale populations in the Kotzebue area. Current archaeological evidence suggests that there is an apparent gap in large, year-round coastal settlements between Point Barrow and the Mackenzie Delta. However, several archaeological excavations at many sites and contemporary Eskimo villages indicate continuous occupation from the late-prehistoric culture. During the early Western Thule phase, groups expanded both onto the North Slope and into the Brooks Range. Sites that date from late in this phase and that have Athabascan Indian artifacts have been documented in the central and eastern Brooks Range and on the North Slope (Anderson 1984:91-93).

The late prehistory and history of the coastal region focuses primarily on the Iñupiat of the North Slope who continued to have settlements based on hunting and gathering seasonal rounds. They relied heavily on fish and sea mammals, as well as caribou and smaller terrestrial animals. In the nineteenth century, a series of "battles" and famines took place in the Interior, which caused population shifts leading anthropologists to suggest that the current ethnic boundaries may have fluctuated. While direct contact with Euroamericans may not have occurred until the mid-nineteenth century, the Iñupiat Eskimo established trade routes to exchange goods along the coast and into the Interior for at least 100 years prior. Trade goods found at historic Eskimo sites include glass beads, metal knife blades, and brass fittings from trade muskets (Anderson 1984:93).

Vitus Bering explored the coastal areas of Alaska in 1741; within a short time, Russian fur hunters began to exploit the rich sea otter grounds along the Aleutian chain. In 1778, Captain James Cook arrived in southern Alaska where, at Cook Inlet, Tanainas came to his ship to exchange furs and fish for iron. Cook noted that at this time, a few European goods were already in the possession of the Indians. At this time, while southern Alaska Indians and Eskimos were eager to trade with Europeans visiting in ships, attempts at settlement were opposed. As a result, with the exception of the Aleuts, Alaska's inhabitants remained relatively free of European influence (VanStone 1984:149,152).

The historic period of the northwestern Arctic begins with direct encounters between the Iñupiat with European explorers along the north and northwestern coasts of Alaska. By 1762, Russian fur hunters had reached Kodiak Island, well to the south of the current area of interest. The Russian fur traders soon established a post on the island, which was destined to become one of the major headquarters of the Russian-American Company. Within 20 years, additional posts were established on the Kenai Peninsula and at Sitka, and several native groups were drawn more actively into the fur trade (VanStone 1984:150-153).

European exploration quickly expanded to the north along the Alaska coastline, most notably with the voyages of Captain James Cook, who explored the area between Bristol Bay and Icy Cape between 1776 and 1780. By 1850, commercial whaling ships began to frequent the waters of the Arctic Ocean in large numbers every summer, trading in large quantities with northern Eskimos. From the 1850s to the 1920s, commercial Euroamerican whaling activities often included an Iñupiat labor force. Many impacts to traditional lifeways, the economy, and material culture occurred as a result of commercial whaling (VanStone 1984:155-156).Whaling persisted until the baleen market collapsed after 1916 (Spencer 1984:278-281). Foreign diseases decimated Native populations and caused major demographic and traditional territorial shifts. Direct contact with Euroamerican missionaries, who arrived in Barrow in 1890, also led to changes in traditional religious practices and resulted in the acceptance of Christianity by many Native Alaskans. Other Euroamerican commercial interests attracted northern Native societies into the larger Western economic sphere. Domestic reindeer 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 1984:156-157). Also, the fur industry sought Arctic fox pelts, providing a brief economic boost for some Natives trappers for nearly a decade after World War I. With prolonged contact, Euroamerican trade goods entered the Native material culture realm as local populations traded for them or earned them in exchange for monetary wages. As commercial whaling and trading expanded, contact caused the disruption and eventual demise of long established Native trade networks as the Iñupiat sought western goods. By the 1920s, mass-produced items produced in the U.S. substantially replaced items of Native manufacture. Archaeological remains of Native historic activities associated with seasonal subsistence activities, and

Euroamerican trade goods lay among sod house ruins and tent rings that can be found along the coast and inland to the foothills and valleys of the Brooks Range (Spencer 1984:278-281).

Beaufort Sea

Offshore Prehistoric Resources

The presence of offshore prehistoric resources is difficult to assess. Approximately 19,000 years ago, at the height of the late Wisconsinan glacial advance, sea level was approximately 120 meters lower than at present. During this time, large expanses of what is now the outer continental shelf were exposed as dry land (MMS 2007c). The exact elevation of past sea levels in relation to present sea level varies geographically, depending primarily on the location of the area in relation to the major glacial ice masses. In the northwestern Arctic region of Alaska, relict fluvial channels and shoreline features evident at the seafloor suggest that sea level was probably between 50 and 60 m lower than present at about 12,000 B.P. (years before present). As a result, a conservative estimate of 60 m below present is used for relative sea level at this time, a date by which current research indicates prehistoric human populations were almost certainly present in the area (MMS 2007c; Dixon et al. 1986.). The location of the 12,000 B.P. shoreline is roughly approximated by the 60-m bathymetric contour. The continental shelf shoreward of this contour would have potential for prehistoric sites dating later than about 12,000 B.P. Seismic-survey and borehole data that have been collected in the Beaufort Sea indicate areas of well-preserved Holocene sedimentary sequences and landforms that have potential for containing prehistoric archaeological deposits (MMS 2007c). In some areas of the Beaufort Sea, available remote-sensing data indicate little evidence of ice gouging at the seafloor and areas of well-preserved landforms, such as river channels with levees and terraces just below the seafloor. Although these features have not been directly dated, their stratigraphic position indicates that they are most likely Holocene in age. The presence of these preserved landforms just beneath the seafloor indicates that there also is potential for preservation of prehistoric archaeological sites that may occur in association with the landforms. The potential for the occurrence of archaeological resources in the Beaufort Sea seaward of the barrier islands, however, is probably much lower than for those areas landward of the barrier islands and in areas protected by floating, landfast ice during the winter (MMS 2007c).

Offshore Historic Resources

Much like prehistoric resources, offshore historic resources are likely to be present in the project area, but are equally difficult to identify or quantify. Available documentation indicates that between 1851 and 1934, at least 34 shipwrecks occurred within a few miles of Barrow; another 13 wrecks occurred to the west and east of Barrow in the waters of the Beaufort and Chukchi seas. No surveys of these shipwrecks have been made; therefore, no exact locations are known. If intact remains are present, these wrecks would be valuable finds, providing significant information on the historic whaling industry (MMS 2007c).

Onshore Prehistoric and Historic Resources

The coast of the Beaufort Sea suffers from active erosion, damaging or destroying important coastal cultural resources. Of the more than 1,200 North Slope prehistoric sites, very few are located in the coastal region (AHRS files). As noted above, onshore resources, 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 (MMS 2007c:; Dixon et al. 1986).

Offshore Historic Resources

Like the Beaufort Sea, shipwrecks were a relatively common occurrence on the Chukchi Sea, and remains of these incidents may very well be present. At Point Belcher near Wainwright, 30 ships were frozen in the ice in September 1871; 13 others were lost in other incidents off Icy Cape and Point Franklin. Another seven wrecks are known to have occurred off Cape Lisburne and Point Hope. From 1865-1876, 76 whaling vessels were lost because of ice and also because of raids by the Confederate battleship *Shenandoah*, which was sent to the Pacific with the goal of destroying the Union whaling fleet. The *Shenandoah* burned 21 whaling ships near the Bering Strait during the Civil War. The possibility exists that some of these shipwrecks have not been completely destroyed by ice and storms. This likelihood is reinforced by the 2010 discovery by Parks Canada archaeologists of the HMS Investigator, a British ship abandoned in the ice in 1853 along the northern coast of Banks Island in Canada's western Arctic during a search for the Northwest Passage. This shipwreck is remarkably well-preserved, standing upright in approximately 11 meters of water (AIA 2011). The likelihood for good preservation has been determined particularly high around Point Franklin, Point Belcher, and Point Hope (MMS 2007c).

Onshore Prehistoric and Historic Resources

Onshore archaeological resources near the Chukchi Sea coast receive less damage from the eroding shoreline than those on the Beaufort Sea coast, which is subjected to more slumping because of water action and permafrost. As a consequence, archaeological resources have been recorded in greater numbers in the Chukchi Sea area, and unknown resources are more likely to be present. There are 200-300 known archaeological sites in the Hope Basin area, and the area around Point Hope is especially rich in archaeological resources. Many of the known sites are of Kukmiut and Iñupiat tradition and include villages, graves, whaling camps, and fishing/hunting camps (MMS 2007c).

Alaska Heritage Resource Survey (AHRS) records indicate that at least 18 historic and prehistoric sites have been documented within a two-mile radius of Wainwright. These include at least two historic Iñupiat village sites; several prehistoric camp sites; the possible remains of a settlement established by Roald Amundsen during his polar exploration efforts of 1925; partial remains of the 1871 whaling fleet, discussed above, scattered over 30 miles of shoreline; and Cold War era communication facilities.

Twenty-four resources are documented in the AHRS files within a two-mile radius of Nome. These include the remains of an historic Eskimo village and a historic fishing camp, but are largely dominated by historic structures related to the community of Nome; World War II facilities are also present.

3.3.5 Land and Water Ownership, Use and Management

The United States government is the sole owner of the Beaufort Sea and the Chukchi Sea Outer Continental Shelf lands, the energy (conventional and renewable) and mineral reasources are managed by the BOEM, but living and non-living resources are managed by other federal agencies, including NMFS and USFWS. However, the adjacent nearshore and onshore areas reflect multiple owners, including the federal government, state government, borough government, Alaska Native corporations and Alaska Native allottees (the Bureau of Indian Affairs holds in trust many of the lands owned by Alaska Native allottees). With the exception of the tidelands offshore of the ANWR (Shalowitz and Reed 2000), the State of Alaska owns all tidelands and submerged lands along the coast out to 3 nautical miles (nmi), which includes three miles out from barrier islands that are owned by the State of Alaska. Lands bordering the coast are within the NSB, and the NAB, and most lands within these boroughs are held by a few major landowners. The predominant landowner within the NSB is the federal government, which owns the ANWR, managed by the USFWS, and the National Petroleum Reserve—Alaska, managed by the Bureau of Land Management (BLM). Other major landholders include the State of Alaska, Alaska Native village corporations, and the Arctic Slope Regional Corporation. Along the coast within the NAB lies the Cape Krusenstern National Monument, managed by the National Park Service (NAB 2004). See Figure 3.3-28 for general ownership patterns on the North Slope of Alaska near the Beaufort and Chukchi seas.

3.3.5.1 Land and Water Ownership

<u>Federal Ownership</u>

Federal Waters

Beyond the 3-mile limit owned by the state, the United States has sovereign rights and control over the living and non-living natural resources of the seabed, subsoil and the waters above them out to 200 nautical miles from the point of average low tide (normal baseline) or to the international maritime boundary (Office of the Press Secretary 1983, NOAA n.d.).

Federal Lands

The federal government owns the land in the ANWR, containing about 30,135 square miles, the NPR-A, containing about 3,906 square miles, Alaska Maritime National Wildlife Refuge, containing about 7,656 square miles, and most of the Cape Krusenstern National Monument, containing about 1,016 square miles, all of which abut the coastline of the Beaufort or Chukchi seas.

<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 Selections

When Alaska gained statehood in 1959, the state was authorized to select about 104 million acres of federal land, to be chosen from lands that were unreserved and unappropriated for any purpose, claimed, or withdrawn. Although the Statehood Act provided for the State of Alaska to select lands, in some instances, certain selections have not been transferred and remain in federal ownership due to legal considerations, conflicting Native selections or similar reasons. In the project area, most of these State selected, but unconveyed, lands are located in the Point Hope area.

Native Ownership

Corporation Lands

In 1971, Congress passed the Alaska Native Claims Settlement Act (ANCSA). The act settled Alaska Native land claims with a grant of 44 million acres and payment of $1 billion. It also provided for village and regional corporations to manage that land and money. Part of the reason for this land grant was to help provide a long-term economic base for the corporations. Corporations were to select mainly from tracts the federal government withdrew near villages, but when there was not enough available land there, they could also choose from other unreserved federal land (UAA 2000). The EIS project area has several of these sections. There are large tracts around the communities of Kaktovik, Nuiqsut, Barrow, Wainwright, Point Lay and Point Hope, as well as scattered pieces along the North Slope.

In Alaska, ownership of land is often characterized by a "split estate" interest, in which rights to the surface estate are separate from the subsurface estate. Surface owners receive title and rights include the use of soil, timber, and lands beneath non-navigable waters. Subsurface owners receive title to rock, gravel, and sand as well as oil, gas, and minerals. Village corporations, established by the ANCSA, generally receive title to the surface estate for their land entitlement. The corresponding subsurface estate is typically conveyed to the ANCSA regional corporation.

ANCSA village corporation surface estate lands are generally selected and conveyed in the vicinity of their home communities. However, ANCSA Regional corporation subsurface estate may also be located in areas away from existing communities.

Corporation Selections

Although ANCSA provided for Native land selections, in some instances, certain selections have not been transferred and remain in federal ownership due to legal considerations, conflicting State selections, incomplete land surveys or similar reasons.

Native Allotments

In 1906, the Native Allotment Act was passed, whereby Natives could apply for up to 160 acres, if they could demonstrate use and occupancy of the land for a minimum of five years. The Native Allotment Act was repealed in 1971 with the passage of ANSCA; however, ANSCA allowed those applications pending before the U.S. Department of the Interior to continue through processing. The lands under application by a Native Allotment applicant are 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, and all through the Point Hope region.

Borough and Other Municipal Lands

Under the Alaska Statehood Act, municipal governments are entitled to select lands from the State of Alaska. In the project area, the NSB and the NAB have selected lands from the State. The NSB's municipal land entitlement is 89,850 acres. Lands conveyed to date are primarily in the vicinity of communities, and some parcels in the Prudhoe Bay/ Deadhorse and Cape Simpson areas. The ability to select and receive conveyance of the Borough's remaining entitlement has been delayed (URS 2005).

The NAB is also entitled to select lands from the State of Alaska, but completion of selection and receipt of its total conveyance has been also been delayed. Borough-owned lands along the Chukchi Sea coast are likely to be limited to village areas.

The incorporated villages within both Boroughs also retain title to municipal lands, generally located in the vicinity of the communities. Villages are entitled to select land from ANCSA village corporations under Section 14 (c) 3 of the act; however, many villages have not completed their selections.

3.3.5.2 Land and Water Use

Land use has many definitions and methods of classification. For this EIS, land use concerns the physical ways in which land is used and modified for different human purposes (UN 1993). The classifications below are based on the nationally standardized scheme by Anderson et al 1976, and the Michigan Resource Information System (MIRIS).

Recreation

This classification refers to the use of land in an outdoor setting for purposes of rest, sport or relaxation. In the context of this EIS, recreation activities are closely related to enjoyment of the natural environment (MIRIS). Recreation occurs at generally low levels of use in the EIS project area. Key recreational activities include wildlife viewing and flightseeing. Recreation is discussed in detail in Section 3.3.8.

Subsistence

Subsistence, which refers to harvest activities involving hunting, fishing, trapping, and gathering as a way of life, is a wide-spread land use throughout the EIS project area. Further details are discussed in Section 3.3.2.

Industrial

Industrial areas include a broad spectrum of facilities, from heavy manufacturing plants to a loading device or storage shed (Anderson et al 1976). Most major industrial uses in the EIS project area are related oil and gas activities and occur in Barrow, and Deadhorse/Prudhoe Bay. In these areas, industrial uses are supported by docks, airstrips, warehouses, roads, pipelines, and other essential infrastructure and facilities.

Residential

This classification refers to land uses that serve as a place of permanent residence (MIRIS). Residential land use occurs in small communities throughout the project area. The communities that would be most proximate to proposed offshore oil and gas exploration and seismic activities are adjacent to the Beaufort and Chukchi seas and include Kaktovik; Prudhoe Bay/Deadhorse; Nuiqsut; Barrow; Wainwright; Point Lay; Point Hope; Kivalina; Kotzebue; and Nome. Section 3.31 discusses population and classification of these communities.

Mining

Mining involves the use of land for mineral extraction purposes using both surface and subsurface methods. Red Dog Mine is the biggest source of mineral extraction in the EIS project area. Located east of the village of Kivalina, it is the second largest zinc mine in the world, and the fourth largest lead mine.

Red Dog Mine covers over 2,000 acres and also includes supporting land uses such as an airstrip, a road to the coast, a dock and dock facilities (Tetra Tech 2009).

Exploration activities are occurring in the Western Arctic coal deposits, between Point Lay and Point Hope, but no mine yet exists (Szumigala et al 2009).

Protected Natural Areas

This classification applies to lands that are set aside in their natural state for the purpose of ecological preservation. In the EIS project area, this includes ANWR, particularly the wilderness and 1002 areas discussed below, Alaska Maritime National Wildlife Refuge, and Kasegaluk Lagoon.

Transportation

Land used for transportation systems can be considered a supporting component of other uses, such as industrial facilities. However, since it can influence the land uses around it; it is considered as its own, separate classification (Anderson et al 1976). In the context of this EIS, Transportation land uses includes the Dalton Highway, industry road systems within the general Prudhoe Bay/Kuparuk filed area, aircraft and shipping infrastructure, and the road to Red Dog Mine.

Commercial

Commercial areas are those used predominantly for the sale of products and services (Anderson 1976). There is only a small amount of land devoted to commercial use in the EIS project area mostly centered within Prudhoe Bay and the communities within the project area.

3.3.5.3 Land and Water Management

Federal Lands Management

Arctic National Wildlife Refuge

The ANWR, managed by the USFWS, was established in 1960 as the Arctic Wildlife Range and expanded in 1980 to nearly 20 million acres and incorporated in 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). The refuge has five management categories: Intensive, Moderate, Minimal, Wild River, and Wilderness. Due to controversy over management of the coastal plain, Section 1002 of the ANILCA established a 1.5 million acre Coastal Plain Resource Assessment Area to develop a baseline study to quantify the extent of oil & gas resources and to characterize important biological resources in that portion of ANWR. This area, referred to as the "1002 Area" is the northernmost section of the refuge adjacent to the Beaufort Sea. The United States Geological Survey estimates the total quantity of technically recoverable oil from the 1002 Area to be between 4.3 and 11.8 billion barrels (USGS 1998), however, at this time, oil extraction is not permitted. The 1002 Area is currently managed as a "Minimal management" area, which is directed at maintaining the existing condition of the areas that have high wildlife and fish values. Activities such as subsistence practices, outfitting, float planes and motor boats, and oil and gas studies are permitted under this management category (USFWS, 1998). Currently, the USFWS is updating the Comprehensive Conservation Plan for the ANWR, with a final revised plan expected to be released in 2013 (USFWS 2011a).

National Petroleum Reserve—Alaska

The NPR-A is 9.4 million acres in north-central Alaska managed by the BLM. The reserve was established in 1923 to provide oil for military purposes, and transferred to the Department of the Interior in 1977 to meet the economic needs of oil for the rest of the nation. The reserve is divided into three Planning Areas: the Northeast, Northwest, and the South. Both the Northeast and the Northwest

Planning Areas include large stretches of coastline off the Beaufort and Chukchi seas (BLM 2005). In the Northwest Planning Area, site-specific restrictions are implemented on all oil/gas related operations within the boundaries of the NPR-A to protect important natural resources such as water quality, vegetation, wetlands, fish/wildlife habitat cultural and paleontological resources subsistence uses and access, scenic and recreation values (BLM 2003). In the Northeast Planning Area, an Integrated Activity Plan outlined land allocations for immediate oil and gas leasing, adopted performance-based stipulations on operating procedures, and detailed required studies and monitoring (BLM 2008a).

Alaska Maritime National Wildlife Refuge

The Alaska Maritime National Wildlife Refuge is managed by the United State Fish and Wildlife Service and contains approximately 4.9 million acres of Alaska coastland and islands. The refuge was created by ANILCA in 1980, consolidating 11 preexisting refuges, adding 1.9 million acres of new land, and combining the majority of Alaska's seabird habitat within a single refuge. The refuge is divided into five distinct geographic units: the Chukchi Sea Unit, the Bering Sea Unit, the Aleutian Islands Unit, the Alaska Peninsula Unit, and the Gulf of Alaska Unit. The refuge encompasses approximately 3,000 headlands, islands, inlets, and pinnacle rocks, used by 80 percent of Alaska's seabird population, about 40 million nesting seabirds. The Chukchi Sea Unit is included in the project area and covers nearly 300,000 acres, 4 percent of the total refuge. It does not extend to the entire coastline, but is made up of non-contiguous areas of offshore public lands on islands, islets, rocks, reefs and spires. There are a few larger land groupings such as at Cape Thomson (USFWS 1988).

A Comprehensive Conservation Plan and Wilderness Review for the Alaska Maritime National Wildlife Refuge was adopted in 1988 that designated areas according to their resources and values, outlined programs for conserving fish and wildlife resource values, and specified uses compatible with the major purposes of the Refuge. The refuge has four management categories: Intensive Management, Moderate Management, Minimal Management, and Designated Wilderness. 99 percent of the Chukchi Sea Unit is managed with Minimal Management, which is directed at protecting existing fish and wildlife populations. Management activities focus on biological monitoring, eradication of introduced predators/rodents, and research and regulation. Oil and gas leasing is not permitted (UWFWS 1988).

Cape Krusenstern National Monument

Cape Krusenstern National Monument was designated pursuant to ANILCA and contains approximately 660,000 acres. The National Park Service manages the monument; the main policies are to protect archeological sites in the area and protect the habitat for wildlife and subsistence resources. The monument is a coastal plain stretching along 70 miles of the Chukchi Sea shoreline, and archeological sites dating back 5,000 years can be found in the beach ridges (NPS 2011).

State Lands Management

Area Plans

The State of Alaska prepares land management plans called Area Plans to govern the use of state lands. Area Plans describe intended uses of state lands. Specifically, the plan contains management guidelines and classifications for specific management units. The document identifies what land should be retained by the state and what land may be sold or granted to municipalities through the municipal entitlement process. Area plans can open and close areas to mineral entry and can recommend legislative designations (for example, parks). The Northwest Area Plan was completed in 1989, and contains 10,000,000 acres of land. It includes lands on the Seward Peninsula, in the NAB and in the western segment of the NSB. An Area Plan has not been prepared for the North Slope Region, which contains 12,252,000 acres of land.

Oil and Gas Lease Sales

The State leases lands and waters for resource development, including oil and gas, minerals, and timber. Annually, ADNR prepares and presents a 5-year program of proposed oil and gas lease sales to the legislature. Currently, Division of Oil and Gas conducts competitive annual areawide lease sales, offering for lease all available state acreage within five areas (North Slope, Beaufort Sea, Cook Inlet, North Slope Foothills, and Alaska Peninsula). The lease sale area is divided into tracts, and interested parties that qualify may bid on one or more tracts. Since the first lease sale in 1964, the State has held 56 onshore and offshore oil and gas lease sales on the North Slope involving Beaufort Sea and North Slope acreage (ADNR 2009).

Municipal Lands Management

Community and Borough Planning

Boroughs and cities vested with land use authority in the State of Alaska are required to prepare a comprehensive plan, which is intended as a long-range vision of possible future development. Generally the planning process involves community members, public officials, planning committees, and any relevant stakeholders. Comprehensive plans do not provide enforcement power. Instead, they are intended as a tool for policy makers to consult in making land development decisions (URS 2005). There are two boroughs that have jurisdictional boundaries along the Beaufort and Chukchi seas. The NSB spans 89,000 square miles across the top of Alaska from the Canadian border to Point Hope and from the Brooks Range to the Arctic Ocean. The NAB comprises approximately 39,000 square miles in the northwest of the state, on the coast of the Chukchi Sea and south of the NSB. Both boroughs have comprehensive plans discussed below and contain eight coastal communities of predominantly Iñupiat populations: Kaktovik, Nuiqsut, Barrow, Wainwright, Point Lay, Point Hope in the NSB and Kivalina, and Kotzebue in the NAB. With the exception of Kotzebue, these communities have no comprehensive plan in place, although the NSB is working with Kaktovik, Nuiqsut, Barrow, Wainwright, Point Lay, and Point Hope to develop village plans that are either in process or planned to begin in 2011.

North Slope Borough Comprehensive Plan and Title 19

In 2005 the NSB Assembly adopted a comprehensive plan to aid the long-range growth and development of the Borough. The vision and goals outlined in the plan helped guide the Borough Assembly when updating and writing ordinances for the region, particularly Title 19, which outlines land use regulations for the Borough and is considered part of the Comprehensive Plan (URS 2005).

Title 19 describes Borough management practices through nine different zoning districts, with four being the most relevant for offshore activities. Barrow Industrial and Storage districts are characterized by terminals, loading docks, storage sheds and airports and are intended to provide uses that support aviation, shipping and other transit. Resource Development Districts (RDDs) are intended to accommodate large-scale resource extraction and related activities, while balancing protection of subsistence resources. Existing RDDs include Badami, Duck Island, Prudhoe Bay, Mine Point, and Kuparuk River. RDDs are generally focused along the north coast of the Borough and the Beaufort Sea, centered on Prudhoe Bay. Transportation Corridor districts are established to accommodate linear transportation facilities such as pipelines and roads. The most significant corridor is the Dalton Highway and Trans-Alaska Pipeline System that runs from Prudhoe Bay to the NSB's southern border (NSB 1990). Communities are zoned as Village Districts, aimed at maintaining traditional values and lifestyle. With the exception of Barrow, there are no further zoning regulations within the Village Districts. Title 19 also outlines policies pertaining to villages, economic development, offshore development, coastal management (reflecting the enforceable policies of the 1988 Coastal Management Program), and transportation corridors. The policies are meant to guide development and uses within the North Slope Borough while protecting the subsistence resources and cultural resources (NSB 1990).

Northwest Arctic Borough Comprehensive Plan and Title 9

The NAB Assembly approved a comprehensive plan in 1993 that addresses land use controls and planning and zoning issues in the borough. At the time of the plan, permits were the primary means of land control. Permits allowed the borough to control land and water use, materials, timber, minerals, certain activities, and lease sales. The comprehensive plan has strategies for the NAB to use in determining land selections under ANCSA, and deciding on land use controls for the development and adoption of zoning ordinances. It details land management strategies, involving zoning, platting, and methods of village planning.

The plan divides the borough into six zoning districts. Subsistence Conservation Districts, General Conservation Districts, and Commercial Recreation Conservation Districts would make up most of the borough land and be oriented towards conservation of habitat, renewable resources and subsistence protection. In addition, the Subsistence Conservation Districts would prohibit development that would negatively affect subsistence resources, the General Conservation Districts would accommodate resource development on a limited scale and encompass undeveloped areas outside the boundaries of other districts, and the Commercial Recreation Conservation Districts would accommodate commercial recreation as long as it is consistent with the conservation of wildlife habitat and other resources, and effects on subsistence could be mitigated. Village Districts would be the boundaries of villages in the borough and reinforce lifestyles and values. Resource Development Districts would accommodate major resource development, most notably Red Dog Mine. The Transportation Corridor District would allow control over location and development of transportation corridors, such as roads, railroads, and pipelines, and supporting transportation facilities (NAB 1993).. Title 9 of the Borough code contains the Zoning Ordinance.

<u>Federal Waters Management</u>

Federal jurisdiction of the coastal waters extends from the three-mile limit, which is under state jurisdiction, to 200 nmi from the point of average low tide. The first 12 nmi from the coast are managed as territorial seas, within which the United States holds complete sovereignty yet ships or aircraft of any country can have the right of transit and innocent passage (64 FR 173 1988). 24 nmi from the coast are managed as the contiguous zone, where the United States has the right to exercise control to prevent or punish infringement of its customs, fiscal, immigration, or sanitary laws (64 FR 173 1999). 200 nmi from the normal baseline is the Exclusive Economic Zone, within which the United States has sovereignty over the mineral deposits and living resources (Office of the Press Secretary 1983).

In the wake of the Deepwater Horizon event in the Gulf of Mexico in April 2010, the President issued an Executive Order (EO) in July 2010 adopting the Final Recommendations of the Interagency Ocean Policy Task Force for management of federal waters off the coasts of the U.S. and the Great Lakes. The EO established a national policy to ensure protection, maintenance and restoration of the health of coastal and ocean ecosystems (Office of the Press Secretary 2010). The policies outlined in the 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 OCS Lands Act gives the U.S. Department of the Interior responsibility to manage the offshore energy (conventional and renewable) and minerals resources, which includes the leasing, exploration, development, and production of those resources on the federal OCS. Other acts that heavily influence management of the federal waters are the National Environmental Policy Act, the Marine Mammal Protection Act, the Magnuson-Stevens Fishery Conservation and Management Act, the Endangered Species Act, the Clean Air Act, the Clean Water Act the Oil Pollution Act, and the Coastal Zone Management Act.

State Waters Management

Waters owned by the State of Alaska were subject to the Alaska Coastal Management Program (ACMP) until 2011. The ACMP included statewide standards and coastal district enforceable policies that balance development and the protection of natural resources within the coastal zone. Oil and gas leases within the 3-mile limit are sold by the Alaska Department of Natural Resources, Division of Oil and Gas and were in that category (ADNR 2011, ADNR 2005). As a result of the ACMP expiration, oil and gas lease sales are not expected to adhere to a coastal management program.

3.3.6 Coastal Zone Management

The State of Alaska operated the federally-approved ACMP from 1979 to 2011 as a voluntary state partner in the National Coastal Management Program. In 2011, the state legislature failed to pass legislation required to extend the ACMP. By operation of Alaska State law (Alaska Statutes 44.66.020 and 44.66.030), this meant that the Alaska Coastal Management Program officially expired on July 1, 2011, resulting in a withdrawal from participation in the National Coastal Management Program. Consequently, the CZMA federal consistency provision, Section 307, no longer applies in Alaska and Alaska is no longer eligible for CZMA grants under Sections 306, 306A, 308, 309 or 310. Because a federally approved coastal management program must be administered by a state agency, reinstatement of the program would require approval by the state legislature. As of February 1, 2013, information about the expired ACMP is available on the ADNR website (http://www.alaskacoast.state.ak.us/).

3.3.7 Transportation

3.3.7.1 Air Transportation Systems

Kaktovik

Air travel provides the only system for year round access to Kaktovik. The airport at Kaktovik is on Barter Island, which is owned by the U.S. Air Force and operated by the NSB. The length of the runway is 1,469 m (4,820 ft). It is serviced daily by ERA Alaska (formerly Frontier Flying Service) (ADCCED 2011b). Chartered aircraft also use this airport.

Nuiqsut

Air travel provides the only transportation system for year round access to Nuiqsut. The 1,324 m (4,343 ft) long by 27 m (90 ft) wide gravel airstrip is owned and operated by the NSB. This airport is serviced by ERA Alaska (ADCCED 2011b). The airport is equipped with a rotating beacon, approach lights, high-intensity runway lights, and visual-approach slope-indicator systems; though the runway is unattended and unmonitored (BLM 2003). Daily flights carry passengers, cargo, and mail, and commercial flights connect Nuiqsut to Barrow and Deadhorse. Chartered and private aircraft also use the airport on a regular basis.

Prudhoe Bay/Deadhorse

There are three major airstrips in the Prudhoe Bay/Kuparuk area--the state-owned and operated Deadhorse airport and the privately owned and operated Prudhoe Bay and Kuparuk airstrips. The airport at Deadhorse services the oil and gas facilities on the North Slope in the Prudhoe Bay area. The airport located at Deadhorse is the primary means of public transportation to the North Slope industrial areas. The state-owned asphalt and gravel airstrip at Deadhorse is 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, ERA Alaska, and private charters service this airport. There are no services beyond Deadhorse (ADCCED 2011b).

Barrow

The state-owned Wiley Post-Will Rogers Memorial Airport serves as the regional transportation center for the NSB. This airport has a 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 ERA Alaska (ADCCED 2011b). Freight arrives by air cargo year-round. This airport is the transportation hub for villages on the North Slope. Alaska Airlines provides regularly scheduled jet passenger flights into Barrow from Anchorage and Fairbanks and other air carriers offer shuttle service from Barrow to various North Slope communities. The Barrow airstrip is accessible year round with use constraints involving severe weather, an occasionally obstructed runway, and migratory waterfowl that may be in the area during spring and fall. Airport facilities include two large hangars, storage warehouses, and equipment for freight handling. Barrow airport has the ability to provide medical evacuation service to larger communities in Alaska and, as a result, could be used as a medevac location for offshore exploration activities for emergencies.

Wainwright

Wainwright's only year-round access is by air travel. The 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 ERA Alaska (ADCCED 2011b). Freight arrives by cargo plane. Wainwright’s airport could be used as a base for offshore exploration activities in the Chukchi Sea given its proximity to active lease exploration programs. It is equipped with a rotating beacon, approach lights, high-intensity runway lights, and visual-approach systems.

Point Lay

A public 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. ERA Alaska provides daily commercial airline service to this community (ADCCED 2011b). Freight arrives by air cargo year-round. Federal government chartered aircraft also use this airport on a limited basis.

Point Hope

The state-owned 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, ERA Alaska (daily), Grant Aviation (by charter), and Tanana Air Service (by charter) provide service to this community (ADCCED 2011b). Freight arrives by air cargo year-round. Federal government chartered aircraft also use this airport on a limited basis.

Kivalina

The primary means of transportation into this community is by plane which lands on the state-owned 914 m (3,000 ft) long by 18 m (60 ft) wide gravel airstrip. Daily flights are available from Kotzebue (ADCCED 2011b). Bering Air, ERA Alaska (daily), Grant Aviation (by charter), and Tanana Air Service (by charter) fly to this community (ADCCED 2011b).

Kotzebue

Air transportation is the primary means of year-round transportation. The state-owned Ralph Wien Memorial Airport supports daily jet service to Anchorage and several air taxis to the region's villages. This community has a 1,798 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. A seaplane base is also operated by the state in Kotzebue. This airport is serviced daily and throughout the week by the following carriers:

Alaska Airlines; Baker Aviation; Bering Air; ERA Alaska; Grant Aviation (by charter); and Tanana Air Service (by charter) (ADCCED 2011b).

<u>Other Aircraft Traffic</u>

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.

3.3.7.2 Marine Transportation Systems

<u>Community Vessel Traffic</u>

Marine transportation in the region is dominated by freight deliveries but also includes relatively small inboard and outboard-engine watercraft used by villagers and less frequently by scientific research vessels. Marine transportation provides an economical means of transporting heavy machinery and other cargo with a low value-to-weight ratio (BLM 2003). Marine shipments along the Beaufort and Chukchi coasts are limited to a seasonal window between late July and early September, when the Arctic coast is ice free.

During the open water period, local skiffs are used for hunting and for transportation between villages and camps. Barge resupply operations for the coastal communities occur during the months of July, August, and September when the Arctic pack ice traditionally recedes and a navigable lead forms along the Alaskan coast. Tugs with barges are the main vessel types used to resupply the communities along the coastline during the ice free months with dry goods, fuel, raw building materials, and other commodities that cannot be flown in on aircraft. Tug and barge operations generally consist of a tug towing several barges. There is no major maritime industrial infrastructure or port in the Beaufort or Chukchi seas that supports transporting goods between major ports. There are small port facilities on the North Slope ranging from shallow-draft docks with causeway/road connections to Prudhoe Bay to beach-landing areas in the local communities. As there is no deep water port, cargo ships and oceangoing barges are typically offloaded to shallow-draft or medium-draft ships for lightering to shore.

<u>Industrial traffic</u>

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 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. 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 bouy 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).

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 will 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). The estimated volume of cargo shipped through the Northern Sea Route is expected to reach a record high in 2012 (Bennett 2012). In 2011 there were 34 ships that shipped 820,000 tons of cargo along the Northern Sea Route (Bennett 2012) 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. There is a need for a vessel traffic service through the Bering Strait and aids to navigation and safety infrastructure (Strader

2012). Growth in all sectors of Arctic marine traffic is expected to occur, including bulk natural resource shipments, scientific exploration, fishing, military activities, and tourism (Arctic Council 2004 and 2009, Brigham and Ellis 2004, U.S. Arctic Commission 2010, US Navy Arctic Roadmap 2009). Transits through the Bering Straits have steadily increased in the past four years (2008 – 2012). In 2011 there were approximately 410 Bering Strait transits; in 2010 approximately 420; in 2009 approximately 280 and in 2008 approximately 220 (Whitney 2012). Vessel traffic of tank vessels, cargo and tugs have increased the most in the 2008 to 2011 timeframe (Whitney 2012). The larger vessels transiting the Bering Strait on the Russian side with smaller tugs and barges which bring supplies to coastal Alaskan communities transiting along the U.S. side of the Strait (DeMarban 2012).

Shipping in the Arctic, including the Beaufort and Chukchi seas, is focused on the transport of regional community goods, and the shipment of natural resources out of the Arctic to world markets (Arctic Council 2009). For instance, Red Dog Mine is one of the world's largest producers of zinc and lead and must carefully plan bulk ore shipments to occur before the fall ice forms. Approximately 25 large commercial ships (bulk carriers) annually sail north through the Bering Strait region (in the ice-free season) to the DeLong Mountain Terminal. Large bulk carriers, *Panamax* and *Handymax* which range in size up to 65,000 tons, visit Red Dog Mine in Alaska during this open water season (Arctic Council 2009).

The USCG is responsible for maritime safety, security, and stewardship, and its mission applies to U.S. Arctic waters as well. Search and rescue missions by the USCG mainly occur in the Gulf of Alaska and the Bering Sea. However, with increased open water in the Arctic and increased vessel traffic, the USCG has expanded its missions in the Beaufort and Chukchi seas and sent assets into the region in several ways (USGC 2009). In recent years during the open water months, summer operations called Arctic Crossroads have been conducted in an effort to integrate local knowledge of the region with military expertise to meet the challenges of Arctic operations. This operation involves USCG, U.S. Air Force, Army National Guard, Air National Guard, and U.S. Public Health Services personnel. This program aims to build Arctic domain awareness, involves cutter operations (including icebreaking, buoy tenders and cutters), deployments to villages, community engagement, and search and rescue exercises. The USCG cutter *Hamilton* entered Arctic waters for the first time in 2009 to conduct search and rescue drills. Use of cutters in the Arctic is considered a challenge as the hulls of these vessels are not ice reinforced. The USCG has indicated that the current infrastructure and small boats and short range helicopters are not effective for long distance search and rescue operations in the Arctic and limit response capabilities for emergencies and response to potential oil spills.

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).The only USCG icebreaker currently available to operate in the Arctic is the *Healy*. The USCG icebreaker *Polar Sea* is scheduled to be decommissioned in 2011, and the USCG *Polar Star* icebreaker is currently in the process of being reactivated for service but is not expected to be commissioned again until 2013 (Colvin 2011, USCG 2010). Polar region ice breaking activities by the USCG are performed as part of scientific and national security activities, including joint scientific, search and rescue exercises. The USCG seasonally has small boat operations off Point Barrow and Prudhoe BayThe 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 available by 2013 to 2014 (UAF 2011, 2012).

A key finding of the Arctic Climate Impacts Assessment was that reductions in seas ice will likely lead to increase in marine transportation and access to resources and development (Ellis 2007, Arctic Council 2009, U.S. Arctic Commission 2010). In 2004, the bulk transport of commodities, including oil gas and minerals such as ore, were a large portion of the total of Arctic vessel traffic (Arctic Council 2009). The types of vessels now entering the Bering Strait have changed and now includes tugs, Arctic research vessels, oil and gas related vessels, cruise ships, government vessels, adventurers (12 in 2009 and 17 in 2010), and government vessels (Colvin 2011). As the open water season increases, as predicted by climate change, it is likely that ships related to a spectrum of uses could eventually be found in the EIS project area, including fishing, hard minerals/mining, science and exploration, tourism, and offshore oil and gas development (Colvin 2011).

The USCG has initiated a Port Access Routing Study to increase safety of vessel traffic that transit the Bering Straits (Colvin 2011). Eventually vessel fairways (also called safe vessel routes) could be established and listed on nautical charts with International Maritime Organization approval. The need for this action was spurred in part by the sharp increase of vessels entering the Bering Strait from 2008 to 2010. Navigation aids are currently limited in the Beaufort and Chukchi seas, as is the ability of the USGS to respond to maritime emergencies. Needs for enhancing Arctic marine safety, protecting Arctic people and their environment, and building marine infrastructure, were identified as important issues in 2009 (Brigham and Sfraga 2009).

Hydrographic surveys have provided the available charting information for limited areas along the northern coast of Alaska (Arctic Council 2009). The expansion of charting knowledge for the currently used routes in the Arctic was identified as important for development of alternative courses when ice conditions are hazardous, for entry to points of refuge for vessels and to support the expected expansion of access to natural resources (Arctic Council 2009). The Arctic Regional Hydrographic Commission was established in 2010 with representatives from the U.S, Canada, Denmark, Norway and Russia to develop nautical charts that will improve the safety of mariners transiting the Arctic (NOAA 2010). NOAA's Office of Coastal Survey and the U.S. Naval Oceanographic Office charting efforts are intended to provide additional hydrographic survey data that would be used to support safe navigation in the Arctic. 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 Magnuson-Stevens Fishery Conservation and Management Act.

3.3.7.3 Increased Aircraft and Vessel Traffic Concerns

The increase in the length of the open water season and increase in offshore oil and gas exploration is leading to an increase in aircraft and vessel traffic along the coastlines. This is viewed as a disruption to marine species by indigenous people and first nations whose culture and way of life are based on subsistence harvests. With regard to presence of increased air traffic, hunters have noticed:

- *We have a lot of air traffic, not just from the oil companies but from tourist stuff going on. Hunters traveling along the coast, too, so we were having to deal with that on top of the helicopters and stuff doing their routes to Point Thompson already. They're flying in the same migration -- or the times as the migration of the caribou and stuff, and I'd just really hate to see more of it happen because I think it's going to -- the cumulative impact is going to have a great negative impact on our community.* – Carla Sims Kayotuk at Kaktovik Scoping Meeting, March 12, 2010
- *They're [airplanes and oil planes] flying all over now around here, and it's impacting us. And more of the things that's happening now, it's impacting us. And we're a subsistence hunters. And I don't want to see more of that. It's our garden.* – Marie Rexford, Kaktovik Scoping Meeting, March 12, 2010
- *These are our only times during the summer [on calm days] that we have access to hunting caribou that go down to the coast. If activity, support activity, such as aircraft or helicopters or other support activities are near the coast -- and we have many people that can make oral statements that during the summer when they're getting close to caribou, either a small plane or helicopter show up and drive the caribou further inland.* – Fenton Rexford, Native Village of Kaktovik, March 12, 2010

Subsistence hunters have also expressed concern about the impacts of vessel traffic and increased ship presence on the animals and on their hunting practices. Oil spills from marine vessels are one of the largest concerns, as are air emissions impacts as well. The accidental release of oil or toxic chemicals can be considered one of the most serious threats to Arctic ecosystems as a result of shipping and increased large vessel marine transportation. The Arctic Council (2009) noted "*potential conflicts between increased ship traffic and indigenous marine resource use in the Bering Strait region include but are not limited to an increased amount of:*

- *Ambient and underwater ship noise;*
- *Ship strikes on large marine mammals;*
- *Potential for collision between coastal and offshore large ship traffic and small open boats using marine resources; and*
- *Pollution affecting the availability and quality of offshore, coastal and beachcast marine resources, due in part, but not limited to lack of navigational and rescue infrastructure in an extremely challenging physical and marine environment; concern for infrastructure to secure a large vessel in distress; concern for infrastructure to assess and respond to an oil and/or chemical spill."*

Concerns regarding the increase in vessel traffic and the relationship between vessel traffic and marine subsistence harvests have been expressed by scientists and residents of the Beaufort and Chukchi communities:

- *What we're expressing now is that on exploration (indiscernible) the barges do interfere and every year we have barges from Outside, coming from Canada going to Prudhoe or Barrow or even from another way around, coming from down through Barrow and get to Prudhoe. What we are facing is that it's pretty hard for us to hunt whales nowadays because all the whales that* *we've been trying to catch are all spooked and pretty hard to catch and never had any whales last year because of early migration or the whales were not in their migration route. That's the barge activities, that absolute reason.* - Eli Napageak, Nuiqsut Government to Government Meeting, March 11, 2010.

- *We had spotted that whale inside the barrier island and went between it. I don't know where -- the boats come from Prudhoe heading to Badami. And then we see that barge – that whale right in between the barges and the whaling. We never see that whale again and what -- which it was disrupted there.* - Eli Napageak, Nuiqsut Government to Government Meeting, March 11, 2010.
- *I was going east to my crew, almost -- there was just hundreds of whales just constantly passing by and the last one I saw that was in front of me, it was a calf and then the mother came up, put her arm around the calf and then they went down. And then that barge came by about five minutes later, five, ten minutes later, and then there was no whales for like 15 miles to my whaling crew. And so barge activity does divert a lot of whales, our whales we were hunting in the Beaufort Sea and Camden Bay.* – Thomas Napageak, Mayor of Nuiqsut and Whaling Captain, Nuiqsut Government to Government Meeting, March 11, 2010.
- *What concerns me here from the AEWC and from different whaling association – shipping is a concern, fishing industry is another and encroachment moving north into our hunting areas. These are the other two potential threats that are out there.* - Harry Brower at Open Water Meeting 2011, Anchorage, AK.
- *We've been able to tag quite a few belugas in Point Lay over the years and we've learned they use a huge amount of the ocean. We need to keep this in mind as we think about what is happening in the Chukchi Sea with vessels, drill ships and seismic in June and July. If there is a bunch of activity out there before Point Lay hunts, there is a potential to disrupt the movement of the belugas.* - Robert Suydam - 2011 ABWC Subsistence Harvest Updates at Open Water Meeting 2011, Anchorage, AK.
- *I'm [Caleb Pungowiyi] also concerned about the cumulative impacts that other activities will have on our subsistence resources. Not only the exploration activities, but other activities associated with that activity. Support vessels, aircraft, vessels going back and forth to restock and provide support to the activity. We also see some potential increased vessel traffic if the area opens up for international commercial ship traffic for shipping between the European countries and the Asian countries through the Arctic Ocean, especially through the northern route or through the northwest passage.* – Caleb Pungowiyi, Kotzebue Scoping Meeting, February, 18, 2010.
- *The impact we are seeing is on our spring hunt. The transporters are ramming the ice and you could see when the belugas were coming. Every time the marine lines are trying to push the ice out of the way, the belugas head back east. We are feeling it. When we are trying to harvest, they are trying to get to Red Dog early. We try to stop it and we get a call from Shishmaref saying they are being disturbed.* - George (unable to hear), Manilliq, Kotzebue at Open Water Meeting 2011, Anchorage, AK.

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 (National Research Council 1996) or through hull fouling (see Section 3.2.1 for a full discussion of current information on aquatic invasive species).

3.3.8 Recreation and Tourism

Recreation and tourism occur at generally low levels of use in the EIS project area. The affected environment for recreation and tourism will be described by setting and activities. It is important to distinguish between recreation and subsistence uses. The vast majority of fishing, hunting, and boating that occurs in the project area are *subsistence*-based, managed completely apart from recreation-based activities, with separate rights and privileges (see Section 3.3.2, Subsistence for further discussion). This section discusses only recreation-based activities, a small portion of the total of human uses in the area.

3.3.8.1 Setting

The EIS project area is a vast Arctic region, with a great deal of opportunities for recreation. The undeveloped setting is conducive to recreation activities such as wildlife viewing and photography, sailing, float boating, hiking/backpacking, camping, fishing, hunting, and winter sports (BLM 2008b). The remoteness of the area, even by Alaska standards, and the vast areas of undeveloped landscape can offer recreationists experiences unlike anywhere else. Possible areas for recreation include the Beaufort and Chukchi seas, Arctic National Wildlife Refuge, the NPR-A, Alaska Maritime National Wildlife Refuge (AMNWR), Cape Krusenstern National Monument, lands managed by the State of Alaska, and communities along the North Slope. However, the area has few facilities to support recreation and tourism and is difficult and costly to access. Most of the North Slope areas are underused for recreation and have the potential to support much more in the future (BLM 2008b).

The EIS project area is described via three recreation settings: offshore, onshore, and coastal communities. The offshore setting is away from the coast of the Beaufort and Chukchi seas. There are presently no facilities located in the offshore setting; marine vessels and aircraft transit the area, but the setting is largely undeveloped and offers abundant opportunities for solitude. The nearshore environment (within three miles of land) contains facilities related to oil and gas development and production in the Beaufort Sea, as well as docks and other industrial support facilities (NSB 2005). While facilities have been located for many years in the vicinity of Prudhoe Bay and Barrow, there are also facilities dispersed across the nearshore environment between Kaktovik and 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 project area often are based from the coastal communities that have facilities and services to support recreation or tourism activities, such as flight services and accommodations. Several of the communities have limited facilities to accommodate tourism activities or a more developed range of recreation activities. A small private lodge exists in Kaktovik, which also offers flight services, wildlife viewing, and other services (Waldo Arms Hotel 2006); Barrow and Kotzebue are larger hub communities in the region, and each hosts hotels and several firms that offer wildlife viewing and sightseeing activities (City of Barrow 2011, The City of Kotzebue 2000). Recreation activities in the coastal communities may occur in a rural setting, within sight and sound of structures and human activities. The communities may also serve as a gateway to backcountry recreation opportunities, which would occur in undeveloped settings. BOEM (2012) indicated that recreation and tourism are not major sources of employment in the NSB and NWAB with total employment of 619 in these sectors in 2008.

3.3.8.2 Activities

Low levels of recreation activities are estimated to occur in the project area. As mentioned above, the vast majority of hunting, fishing, and boating in the area are subsistence-based and rarely considered as recreation or pleasure. While estimated to occur at very low levels, local and non-local residents engage in recreation activities in the project area, including the offshore environment, nearshore environment, as well as in the vicinity of the coastal communities evaluated in this document.

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 project area.

Offshore

Offshore recreation activities in the project area generally require the use of large boats, including sail boats, cruise ships, and other large motorized vessels. Wildlife viewing by boat is also a featured recreation activity in the area. There are a number of whale watching tours and wildlife viewing/photographing boats available for charter along the Beaufort and Chukchi seas, primarily out of Barrow, Kaktovik, and Kotzebue. A limited number of flight services also offer wildlife viewing opportunities (Alaska PhotoGraphics 2011, Arctic Air Guides 2009, Kaktovik Arctic Tours 2010).

Residents in the NSB and NWAB also have observed an increase in yachts or personal pleasure boats traversing the project area. Opportunities exist for expeditions to the North Pole that would traverse through the EIS project area. 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 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 PhotoGraphics 2011, Arctic Air Guides 2009, Kaktovik Arctic Tours 2010).

Guided and unguided sport hunting, fishing, and hiking occur in the vicinity of coastal communities, as well as on state and federal lands. The Alaska Department of Fish and Game permits sport hunting, trapping, and fishing on the North Slope in Game Management Units 26 and 23, with certain restrictions (ADFG 2010b). 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 (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 PhotoGraphics 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 (NWAB 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 (NWAB 2006). Outfitters and guides provide recreational opportunities from Kotzebue for sport fisherman and hunters seeking more remote caribou and moose hunts in Northwest Alaska (NWAB 2006).

3.3.9 Visual Resources

3.3.9.1 Analysis Area

The analysis area for visual resources includes onshore and offshore areas. Onshore areas included native communities located along the shoreline between Kotzebue, on the western shore of the Arctic Coastal Plain (ACP), across the north edge of the ACP to the U.S.-Canadian border. This portion of the analysis area was established to assess views of the EIS project area from these locations. Offshore areas include the Beaufort Sea, located north of the ACP, between Point Barrow and the U.S.-Canadian border, and the Chukchi Sea, located between Point Barrow and Kotzebue. Both the Beaufort and Chukchi seas are located in the Arctic Ocean. The geographic extent of the offshore portion of the analysis area was defined by the boundary of the EIS project area (Figure 1.1).

3.3.9.2 Methods

Visual resources of the project area were assessed from onshore and offshore locations, and from the air, using methods adopted from the BLM visual resource inventory methodology (BLM 1986). The goal of the assessment was to establish a scenic quality rating for the EIS project area.

Scenic quality is defined as "a measure of the visual appeal of a tract of land." The highest scenic quality ratings are assigned to landscapes that have the most variety and most harmonious composition in relation to the natural landscape. For the purpose of this assessment, the analysis area was subdivided into four scenic quality rating units (SQRUs) based on changes in physiography, land use, or offshore development. The geographic extent of each SQRU is described as follows:

- *West Beaufort Sea*: On- and offshore portions of the analysis area extending from Point Barrow, east to the border between ANWR and the North Slope Foothills Areawide Oil and Gas Lease Sale Area.
- *East Beaufort Sea*: On- and offshore portions of the analysis area extending from the border between ANWR and the North Slope Foothills Areawide Oil and Gas Lease Sale Area, to the Alaska-Canada border.
- *North Chukchi Sea*: On- and offshore portions of the analysis area extending from Point Barrow, west to the border between the National Petroleum Reserve and the Alaska Maritime National Wildlife Refuge (Chukchi Unit).
- *Southern Chukchi Sea*: On- and offshore portions of the analysis area extending from the border between the National Petroleum Reserve and the Alaska Maritime National Wildlife Refuge (Chukchi Unit), west to Point Hope, and south to Kotzebue.

The visual quality of landforms/water, vegetation, and structure within each SQRU was assessed in terms of texture, color, form, and line. Visual quality within each SQRU was then ranked using seven factors, including: landform; vegetation; water; color; adjacent scenery; scarcity; and cultural modification. Factors were ranked based on an understanding of the visual landscape of the area, and by reviewing photographs of the project area. A final score was then calculated for each SQRU by totally scores for each key factor. Based on these results, each SQRU was assigned a scenic quality rating of A, B, or C.

Visual quality is typically assessed within the framework of three prevailing distance zone: Foreground / Middleground (3 to 5 miles); Background (5 to 15 miles); and Seldom Seen (beyond 15 miles). For the purpose of this analysis, no distance zones were established. The rationale for this decision is twofold: 1) it is assumed that offshore viewers see the analysis area from various locations, and therefore no fixed point can be established; and 2) views of the analysis area from onland locations are generally unobstructed, and therefore could extend to a distance of 15 miles. For both on- and offshore viewers, it is assumed that landscape components are most easily discerned within the foreground / middleground distance zones. During winter months visibility may be limited to areas within one mile, depending on the level of light present in an area.

In addition to quantifying scenic quality, additional qualitative indicators were assessed, including seasonality and motion. Seasonality will influence the visibility within the project area due to lighting and atmospheric conditions. Motion was evaluated to provide a baseline of activity level within the analysis area.

3.3.9.3 Regulatory Framework

The project area includes inland areas administered by the NPS, the USFWS, the State of Alaska, the NSB and the NAB. Land use and planning documents for all federal and state agencies do not contain management provisions for offshore visual resources. Borough requirements under its Title 19 Land Management Regulations provide guidance to reduce potential effects to visual resources. The guidance is similar to mitigation measures that have been required in local and federal permits for nearshore and offshore development, and that have been included in Records of Decision for NEPA compliance documents.

3.3.9.4 Viewer Sensitivity

Viewer sensitivity was assessed for three predominant viewer groups: Native communities; recreators (including Arctic marine tourists); and industrial workers. Viewer groups and their anticipated exposure to the proposed project area are described below.

- *Native Communities*: Native communities include Kaktovik, Nuiqsut, Barrow, Wainwright, Point Lay, Point Hope, Kivalina, and Kotzebue. These communities are situated on or near the coastline and contain views of the offshore portion of the analysis area. Individuals from these communities may also engage in offshore subsistence activities, where they may experience views of the project area.
- *Recreators*: Recreational viewers include land-based user groups located in the Cape Krusenstern National Monument, the Alaska Maritime National Wildlife Refuge and ANWR. Recreators situated near shorelines in these locations experience views of the offshore portion of the project area. Other recreation groups include those accessing the area by boat. Recreators may also experience views of the project area from the air when traveling to/from recreation destinations.
- *Arctic Tourists*: Arctic tourists include individuals traveling through the project area by ship. These individuals may experience views of the project area from the offshore perspective.
- *Industrial Workers*: Industrial workers are primarily situated in Oil and Gas lease areas located on the north shore of the ACP.

Visual sensitivity was determined using criteria provided by the BLM Sensitivity Level Analysis procedure. Sensitivity level rating units (SLRU) coincided with SQRU, and included: 1) the west Beaufort Sea; 2) the east Beaufort Sea; 3) the northeast Chukchi Sea; and 4) the southern Chukchi Sea.

For each SLRU, visual sensitivity was established by evaluating the following factors:

- *Type of Users*: Visual sensitivity is expected to vary with the type of user. For example, recreational sightseers may be highly sensitive to any changes in visual quality, whereas industrial workers who pass through the area on a regular basis may not be as sensitive to change.
- *Amount of Use*: Areas seen and used by large numbers of people are potentially more sensitive. Protection of visual values usually becomes more important as the number of viewers increase.
- *Public Interest*: The visual quality of an area may be of concern to local, state, or national groups. Indicators of this concern are usually expressed in public meetings, letters, newspaper or magazine articles, newsletters, land-use plans, etc. Public controversy created in response to proposed activities that would change the landscape character should also be considered.
- *Adjacent Land Uses*: The interrelationship with land uses in adjacent lands can affect the visual sensitivity of an area. For example, an area within the viewshed of a residential area may be very sensitive, whereas an area surrounded by commercially developed lands may not be visually sensitive.
- *Special Areas*: Management objectives for special areas such as Natural Areas, Wilderness Areas or Wilderness Study Areas, Wild and Scenic Rivers, Scenic Areas, Scenic Roads or Trails, and Areas of Critical Environmental Concern frequently require special consideration for the protection of the visual values. This does not necessarily mean that these areas are scenic, but rather that one of the management objectives may be to preserve the natural landscape setting. The management objectives for these areas may be used as a basis for assigning sensitivity levels.

Native communities, including individuals engaged in subsistence, recreators, and air travelers, were assigned a high visual sensitivity. Industrial workers were assigned a low visual sensitivity. The sensitivity level analysis and determination of visual sensitivity is presented in Table 3.3-48.

Table 3.3-48 Sensitivity Level Analysis for Viewer Groups Located Within the Visual Resources Analysis Area

SLRU[1]	Viewer Location	Public Interest	Adjacent Land Use	Special Areas[3]	Type of User	Amount of Use	Other Factors	Overall Visual Sensitivity
West Beaufort Sea	Onshore	Moderate	ANWR[2]	N/A	Native community of Nuiqsut (HIGH)	Prolonged; small population (LOW)	Traditional use area (HIGH)	HIGH
					Industrial workers (Oil & Gas) centered on Prudoe Bay and Deadhorse (LOW)	Variable and at specific locations (LOW)	Located in and adjacent to well established industrial nodes	LOW
	Offshore	High	N/A	N/A	Individuals engaged in subsistence (HIGH)	Year-round; low numbers (LOW)	Well-established sense of place (HIGH)	HIGH
					Industrial workers (LOW)	Seasonal – low numbers (LOW)	N/A	LOW
					Arctic tourists expecting to see oil & gas activity (LOW)	Seasonal – low numbers (LOW)	N/A	LOW
East Beaufort Sea	Onshore	High	N/A	ANWR[2] (HIGH)	Native Community of Kaktovik (HIGH)	Prolonged; small population (LOW)	Traditional use area (HIGH)	
					Recreators located in the ANWR[2] (HIGH)	Seasonal – low numbers (LOW)	N/A	HIGH
	Offshore	High	N/A	N/A	Individuals engaged in subsistence (HIGH)	Year-round; low numbers (LOW)	Well-established sense of place (HIGH)	HIGH
					Industrial workers (LOW)	Seasonal – low numbers (LOW)	N/A	LOW
					Arctic tourists expecting more pristine views associated with ANWR[2] (HIGH)	Seasonal – low numbers (LOW)	N/A	HIGH
Northeast Chukchi Sea	Onshore	Moderate	AMNWR[4]	N/A	Native Communities of Barrow and Wainwright (HIGH)	Prolonged; small populations (LOW)	Traditional use area (HIGH)	HIGH
					Industrial workers (Oil & Gas) (LOW)	Variable and at specific locations (LOW)	Located in and adjacent to well established industrial nodes	LOW

SLRU[1]	Viewer Location	Public Interest	Adjacent Land Use	Special Areas[3]	Type of User	Amount of Use	Other Factors	Overall Visual Sensitivity
	Offshore	High	N/A	N/A	Individuals engaged in subsistence (HIGH)	Year-round; low numbers (LOW)	Well-established sense of place (HIGH)	HIGH
					Industrial workers (LOW)	Seasonal – low numbers (LOW)	N/A	LOW
					Arctic tourists (HIGH)	Seasonal – low numbers (LOW)	N/A	HIGH
South Chukchi Sea	Onshore	High	Noatak National Preserve; Cape Krusenstern National Monument (HIGH)	HIGH	Native communities of Point Lay, Kivalina, and Kotzebue (HIGH)	Prolonged; small population (LOW)	Traditional use area (HIGH)	HIGH
					Recreators located in the AMNWR[4] (HIGH)	Seasonal – low numbers (LOW)	N/A (HIGH)	HIGH
	Offshore	High	Cape Krusenstern National Monument (HIGH)	N/A	Individuals engaged in subsistence (HIGH)	Year-round; low numbers (LOW)	Well-established sense of place (HIGH)	HIGH
					Arctic tourists (HIGH)	Seasonal – low numbers (LOW)	N/A	HIGH
ALL SLRUs	Onshore / Offshore	High	HIGH	N/A	Air travelers (industrial workers, tourists, researchers / scientists)	Variable; dependent on work rotations and seasonal access	Short viewer duration; variable angle of observation.	HIGH

Notes:

[1] SLRU = Sensitivity Level Rating Unit, [2] ANWR = Arctic National Wildlife Refuge, [3] N/A – Not Applicable, [4] Alaska Maritime National Wildlife Refuge
Cape Krusenstern National Monument: http://www.nps.gov/cakr/parkmgmt/lawsandpolicies.htm

3.3.9.5 Regional Landscape

The EIS project area is located offshore, to the north and west of ACP and Arctic Foothills physiographic province (Arctic Research Consortium 2011). Physiographic 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 Alaska Maritime National Wildlife Refuge, and Cape Krusenstern National Monument.

3.3.9.6 Seasonality

A high degree of seasonality exists within the EIS project area. Winter conditions persist for much of the year, with extensive snowpack between the months of October to June. Nearshore conditions are marked by extensive ice pack (described below). Summers are marked by inland thaws that expose extensive wetlands, rivers, and low-growing vegetation. Periods of darkness and light vary across the year, bracketed by extremes of 24-hour daylight and the mid-winter "day" devoid of direct sunlight. Between extreme periods of light and darkness are long periods characterized by low-angle sunlight and prolonged periods of darkness. Visibility in winter and spring may be obscured by "Arctic haze" that results from the transport of industrial pollutants from Europe and Asia, which can limit visibility during winter and spring months.

3.3.9.7 Activity and Viewpoints

Activities within the EIS project area are supported by air, marine vessel, or snowmobile travel. The modes of travel in the project area provide common means of viewing the project area. (For more detailed information on transportation, refer to Section 3.3.7.)

Onshore and offshore portions of the EIS project area are frequently viewed via regularly scheduled air travel on commuter airlines. Occasional unscheduled air travel (fixed wing and helicopter) may provide viewpoints in support of recreation, tourism, scientific research, or oil and gas activity (MMS 2008).

Two forms of vessel traffic provide viewpoints of the offshore environment during the Arctic Ocean open-water season: smaller vessels, or skiffs, used for hunting and between-village transportation, and larger barges that deliver goods to local communities. Tug and barge traffic associated with the onshore oil development provide viewpoints mainly in nearshore waters along the coast. Offshore, nearshore, and coastal areas may be viewed from marine vessels.

Industrial workers and residents use snowmachines for local travel, with views of onshore and nearshore areas. Snowmachine traffic commonly runs along many of the same routes each year, often following the coastline, major rivers, or industrial support trails (MMS 2008).

3.3.9.8 Characteristic Landscape Description

The analysis area is described as a broad panoramic that extends to the edge of the horizon. Views from and toward the analysis area are largely unobstructed, with the exception of isolated oil and gas facilities, including structures and, in onshore locations, associated roads and pipelines. Views from within the project area toward land, though still largely panoramic, include the backdrop of the Brooks Range.

Landscape character elements, including landform/water, vegetation, and cultural modification are described below.

Landform/Water

Visual resources within the EIS project area across all units are dominated by characteristics of the Beaufort and Chukchi seas. The visual characters of these waterbodies undergo dramatic changes across seasons, due in large part to the dynamic seasonal cycle of sea ice. Despite the season, views from on-shore portions of the analysis area (i.e. Native communities, recreation areas) and from within the analysis area (i.e. Arctic tourists, individuals engaged in subsistence activities) are marked by the bold horizontal line of the horizon. Views of both seas may be seen from beaches, such as along the East and West Beaufort analysis units, or from seaside cliffs, such as those characterizing the more rugged coastlines of the North and South Chukchi analysis units.

During the fall, winter, and spring seasons, both the Beaufort and Chukchi seas are covered by sea ice. The southern portion of the Chukchi Sea is typically ice-free for one to two months longer than the Beaufort Sea; however a large amount of inter-annual variability in the formation and breakup patterns of sea ice exists in both waterbodies. Sea ice occurs in three distinct forms, landfast ice, stamukhi ice, and pack ice each of which imparts a different appearance (Figures 3.3-8 and 3.3-9). All ice forms appear predominantly white, although variation in color and texture occurs across ice forms, and may change seasonally as ice thins. Ice formation, deformation, and melt processes create variability in appearance, and overall surface roughness (MMS 2008). For further discussion of sea ice forms, refer to Section 3.1.2.

In late spring, leads – or areas of open water between large pieces of ice – form within the pack-ice zone and particularly around the seaward landfast ice edge (MMS 2008) (Figure 3.3-10). Leads may expose large areas of open water along the shoreline, creating contrast in color and texture between sea ice, land, and sea. A distinct pattern of leads occurs in the western and west-central Beaufort Sea exists creating large arc-shaped areas of open water that emanate from Point Barrow and Harrison Bay. These leads separate a region of largely immobile ice in the southeastern Beaufort Sea from the more mobile pack ice in the west. The Chukchi Sea also exhibits large leads along the northern coast. In May through June, open water can extend up to 4 km at the northern end, and up to 100 km at the southern end. Patterns created from leads are most visible from the air, where large areas can be seen (MMS 2008).

After the first openings and ice movement from late May to early June, the areas of open water with few iceflows expand along the coast and away from the shore, and there is a seaward migration of the pack ice (Figures 3.3-11 and 3.3-12). Although the concentration of ice flows generally increases seaward, the movement of the ice is variable, and can change across years. Summer months expose panoramic views of the waters of the Beaufort and Chukchi seas that extend, largely uninterrupted, to the Arctic Sea.

Vegetation

Vegetation within the analysis area is limited to low-growing herbaceous forbs and shrubs, exposed only during the snow-free summer months (Figure 3.3-13). As vegetation is not present in the offshore portion of the analysis area, the contribution of on-land vegetation serves only as a back drop of views from within the analysis area toward land. When viewed from the sea, on-land vegetation imparts a green, golden, and brown color to the tundra. Because of the short stature of vegetation in the area, predominant lines created by vegetation follow that created by the predominant topography of the area.

Structures

Structures within the analysis area exist primarily in onshore locations, however offshore development does exist. Structures occur as oil and gas developments (including industrial nodes and associated pipelines, roads, and landing strips), and Native communities. In general, structures related to oil and gas development that are visible from on land and near shore locations are largely confined to the West Beaufort Sea analysis unit. Structures related to oil and gas exploration and possible development in the North Chukchi Sea would potentially be located over 113 km (70 mi) offshore and would not be visible from land locations. The appearance of Native communities across all analysis units is similar, with each characterized by a dense collection of one or two-story residential and commercial structures, limited roads, and a single airstrip. Night time lighting is present in Native communities and areas of industrial development.

Oil and Gas -- Large scale oil and gas exploration is a major component of the landscape character of the West Beaufort Sea analysis unit. Oil and gas-related development has occurred in this area since the 1940s, with major onshore development in Prudhoe Bay and offshore exploration in the Beaufort Sea underway by the 1970s. Development and production in the near shore Beaufort Sea began in the early 1980s. Industrial development is primarily situated on the Beaufort Sea. The primary onshore and near-shore (within three miles) activity extends from the Town of Barrow, east to the Badami Unit, and includes discrete industrial facilities connected by a network of roads and pipelines. Oil and gas related development is the most defining landscape characteristic separating the West Beaufort Sea analysis unit from other analysis units. This unit is characterized by ongoing oil and gas activity. Views of the project area from native communities and industrial nodes along the shoreline of this unit would experience views of existing on- and offshore oil and gas activity. Viewers situated along the shoreline of the adjacent East Beaufort analysis unit may also experience views of on- and offshore oil and gas development. Developments may be long-term, such as facilities present in Deadhorse and Prudhoe Bay (Figure 3.3-14), whereas exploration structures will be temporary, such as the Mars Ice Island (Figures 3.3-15 and 3.3-16). Developments appear as compact areas of dense development with distinct vertical lines that contrast color, texture, and reflexivity to varying extents with the surrounding landscape. When viewed from the project area, the low-lying, horizontal lines of roads and pipelines blend with predominant horizontal lines of the landscape; however, when viewed from the air, the broad network of linear roads and pipelines are apparent.

In contrast, because much of the oil and gas activity occurs over 113 km (70 mi) offshore in the Chukchi Sea, these areas are not seen by viewer groups located on-land, and are rarely observed by non-industrial marine travelers.

Native Communities -- Native communities vary in size but typically have many of the same types of infrastructure. These structures and facilities include an airstrip, a landfill, and a variety of buildings and dwellings. When viewed from within the project area, communities are generally small in scale compared to the surrounding landscape.

3.3.9.9 Scenic Quality Rating

Scenic quality of seven key factors listed below was ranked for summer and winter conditions in each SQRU. Ranking was based on a scale of 0 to 5; however cultural modification also included options for ranking with negative values extending to -4. Mid-range values (i.e. 2 or 4) were permissible if that ranking most accurately portrayed existing conditions. An explanation for rating criteria is provided below (BLM 1986).

- *Landform*: A ranking of 5 is given to areas with high vertical relief as expressed in prominent cliffs, spires, or massive rock outcrops, or severe surface variation or highly eroded formations. A rating of 3 is generally assigned to steep canyons, mesas, buttes, cinder cones, and drumlins; or interesting erosional patterns or variety in size and shape of landforms; or detail features which are interesting though not dominant or exceptional. A rating of 1 is typically assigned to rolling hills, foothills, or flat valley bottoms; or few or no interesting landscape features.
- *Vegetation*: A ranking of 5 is given to areas where a variety of vegetative types are expressed in interesting forms, textures, and patterns. A ranking of 3 is given to areas where some variety of vegetation exists; however only one or two major types are present. Finally, a ranking of 1 is assigned to areas with little or no variety or contrast in vegetation.
- *Water*: A ranking of 5 is given to areas where water is clear and clean appearing, still, or cascading white water, any of which are a dominant factor in the landscape. A ranking of 3 is given to areas where water is flowing, or still, but not dominant in the landscape. Finally, a ranking of 0 is given to areas where water is absent, or present, but not noticeable.
- *Color*: A ranking of 5 is given to areas where rich color combinations, variety or vivid color exist; or where pleasing contrasts in the soil, rock, vegetation, water or snow fields is expressed. A ranking of 3 is given to areas where some intensity or variety in colors and contrast of the soil, rock and vegetation is present, but not a dominant scenic element. A ranking of 1 is given to areas with subtle color variations, contrast, or interest and/or generally mute tones.
- *Adjacent Scenery*: A ranking of 5 is given to areas where adjacent scenery greatly enhances visual quality. A ranking of 3 is given to areas where adjacent scenery moderately enhances visual quality. A ranking of 0 is given to areas where adjacent scenery has little or no influence on overall visual quality.
- *Scarcity*: A rating of 5+ is given to areas that are considered one of a kind; or unusually memorable, or very rare within region. A rating of 3 is given to areas that are distinctive, though somewhat similar to others within the region. A rating of 1 is given to areas that are interesting within its setting, but fairly common within the region.
- *Cultural Modification*: A ranking of 2 is assigned to areas where modifications add favorably to visual variety while promoting visual harmony. A ranking of 0 is given to areas where modifications add little or no visual variety to the area, and introduce no discordant elements. A ranking of -4 is given to areas where modifications add variety but are very discordant and promote strong disharmony.

The ranking of each key factor was added to derive an overall score for the unit. Based on these results, each SQRU was assigned a scenic quality rating of A, B, or C using the following convention:

Score of 19+ = Class A
Score of 12 to 18 = Class B
Score of 11 or less = Class C

Class A Scenery is thus characterized by higher scenic quality then areas classified as Class C.

All units were ranked as having Class A scenery during summer months and Class B scenic quality during the winter months. Results of the scenic quality analysis are presented below (Table 3.3-49).

Table 3.3-49 Scenic Quality Rating Summary

Key Factor	Scenic Quality Sore (Summer / Winter)				Comments
	East Beaufort Sea Unit	West Beaufort Sea Unit	North Chukchi Sea Unit	South Chukchi Sea Unit	
Landform	3 / 3	3 / 3	4 / 4	4 / 4	Views from the project area are expansive and dramatic. Landforms serve as a backdrop to the project area. Cliffs located along the shoreline of the North and South Chukchi Sea analysis units contribute visual variety in F/M distance zones through abrupt vertical relief.
Vegetation	4 /1	4 /1	4 /1	4 /1	Vegetation viewed from the project area, and serves as a backdrop. Vegetation not visible in winter. During snow-free months, vegetation contributes color and texture to landforms.
Water / Ice	5 / 5	5 / 5	5 / 5	5 / 5	Water is dynamic, striking, and dominant throughout the year.
Color	4 / 1	4 / 1	4 / 1	4/ 1	Great contrast in color exists during summer months.
Adjacent Scenery	3 / 0	3 / 0	3 / 0	3 / 0	The Brooks Range moderately enhances the visual quality of views from the project area.
Scarcity	5 / 5	5 / 5	5 / 5	5 / 5	Waters of the Beaufort and Chukchi seas are distinctive.
Cultural Modification	0 /0	-4 / -3	0 /0	0 / 0	Cultural modification most apparent in the West Beaufort Sea Unit, particularly during summer months when activity increases.
Total Score	24 / 15	20 / 12	25 / 16	25 / 16	
Scenic Quality Class	A / B	A / B	A / B	A / B	

Notes:
Class A = score of 19+
Class B = score of 12-18
Class C =- Score of 11 or less

3.3.10 Environmental Justice

EO 12898 requires federal agencies to identify and address disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on low-income populations and minority communities (1994). Agencies identify early-on when actions may have disproportional adverse environmental or health effects on minority and/or low-income communities in order to screen feasible alternatives (EPA 1998). One of the tools to identify disproportionate effects is "scoping," a public involvement process designed to identify potential areas of concern *before* the analysis of the proposed project proceeds. A detailed description of the scoping process for this project, including government-to-government consultation with Tribes, is included in the Scoping Summary Report (Appendix C).

"Minority community" and "low-income" are defined for the purposes of analyzing the effects of the agencies' actions on potentially affected populations.

- A minority is any individual self-identified as American Indian, Alaska Native, Asian or Pacific Islander, African American, or Hispanic.
- A low-income population is a community or group with a median household income at or below the U.S. Department of Health and Human Services poverty guidelines. Poverty guidelines are an administrative tool that determines financial eligibility for certain programs and are comparable to the poverty thresholds calculated by the U.S. Census Bureau for statistical purposes.
- Disproportionate high and adverse human health or environmental effects are defined when the health effects of an action are significant or above generally accepted norms (e.g. infirmity, illness or death); the risk or rate of hazard exposure is significant and exceeds the rate to the general population; or the population is exposed to cumulative or multiple adverse exposures to environmental hazards.
- Low-income populations and minority communities are defined as any readily identifiable group of minority or low-income persons who live in geographic proximity and their population percentage is meaningfully greater than the low-income/minority population percentage in an appropriate geographic unit of analysis (CEQ 1997).

Impacts to Alaska Native populations may be different from impacts on the general population due to a community's distinct cultural practices (CEQ 1997). EO 12898 recognizes the importance of research, data collection, and analysis, particularly with respect to multiple and cumulative exposures to environmental hazards and/or a disproportionately high adverse impact resulting from a federal action. Environmental justice analysis considers impacts to subsistence resources and harvest practices, sociocultural systems, and public health. Current and historic subsistence practices are described in Section 3.3.2, and Sociocultural systems are addressed in Section 3.3.1. Public Health discussions and analysis can be found in Section 3.3.3. Impacts to these resources are discussed in Chapter 4.

3.3.10.1 Definition of the Affected Populations

The area of potential affect includes the coastal communities (including critical staging areas) of the Beaufort and Chukchi seas within the NSB, NAB, and the City of Nome.

3.3.10.2 Ethnicity and Race

Each of the affected communities has a majority Iñupiat or Alaska Native population as shown in Table 3.3-50. The communities of Kaktovik, Nuiqsut, Barrow, Wainwright, Point Lay, Point Hope, Kivalina, Kotzebue, and Nome would be considered a minority community under the definition of EO 12898. Nome residents identified as 49 percent Alaska Native in the U.S. Census, but with the addition of other racial groups, a total of 68 percent of the city's population identifies as non-White. Additional demographic information and a narrative profile about each community can be found in Section 3.3.1, Socioeconomics.

3.3.10.3 Income Distribution and Poverty Status

The U.S. Census defines "income" as cash payments received on a regular basis, not including noncash benefits such as food stamps, health benefits, or subsidized housing (US Census 2011b). The U.S. Census 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. Estimates for affected communities from the U.S. Census 2006-2010 "American Community Survey" had extremely large margin of errors and were not used due to the data's low accuracy.

The State Department of Labor and Workforce Development (ADLWD) tracks average per capita personal income for Alaska by region (ADLWD 2010). Statewide it was $44,395 in 2008 compared to $40,673 nationwide. The highest average per capital personal income was NSB ($66,664), while Nome Census Area ($33,254) and NAB ($31,168) were less than the state average.

Per capita income data are available for 2003 in some NSB Communities from the *North Slope Borough Economic Profile and Census Report*, but are not available at the community level elsewhere. In descending order: Nuiqsut $59,907; Kaktovik $59,342; Point Hope $53,835; Point Lay $33,656; Wainwright $28,320; and data was not available for Barrow (Shepro et al. 2003). Based on data available from the 2010 Census, per capita income (based on 2011 dollars) for the NAB was $21,751 and $20,325 for the Nome Census Area (U.S. Census Bureau 2013).

The NSB fares better than the state, nation, and other affected regions in the measure of median household income (shown in Table 3.3-51). However, Alaska's higher cost of living pushes the poverty threshold about 125 percent times the U.S. level (DHHS 2011). The poverty threshold for a family of four in Alaska is an annual household income of $27,570 or less (DHHS 2009). Note that definitions of families and households are not the same although they are both included in Table 3.3-51. All three regions have higher rates of households below the poverty threshold than the state and national averages. Looking more closely at ethnic groups below the poverty level, Alaska Native people are disproportionately below the poverty threshold (Table 3.3-52). For example, the City of Kotzebue is 70 percent Alaska Native, so it would be proportionate to have 70 percent of the individuals below the poverty line to be Alaska Native. However, 85 percent of individuals living in poverty in Kotzebue are Alaska Native.

Considering the data displayed by per capita income, median household income, and poverty threshold levels, the communities of Kaktovik, Nuiqsut, Barrow, Wainwright, Point Lay, Point Hope, Kivalina, Kotzebue, and Nome would be considered low-income communities under the definition of EO 12898.

Table 3.3-50 Community Population, Race, and Ethnicity, 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 Project Area

Geographic Area	# Population for whom poverty status is determined	# Alaska Native in Population	% Population that is Alaska Native	# Individuals below poverty	Alaska Native below poverty	% of people below poverty that are Alaska Native
Kaktovik	260	227	87	27	27	100
Nuiqsut	366	345	94	2	2	100
Barrow	4,026	2,196	55	719	585	81
Wainwright	534	503	94	68	65	96
Point Lay	191	189	99	32	32	100
Point Hope	860	691	80	69	69	100
North Slope Borough	6,646	4,470	67	984	838	85
Kivalina	446	431	97	55	53	96
Kotzebue	3,117	2,197	70	484	410	85
Northwest Arctic Borough	7,392	5,948	80	1,421	1,312	92
Nome	3,383	1,559	46	132	126	95
Nome Census Area	8,694	6,430	74	2,013	1,973	98
State of Alaska	666,059	88,847	13	64,038	20,117	31
U.S.	293,507,923	2,334,492	1	39,537,240	603,682	2

Notes:
a) US Census, 2005-2009 American Community Survey, 5-Year Estimates
b) Household income in the last 12 months (in 2009 inflation-adjusted dollars)
c) The total population for whom poverty status is determined.

4.0 ENVIRONMENTAL CONSEQUENCES

This chapter provides the scientific and analytic basis for evaluation of the potential effects or impacts of each of the alternatives described in Chapter 2 on the physical, biological, and social environments. To complete the analysis of effects entails several steps. The first step is to examine the direct and indirect effects to a particular resource resulting from the implementation of a particular alternative. The second step focuses on cumulative effects, considering the contribution of the proposed alternatives to the effects of the past, present, and reasonably foreseeable future actions (RFFAs). These steps are described in more detail below.

This chapter also includes a separate discussion and analysis of potential environmental impacts resulting from an oil spill within the EIS project area. Oil spills are accidental or unlawful events that are evaluated according to three different size categories: small; large; and very large. A small oil spill is defined as less than 1,000 barrels (bbl). Small fuel spills could occur during G&G or exploration drilling activities. Additional information regarding small fuel spills from G&G or exploration drilling activities is discussed in Section 4.2.7 of this EIS. A large or very large oil spill is not considered part of the proposed action for any alternative because the occurrence of such a spill is a highly unlikely event. However, if a very large spill were to occur, it could result in adverse impacts on the resources discussed below. For this reason, the potential impacts of a very large oil spill are discussed and analyzed separately in Section 4.10 of this EIS.

4.1 Analysis Methods and Impact Criteria

The following terms are used throughout this document to discuss effects:

Direct Effects – caused by the action and occur at the same time and place (40 Code of Federal Regulations [CFR] § 1508.8). "Place" in this sense refers to the spatial dimension of impacts and generally, would be analyzed on the basis of the project area. The spatial dimension of direct impacts may not be the same for all resources, and will be defined on a resource by resource basis;

Indirect Effects – defined as effects which are "*caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosystems*" (40 CFR 1508.8). Indirect effects are caused by the project, but do not occur at the same time or place as the direct effects;

Cumulative Impacts – additive or interactive effects that would result from the incremental impact of the proposed action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions (40 CFR 1508.7). Interactive impacts may be either countervailing – where the net cumulative impact is less than the sum of the individual impacts; or synergistic – where the net cumulative impact is greater than the sum of the individual impacts. Focusing this EIS on reasonably foreseeable cumulative impact issues, rather than on speculative impact relationships, is critical to the success of the analysis. Direct impacts are limited to the proposed action and alternatives only, while cumulative impacts pertain to the additive or interactive effects that would result from the incremental impact of the proposed action and alternatives when added to other past, present, and reasonably foreseeable future actions. Sections 4.10.1 and 4.10.2 describe the steps involved in the cumulative impact assessment; and

Reasonably Foreseeable Future Actions – this term is used in concert with the Council on Environmental Quality (CEQ) definitions of indirect and cumulative impacts, but the term itself is

> not further defined. Most regulations that refer to "reasonably foreseeable" do not define the meaning of the words but do provide guidance on the term. For this analysis, reasonably foreseeable future actions (RFFAs) are those that are likely (or reasonably certain) to occur, and although they may be uncertain, they are not purely speculative. Typically, they are based on documents such as existing plans and permit applications.

Effects can include ecological, aesthetical, historical, cultural, economic, social, or health, whether indirect, direct, or cumulative. The terms "effects" and "impacts" are often used interchangeably in preparing these analyses. The CEQ regulations for implementing the procedural provisions of NEPA also state: "Effects and impacts as used in these regulations are synonymous" (40 CFR 1508.8).

4.1.1 EIS Project Area and Scope for Analysis

The overall spatial scope of the analysis is illustrated in Figure 1.1. It includes state 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 BOEM Beaufort Sea and Chukchi Sea Planning Areas, approximately 322 kilometers (km) (200 miles [mi]) offshore. Onshore locations include the communities of Kaktovik, Nuiqsut, Barrow, Wainwright, Point Lay, Point Hope, Kivalina, and Kotzebue, as well as the Prudhoe Bay area. When the overall spatial scope is not applicable to a given resource, a relevant geographic sub-area within this overall project area is defined in the analysis.

Evaluation of cumulative effects requires an analysis of the potential direct and indirect effects of the proposed alternatives, in combination with other past, present and RFFAs. Potential sources of past, present, and RFFAs may occur outside of the EIS project area, such as oil and gas activities in Canadian and Russian offshore waters. For each resource, the time frame for past/present effects is defined under the corresponding cumulative effects section. RFFAs considered in the cumulative effects analysis consist of projects, actions, or developments that can be projected, with a reasonable degree of confidence, to occur over the next five to ten years and are likely to affect the resources described.

4.1.2 Incomplete and Unavailable Information

The CEQ guidelines require that (40 CFR 1502.22):

> *When an agency is evaluating reasonably foreseeable significant adverse effects on the human environment in an environmental impact statement and there is incomplete or unavailable information, the agency shall always make clear that such information is lacking.*
>
> *(a) If the incomplete information relevant to reasonably foreseeable significant adverse impacts is essential to a reasoned choice among alternatives and the overall costs of obtaining it are not exorbitant, the agency shall include the information in the environmental impact statement.*
>
> *(b) If the information relevant to reasonably foreseeable significant adverse impacts cannot be obtained because the overall costs of obtaining it are exorbitant or the means to obtain it are not known, the agency shall include within the environmental impact statement:*
>
> *1) A statement that such information is incomplete or unavailable;*
>
> *2) A statement of the relevance of the incomplete or unavailable information to evaluating reasonably foreseeable significant adverse impacts on the human environment;*
>
> *3) A summary of existing credible scientific evidence which is relevant to evaluating the reasonably foreseeable significant adverse impacts on the human environment, and*
>
> *4) The agency's evaluation of such impacts based upon theoretical approaches or research methods generally accepted in the scientific community. For the purposes*

of this section, "reasonably foreseeable" includes impacts which have catastrophic consequences, even if their probability of occurrence is low, provided that the analysis of the impacts is supported by credible scientific evidence, is not based on pure conjecture, and is within the rule of reason.

NMFS and BOEM have relied upon the best available science to inform our consideration of the environmental impacts surrounding oil and gas exploration activities in the Beaufort Sea OCS, Chukchi Sea OCS, and in State of Alaska waters of the Beaufort Sea. However, the nature, abundance, and quality of the data often varies depending upon the action, the geographic region in which it occurs, and the environmental resources that may be affected, and all of these variables influence our understanding of how certain oil and gas exploration activities may affect environmental features. When confronted with missing information, this EIS complies with 40 CFR 1502.22 by employing the following methodology:

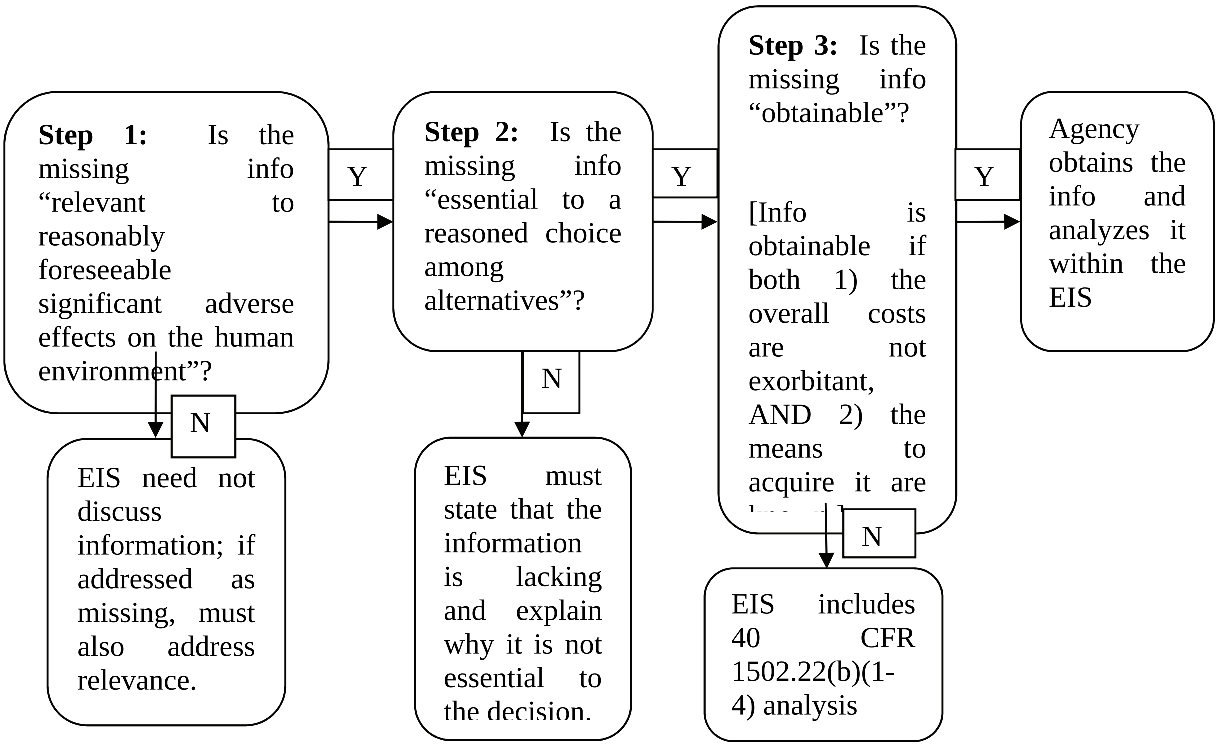

Figure 4.1-1. This diagram explains the steps utilized in this EIS for evaluating incomplete or unavailable information to comply with CEQ regulations at 40 CFR 1502.22.

4.1.3 Methods for Determining Level of Impact

4.1.3.1 Direct and Indirect Effects

Direct effects would be caused by the alternative action and would occur at the same time and place as the alternative action. Indirect effects would also be associated with the alternative but would occur later in time or at a more distant location from the action. Direct and indirect effects could be associated with seismic activities or exploratory drilling activities identified in the alternatives.

NEPA requires Federal agencies to prepare an EIS for any major federal action that significantly affects the quality of the human environment. The CEQ regulations implementing NEPA state that an EIS should discuss the significance, or level of impact, of the direct and indirect impacts of the proposed alternatives (40 CFR 1502.16). Significance is determined by considering the context in which the action will occur and the intensity of the action (40 CFR 1508.27). Actions may have both adverse and beneficial effects on a particular resource. Definitions are provided below.

4.1.3.1.1 Intensity (Magnitude)

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

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

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

4.1.3.1.2 Duration

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.

4.1.3.1.3 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.

4.1.3.1.4 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.

4.1.3.2 Impact Criteria and Summary Impact Levels

The impact criteria tables located at the start of each resource section provide a guideline for the analysts to place the effects of the alternatives in an appropriate context and to draw conclusions about the level of impact. The criteria used to assess the effects of the alternatives vary for the different types of resources analyzed, but each resource establishes criteria to determine the level of impact based on magnitude, duration, extent, and context of occurrence. 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". The following descriptions are intended to help the reader understand the distinctions made in the analyses.

Negligible[1]: 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.

4.1.4 Resources Not Carried Forward for Analysis

Resources that were chosen for analysis in this EIS may be impacted by offshore oil and gas seismic exploration activities or the authorized take of marine mammals that could occur from seismic or drilling exploration activities. While the affected environment for geology is relevant to the proposed action, geological processes would not be altered by the project alternatives; this resource is not carried forward for analysis in Chapter 4.

4.2 Assumptions for Analysis

The following discussion provides potential assumptions and scenarios about how geophysical survey methods and exploratory drilling programs could be deployed in order to provide a more complete context for the analysis of effects in this EIS. These assumptions are based on recent federal and state lease planning and recent industry plans for both seismic surveys and exploratory drilling programs in the Beaufort and Chukchi seas. The purpose of developing these assumptions is to ensure a common basis for the analysis of potential environmental effects associated with these future activities.

An overriding assumption for this EIS is that activities associated with lease operations (exploratory drilling and site clearance high resolution seismic surveys) will only occur on active leases, along potential pipeline corridors, and on leases acquired in future lease sales (both federal and state). In addition, there were five pre-2003 leases in the Northstar and Liberty units which could be subject to additional seismic exploration. Seismic surveys not specifically associated with a lease (i.e. 2D and 3D surveys) would potentially occur over large areas within the EIS project area and could occur either on- or off-lease.

For federal leases, it is reasonable to analyze exploratory operations on active leases in both the Beaufort and Chukchi seas. Active federal leases include 34 leases from the Sale 186 area (15,217 hectares), 117

[1] 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.

leases from Sale 195 (170,464 hectares), and 90 leases from Sale 202 (196,276 hectares) in the Beaufort Sea; and 487 leases (1,116,277 hectares) from the Sale 193 area in the Chukchi Sea (Figures 1-2 and 1-3).

Active State of Alaska leases only occur in the Beaufort Sea from the coastline out to three nautical miles (Figures 1-2 and 1-3) except in the areas of Harrison Bay and Smith Bay, which are considered historical bays thus extending the area beyond three nautical miles from the coastline. Most of the State's active leases are concentrated between Harrison Bay and Bullen Point. There are currently no State of Alaska leases in the Chukchi Sea. As of December 2012, the State has 406,408 acres (39,085 onshore acreage and 367,323 offshore acreage) on 166 leases in the Beaufort Sea. Exploratory activities (drilling and seismic surveys) could occur in any of these active state leases within the life of this EIS. The State of Alaska plans to conduct area-wide lease sales in the Beaufort Sea annually through 2017 (ADNR 2013), potentially adding new areas where exploratory activities could occur. Such sales could occur on state-owned tide and submerged lands located along the Beaufort Sea coast between the U.S./Canada border and Point Barrow. Industry activities on State of Alaska Beaufort Sea leases in the recent past have largely been concentrated offshore between Harrison Bay and Bullen Point. For this EIS, it is assumed that future activities would likely be concentrated here but could eventually expand beyond this area.

As mentioned in Chapter 2, one seismic or marine survey "program" entails however many survey areas a particular company is planning for that open water season. Each seismic or marine survey "program" would use only one source vessel (or two if the vessels are working in tandem such as with ocean-bottom cable seismic surveys) to conduct the program and would not survey multiple sites concurrently. One exploratory drilling program can entail multiple wells drilled by a single drilling platform (operated by one or multiple companies working together) working under a single approved Exploration Plan in a single season on specific leases. However, only one well would be drilled at a time for a specific program during the season.

Different combinations of seismic activity types could potentially occur under the different action alternatives within the overall limits for the three levels of activity outlined in Chapter 2. For the purposes of analysis only in this EIS, the different types and numbers of seismic and exploration drilling activity that could occur under the action alternatives will be analyzed as identified in Tables 4.2-1, 4.2-2, and 4.2-3 below. A conceptual example of temporal and spatial distributions that could occur for exploration activities is depicted for Alternative 2 (Figures 4.3-1 through 4.3-3), Alternative 3 (4.4-1 through 4.4-3), and Alternative 4 (4.5-1 through 4.5-3). These are only examples that are depicted in order to provide a conceptualization of the differences in levels of activity that could potentially occur under the different alternatives.

Table 4.2-1 Alternative 2 Activity Level 1

Beaufort Sea	Chukchi Sea
Two 2D/3D deep penetration towed-streamer seismic surveys	**Two** 2D/3D deep penetration towed-streamer seismic surveys
One in-ice towed-streamer 2D survey (using icebreaker)	**One** in-ice towed-streamer 2D survey (using icebreaker)
One ocean-bottom cable survey	**Three** site clearance and high resolution shallow hazards survey programs
Three site clearance and high resolution shallow hazards survey programs	**One** exploratory drilling program
One on-ice vibroseis seismic survey	
One exploratory drilling program	

Table 4.2-2 Alternative 3 Activity Level 2

Beaufort Sea	Chukchi Sea
Three 2D/3D deep penetration towed-streamer seismic surveys	**Four** 2D/3D deep penetration towed-streamer seismic surveys
One in-ice towed-streamer 2D survey (using icebreaker)	**One** in-ice towed-streamer 2D survey (using icebreaker)
Two ocean-bottom cable surveys	**Five** site clearance and high resolution shallow hazards survey programs
Five site clearance and high resolution shallow hazards survey programs	**Two** exploratory drilling programs
One on-ice vibroseis seismic survey	
Two exploratory drilling programs (**one** in federal waters, **one** in state waters)	

Table 4.2-3 Alternatives 4, 5, and 6 Activity Level 3

Beaufort Sea	Chukchi Sea
Three 2D/3D deep penetration towed-streamer seismic surveys	**Four** 2D/3D deep penetration towed-streamer seismic surveys
One in-ice towed-streamer 2D survey (using icebreaker)	**One** in-ice towed-streamer 2D survey (using icebreaker)
Two ocean-bottom cable surveys	**Five** site clearance and high resolution shallow hazards survey programs
Five site clearance and high resolution shallow hazards survey programs	**Four** exploratory drilling programs
One on-ice vibroseis seismic survey	
Four exploratory drilling programs (there is the potential for a combination up to 4 total in federal and state waters)	

4.2.1 2D and 3D Seismic Surveys

Marine 2D and 3D seismic surveys towing long streamers in OCS waters require essentially ice-free conditions to effectively maneuver the source arrays and receiver streamers, which usually begin in July or August and end in October or November depending on the onset and presence of winter ice. Marine in-ice 2D seismic surveys towing a single, long streamer and a source array can operate in up to ten tenths ice coverage by using special deployment gear to protect the equipment and following an ice breaker. In-ice surveys can be conducted in late-September into December. Marine seismic surveys could cover hundreds to a few thousand square miles depending on the survey objectives. Table 2.4 (Chapter 2) outlines specifics associated with these activities. Assumptions for analysis within this EIS for 2D and 3D marine seismic surveys, including in-ice surveys, are as follows:

- One “survey” program would be the 2D or 3D exploration conducted by a single company (or multiple companies working together) in a specific year (July to November if a traditional open water survey or late-September to December if an in-ice survey with an icebreaker for support) in either the Beaufort or Chukchi Sea.

- It is assumed that there could be one 2D/3D seismic survey in state waters of the Beaufort Sea each season. There will be no 2D/3D seismic surveys occurring in state waters of the Chukchi Sea.
- One seismic survey vessel would be deployed, supported by up to two chase/monitoring vessels or an icebreaker for surveys occurring in-ice.
- Chase/monitoring vessels would provide crew change, resupply, and acoustic and marine mammal monitoring support, and assist in ice management operations if required. These vessels will not be introducing sounds into the water beyond those associated with standard vessel operations.
- The survey source vessel, chase/monitoring vessels, and icebreaker would be self-contained, with the crew living aboard the vessels. Crew changes and resupply for open-water activities would occur at least once during each survey, involving transit to onshore support areas.
- Surveys would operate 24 hours per day and data acquisition would occur within 90 days per survey, not including downtime, such as weather delays or shutdowns for mitigation.
- For surveys in the Beaufort Sea, support operations (including crew changes and resupply) would occur out of West Dock or Oliktok Dock near Prudhoe Bay or Barrow. Air support would occur out of Prudhoe Bay or Barrow.
- For surveys in the Chukchi Sea, support operations (including crew changes and air support) would occur primarily out of Nome or Wainwright, with the possibility that these activities could be conducted out of Barrow or Wainwright as well.
- Helicopters stationed at Barrow (for operations in either the Beaufort or Chukchi Sea) or Deadhorse (for operations in the Beaufort Sea) would provide emergency or search-and-rescue (SAR) support, as needed.
- On-ice vibroseis surveys and ocean-bottom cable (OBC) surveys are also used to acquire 2D and 3D data. Vibroseis surveys occur in nearshore areas (primarily on state leases) and federal acreage in shallow water on thickened sea ice capable of supporting the equipment during the winter months. OBC surveys are conducted during open water in nearshore shallow water zones. This type of seismic survey is used to acquire seismic data in water that is too shallow for large marine-streamer vessels and/or too deep to have grounded ice in the winter. For this EIS, these two survey methods will only be analyzed for use in the Beaufort Sea.

4.2.2 Site Clearance and High Resolution Shallow Hazards Surveys

These surveys in OCS waters are conducted on active leases to evaluate for potential hazards at specific drilling locations prior to drilling or along potential pipeline routes. For analysis in this EIS, a site clearance and high resolution shallow hazards survey program may consist of several surveys conducted by a single company (or multiple companies working together) in a specific year (open water season of July to November) in either the Beaufort or Chukchi Sea. Such surveys would use the variety of methods and devices discussed in Section 2.3.2. Table 2.4 (Chapter 2) outlines specifics associated with these activities. Assumptions for analysis within this EIS for site clearance and high resolution shallow hazards surveys are as follows:

- Mobilization of a survey program would occur by mid-July and end by November 30.
- Surveys would operate 24 hours per day, and total time for data acquisition for a single program could last 45-90 days, not including downtime.

- Survey vessels are self-contained with the crew living aboard the vessel. Refueling, resupply, and crew changes would occur one time during the season.
- For surveys in the Beaufort Sea, support operations would occur out of West Dock or Oliktok Dock near Prudhoe Bay or Barrow.
- For surveys in the Chukchi Sea, support operations would occur out of Wainwright, Nome, or Barrow.
- Helicopters stationed at Barrow (for operations in either the Beaufort or Chukchi Sea) or Deadhorse (for operations in the Beaufort Sea) would provide emergency or SAR support, as needed.
- Site clearance and shallow hazards survey programs in the OCS typically also include ice gouge and strudel scour surveys. 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 multi-beam echosounders, and sub-bottom profilers, and side scan sonar.

4.2.3 Exploratory Drilling in the Beaufort Sea

While exploratory drilling located in offshore portions of the Beaufort Sea (as compared to directional drilling from onshore or existing offshore facilities) could occur on any active lease, as part of the assumptions for analysis in this EIS, it is assumed that exploratory drilling will likely occur initially in areas offshore of Camden Bay in the eastern portion of the Beaufort Sea during the initial year of this EIS's analysis window. There is also the potential for one or maybe two exploratory drilling programs on state leases in the Beaufort Sea. Table 2.4 (Chapter 2) outlines specifics associated with these activities. Assumptions for analysis within this EIS for exploratory drilling in the Beaufort Sea OCS are as follows:

- For each exploratory drilling program, a drillship , steel drilling caisson (SDC), or other Mobile Offshore Drilling Unit (MODU) with a fleet of support vessels (typically about 8-12 vessels) would be deployed that would be used for ice management (likely an icebreaker), anchor handling, oil spill response, capping and spill containment, refueling, resupply, and servicing the drilling operations.
- At the start of the program, the drillship, SDC, or other MODU and support vessels would transit the Bering Strait into the Chukchi Sea, and then transit further on to the Beaufort Sea drill site(s). Vessels could transit from maritime ports in the Canadian Beaufort Sea (e.g. Tuktoyaktuk) or the Russian Arctic.
- Timing of operations would commence in approximately early July and end by approximately early November. (In the future, with changing ice conditions, there is the potential that seasons could begin slightly earlier and end slightly later.)
- Drilling could occur on multiple drill sites per drilling program per year, allowing for up to four wells to be drilled per season per program depending upon weather and ice conditions. For purposes of analysis, assume up to three wells could be drilled in the season. If two programs were conducted simultaneously in the Beaufort Sea, this could result in up to six to eight wells drilled per season (with some on federal leases and others on State of Alaska leases). If up to four programs were to occur simultaneously in one season, up to 12-16 wells could be drilled in Beaufort Sea State and federal waters per year.
- Resupply vessels would operate from both Dutch Harbor and West Dock at Prudhoe Bay. Ten resupply trips per drilling program are estimated.
- Helicopters would provide support for crew change, provision resupply, and SAR operations for each drilling program. Helicopters (assume two flights per day or 12 flights per week)

used for crew change and resupply would be based in Deadhorse or Barrow and transit to/from the drill sites. Fixed winged aircraft operating daily out of Deadhorse or Barrow would support marine mammal monitoring and scientific investigations. SAR helicopters would operate as needed from Barrow.

- At the end of the drilling season, the drilling unit and associated support vessels will typically exit the area by traveling west into and through the Chukchi Sea and Bering Strait. As an alternative, the SDC, if used, could be towed to the Canadian Beaufort for the winter.

Open-water exploratory drilling currently does not occur in state waters of the Beaufort Sea. Exploratory drilling on state leases would likely occur from artificial ice islands, where the drilling is done directionally. Assumptions for analysis within this EIS for exploratory drilling in state waters of the Beaufort Sea are as follows:

- Exploratory drilling would occur within State of Alaska waters which are generally within three miles of the coastline and barrier islands in the Beaufort Sea between Point Barrow and the Canadian border; most of the state leases are concentrated between Harrison Bay and Bullen Point.
- The use of artificial ice islands requires that drilling occur during the winter months (December to April).
- Resupply and crew change support would occur through the construction of ice roads to the artificial ice island, originating from the road system at or near the Prudhoe Bay oilfield. Helicopters could also be used that would operate out of the Deadhorse airport.

4.2.4 Exploratory Drilling in the Chukchi Sea

While exploratory drilling located in offshore portions of the Chukchi Sea could occur on any active lease, as part of the assumptions for analysis in this EIS (similar to the Beaufort Sea), it is assumed that exploratory drilling in the Chukchi Sea will likely occur initially in areas on federal leases for which exploration plans have recently been submitted or are intended to be submitted during the time frame of this EIS and where there have been recent requests to approve ancillary activities. Table 2.4 (Chapter 2) outlines specifics associated with these activities. Assumptions for analysis within this EIS for exploratory drilling in the OCS portion of the Chukchi Sea are as follows:

- For each exploratory drilling program, a drillship or jackup rig (i.e. drilling unit) with approximately six to eight support vessels would be deployed. Support vessels would be used for ice management (likely an icebreaker), anchor handling, oil spill response, refueling, resupply, and servicing the drilling operations. Oil spill response vessels would be staged near the drillship or jackup rig. The icebreaker and anchor handler would be staged away from the drill site when not in use but would move closer to perform duties when needed.
- The drilling unit and support vessels would be deployed on or about July 1, traveling from the south through the Bering Sea, or from the east through the Beaufort Sea from maritime ports in the Canadian Beaufort Sea (e.g. Tuktoyaktuk) or the Russian Arctic, arriving on location in the Chukchi Sea in early July.
- Timing of drilling operations would commence soon after arriving at the drill site in early July and ending by approximately mid-November. (In the future, with changing ice conditions, there is the potential that seasons could begin slightly earlier and end slightly later.)
- Drilling could occur on multiple drill sites per drilling program per year, depending upon weather and ice conditions, allowing for up to four wells to be drilled per season. For

purposes of analysis, assume up to four wells could be drilled in the season. If two programs were conducted simultaneously in the Chukchi Sea, this could result in up to six to eight wells drilled per season. If up to four programs were to occur simultaneously in one season, up to 12-16 wells could be drilled in the Chukchi Sea per year.

- Marine resupply vessels would operate between the drill sites and Dutch Harbor or Wainwright. Ten resupply trips per drilling program are estimated.
- Aircraft operations, up to 12 flights per week, would transit from Wainwright or Barrow to each of the drilling sites. For emergencies, SAR helicopters would operate out of Barrow.
- At the end of the drilling season, the drillship or jackup rig, and associated support vessels will transit south out of the Chukchi Sea through the Bering Strait.
- There are currently no leases available in state waters in the Chukchi Sea. Exploratory drilling in state waters of the Chukchi Sea is not analyzed in this EIS.

4.2.5 Conceptual Examples

Three conceptual examples have been provided to help illustrate potential temporal and spatial arrangements of exploration activities under the action alternatives. The three conceptual examples are within the levels of activity contemplated for Alternatives 2, 3, and 4. Additionally, the examples do not exceed the level of each type of activity described in Tables 4.2-1, 4.2-2, 4.2-3 above.

For Alternative 2, Figures 4.3-1 and 4.3-2 depict conceptual examples of the spatial distribution of different activity types in the Beaufort and Chukchi seas, respectively. In order to help reviewers better visualize the impacts that could potentially result from these activities, these maps include examples of: the distances from certain sources at which sounds attenuate to below NMFS MMPA harassment threshold levels, tracklines of seismic vessels, the locations of associated support vessels for drilling platforms, and areas of particular importance for marine mammals. To avoid making the maps hard to read, subsistence areas were not included, but reviewers may cross reference to Figures 3.3-18 – 3.3-24. An associated bar graph (Figure 4.3-3) was included to depict an example of the temporal distribution of the activities in Alternative 2 illustrated in Figures 4.3-1 and 4.3-2, which provides an example of the number and types of activities that might be occurring concurrently, and for how long.

For Alternative 3, the same conceptual examples described above for Alternative 2 were also included in Figures 4.4-1, 4.4-2, and 4.4-3. These figures illustrate how for Alternative 3 (as compared to Alternative 2), which adds both seismic surveys and drilling operations, the total area over which potential impacts from the activities may occur is larger, and the amount of time that multiple activities are co-occurring (and the number of activities that are co-occurring) either within or across the Beaufort and Chukchi seas is greater. For these reasons, these figures support the general suggestion that conducting the level of activity proposed for Alternative 3 would result in both impacts to more individuals, as well as impacts of a likely more intense nature (from the combined exposure to more activities in time and space), than conducting the level of activity proposed for Alternative 2.

For Alternative 4, the same conceptual examples described above for Alternatives 2 and 3 were also included in Figures 4.5-1, 4.5-2, and 4.5-3. These figures illustrate how for Alternative 4 (as compared to Alternatives 2 and 3), which includes additional drilling operations but the same number of seismic surveys as Alternative 3, the total area over which potential impacts from the activities may occur is likely somewhat larger, and the amount of time that multiple activities are co-occurring (and the number of activities that are co-occurring) either within or across the Beaufort and Chukchi seas is somewhat greater. For these reasons, these figures support the general suggestion that conducting the level of activity proposed for Alternative 4 could result in both impacts to more individuals, as well as impacts of a likely more intense nature (from the combined exposure to more activities in time and space), than conducting the level of activity proposed for Alternatives 2 and 3. However, the difference in the level of direct impacts between Alternative 4 and Alternative 3 is not expected to be as large as the difference between Alternative 3 and Alternative 2.

4.2.6 Estimating Take of Marine Mammals

Background

The MMPA prohibits the taking of marine mammals with certain exceptions, one of which is MMPA incidental take authorizations. Incidental take authorizations allow for the take of small numbers of marine mammals if NMFS finds that the activity will have a negligible impact[2] on the affected marine mammal species and will not have an unmitigable adverse impact[3] on subsistence uses, and provided mitigation and monitoring requirements are set forth. Applicants for these authorizations are required by the MMPA implementing regulations to estimate (in advance) the number of individuals of each species that may be taken by their proposed activity [50 CFR 216.104 (a)(6)]. Take estimates are also necessary to inform the analyses that NMFS must conduct.

In order to help applicants with noise-producing activities understand when their activity might be expected to take a marine mammal (i.e., when an ITA would be needed) and to assist in the necessary quantification of likely takes, NMFS has established acoustic thresholds (discussed below). Acoustic thresholds identify received sound levels above which marine mammals would be expected to be taken (either by behavioral harassment or injury), if exposed. In short, animals predicted to be exposed to levels at or above the acoustic threshold are predicted to be taken in the specified manner (e.g., by behavioral harassment or injury).

The estimated number of animals that will be exposed at or above acoustic thresholds (and, therefore, predicted to be taken) is a valuable piece of both the “negligible impact” and “unmitigable adverse impact” analyses and directly informs whether the take numbers are “small,” however, it is only one piece of an effects analysis under the MMPA. The expected occurrence of a take or a particular *number* of estimated takes does not necessarily relate directly to the biological significance of the impacts, i.e., whether the takes will result in adverse impacts on the fitness or health of the individuals taken. The potential and likelihood of impacts on the health and fitness of individuals taken must be determined in consideration of the manner, context, duration, and intensity of those takes.

For example, some takes (such as injuries or those with significant negative energetic impacts) may have the potential to negatively affect reproductive success or survivorship, depending on the circumstances, while other takes may have no impact on the health or fitness of the affected individual. If the analysis predicts that the activity is likely to adversely affect the reproductive success or survivorship of any individual marine mammals, then additional analysis must consider how the anticipated fitness affects to those individuals would likely affect the population (e.g., rates of recruitment and survival), in consideration of the species status. Additionally, the negligible impact analysis must consider the impacts on marine mammal habitat, such as impacts on prey species or the more difficult-to-quantify acoustic

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[2] Under the MMPA implementing regulations, a negligible impact is defined 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 (50 CFR § 216.103).

[3] An unmitigable adverse impact is defined as an impact resulting from the specified activity that is: 1) likely to reduce the availability of the species to a level insufficient for a harvest to meet subsistence needs by: causing marine mammals to abandon or avoid hunting areas; directly displacing subsistence users; or, placing physical barriers between the marine mammals and the subsistence users; AND 2) cannot be sufficiently mitigated by other measures to increase the availability of marine mammals to allow subsistence needs to be met.

habitat impacts that necessitate the consideration of the chronic effects of longer-term exposure to increased sound levels.

Finally, the need to ensure "no unmitigable adverse impacts" to the availability of subsistence uses requires consideration of far more than just take numbers, both because activities can interfere with a hunt without ever affecting a marine mammal (e.g., by blocking access of hunters to marine mammals), and because it is possible for noise to affect marine mammals in a way that would make them more difficult to hunt without always rising to the level of a take (e.g., as traditional knowledge suggests, making them "skittish.")

Current Acoustic Thresholds

When assessing impacts to marine mammals from sound sources, NMFS has historically used the following acoustic thresholds (meaning that take is predicted to occur, or assumed to have occurred, if animals are exposed at or above these levels). These thresholds have been applied to all marine mammal species under NMFS' jurisdiction.

- ***Level A Harassment (potential injury) from all non-explosive sound sources: 180 and 190 dB re 1 µPa (rms) received level for cetaceans and pinnipeds, respectively***. These received levels represent the levels above which, in the view of a panel of bioacoustics specialists convened by NMFS before additional TTS measurements for marine mammals became available, one could not be certain that there would be no injurious effects, auditory or otherwise, to marine mammals (NMFS 1995, 2000).
- ***Level B Harassment (behavioral harassment) from impulsive sources (e.g., seismic airguns): 160 dB re 1 µPa (rms) received level for all species.*** This sub-injurious threshold was based on measured avoidance responses observed in whales in the wild. Specifically, the 160 dB rms re: 1µPa threshold was derived from data for mother-calf pairs of migrating gray whales (Malme et al. 1983, 1984) and bowhead whales (Richardson et al. 1985; Richardson et al. 1986) responding when exposed to seismic airguns.
- ***Level B Harassment (behavioral harassment) from continuous sources (e.g., drilling): 120 dB re 1 µPa (rms) received level for all species.*** This threshold originates from research on baleen whales, specifically migrating gray whales (Malme et al.1984; predicted 50% probability of avoidance) and bowhead whales reacting when exposed to industrial (i.e., drilling and dredging) activities (non-impulsive sound source) (Richardson et al. 1990).

Revision of Acoustic Thresholds[4]

NMFS is currently in the process of revising and updating our acoustic thresholds to incorporate newer science and utilize improved methods. NMFS is using a phased approach to conduct these update. The thresholds currently being revised include: 1) the injury (Level A Harassment) thresholds to be applied to all sound sources and; 2) the behavioral (Level B Harassment) thresholds to be applied only to seismic activities and seismic-like sound sources (e.g., primarily mobile and impulsive sources). In addition to ensuring that NMFS is using the appropriate acoustic thresholds in its decision-making processes, the development of these revised acoustic thresholds will create a single document/ reference that clearly articulates the thresholds, how they were scientifically derived, and how NMFS plans to apply them pursuant to the multiple NOAA authorities that address noise impacts (e.g., MMPA, ESA).

The process for revising the acoustic thresholds is separate from this NEPA process for Arctic Oil and Gas Exploration. The acoustic threshold revision process will include extensive internal (NOAA) review,

[4] This information is distributed solely for the purpose of predissemination peer review, including public review and comment, under applicable Information Quality Guidelines. It has not been formally disseminated by NOAA. It does not represent and should not be construed to represent any agency determination or policy.

an external peer review, and public review. Currently, NMFS is in the internal review part of this process and we expect the other steps (peer and public review) to occur generally in parallel with the development of the Final EIS for Arctic Oil and Gas Exploration. This means that we expect final or near-final acoustic threshold revisions for inclusion in this Final EIS. However, importantly, the revised acoustic thresholds specifically referenced here will not be used in any final management decisions pursuant to the MMPA or ESA until they have undergone both public and peer review and have been officially finalized by NMFS. Until then, NMFS will continue to use the current thresholds referenced above.

Government agencies must make decisions every day based on the best available science. NEPA requires agencies to conduct environmental impact analyses, some of which span multiple years during which science and policy related to the actions being considered are constantly evolving. As noted above, NMFS is currently in the internal review phase of our revision of the acoustic thresholds and some facets of the revisions are not yet ripe for consideration by the public. Additionally, both peer review and public review will create opportunities for any draft thresholds available now to change, potentially significantly. However, enough basic information about the likely nature of the revisions to the thresholds is available to provide valuable input into the environmental analysis contained in this Supplemental DEIS, and not including an introduction to these anticipated changes here and (in fuller form) in the Final EIS would lessen the value of the Final EIS to inform NMFS decision-making. As noted above, a full draft of the revised acoustic thresholds will be made available to the public for review in a separate process (anticipated later in 2013) and the input from that process will inform both the final acoustic thresholds that are ultimately adopted, as well as NMFS' effects analysis in the Final EIS for Arctic Oil and Gas Exploration.

Below, we include an introduction to the revision of the acoustic thresholds (including actual preliminary draft thresholds for injury), along with a summary of the ways in which changes of the nature discussed might be expected to shape the analysis of effects contained elsewhere in the document (and informed by the current acoustic criteria). As discussed in more detail above and below, acoustic thresholds are only one part of the analysis of marine mammal and subsistence impacts and the analysis contained elsewhere in this document (informed by current acoustic criteria) creates a solid analytical foundation upon which considerations of acoustic threshold revisions can be layered for a fuller understanding of how the anticipated changes may inform future decision-making.

Behavioral Harassment Thresholds

As noted above, NMFS is currently in the process of revising the acoustic thresholds for behavioral harassment for seismic activities, including airguns and similar sources (e.g., primarily mobile and impulsive sources). Although new numerical thresholds are not presented here (for behavioral harassment), an introduction to the anticipated change in methodology and a preview of the quantitative adjustments that could result from the inclusion of newer data are included.

The current acoustic threshold for behavioral harassment from impulsive sounds, a 160-dB rms step function, predicts that all animals exposed to levels above 160 dB would be taken, and that no animals exposed to levels below 160 dB would be taken. Both data and logic suggest that this method may oversimplify the relationship between sound exposure and behavioral harassment, and there are other methods available that can better characterize this relationship, given the available data, while also incorporating consideration of variability in individual responses to sound. Dose-response-type curves, or risk functions (see Figure 4.6-1), when supported by data and with an appropriate cut-off, can be used to more fully describe how exposures to different received levels can result in different outcomes (e.g., number of animals responding in a certain way, probability of individual responses). For example, given a specifically defined response, a risk function could describe how a higher percentage of animals exposed to higher received levels might demonstrate that response, while a lower percentage of animals exposed to lower received levels might demonstrate that response (see example used for Navy mid-frequency sources below). NMFS' preliminarily plans include exploring the use of dose-response or risk function-like curves to characterize the relationship between received sound level and behavioral responses. Further, while other metrics have been explored, based on the available data NMFS' believes that dB rms (the metrics used in the current acoustic thresholds) is still the most appropriate metric to characterize the relationship between received level and behavioral response.

Additionally, as has become increasingly evident and more highlighted in publications (e.g., Ellison et al., 2011), the context of an exposure of marine mammals to sound (e.g., the behavioral state of the animal, whether a sound source is approaching and how fast, etc.) can affect both how an animal initially responds to a sound and the ultimate impacts of the sound exposure on that individual. NMFS is also exploring additional methods of augmenting the use of a dose-response-like curve to address contextual factors beyond received level (such as distance from the sound or behavioral state of the animal), as well as the more chronic effects of sound sources operated over longer periods of time.

Currently, based on the limited data available and what it suggests is appropriate, NMFS plans to have different basic acoustic thresholds for mysticetes, odontocetes, and pinnipeds, with the recognition that sometimes there may be sufficient data to suggest that a species within one of those groups is "sensitive" and should have different (lower) acoustic threshold. Although draft curves will not be presented here, a look at some of the data that will be used to derive the curves will help us understand how the results of using a curve may differ from the results of using the current 160-dB step function. Because data indicate that not all mysticetes exposed to received levels of 160 dB or above would be expected to be taken (Miller 2005, Malme et al. 1983, 1984, 1985), a dose-response approach for mysticetes would likely result in estimates that show fewer takes resulting from exposures to received levels above 160 dB (than when the current step function is used). However, there are also data showing that some portion of mysticetes (including, and perhaps especially, bowheads) exposed to seismic signals at received levels below 160 dB, and potentially down to around 120 dB, may respond in a manner that NMFS would categorize as a Level B behavioral take, especially in certain contexts, such as within a migratory corridor or if the activity were expected to be continuous over multiple days (Di Iorio and Clark 2009, Richardson et al. 1985/1986, Richardson et al. 1999). A dose-response-like approach incorporating these data would result in some number of animals exposed at levels below 160 dB being predicted to be taken.

Fewer data exist showing how odontocetes and pinnipeds (as compared to mysticietes) behaviorally respond to seismic airguns and similar sources. However, what data are available suggest that some percentage of odonotcetes exposed to received levels above 160dB would not be taken and that some percentage exposed to levels below 160 dB may respond in a manner that NMFS would consider Level B harassment (Miller et al. 2005). Alternately, data suggest that not all pinnipeds will be taken at received levels of 160 dB (or higher), and there are no data (with measured received levels) indicating how they would respond to levels below 160 or 165 dB.

In consideration of the acoustic threshold revisions being conducted, NMFS qualitatively considers how changes of the nature described above could potentially shape our further analyses of the alternatives in this Supplemental DEIS. As described above, much of the impact analysis occurs subsequent and in addition to the initial estimate of the number exposures that are predicted to result in a take. This additional analysis determines whether the anticipated exposures with the potential to injure or disturb marine mammals (counted as takes) would be likely to affect the health or fitness of any individuals (in a manner that would affect survivorship or reproductive success), whether altered health or fitness of the expected number of individuals would adversely affect rates of recruitment or survival, and whether any of the expected effects on individuals would have an unmitigable adverse impact on subsistence uses.

When estimating the potential number of take from a particular activity, NMFS has typically multiplied the anticipated area to be ensonified by the appropriate threshold (noted above) by the expected species density. For some activities occurring in the Beaufort Sea during the fall bowhead migration, additional factors were taken into consideration in the take estimates, such as the proportion of whales migrating past in certain water depths and how that falls within the applicable sound thresholds. When sound propagation is considered (and the larger areas ensonified at lower levels), if the acoustic thresholds were revised in the form of dose-response curves reflecting the data referenced above (after input from the public and peer reviewers), it is likely that it would result in a change in the estimated number of takes that would result from the operation of seismic airguns (as compared to the numbers predicted using the current criteria). This change would likely be in the direction of a moderate to large increase in the number of predicted mysticete behavioral harassment takes, a small to moderate increase in the number of odontocete takes, and little change or a slight decrease in the number of pinniped takes.

Any increase in numbers of estimated take would entirely be the result of adding behavioral harassment takes that would be predicted to result from lower level exposures, which are also typically associated with lower potential severity, or lower likelihood of affecting the health and fitness of any individual marine mammals. As discussed above, the quantification of anticipated takes is only part of the larger marine mammal impact analysis and is separate from the analysis of the severity of any single one of those takes, which must consider the biological and operational context in which those takes occur. So, while these revisions could notably change predicted take numbers in some cases, we would not *necessarily* change our analyses (i.e., the analysis contained elsewhere in this Supplemental DEIS) of the biological significance of the increased total takes on the individuals or populations. The analysis of the potential health and fitness impacts of the expected take, or the population level impacts, includes consideration of the life history of the affected species, their behavioral patterns and distribution within the action area, the duration, season, geographic scope, and operational parameters of the expected activities, along with the potential implementation of multiple mitigation measures intended to minimize the intensity of the affects – and these analyses are not notably changed by the likely modification of predicted harassment take numbers.

Separately, any revisions to the acoustic thresholds also result in changes to the distances from sound sources within which we quantify impacts. NMFS has previously qualitatively acknowledged our concerns regarding the more chronic, longer-term effects of increasing noise levels (at levels below 160 dB) in potentially interfering with marine mammal's ability to detect and interpret important environmental cues (especially for low frequency specialists and low frequency sounds). For example, we outlined the 120-dB isopleths around seismic airgun operations in the original DEIS (even though the current acoustic threshold for behavioral harassment is 160 dB) to give a sense of the geographic scope of these chronic noise concerns. Revised acoustic thresholds, with which we may include methods to address the contextual and chronic concerns of noise exposure, may allow us to quantitatively augment the existing qualitative analysis of these concerns.

Injury

NMFS is also currently in the process of revising the acoustic criteria for determining at what received levels a marine mammal is likely to incur injury (i.e., PTS onset) from seismic activities, including use of airguns. Southall et al. (2007) identified dual criteria (using peak pressure and sound energy level) for assessing PTS from multiple pulse sounds. Using those proposed levels as a starting point, NMFS is proposing to modify them using more recent data, which suggest: 1) that phocids should be separated from otariids when estimating TTS or PTS (because of their inner ear anatomy) and likely incur hearing impairment at lower received levels based on the data currently available (Kastak and Schusterman 1998; Hemilä et al. 2006; Mulsow et al. 2011), and; 2) that cetaceans are more likely to incur TTS and subsequent PTS within the frequency ranges of their best hearing sensitivity (,Finneran and Schlundt 2010; Finneran and Jenkins 2012). An overview of these NMFS draft acoustic exposure criteria is included below. Finneran and Jenkins (2012), which describes the new weighting functions, is included here as Appendix B, and Figure 4.6-2 summarizes the weighting. Additional information regarding the derivation of these draft thresholds may be found in Southall et al. (2007) and section 3.4 of the Navy's Atlantic Fleet Training and Testing DEIS (aftteis.com). NMFS will provide our own full description of the derivation of the revised acoustic thresholds once the internal review is complete and NMFS' revised acoustic thresholds are released for public comment through the separate process referenced above.

Table 4.2-4 NOAA Draft Proposed Injury (PTS) Criteria for Marine Mammals

Draft Proposed Injury Criteria		
	PTS Onset (Received Level)	
Hearing Group	**Impulsive**	**Non-impulsive**
Low-Frequency Cetaceans	*Cell 1* *230 dB_{peak}* **&** *187 dB cSEL***	*Cell 2* *230 dB_{peak}* **&** *198 dB cSEL***
Mid-Frequency Cetaceans	*Cell 3* *230 dB_{peak}* **&** *187 dB cSEL***	*Cell 4* *230 dB_{peak}* **&** *198 dB cSEL***
High-Frequency Cetaceans	*Cell 5* *201 dB_{peak}* **&** *161 dB cSEL***	*Cell 6* *201 dB_{peak}* **&** *171 dB cSEL***
Phocid Pinnipeds (Underwater)	*Cell 7* *224 dB_{peak}* **&** *181 dB cSEL***	*Cell 8* *224 dB_{peak}* **&** *186 dB cSEL***
Otariid Pinnipeds (Underwater)	*Cell 9* *230 dB_{peak}* **&** *215 dB cSEL***	*Cell 10* *230 dB_{peak}* **&** *220 dB cSEL***

* Dual criteria: Use on one [dB_{peak} or dB cSEL] exceeded first.

** NOTE – When comparing these thresholds to existing 180/190-dB rms thresholds, two important differences must be kept in mind: 1) these thresholds are based on the frequency of highest sensitivity for each taxa and are intended to be used in conjunction with frequency weighting, and 2) the metric of these thresholds are SEL instead of SPL.

When considering how revised acoustic thresholds for injury similar to those outlined above might compare (adopted in this form after public and peer review and finalized) to the current 180/190-dB rms thresholds, it is important to note three important differences in what the two sets of thresholds (current and revised) represent. First, dual criteria are utilized, meaning that whichever is exceeded first is the one that should be used for assessing injury (in almost all cases, the cSEL metric will be exceeded first). Second, the thresholds outlined above use the cSEL metric (which allows for the consideration of how the sound accumulates over time), not the SPL rms metric of the current thresholds (which does not directly take into account the duration of exposure). This means, for example, that one 100-ms pulse with a received SPL rms level of 161 dB would only have an SEL of 151 dB. However, multiple pulses must be taken into consideration, and, if a receiver were in a position to receive 10 of those same pulses within that same distance, the cSEL would accumulate up to 161 dB (e.g, cSEL equals SPL rms levels when the total duration of exposure to the same level is 1 second). Last, the cSEL thresholds outlined above take into account the frequency range of highest sensitivity for each functional hearing group and are intended to be used in conjunction with frequency weighting functions that are depicted below (Figures 4.6-2 and 4.6-3) and outlined in more detail in Finneran and Jenkins (2012) technical memo (Appendix B). In short, applying frequency weighting functions puts the sound produced by the source in question through a functional hearing group-specific and frequency-specific filter and for any part of the signal that is not in the area of highest sensitivity for that functional hearing group, i.e., more energy is needed to reach the threshold (e.g., range to isopleth decreases). Of note, the values of highest sensitivity for mysticete hearing specialists depicted below are extrapolated from mid-frequency hearing specialists and NMFS expects that these values may be more likely to significantly change than other groups.

NMFS has conducted some simple calculations, with underlying assumptions (e.g., spherical spreading, airgun shot lasts 100 ms, accumulate 20 shots, animal not avoid source). If thes revised thresholds were adopted in this form, it is likely that the distances from the source within which we would expect animals to potentially be exposed to injurious levels (e.g., within these cSEL thresholds) would primarily fall within the distances to the current 180-dB SPL rms threshold for cetaceans. However, for phocids, the distances within which received levels may exceed the new thresholds could be somewhat larger than the distances to the current 190-dB threshold. However, as noted, these calculations do not take into account the likely avoidance of higher sound levels by some portion of marine mammals or the potential success of mitigation measures in avoiding exposures to those animals that approach more closely. This Supplemental DEIS analysis currently suggests that while marine mammal injury resulting from airgun exposure is unlikely, it cannot be ruled out – and that analysis is anticipated to remain accurate in consideration of revised acoustic thresholds.

Tables 4.2-5, 4.2-6, and 4.2-7 contain a representative summary of takes that were predicted to occur in the Beaufort and Chukchi seas based on previously issued IHAs for the different types of activities analyzed in this EIS.

Table 4.2-5 Examples of estimated takes for different types of oil and gas exploration activities in the Beaufort Sea using the current acoustic criteria, followed by estimated takes if those examples are used to total maximum activity levels for each alternative.

BEAUFORT	Bowhead Whale	Beluga Whale	Gray Whale	Minke Whale	Humpback Whale	Harbor Porpoise	Ringed Seal	Bearded Seal	Spotted Seal	Ribbon Seal
OBC Seismic Survey using an 880 in^3 array	20	15	0	0	0	0	225	30	15	0
3D Seismic Survey using a 3147 in^3 array	400	210	250	0	0	0	7300	375	20	0
Site Clearance and High Resolution Shallow Hazards Survey using a 40 in^3 airgun	300	10	5	0	0	0	140	10	5	0
On-ice Seismic Survey	0	0	0	0	0	0	500	5	0	0
In-ice 2D Seismic Survey	240	4900	20	18	18	18	39,200	70	17	17
Exploratory Drilling Program with a drillship	1500	20	10	0	0	15	440	22	5	2
ALTERNATIVE 2 Total - Maximum levels of all Beaufort activities combined	**3460**	**5385**	**545**	**18**	**18**	**33**	**55385**	**907**	**92**	**19**
ALTERNATIVE 3 Total - Maximum levels of all Beaufort activities combined	**5980**	**5650**	**815**	**18**	**18**	**48**	**63630**	**1354**	**142**	**21**
ALTERNATIVE 4 Total - Maximum levels of all Beaufort activities combined	**8980**	**5690**	**835**	**18**	**18**	**78**	**64510**	**1398**	**152**	**25**

Table 4.2-6 Examples of estimated takes for different types of oil and gas exploration activities in the Chukchi Sea using the current acoustic criteria, followed by estimated takes if those examples are used to total maximum activity levels for each alternative.

CHUKCHI	Bowhead Whale	Beluga Whale	Gray Whale	Minke Whale	Humpback Whale	Fin Whale	Killer Whale	Harbor Porpoise	Ringed Seal	Bearded Seal	Spotted Seal	Ribbon Seal
3D Seismic Survey using a 3000 in^3 array	150	190	145	5	5	5	5	20	6,500	215	130	10
Site Clearance and High Resolution Shallow Hazards Survey using a 40 in^3 array	5	10	20	2	2	2	5	7	700	30	7	2
In-ice 2D Seismic Survey	40	50	5	5	5	0	0	5	21,300	20	5	5
Exploratory Drilling Program with a drillship	80	15	50	15	15	15	15	15	815	35	20	15
Exploratory Drilling Program with a jack-up rig	70	10	35	5	5	5	20	10	340	160	160	15
ALTERNATIVE 2 Total - Maximum levels of all Chukchi activities combined	**435**	**475**	**405**	**36**	**36**	**31**	**40**	**81**	**37215**	**575**	**306**	**46**
ALTERNATIVE 3 Total - Maximum levels of all Chukchi activities combined	**825**	**890**	**785**	**65**	**65**	**60**	**75**	**150**	**52430**	**1100**	**600**	**85**
ALTERNATIVE 4 Total - Maximum levels of all Chukchi activities combined	**985**	**920**	**885**	**95**	**95**	**90**	**105**	**180**	**54060**	**1170**	**640**	**115**

Table 4.2-7 Using the examples provided above, estimated takes for total maximum activity levels in both the Beaufort and Chukchi seas combined for each alternative.

BEAUFORT/CHUKCHI COMBINED	Bowhead Whale	Beluga Whale	Gray Whale	Minke Whale	Humpback Whale	Fin Whale	Killer Whale	Harbor Porpoise	Ringed Seal	Bearded Seal	Spotted Seal	Ribbon Seal
ALTERNATIVE 2 Total - Maximum levels of all activities combined	3895	5860	950	54	54	31	40	81	92,600	1,482	398	65
ALTERNATIVE 3 Total - Maximum levels of all activities combined	6805	6540	1600	83	83	60	75	150	116,060	2,454	742	106
ALTERNATIVE 4 Total - Maximum levels of all activities combined	9965	6610	1720	113	113	90	105	180	118,570	2,568	792	140

4.2.7 Accidental Exploration Spills

An accidental hydrocarbon spill or release is an event of concern because it has the potential to result in environmental impacts. A hydrocarbon spill can affect environmental, social, and economic resources. For these reasons, it is important to understand the frequency of occurrence and fate for impact assessment purposes. To this end, the frequency of varying sizes of hydrocarbon spills have been estimated using historical data from the U.S. OCS and other offshore oil and gas development regions, and the trajectories of large and very large spill scenarios have been modeled (MMS 2003, 2007, 2008, BOEMRE 2010 a, b; 2011 a, b, c).

For the purposes of the environmental assessment, two types of accidental events during exploration operations are considered – small spills and very large spills. Small spills are likely to occur over the life of exploration activities and are generally 50 bbls or less. Approximately 99% of OCS spills are less than 50 bbl (BOEM 2012). Very large spills are very unlikely to occur during exploration activities and are greater than or equal to 150,000 bbl. Although very large spills are not estimated to occur during exploration activities, Section 4.10 addresses very large spills to inform the decision maker of the impacts of a very unlikely but not impossible very large oil spill.

Small fuel spills associated with the vessels used for G&G activities could occur, especially during fuel transfer. However, there are no reported historical fuel spills from geological or geophysical operations on the Chukchi and Beaufort OCS. Small spills could also occur during exploration drilling operations. A ≤50 bbl spill was estimated to occur during exploration drilling operations from refueling (MMS 2009a, b; BOEMRE 2011a.c). Historical Beaufort Sea and Chukchi Sea OCS exploration spill data suggest that a small spill is likely to occur. Thirty five exploration wells were drilled in the Arctic OCS from 1981-2003. During that time period 35 small spills have occurred spilling a total of 26.7 bbl (of which 24 bbl was recovered). The largest Arctic OCS exploration spill was less than 20 bbl. The most likely cause of a small oil spill during exploration is operational, such as a hose rupture. Estimated ranges for small fuel spill volumes with respect to G&G activities and exploration activities are discussed below and summarized in Table 4.2-8.

Table 4.2-8 Number of respective activities for each activity level and the estimated small spill volume range used for purposes of analysis.

Alternative	Activity	Activity Number Beaufort	Activity Number Chukchi	Small Spill Volume Range (bbl)
2	Seismic or CSEM surveys	4	3	0–<7*
	Exploratory Drilling	1	1	0–100*
3	Seismic or CSEM surveys	6	5	0–<11*
	Exploratory Drilling	2	2	0–200*
4	Seismic or CSEM surveys	6	5	0–<11*
	Exploratory Drilling	4	4	0–400*

*A single small exploratory drilling spill would be ≤50 bbl, and a single seismic or CSEM survey spill would be <1 bbl.

G&G Small Fuel Spill. For purposes of analysis, a seismic vessel transfer spill was estimated to range from <1-13 bb (BOEMRE 2010a, b). The <1 bbl minimum volume represents a spill where dry quick disconnect and positive pressure hoses function properly. The 13 bbl maximum spill volume represents a spill where spill prevention measures fail or fuel lines rupture. For purposes of analysis the lesser volume is used to estimate cumulative spill volumes. Using the maximum volume would overestimate the likely volume spilled at the upper end of the range. Should one fuel hose rupture occur the fate and effects would be similar to the upper range volume.

Refueling spills could range from no fuel spills to one per activity. The estimated fuel spills from maximum anticipated annual levels of geophysical or geological activities for Alternative 2 could range from zero bbl if no fuel spills occur to <7 bbl if every operation refuels, every refueling operation has a fuel spill, and spill prevention equipment functions properly. For Alternatives 3, 4, 5 and 6, small spills could range from zero if no fuel spills occur to <11 bbl if every operation refuels, every refueling operation has a fuel spill, and spill prevention equipment functions properly. Refueling operations for Beaufort Sea operations likely would occur at Prudhoe Bay's West Dock facility, in Tuktoyuktok, Canada, or at sea with the use of fuel supply vessels. Refueling operations in the Chukchi Sea likely would occur at sea with the use of fuel supply vessels.

Exploration Small Fuel Spill. For purposes of analysis, a ≤50 bbl spill was estimated to occur during exploration drilling operations from refueling (MMS 2009a, b; BOEMRE 2011a, b). For Alternative 2 the estimated fuel spills that could occur during exploratory drilling could range from zero if no fuel spills occur to 100 bbl if both exploratory drilling operations have a spill. For alternatives 3, 5 and 6 estimated fuel spills could range from zero to 200 bbl and for Alternative 4 could range from zero to 400 bbl.

Summary. Previous NEPA analyses, such as those for Shell's 2010 and 2012 Exploration Plans (MMS 2009a, b; BOEMRE 2011 a, c), concluded any effects from a 48 bbl spill would be localized and temporary (persisting up to 3 days). At the high end of the range, exploration spills would not overlap temporally or spatially, such that any single spill would likely be ≤50 bbl. Likewise the effects of seven spills <1 bbl (each) or 11 spills <1 bbl (each) cannot reasonably be expected to exceed those of a 48 bbl spill as was analyzed in Shell's 2010 and 2012 Exploration Plan (MMS 2009a, b; BOEMRE, 2011 a, c). Therefore the effects of seven spills <1 bbl (each) or 11 spills <1 bbl (each) would most likely be localized, persisting less than three days.

Given that small spills are low in intensity, temporary in duration, and local in extent, and that small spills would not overlap in time or space, they are analyzed only once for each resource under Alternative 2. Subsequent alternatives 3, 4, 5 and 6 reflect the same level of effect for small spills.

4.3 Mitigation Measures

Mitigation measures associated with this EIS (Appendix A) are placed into two categories for analysis:

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. These measures (e.g. shutdown zones, time/area closures to protect known subsistence uses) have been used consistently in past permits and authorizations.

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

The suite of standard and additional mitigation measures that are analyzed in this EIS are designed specifically to reduce adverse impacts to marine mammals and to subsistence uses of marine mammals. Therefore, the discussion and full analysis of the standard and additional mitigation measures, the degree to which the measures are expected to lessen impacts to the resource, their likely effectiveness, and their practicability for implementation are contained in the marine mammal and subsistence sections of Alternative 2 (Sections 4.5.2.4.15, 4.5.2.4.16, 4.5.3.2.3, and 4.5.3.2.5). As each measure is analyzed independently in this EIS, the additive evaluation and implementation of measures will occur at the MMPA authorization stage. Even though the measures are specifically designed to mitigate impacts to marine mammals and to ensure the availability of marine mammals for subsistence uses, there is the potential for some measures to mitigate impacts to other resources described in this EIS. Sections 4.5.1.7, 4.5.2.7, and 4.5.3.10 contain brief summaries regarding the mitigation measures for the Physical, Biological, and Social Environments.

As discussed in Chapter 2 (Section 2.4.2), NMFS' evaluation of the standard and additional mitigation measures 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) Never be required; or

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

All Additional Mitigation Measures ultimately identified in the Final EIS 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) using the additional detail that will be available once applicants have determined the specific activities that they propose to conduct in a given year and submitted their applications. These measures will be further evaluated using this more specific information to determine the degree to which the measure is likely to reduce impacts to marine mammals or subsistence uses based on the proposed specified activity, the likely effectiveness of the measure, and the practicability of the measure. Some of the types of more specific information that will be used to make the decision of whether to require a given measure include:

- The timeframe, duration, and location of the proposed activity and the spatiotemporal 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).

4.4 Direct and Indirect Effects for Alternative 1 – No Action

Under Alternative 1, NMFS would not issue any ITAs under the MMPA for seismic surveys or exploratory drilling in the Beaufort and Chukchi seas, and BOEM would not issue G&G permits or authorize ancillary activities in the Beaufort and Chukchi seas. There would be no direct or indirect effects to resources as a result of Alternative 1, other than to socioeconomics and land and water use, management, and ownership. Therefore, only these two resources are discussed under Alternative 1.

Over the past several years, there has been a certain level of oil and gas exploration activity permitted by BOEM in the Beaufort and Chukchi seas, with associated MMPA ITAs issued by NMFS. This level of activity is greater than what is associated with Alternative 1 (no activity permitted) but less than what is associated with Alternative 2. The impacts analyzed for Alternative 1 would be less than the status quo for oil and gas exploration activities in the Beaufort and Chukchi seas.

4.4.1 Social Environment

4.4.1.1 Socioeconomics

Offshore seismic activity and exploration drilling is conducted to locate potential commercially recoverable sources of oil and gas. Offshore exploratory drilling is a precursor to oil and gas development and production if potentially commercial quantities of oil are found in a prospect. Alaska OCS development is anticipated to be a significant driver in "the next generation of economic activity by extending the duration of the petroleum industry in the state" (ISER 2009). The Institute of Social and Economic Research (ISER) at the University of Alaska, Anchorage conducted a study for Shell Exploration and Production to estimate the economic impacts of exploration, development, and production in three Alaska OCS areas (Beaufort Sea, Chukchi Sea, and North Aleutian Basin). Based on certain assumptions and production scenarios, ISER concluded that OCS development could offset the decline of petroleum production on state lands on the North Slope.

A number of issues associated with economic development and potential socioeconomic effects were raised during the scoping process. Because of the potential importance of offshore oil and gas development to Alaska's economy, there was interest in the potential for this EIS to result in greater predictability in the issuance of MMPA ITAs. New natural gas production from the Alaska OCS was also perceived to enhance the economic viability of the proposed natural gas pipeline from Alaska to the Lower 48. Also voiced during scoping was the concern that the personal incomes of whaling crews could be negatively impacted because greater deflection of marine mammals could make subsistence activities more expensive.

The following discussion of direct and indirect effects of the Alternatives (which were presented in Chapter 2) describes the nature of the socioeconomic contribution of offshore (including on-ice) seismic and exploratory drilling activities in the Beaufort and Chukchi seas. Based on the nature of these activities, this section describes effects on public revenues and expenditures, employment and personal income, demographic characteristics, and demand on social organizations and institutions.

The analysis of impacts is general in nature because publicly available economic information has not disaggregated the impact of exploration activities from the larger process of development and production nor estimated contributions at a community level. Section 3.3.1.2 provides the best available detailed information regarding employment and personal income in the NSB and NAB.

The level of impacts will be based on levels of intensity, duration, geographic extent, and context, as shown in Table 4.4-1.

Table 4.4-1 Impact Levels for Effects on Socioeconomics

Impact Component	Effects Summary		
Magnitude or Intensity	**Low**: <5% increase or decrease in social indicators	**Medium**: 5% to 10% increase or decrease in social indicators	**High**: >10% increase or decrease in social indicators (such as employment, population, or tourism levels)
Duration	**Temporary**: Changes in social indicators last less than one year	**Long-term**: Changes in social indicators extend up to several years	**Permanent**: Changes in social indicators persist after actions that caused the impacts cease
Geographic Extent	**Local**: Affects a sector of a single community; may alter but does not impair functions of that sector	**Regional**: Affects two or more communities in the region or multiple sectors of a single community	**State-wide**: Affects multiple sectors of multiple communities in the region and/or a single sector of a community outside the region
Context	**Common**: Affects communities that are not minority or low-income	**Important**: Not Applicable	**Unique**: Affects minority or low-income communities

4.4.1.1.1 Direct and Indirect Effects

Public Revenue & Expenditures

Under Alternative 1, there would be no new (or there would be delayed) public revenue sources associated with offshore exploration activities and any subsequent production. There would be no change of expenditures to the public sector from federal, state, or local governments. If Alternative 1 results in no issuance of authorizations or permits by NMFS and BOEM, respectively, then exploratory drilling and new leasing could be delayed or may not occur. Furthermore, if there is no prelease seismic surveying or issuance of MMPA ITAs, potential lessees might not participate in the OCS lease sales as scheduled under the 2012-2017 Program; as a result, revenue from bids and rentals might not be generated.

There is potential corresponding loss in State revenue from foregone taxes, and to the NSB from foregone facility improvements to handle produced petroleum. Because NMFS and BOEM have assumed that no staging activities would occur out of Kivalina or Kotzebue, as such activities have not occurred from those communities in the past, there would be no change to municipal tax revenue for the NAB. Potential production foregone associated with Alternative 1 could result in a decline in domestic production and an increase in the import of fossil fuels from other countries, which would not have the same revenue benefits as production from federal and state waters in the Beaufort and Chukchi seas. Further, potential offshore production would not occur or would be delayed.

Although the likelihood of exploration resulting in production cannot be predicted, and the magnitude is unknown, any production from a successful oil discovery would likely be transported through the Trans Alaska Pipeline System (TAPS). Current TAPS throughput has fallen to one-third its peak flow, and any OCS contribution would extend its commercial life. This would continue state and local royalty oil revenue that otherwise would end immediately upon closure of TAPS. If the inability of NMFS and BOEM to issue authorizations and permits delays offshore leasing and exploration, OCS production could occur too late to contribute to TAPS throughput.

Employment & Personal Income

Alternative 1 would result in lost opportunities for employment and personal income in areas providing support activities in the NSB, NAB, Nome, and Dutch Harbor. This includes lost employment to NSB and NAB residents as PSOs, subsistence advisors, Com Center staff, and spill response personnel. There could also be lost employment and personal income to oil and gas professionals in Anchorage, other parts of the state, and nation as a result of Alternative 1. An example of the number of unrealized jobs can be found in Tables 4.5-23 and 4.5-24.

Demographic Characteristics

Under Alternative 1, the potential for new local jobs associated with exploration activities would be unrealized. However, the small number of local hire positions and short term nature of the work is not enough to cause any outmigration, therefore there would be no change to coastal communities' populations in the Beaufort and Chukchi seas.

Social Organizations & Institutions

Under Alternative 1, there would be no impact on social organizations and institutions because there would be no new revenue moving throughout municipalities, native villages or corporations, and there would be no additional demand for non-governmental organization (NGO) response.

4.4.1.1.2 Conclusion

The general direction of the socioeconomic direct and indirect impacts under Alternative 1 is generally negative, due to unrealized local employment and tax revenue to local, state, and federal governments and the strong probability that at a minimum the federal government would return several billion dollars to the current leaseholders. In terms of local employment and sales tax, the potential impact is low in magnitude because total personal income and local employment rates are not increased by more than five percent. The duration of the local socioeconomic impacts are temporary because it is not year-round. However, the activity is scheduled to occur over a fixed number of years. With regard to potential unrealized revenue for state and federal governments, the likelihood of exploration resulting in production cannot be predicted, and the magnitude is unknown but is likely to be medium to high as only a large discovery would be developed. However, these potential negative economic impacts of the activity are statewide and even nationwide. The context of the socioeconomic impacts, the people that would experience the flow of workers and research vessels, are considered unique Iñupiat communities. Therefore, the summary impact level for socioeconomics is moderate.

4.4.1.2 Land and Water Ownership, Use, and Management

Section 4.1.3 describes the basic significance criteria used to assess direct and indirect impacts throughout this document. For land and water ownership, use and management, impact levels would be derived primarily from the response needed by owners or managers, and whether or not the impacts were perceived as positive or negative. A major adverse impact would be one associated with a forced change in ownership or management that is inconsistent with existing plans and management regulations. It is assumed that, for all action alternatives, existing land use and management is in compliance with current federal and state regulations and existing management plans and is consistent with other land uses. Currently, the BOEM manages oil and gas activities in federal waters, and these activities comply with federal management guidelines. Similarly, ADNR manages oil and gas activities in state waters, and permitted exploration activities comply with state management guidelines. Offshore activities are subject to voluntary compliance with the NSB and the NAB management guidelines. For this section, the basic significance criteria are further refined as described in Table 4.4-2.

Table 4.4-2 Impact Criteria for Land and Water Ownership, Use, and Management

Impact Category	Intensity Type	Definition
Intensity (Magnitude)	Low	Land/water ownership/use or development rights do not change and/or owner need not respond to action in any substantive way; action is substantially consistent with existing land use and management plans.
	Medium	Changes in land/water ownership/use or development rights are minor and/or owner must respond to the action, but response is minor or routine. Action is neither wholly consistent nor wholly inconsistent with existing uses and management plans.
	High	Changes in land/water ownership/use are major and/or owner must respond in substantial ways to the action—change in ownership (condemnation) or substantial change in management– major inconsistency with land management plan that forces amendment of plan.
Duration	Temporary	Land/water use, ownership or management changes do not occur, are expected to be infrequent, or last only a single season.
	Long term	Land/water use, ownership, or management changes may reasonably be expected to convert (or revert) to another use frequently, or extend up to several years.
	Permanent	Land/water use, ownership, or management changes are expected to have a permanent change that would last beyond the life of the plan even if the actions that caused the change 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 supply of land or water for an affected use or management category is extensively available, serves no specialized function and is not identified as having special, rare, protected or unique characteristics in an adopted management plan.
	Important	The supply of land or water for an affected use or management category is moderately available, serves a specialized function but is not identified as having special, rare, protected, or unique characteristics in an adopted management plan.
	Unique	The supply of land or water for an affected use or management category is constrained and is identified as having special, rare, protected, or unique characteristics in an adopted management plan.

Under Alternative 1, NMFS would not issue ITAs under the MMPA for seismic surveys or exploratory drilling in the Beaufort and Chukchi seas. From a land ownership and use perspective, this is characterized as the inability to issue permits and authorizations, as compared to the denial of a permit/authorization based on regulatory review. Alternative 1 would result in leaseholders not being able to drill, and would affect the leaseholders' ability to pursue exploration and discovery of hydrocarbons. This would run contrary to current federal and state management of offshore waters. It would cause some change in activity levels or procedures and affect management plans for land and water in the EIS project area.

4.4.1.2.1 Direct and Indirect Effects on Land and Water Ownership

Federal Ownership

Because BOEM has awarded leases in the Beaufort and Chukchi seas for the purpose of exploring for and developing petroleum resources in the federal OCS, the non-issuance of G&G permits and authorizing ancillary activity by BOEM would prevent leaseholders from pursuing exploration activities in compliance with federal regulations. This would indirectly affect BOEM mandate to manage development of offshore energy and balance economic development, energy indepdence, and environmental protection by constraining activities on leases awarded and represents a high intensity, long-term adverse effect of regional extent. There would be no indirect effect to federal ownership by constraining activities on leases. The federal ownership would be maintained.

State Ownership

The ADNR has awarded leases in the Beaufort Sea for the purpose of exploring for and developing petroleum resources. ADNR could continue to permit activities on leases awarded, but the inability to obtain ITAs from NMFS would prevent leaseholders from pursuing exploration activities if there is the potential for take of marine mammals, as non-compliance with federal regulations could constrain their ability to utilize their leases. This would indirectly affect state ownership by constraining activities on leases awarded and represents a high intensity, long-term adverse effect of regional extent. There would be no indirect effect to state ownership by constraining activities on leases. The state ownership would be maintained.

Private Ownership

The award of oil and gas leases to a private entity is a right to use property and is characterized as a form of private ownership for the purposes of this EIS. The Supreme Court has recognized that "[u]nder OCS Lands Act'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]. The inability of BOEM and NMFS to issue permits and authorizations, as compared to the denial of a permit/authorization based on regulatory review, would prevent leaseholders from pursuing exploration activities on awarded federal and state offshore oil and gas leases in compliance with federal regulations and would constrain their ability to utilize their leases. This represents a high intensity, long-term adverse effect of regional extent on lease awarded to private parties and their exploration rights.

There would be no direct or indirect effects on Alaska Native land ownership from the inability of BOEM and NMFS to issue permits and authorizations.

Borough and Other Municipal Lands

There would be no direct or indirect effects on borough and other municipal land ownership from the inability of BOEM and NMFS to issue permits and authorizations.

4.4.1.2.2 Conclusion

Based on Table 4.4-2 and the analysis provided above, the impacts on land and water ownership under Alternative 1 are described as follows. The magnitude of ownership impacts on federal and state waters is high because major changes in the ability to conduct activities on leases on federal and state waters will result from this action. The duration of impact would be long-term because leaseholders will not be able to utilize leases for exploration of oil and gas resources. The extent of impacts would be regional, covering federal and state leases in the Beaufort and Chukchi seas. The context of impact would be important because the affected federal and state waters are currently available for leasing, and no additional waters would be available for exploration under the characteristics of this alternative. In total, the direct and indirect impacts on land ownership are considered to be major; they are high intensity, long-term, regional, and result in changes of federal, state, and private development rights by effectively preventing exploration for oil and gas resources in compliance with federal regulations.

4.4.1.2.3 Direct and Indirect Effects on Land and Water Use

Recreation

There would be no direct or indirect effects on recreation use from the inability of BOEM and NMFS to issue permits and authorizations.

Subsistence

The inability of BOEM and NMFS to issue permits and authorizations could reduce or eliminate potential conflicts between oil and gas exploration activities and subsistence uses. These conflicts can be mitigated to some degree through plans of cooperation and other measures. For more detail, see Section 4.7.3.2, Subsistence.

Industrial

The inability of BOEM and NMFS to issue permits and authorizations could reduce or eliminate oil and gas exploration activities on existing leases in federal and state waters. This would lead to an overall reduction in ship traffic and the potential for a decrease in or elimination of support activities like crew change and survey preparations in areas such as Prudhoe Bay, Barrow, Wainwright, Nome, and Dutch Harbor. These activities require facilities and structures (e.g. warehouses, repair and maintenance shops) in areas generally zoned for industrial use. A reduction in support activities could create decreased demand for industrial facilities resulting in higher vacancy rates and building underutilization when compared to current levels.

Residential

There would be no direct or indirect effects on residential use from the inability of BOEM and NMFS to issue permits and authorizations.

Mining

There would be no direct or indirect effects on mining from the inability of BOEM and NMFS to issue permits and authorizations.

Protected Natural Lands

There would be no direct or indirect effects on protected land use from the inability of BOEM and NMFS to issue permits and authorizations.

Transportation

The inability of BOEM and NMFS to issue permits and authorizations could reduce or eliminate transportation activities supporting oil and gas exploration activities on existing leases in federal and state waters. This would be reflected in lower numbers of ships, aircraft, and surface vehicles and a reduction in use of affiliated docks, airstrips, and roads. Initially, lower usage would place less maintenance demand on these facilities. However, chronically low usage can have a long term detrimental effect on maintenance and funding priorities resulting in accelerated infrastructure deterioration. Deteriorating infrastructure then impacts the viability of surrounding land uses that rely on it. Transportation uses most likely to be affected would occur primarily in Prudhoe Bay, Barrow, Wainwright, Nome, and Dutch Harbor.

Commercial

The inability of BOEM and NMFS to issue permits and authorizations could reduce or eliminate commercial uses supporting oil and gas exploration activities on existing leases in federal and state waters. This could indirectly affect commercial land use if demand is reduced for the sale of goods and services to support exploration activities. This would reduce the amount of crew and resupply activity in port communities and could impact retail stores, maintenance equipment suppliers, restaurants, taxi services, and similar commercial businesses. A reduction in demand would be reflected in reduced sales and could result in struggling businesses, business closures, and the rezoning of land to other uses. Commercial uses most likely to be affected would occur primarily in Prudhoe Bay, Barrow, Wainwright, Nome, and Dutch Harbor.

4.4.1.2.4 Conclusion

Based on Table 4.4-2 and the analysis provided above, the impacts on land and water use under Alternative 1 are described as follows. The magnitude of use impacts on federal and state waters is high because major changes in the ability to conduct activities on leases in federal and state waters will result from this action, also affecting transportation and commercial uses that support these activities. The duration of impact would be long-term because leaseholders will not be able to utilize leases for exploration of oil and gas resources. The extent of impacts would generally be regional, covering federal and state leases in the Beaufort and Chukchi seas. However, supporting transportation and commercial uses would be affected out of region, in areas that provide support services such as Nome and Dutch Harbor. The context of impact would be important because the affected federal and state waters are currently available for leasing, and no existing or additional waters would be available for exploration under the characteristics of this alternative. In total, the direct and indirect impacts on land use are considered to be major; they are high intensity, long-term, regional, and result in changes of federal, state, and private development rights by effectively preventing exploration for oil and gas resources in compliance with federal regulations. This would be offset to some degree by the potential reduction/elimination in conflicts with subsistence uses in the EIS proposed project area.

4.4.1.2.5 Direct and Indirect Effects on Land and Water Management

Federal Land and Water Management

Because BOEM has awarded leases in the Beaufort and Chukchi seas for the purpose of exploring for and developing petroleum resources in the federal OCS, the inability to issue ITAs and G&G permits and authorizing ancillary activities would prevent leaseholders from pursuing exploration activities in compliance with federal regulations and constrain their ability to utilize their leases. This would indirectly affect federal management by constraining activities on leases and conflicting with the BOEM mandate to manage development of offshore energy and balance economic development, energy indepdence, and environmental protection. This represents a high intensity, long-term adverse effect of national extent.

State Land and Water Management

The ADNR has awarded leases in the Beaufort Sea for the purpose of exploring for and developing petroleum resources. ADNR could continue to permit activities on leases awarded, but the inability to obtain ITAs from NMFS would prevent leaseholders from pursuing exploration activities in compliance with federal regulations and constrain their ability to utilize their leases. This would indirectly affect state management of offshore waters by constraining activities on leases awarded and conflicting with the management objective of allowing oil and gas exploration and development of state waters. Preventing oil and gas exploration and development of the federal OCS would eliminate any oil production that could extend the commercial life of TAPS. This represents a high intensity, long-term adverse effect of statewide extent.

Private Land Management

The inability of BOEM and NMFS to issue permits and authorizations for offshore oil and gas exploration activities could have an adverse effect on management of Alaska Native corporation lands that would provide support for offshore oil and gas activities. This would apply to lands intended to provide support activities primarily in Wainwright, where there has been discussion of developing marine support facilities, and potentially in Barrow.

Borough Land and Water Management

The inability of BOEM and NMFS to issue permits and authorizations for offshore oil and gas exploration activities would reduce or eliminate potential conflicts of exploration activities with NSB and NAB comprehensive plans and Land Management Regulations coastal management policies. However, compliance with Borough Land Management Regulations is undertaken on a voluntary basis for activities occurring on state and federal waters. The Alaska Coastal Management program was not reauthorized by the State legislature in 2011 and is no longer in effect.

4.4.1.2.6 Conclusion

Based on Table 4.4-2 and the analysis provided above, the impacts on land and water management under Alternative 1 are described as follows. The magnitude of management impacts on federal and state waters is high because major changes in the ability to conduct activities on leases on federal and state waters will result from this action and conflict with management objectives. The duration of impact would be long-term because leaseholders will not be able to utilize leases for exploration of oil and gas resources. The extent of impacts would generally be regional, covering federal and state leases in the Beaufort and Chukchi seas, although some changes in land use could occur in support areas out of the region. The context of impact would be important because the affected federal and state waters are currently available for leasing, and no additional waters would be available for exploration under the characteristics of this alternative. In total, the direct and indirect impacts on land and water management are considered to be major; they would be high intensity, long-term, regional, and result in changes of federal and state land and water management by effectively preventing exploration for oil and gas resources.

4.4.2 Mitigation Measures Under Alternative 1

No standard mitigation measures associated with socioeconomics would be implemented under Alternative 1 as no oil and gas exploration activities would occur. Additionally, there would be no additional mitigation measures employed under Alternative 1 as no oil and gas exploration activities would occur.

4.5 Direct and Indirect Effects for Alternative 2 – Authorization for Level 1 Exploration Activity

4.5.1 Physical Environment

4.5.1.1 Physical Oceanography

Physical characteristics of the ocean in the EIS project area are discussed in Section 3.1.1 of this EIS. The discussion in Section 3.1.1 is divided into several sections, with each section focusing on particular physical characteristics of the ocean:

- Water Depth and General Circulation;
- Currents, Upwellings, and Eddies;
- Tides and Water Levels;
- Stream and River Discharge; and
- Sea Ice.

The analysis below discusses the effects of the proposed activities on the physical characteristics of the ocean and potential hazards that may be caused by physical characteristics of the ocean on the proposed activities (i.e. risks to human safety). The analysis of alternatives is structured in a fashion parallel to the discussion of physical oceanography in Section 3.1.1. The level of impacts on physical oceanography will be based on levels of intensity, duration, geographic extent, and context, as shown in Table 4.5-1.

Table 4.5-1 Impact Levels for Effects on Physical Oceanography

Impact Component	Effects Summary		
Magnitude or Intensity	**Low**: Changes in physical characteristics of the ocean may not be measurable or noticeable	**Medium**: Noticeable changes in physical characteristics of the ocean	**High**: Acute or obvious changes in the physical characteristics of the ocean including waves, currents, tides, sea ice
Duration	**Temporary**: Physical characteristics of the ocean would be impacted infrequently but not longer than the span of the project season and would be expected to return to pre-activity states at the completion of the activity	**Long-term**: Physical characteristics of the ocean would be impacted through the life of the project and would return to pre-activity states at some time after completion of the project	**Permanent**: Chronic effects; physical characteristics of the ocean would not be anticipated to return to previous state
Geographic Extent	**Local**: Impacts limited geographically; <10% of EIS project area affected	**Regional**: Affects physical characteristics of the ocean beyond a local area, potentially throughout the EIS project area	**State-wide**: Affects physical characteristics of the ocean beyond the region or EIS project area
Context	**Common**: Affects usual or ordinary physical characteristics of the ocean	**Important**: Affects semi-unique physical characteristics of the ocean	**Unique**: Affects unique physical characteristics of the ocean

4.5.1.1.1 Direct and Indirect Effects

Water Depth and General Circulation

Effects on water depth and general circulation resulting from the activities described under Alternative 2 would be restricted to changes in bathymetry that would result from deposition of material discharged to the seafloor during exploratory drilling programs. Certain permitted materials, including drill cuttings and drilling fluids, would be discharged to the water in the vicinity of the drilling activity (see Section 2.3.3 - Exploratory Drilling Activity Discharges and Emissions). The discharged cuttings and drilling fluids would be composed of a slurry of particles with wide ranges of grain sizes and densities, ranging from liquids and neutrally-buoyant colloids to gravel (Neff 2005). Most cuttings solids would have densities between 2.30 to 2.65 g cm^{-3}, whereas barite (a common component of drilling muds) has a density of 4.3 g cm^{-3} (Neff 2005). As a result of the physical and chemical heterogeneity of typical drill cuttings and drilling fluids, the mixture would undergo rapid fractionation (separate into various components) as it is discharged to the ocean. The larger particles, which represent about 90 percent of the mass of drilling mud solids, would settle rapidly out of solution, whereas the remaining 10 percent of the mass of the mud solids consisting of fine-grained particles would drift with prevailing currents away from the drilling site (NRC 1983, Neff 2005). The fine-grained particles would disperse into the water column and settle slowly over a large area of the seafloor, whereas coarser and denser particles would be deposited on the seafloor within several hundred meters of the point of discharge, forming a mud/cuttings pile that would affect water depths near the drilling site (Figure 4.5-1) (Neff 2005, NRC 1983).

A working definition of a cuttings pile is taken to be “a discrete accumulation of material clearly identifiable as resulting from material discharged from drilling activities, and forming a topographic feature distinct from the surrounding seabed” (adapted from Gerrard et al. 1999).

The distance traveled by discharged particles, and thus, the spatial extent and depth of the cuttings pile would depend not only upon the attributes of the discharged material but also upon the rate and duration of the discharge, the distance between the discharge point and the seafloor, lateral transport of discharged material in the water, turbulence, and local current speeds (MMS 2002, Neff 2005). Modeled distribution and loading of material on the seafloor following discharges of drill cuttings to offshore waters suggests that maximum loading of the seafloor from drilling waste solids would be 64 kg m^{-2}, equating to a depth of about 4 cm (1.6 inches), in an area adjacent to a platform (Smith et al. 2004, Neff 2005). However, cuttings pile heights measured in the North Sea under conditions different from those used in the model are 15 to 19 m (49 to 62ft) for cuttings piles with volumes of 40,000 to 45,000 m^3 (251,592 to 283,041 bbl) (Gerrard et al. 1999, Koh and Teh 2011). Exploratory wells are estimated to discharge about 1,000 m^3 (6290 bbl) of dry solids over the life of the well (NRC 1983). In 2012, the EPA released information regarding the deposition of open water drilling fluid solids in the Beaufort and Chukchi Seas in relation to Shell’s exploration drilling programs on leases in both OCS regions (EPA 2012c, d). In the Beaufort Sea, the maximum deposition for a slower current speed of 0.1 m/s (0.32 ft/sec) occurs from 100 to 500 m (328 to 1,640 ft) from the discharge point while the maximum deposition occurs 800 to 1,400 m (2,624 to 4,600 ft) from the discharge point for a higher current speed of 0.3 m/s (1 ft/sec) (EPA 2012c, d). Current speeds in the Beaufort and Chukchi seas can exceed 0.3 m/s. Additional information can be found in the EPA’s evaluations (2012c, d).

The overall effect of material discharged from exploration wells on water depth in the proposed action area would depend on the characteristics of the discharged material, the rate and duration of the discharge, the distance between the discharge point and the seafloor, lateral transport of discharged material in the water, turbulence, and local current speeds (MMS 2002, Neff 2005). Changes in water depth from discharged material would have only minor effects on the physical resource character of the proposed action area. Those effects would be low-intensity, permanent, and would affect a common resource as defined in the impact criteria in Section 4.1 of this EIS.

Currents, Upwellings, and Eddies

Seismic surveys, site clearance and shallow hazards surveys, and on-ice seismic surveys would have only negligible effects on currents, upwellings, and eddies within the proposed action area.

Construction of artificial islands, which could occur in nearshore state waters of the Beaufort Sea at a rate of one island per year under Alternative 2, would result in medium-intensity, permanent, localized effects on nearshore currents in the waters adjacent to the artificial islands. Over the life of this EIS, those effects would be minor and would occur only if artificial islands are constructed to support exploratory drilling activities. Use of drillships or jackup rigs in deeper state and federal waters would be temporary in nature and have only a seasonal presence of extremely limited size and geographic distribution, and would have negligible effect on currents, upwellings, and eddies within the proposed action area.

Tides and Water Levels

The activities described under Alternative 2 would be temporary in nature and would have only a seasonal presence of extremely limited size and geographic distribution, and would not affect tides or water levels within the proposed action area.

However, wind, waves and storm surge would potentially impact seismic and exploratory drilling activities, and could influence human safety as a result of the activities described under Alternative 2.

Stream and River Discharge

The activities described under Alternative 2 would occur in marine waters and would generally not affect stream and river discharge within the proposed action area. Exploratory drilling in state waters on grounded ice could occur from manmade reinforced ice "islands," but would have negligible effects on stream and river discharge within the nearshore portion of the proposed action area.

Sea Ice

Seismic surveys and site clearance and shallow hazards surveys conducted during the open water period would not affect sea ice in the proposed action area.

Icebreaking activities and thermal inputs associated with in-ice seismic surveys and exploratory drilling activities in the Beaufort and Chukchi seas would result in noticeable changes in the character of the sea ice in the vicinity of the icebreaking activity. However, the effects of icebreaking activities would be temporary as seawater exposed to the air as a result of icebreaking activities would freeze within hours of the activity, effectively replacing the broken ice. Repeated icebreaking within a given channel may lead to formation of 'brash ice' and an overall thickening of ice within the channel (Ettema and Huang 1990). Icebreaking activity would have medium-intensity, temporary, and local effects on sea ice. These effects would be minor and would affect a common resource.

On-ice seismic surveys involving truck-mounted vibrators would have minor effects on sea ice within the proposed action area. On-ice vibroseis operations would require stable sea ice at least 1.2 m (3.9 ft) thick. Such surveys would generally occur only between January and May over landfast ice or stable pack ice near the shore. Noticeable changes to the character of the ice would result from marking the ice in order to designate source receiver locations and from construction of snow ramps to smooth rough ice within the survey area. The effects of these activities on sea ice would be medium-intensity, local, temporary, and would affect a resource that is common in the proposed action area.

Construction of ice islands, which could occur in nearshore state waters of the Beaufort Sea under Alternative 2, would result in medium intensity, temporary, localized effects on sea ice in state waters of the Beaufort Sea. These effects would be minor, and would occur only if artificial islands are constructed to support exploratory drilling activities.

The presence of sea ice in lease and non-lease areas targeted for open water seismic exploration and exploratory drilling could result in changes to the schedule, location and duration of exploratory activities. The presence of ice also represents a potential hazard to vessels and exploratory drilling platforms. Industry operators in offshore areas have developed procedures for managing sea ice, including changes to schedule, vessels dedicated to ice management, and procedures for taking drilling platforms off location until potential hazards subside.

In-ice and on-ice seismic exploration activities could experience similar and additional hazards from sea ice, including the potential for ice override events. On-ice exploration activities have established protocols for response to potential ice hazards. Moving ice is not expected to impact drilling on artificial ice islands, but storm surge and ice override events could have potential effects. Within the Beaufort Sea, where drilling on artificial ice islands could occur in state waters, much of the area is protected from ice override by barrier islands. Individual drilling operations would need to assess the potential for ice related hazards and develop appropriate design and operation protocols. In-ice exploration activities would use an ice breaker for the purpose of ice management and have established protocols for response to potential ice hazards.

<u>4.5.1.1.2 Conclusion</u>

The overall effects of Alternative 2 on physical ocean resources would be of medium intensity, temporary, local, and would affect common resources as defined in the impact criteria in Section 4.1 of this EIS. The overall direct and indirect effects of the proposed level of activity described in Alternative 2 on physical ocean resources in the EIS project area would be minor.

4.5.1.2 Climate

The Intergovernmental Panel on Climate Change (IPCC) (2007) reports the Alaskan Arctic has reacted to changes in climate over the past century. Emissions of greenhouse gases (GHGs) around the world are believed to be one of several factors driving the changes, which are attributed to atmospheric warming of the Earth's climate and referred to as the greenhouse effect. As a result, the Council on Environmental Quality (CEQ) has provided draft guidance for consideration of climate change when proposed federal actions are evaluated under NEPA (CEQ 2010). Following this guidance, NMFS finds the proposed action and alternatives have the potential to emit GHGs into the atmosphere in quantities that may be meaningful to an evaluation of climate change. Consequently, GHG emissions due to the proposed action and alternatives are quantified and discussed with respect to the potential contribution to climate change. Greenhouse gas emissions are also discussed relative to the relationship to (or affect on) the proposed action and alternatives.

The GHGs that EPA regulates under the Clean Air Act are, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). The combustion of fossil fuels, such as diesel and gasoline, is responsible for the majority of GHGs. For example, when burned, a gallon of regular diesel fuel produces 22.4 pounds of CO_2, and burning a gallon of regular gasoline (with 10 percent ethanol) produces 17.7 pounds of CO_2 (BP, 2005; EIA, 2012). Because the overwhelming majority of GHG emissions from the combustion of fossil fuels are CO_2, emissions, the other GHGs are typically reported in terms of equivalency to the global warming potential (GWP) of CO_2. As such, total GHG emissions are referred to collectively as "CO_2 equivalent" emissions, or CO_2e.

Refer to Section 3.1.4.4 (*Climate Change in the Arctic*) for a thorough discussion of climate systems.

<u>4.5.1.2.1 Direct and Indirect Effects</u>

Direct effects contributing to climate change would occur as a result of CO_2e emissions caused by the drilling and seismic vessels proposed to be used under this alternative. Indirect effects occur due to the operation of vessels and aircraft in support of the proposed activities but are separated from the original project in either time or space. In addition, the sources identified as causing indirect effects are those that remain under practical control and responsibility of the operator, assuming the effects can be quantified.

Direct Effects

Direct effects contributing to climate change under this alternative would occur from CO_2e emissions occurring during operation of engines used to power the drillships, drilling units, seismic vessels, and all other onboard engines and generators necessary to operate the vessels and equipment. The engines are powered by diesel oil, a fuel produced from a fossil source of carbon that when burned adds CO_2e emissions to the biosphere contributing to climate change.

Indirect Effects

Indirect effects to resources under this alternative that have the potential to contribute to climate change are emissions of CO_2e from the operation of crew boats, supply vessels, icebreaker vessels, aircraft, and other support vessels needed to complete and protect the activities and programs proposed under this alternative. The owner or operator would have an oversight role in these activities and would have the authority to limit or otherwise control operations of the vessels and hence the emissions. The activities proposed under this alternative, which include EPs and seismic surveys, do not include removal or extraction of any product of drilling. Therefore, potential emissions from the transport of raw materials, refining the oil and gas product, usage of oil and related products, or the manufacturing of plastic products and asphalt from crude oil is not considered under this or any other alternative in this EIS.

Regulatory Reporting and Permitting

The EPA established the portion of the Greenhouse Gas Reporting Rule that applies to petroleum and natural gas systems in 2010 (75 FR 74458, November 30, 2010). Established at 40 CFR Part 98, Subpart W, the EPA requires the owner or operator of certain stationary facilities to report potential emissions of CO_2e that is expected to equal or exceed 25,000 metric tons per year (metric tpy). The EPA finalized the last step to the phase-in approach to permitting emissions of CO_2e under the Clean Air Act effective on August 13, 2012 (77 FR 41051, Jul. 12, 2012). Under the last step, certain new and existing stationary industrial facilities identified by the EPA with CO_2e emissions that equal or exceed 100,000 metric tpy must obtain an operating permit under Title V of the Clean Air Act. The data are used by EPA to implement the Clean Air Act Section 103(g) regarding improvements in strategies and technologies for preventing or reducing air pollutants, and to inform policy-makers on possible regulatory actions to address and reduce CO_2e emissions. The rule, as it applies to the oil and gas industry, pertains only to the extraction of crude petroleum and natural gas, the transportation by pipeline of natural gas, and natural gas distribution facilities. Consequently, the activities and programs proposed under this alternative are not subject to the EPA Greenhouse Gas Reporting Rule and a permit is not required. However, reporting the total potential emissions of CO_2e should be disclosed in any environmental review under the NEPA..

CO_2e Emissions Inventory

Under this alternative several programs and activities are proposed including exploration plans, multiple seismic surveys (some including an icebreaker vessel), shallow hazards surveys, and on-ice seismic surveys plans within the U.S. Chukchi and Beaufort seas. The specific description and number of each of these programs and activities proposed for the U.S. Chukchi and Beaufort seas, on an annual basis, were summarized earlier in Table 2.4 (*Activity Definitions*) and Section 2.4.5 (*Alternative 2 – Authorization for Level 1 Exploration Activity*). The estimated potential annual emissions of CO_2e for each type of activity and program proposed under this alternative are provided in **Table 4.5-2**. The data in this table assume no controls to reduce emissions.

Effects of this Alternative on Climate Change

Existing climate models are not refined enough to accurately predict changes in the climate within the timeframe considered under this EIS. This is because climate change resulting from CO_2e emissions occurs many years, often decades, after the emissions are generated and in locations far from the point of emission. Given the uncertainty of existing climate change models, it is not feasible to determine the effect of this alternative to such a degree that measurable consequences can be defined over a relatively short period of time (120-day drilling season or 76-day survey). Nonetheless, the potential impact of contributions to the CO_2e emission budget, particularly in the Arctic, is recognized as a concern by the EPA. Therefore, total annual CO_2e emissions will be reported for activities and programs once specific project details are proposed and available under this alternative.

Table 4.5-2 Estimated CO_2e Emissions by Activity and Program Type for the Arctic OCS

Activity/Program Types	Chukchi Sea OCS Annual CO_2e Emissions (metric tons per year)
2D/3D Seismic Survey (including one survey using an ice breaker vessel)	44,761
Site Clearance and High Resolution Shallow Hazards Survey Program	7,435
Exploration Plan	93,007
Total	**145,203**
Activity/Program Types	**Beaufort Sea OCS Annual CO_2e Emissions** (metric tons per year)
2D/3D Seismic Survey (including one survey using an ice breaker vessel)	58,405
Site Clearance and High Resolution Shallow Hazards Survey Program	7,435
On-Ice Seismic Survey	25
Exploration Plan	93,007
Total	**158,872**

Sources: EPA. October 1996. Compilation of Air Pollutant Emission Factors (AP-42) 5th ed., Volume I, Chapter 3, Table 3.3-1 and Table 3.4-1.
EPA. July 2010. Median Life, Annual Activity and Load Factor Values for Nonroad Engine Emissions Modeling (EPa-420-R-10-016, NR-005d).
BOEM. 2012. ION Seismic Survey.
EPA. 2012. EPA and NHTSA Set Standards to Reduce GHG and Improve Fuel Economy for Model Years 2017-2025 Cars and Light Trucks. Table 1. http://www.epa.gov/oms/climate/documents/420f12051.pdf

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Effects of Climate Change on Resources under this Alternative

Warming of permafrost could affect the ability and timeframe for moving large, heavy equipment over frozen tundra to the EIS project area. Keeping in mind that warming in the Arctic that could potentially impact environmental resources within the next five years would not be the result of the alternative, but from emissions worldwide within recent decades. The decrease in sea ice thickness and extent could affect timing and location of in-ice seismic and on-ice vibroseis surveys, as well as extend the season for drilling activities requiring ice-free conditions. The types of conditions that could affect activities under this alternative may require unique planning and engineering but are not expected to adversely affect the implementation of this alternative.

4.5.1.2.2 Conclusion

Direct and indirect impacts associated with climate are associated mainly with potential emissions of CO_2e that could, decades from now, contribute to changes in the environmental conditions already occurring in the Arctic and throughout the world. As such, the impacts to climate change cannot be measured on a project-level basis and instead are global in scope. However, data provided in Table 4.5-2 should be disclosed in NEPA documentation.

While there is no mandatory reporting or permitting required for CO_2e emissions that could potentially occur under this alternative, the contribution of CO_2e emissions should be reported in the environmental review to disclose potential contributions to climate change.

To control the degree of climate change taking place around the world, federal agencies, owners, and operators of CO_2e emission sources may use alternative fuels or after-market emission-reduction devices. Emissions of CO_2e and sulfur dioxide are reduced to some extent by the use of ultra-low sulfur diesel fuel, which is mandatory in Alaska for both on-road and non-road (including marine) diesel engines (71 FR 32450, June 6, 2006). Ultra-low sulfur diesel (ULSD) is diesel fuel containing a maximum of 15 parts per million (ppm) of sulfur; whereas regular diesel fuel had sulfur levels up to 3,000 ppm (EPA, 2012). In addition to sulfur emissions, using ULSD fuel would reduce fine particle emissions ($PM_{2.5}$), nitrogen oxides (NO_x), hydrocarbons (HC), and carbon monoxide (CO) emissions in diesel exhaust; the greatest emission reduction would occur in a 2007 or newer model-year engine. However, most of the engines used to power the ships for drilling and surveys under this alternative are likely to be pre-2007 models. Using ULSD fuel in older engines will not harm the engines and the degree of emission reduction would be less, nevertheless there would still be some reduction in emissions.

To increase emission reductions in older engines while using ULSD fuel, operators may invest in diesel retrofits, which are control devices that can be installed after-market on older engines. These devices can reduce emissions of criteria pollutants and VOCs. Use of the emission reduction devices that lead to improved engine performance and fuel economy, such as the Selective Catalytic Reduction device that reduces emissions of NO_2, also reduces emissions of CO_2e.

4.5.1.3 Air Quality

Activities associated with oil and gas exploration work that have the potential to affect air quality include: seismic surveys, site clearance and shallow hazards surveys, other various surveys (e.g. on-ice vibroesis and electromagnetic surveys), and exploratory drilling. A list of typical equipment used for these activities is provided in Table 2.2 *Summary of Typical Support Operations for Exploration Activities*, and includes survey vessels, diesel-fired power generating equipment needed for drilling and miscellaneous support activities, and various other vessels used in support of these survey and drilling activities (e.g., tugboats, supply boats, icebreakers, crew boats, oil spill response vessels, and aircraft). The majority of air emissions from these activities are due to fuel combustion used to power vessel propulsion and power generation. The federal and state regulated air pollutants that are associated with this alternative are summarized in Table 3.1-4 *Federal and State Ambient Air Quality Standards*, which is based on the National Ambient Air Quality Standards (NAAQS). The criteria pollutants mainly associated with combustion of diesel fuel include:

- CO – carbon monoxide,
- PM_{10} – coarse particulate matter,
- $PM_{2.5}$ – fine particulate matter,
- SO_2 – sulfur dioxide,
- NO_2 – nitrogen dioxide, and
- Pb – lead.

Also under consideration are emissions of volatile organic compounds (VOCs), not a criteria pollutant, but a precursor to the development of O_3; therefore, VOC is a regulated pollutant under other rules rather than the NAAQS. Fuel combustion releases lesser amounts of ammonia (NH_3) and reduced sulfur compounds (RSC) depending on fuel characteristics and applied control technologies, if any are used. While not specifically evaluated, the activities proposed under this alternative may release a limited amount of fugitive emissions from storage tanks (i.e. VOCs) and potential associated onshore activities (i.e. emissions of PM).

4.5.1.3.1 BOEM Air Quality Regulatory Program (AQRP)

Jurisdiction to authorize air emissions on the Arctic OCS was the responsibility of the EPA beginning in 1990 until amendments to the Clean Air Act Section 328 were enacted on December 23, 2011, through the Consolidated Appropriations Act, 2012 (Public Law [Pub. L.] 112-74). The signing of Pub. L. 112-74 transferred the jurisdiction for emission source control from the EPA to the Department of Interior, BOEM Alaska OCS Region (AOCSR), for the U.S. Beaufort Sea and Chukchi Sea OCS Planning Areas adjacent to the Alaska North Slope Borough (Arctic OCS) (Consolidated Appropriations Act, 2012). The authority supporting the restored jurisdiction is granted under Section 5(a)(8) of the OCS Lands Act, and the control procedures are structured under the BOEM Pollution Prevention and Control regulations (30 CFR Part 550 Subpart C). The other Alaska OCS Planning Areas remain under EPA jurisdiction by authority granted under the Clean Air Act Section 328 and regulated pursuant to 40 CFR Part 55. However, Pub. L. 112-74 did not change the jurisdiction of the State of Alaska Department of Environmental Conservation (ADEC). All actions within three miles of Alaska's coast remain within the jurisdiction of the ADEC and may require state air quality operating permits.

The BOEM Air Quality Regulatory Program (BOEM AQRP), which now applies to the Arctic OCS, requires a unique evaluation of emissions generated by individual stationary facilities on the OCS. The BOEM AQRP applies only while facilities are securely attached to the sea floor, regardless of whether the sources are permanent or temporary. The objective of the BOEM AQRP is to ensure that onshore effects from offshore drilling activities will be inconsequential (i.e. negligible) (47 FR 15128, March 7, 1980). To achieve this objective, the BOEM AQRP requires control of stationary-source emissions on the OCS only when the emissions are shown to have significant effects on the air quality of an onshore area. Emission controls refer to mechanical devices such as selective catalytic reduction (SCR) devices. Emission reduction strategies include operational modifications such as limiting operational hours or fuel use. The BOEM AQRP is not applicable to geophysical seismic surveys, shallow hazards surveys, and on-ice seismic surveys, as all emission sources for these surveys are mobile marine vessels. The BOEM AQRP applies only to stationary sources on the OCS, meaning drilling units that are securely attached to the sea floor (including drillships, drill rigs, and platforms).

Under the BOEM AQRP, the AOCSR requires emission control strategies only for stationary sources on the Arctic OCS under specific conditions. Referred to as "facilities," the stationary sources would include drill rigs, drillships, and platforms only while securely attached to the seafloor. Facilities with annual emission rates (tons per year) that do not exceed the calculated emission exemption thresholds are excused from further review and possible additional analysis under the BOEM AQRP (30 CFR 550.303(d)). The calculations for the emission exemption thresholds are based on the distance of the facility from the nearest onshore area. The exemption thresholds serve as a screening tool to eliminate from further review those facilities which will have no significant effect on the air quality of any onshore area. The BOEM AQRP does not assign exemption rates for emissions of CO_2e. The emission exemption threshold equations are in the form:

$$E = k * (d^{n})$$

where, E is the annual emission exemption threshold rate expressed in tons per year, and *d* is the distance between the facility and the nearest onshore area of the State, expressed in statute miles, and measured from the facility to the mean high water mark onshore; *n* is the pollutant-specific exponent, and k is the pollutant-specific constant, such that:

$E = 3400(d^{2/3})$ for CO emissions

$E = 33.3d$ for emissions of each, TSP, SO_2, NO_x, and VOC

Source: 30 CFR §550.303(d).

If not exempt, lessees would be required to conduct an air quality impact analysis (i.e. dispersion analysis) to compare facility-specific pollutant concentrations predicted to occur on the nearest onshore area to the EPA Significance Impact Levels (EPA SILs) published at 40 CFR 51.165(b)(2) and adopted under the BOEM AQRP at 30 CFR 550.303(e) as the "Significance Levels: Air Pollutant Concentrations" (SLs). Projects that exceed any of the EPA SILs on the shore are considered to cause, or contribute to, a violation of a national ambient air quality standard and thus generate a potentially significant air quality effect onshore. Conversely, onshore concentrations from a facility that are equal to or less than the EPA SILs are considered to be *de minimis* by the EPA and BOEM (i.e. negligible impact). Should the air quality impact analysis demonstrate that the onshore effects would exceed one or more of the EPA SILs, the application of BACT would be required to reduce emissions of the relevant pollutant(s). Note that significant effects from emissions of VOCs cannot be discerned through a dispersion analysis. When VOC emissions are not exempt, control technology and other strategies would be applied in lieu of a dispersion analysis.

No air quality permit is issued or required under the BOEM AQRP; rather, the AOCSR, Office of Environment, would conduct a critical appraisal of the air quality information provided in an EP, or other drilling plan, for compliance with the BOEM AQRP. None of the exemption thresholds may be exceeded if the emissions from the facility are to be considered exempt from further review under the BOEM AQRP. Should the appraisal result in such an affirmative finding of compliance with the BOEM AQRP, the AOCSR, Office of Leasing and Plans, would be notified that emissions from the facility are compliant, and the emissions would be authorized upon approval of the overall plan. Should the appraisal result in an affirmative finding of compliance only when BACT or other emission controls are applied, the use of control strategies for the sources and pollutants exceeding the thresholds would be enforced by BSEE AOCSR, and the emissions would be authorized upon approval of the overall plan by the AOSCR, Office of Leasing and Plans.

When a drillship is anchored at a position where any one or more of the exemption thresholds (excluding VOC) is exceeded, the lessee must perform computer dispersion analysis to disclose the air quality impact of that pollutant on the nearest onshore area. The results of the dispersion analysis would be compared to the EPA SILs to determine whether emissions from the facility would likely have a significant air quality effect onshore (40 CFR 51.165(b)(2) and 30 CFR §550.303(e)). The EPA SILs are provided in Table 4.5-3.

A finding that emissions from the facility would not exceed the exemption thresholds indicates the facility would not likely produce onshore ambient air pollutant concentrations above the EPA SILs, no emission controls or control strategies would be required, and the projected emissions would not have the potential to cause or contribute to a significant air quality effect onshore. If dispersion modeling indicates the project would generate emissions that exceed any of the EPA SILs, the lessee must apply BACT to reduce the emissions from the facility. When drilling operations proposed in an EP are not expected to continue in the same location for more than three years, the emissions from the facility are considered temporary, and no further analysis beyond the application of BACT is required under the BOEM AQRP for a temporary facility. Exploratory drilling on the Arctic OCS is conducted only during a summer ice-free season of approximately 120 days (30 CFR Part 550.302).

Table 4.5-3. EPA Significance Impact Levels

Air Pollutants and Averaging Periods	Pollutant Concentrations (μg/m^3)
SO_2	
Annual	1
24-hour	5
3-hour	25
1-hour [1/]	7.80
$PM_{2.5}$ [2/]	
Annual	0.3
24-hour	1.2
PM_{10} [3/]	
24-hour	5
NO_2	
Annual	1
1-hour [4/]	7.53
CO	
8-hour	500
1-hour	2,000

Note: Data in this table is valid for EPA significant impact levels (SILs) at 40 CFR 51.165(b)(2), including the interim values (*see* 1/ and 4/ below), which are not exactly the same as the data for significance levels published under BOEM's 30 CFR 550.303(e) in the early 1980s. Should the BOEM adopt or require the updated EPA SILs, the data in this table would apply.
μg/m^3 is micrograms of pollutants per cubic meter of air.
SO_2 is sulfur dioxide.
PM_{10} and $PM_{2.5}$ are coarse and fine particles, respectively.
NO_2 is nitrogen dioxide.
VOC is volatile organic compounds.
CO is carbon monoxide.

1/ EPA Office of Air Quality Planning and Standards. Aug. 23, 2010. Memorandum to Regional Air Division Directors, from Stephen D. Page, Director, Office of Air Quality Planning and Standards, stating interim 1-hour average SO_2 "significant impact level" (SIL) for 40 CFR 51.166 and 40 CFR 52.21 is 4 percent of the 1-hour average concentration of SO_2 NAAQS (ie. 75 ppb) or 7.80 μg/m^3. An air quality effect at or below the SIL is *de minimis* in nature and would not cause a violation nof the NAAQS.

2/ Table published at 30 CFR Part 550, Subpart C [30 CFR 550.303(e)] provides "total suspended particles" (TSP) instead of the updated PM_{10} and $PM_{2.5}$ standards.

3/ 71 Federal Register 61144, Oct. 17, 2006; effective Dec. 18, 2006. Revoke annual PM_{10} standard.

4/ EPA Office of Air Quality Planning and Standards. Jun. 28, 2010. Memorandum to Regional Air Division Directors, from Anna Marie Wood, Acting Director, Air Quaity Policy Division, stating interim 1-hour average NO_2 "significant impact level" (SIL) for 40 CFR 51.166 and 40 CFR 52.21 is 4 percent of the 1-hour average concentration of NO_2 NAAQS (ie. 100 ppb) or 7.53 μg/m^3. An air quality effect at or below the SIL is *de minimis* in nature and would not cause a violation nof the NAAQS.

Source: 40 CFR 51.165(b)(2).
30 CFR §550.303(e) *Significance Levels*.

4.5.1.3.2 Direct and Indirect Effects

The assessment of direct and indirect air quality effects that may potentially occur as a result of implementation of an OCS EP or to conduct seismic surveys requires consideration of provisions under NEPA, the Clean Air Act, and the OCS Lands Act. Under NEPA, an inventory is created to disclose total emissions likely to occur as a result of the proposed alternative. The total emission inventory would include an accounting of emissions from all reasonably foreseeable sources, including mobile and stationary, land, sea, and air, and temporary and permanent emissions—all emissions that would occur only through the implementation of the proposed alternative. Based on the annual emission rate (expressed in tons per year), the inventory may be translated into pollutant concentrations (expressed as micrograms per cubic meter, $\mu g/m^3$) using an EPA-approved computer dispersion model to discern the onshore effect of the proposed alternative. The results of the computer dispersion modeling would be compared to the NAAQS, together with the background concentrations, as required under the Clean Air Act.

Emission Inventory

Emission inventories measure the total rate of direct and indirect emissions from a proposed action and are the first step in identifying potential air quality effects of a proposed alternative. The emission inventory is also the basis for dispersion analysis, when needed, that measures the actual air quality effect on the nearest onshore areas, including potentially affected communities on the North Slope. Regulated pollutants that are considered in the emission inventory include:

- CO,
- PM_{10},
- $PM_{2.5}$,
- SOx – sulfur oxides that include emissions of SO_2,
- NO_x – nitrogen oxides that include emissions of NO_2,
- VOC, and
- CO_2e – carbon dioxide equivalent emissions.

Preparing an inclusive emission inventory for each proposed alternative requires operational information for all the marine engines and equipment sources of the pollutants listed above. As no specific project or plan is proposed under the alternatives of this EIS, the inventories provided in this section reflect emissions from sources likely to be engaged in an EP or seismic survey plan. Likely sources include the drilling unit for the EP (i.e. drillship), survey vessels, and support vessels for monitoring, crew change, ice-management, oil-spill-response equipment, fuel barges, and aircraft (helicopter and fixed-wing). The varied use of these sources will be specific to actual operations proposed for an action, and the operational specifics will modify the emission inventory presented in an EIS or EA. Operational specifics include vessel transit speeds, which are highly variable, and range from 8 knots to 20 knots depending on the operational need, vessel's design, the sea state, ice conditions, local meteorology, length of the operation, and choice and design of drilling units and survey vessels.

Exploration Plan Emission Inventory. An inventory of emissions likely to occur from the implementation of the EP under the proposed alternative was prepared using information available for recent EPs submitted to BOEM AOCSR by lessees proposing similar activities. A summer drilling season on the Arctic OCS for an EP was assumed to be 120 days throughout the ice-free period from July through the end of October. The inventory methodology conservatively assumes operation of the drilling unit for 24 hours each day for the entire 120 days.

The emission rates likely to occur as a result of implementation of one EP, where one EP is proposed for the U.S. Chukchi Sea OCS and one EP for the U.S. Beaufort Sea OCS are presented in **Table 4.5-4**.

The inventory assumes no application of BACT or the use of ultra-low-sulfur diesel (ULSD) fuel and so would be considered a conservative estimate of projected emissions for one EP occurring during one drilling season of 120 days. The emission inventory presented in Table 4.5-4 assumes the lessee proposes each EP would use a drillship with a maximum horsepower of 61,800 (157.2 MMBTU/hr), estimated using the BOEM Maximum Emissions Estimates for Rig and Drillship Types provided by BOEM Gulf of Mexico Region (GOMR). The emissions from the drillship and support vessels were calculated using the Form BOEM-0138 as provided by the GOMR (BOEM, 2011). Aircraft emissions includes both helicopter and fixed-wing aircraft. Emissions from aircraft were estimated using the Federal Aviation Administration (FAA) Emissions and Dispersion Modeling System (EDMS v 5.1.3) (FAA 2010).

Table 4.5-4. Estimated Annual Emission Inventory of an Exploration Plan

Pollutant Sources	One (1) Exploratory Drilling Program and Annual Emissions for One Drilling Season (tons per year)					
	PM	**NO_X**	**SO_2**	**CO**	**VOC**	**CO_2e***
Drill Rig	62.73	2,156.20	1.08	470.40	64.69	18,184
Ice Breakers (2 vessels each EP)	48.20	1,659.40	0.84	362.00	49.78	36,369
Anchor Handler	11.20	156.10	0.06	33.80	12.50	455
Oil Spill response Barge	24.10	829.70	0.42	181.00	24.89	18,184
Oil spill Response Tug	11.20	156.10	0.06	33.80	12.50	455
Tank Vessel for Spill Storage	24.10	829.70	0.42	181.00	24.89	18,184
Support Vessels (3 vessels each EP)	33.60	468.30	0.18	101.40	37.50	1,176
Aircraft	0.001	0.05	0.21	8.06	3.28	**
Total	**215.1**	**6,255.6**	**3.3**	**1,371.5**	**230.0**	**93,007**

Notes: SO_x (sulfur oxides) includes emissions of sulfur dioxide (SO_2).
NO_x (nitrogen oxides) includes emissions of nitrogen dioxide (NO_2).
PM (particulate matter) includes emissions of coarse and fine particulate matter (PM_{10} and $PM_{2.5}$).
VOC is volatile organic compounds.
CO is carbon monoxide.
CO_2e (carbon dioxide equivalent) is a combination of emissions of the six most common greenhouse gases expressed as a rate in relation to the global warming potential of CO_2.
*CO_2e is expressed in metric tons; all other data are given in units of short tons.
** No information on CO_2e emissions is available from EPA for aircraft.
Sources: BOEM, Alaska OCS Region. 2012.

Survey Emission Inventory. An inventory of emissions likely to occur from operations throughout seismic, on-ice, and shallow hazards surveys was prepared using information developed for the 2012 ION Seismic Survey EA (USDOI, BOEM, 2012), which for each survey assumed a research survey vessel with gross tonnage of approximately 3,500 tons. The survey was conservatively assumed to occur over a period of 76 days, operating 24 hours each day. The annual emission rates likely to reflect the multiple surveys proposed under this alternative for the Arctic OCS are presented in **Table 4.5-5** and **Table 4.5-6**.

Greenhouse Gases and Hazardous Air Pollutants

In addition to the pollutants regulated under the BOEM AQRP, emissions of greenhouse gases (GHGs) and hazardous air pollutants (HAPs) occur as a result of the operation of diesel-powered vessels supporting oil and gas activities on the OCS. Because of the change in jurisdiction under Pub. L. 112-74, GHG and HAP emissions are no longer reported to the EPA through the Clean Air Act Title V or Prevention of Significant Deterioration (PSD) permitting processes. The BOEM does not require reporting these emissions as a condition of EP approval. It is, therefore, the independent responsibility of the lessee to coordinate with the appropriate EPA office to arrange and comply with mandatory reporting of GHG and HAP emissions, including any permits for GHG emissions that exceed 100,000 tons per year under the Prevention of Significant Deterioration (PSD) Tailoring Rule (77 FR 41051, Jul. 12, 2012) or for HAPs under Section 112 of the Clean Air Act. Should a State of Alaska air permit be required, which would only occur if a lessee proposed a drilling location within the three-mile State boundary, an accounting of ammonia (NH_3) emissions and reduced sulfur compounds (RSC) may be required. The BOEM does not regulate emissions of NH_3 or RSC. Therefore, the lessees would be expected to coordinate independently with the ADEC to arrange and comply with mandatory reporting of NH_3 and RSC emissions.

Applications for State air quality permits, if required, are not included as part of this EIS. State air quality permits on the Arctic OCS are only required when a lessee proposes a drilling location within three miles of shore, which are considered State jurisdictional waters. Details regarding air permit actions (type and schedule), along with specific source/equipment applicability, will be determined once a project alternative has been selected and specific project details are known.

Fugitive Emissions and Oil Spills

Potential fugitive emissions from fuel storage tanks on vessels are not included in this EIS assessment and would be expected to have a minor impact at the facility and an even lower impact onshore. However, fugitive emissions may need to be inventoried in connection with a State of Alaska air permit, if one is required.

There are no regular activities associated with the proposed alternative that would generate fugitive dust, as most activities would occur over open water. In the event of temporary onshore activities that may generate dust, measures would be taken to reduce fugitive dust. Neither of these localized or onshore occurrences is expected to vary with the proposed alternatives; therefore, no evaluation of these pollutant sources is provided in this analysis.

There is the potential for oil spills from drilling failure or equipment leaks under the proposed alternative. Although these emissions are unplanned, oil spills have the potential to impact air quality due to the hydrocarbon volatilization, in-situ burning of spilled fuel, and the operation of additional vessels and equipment for clean up and restoration. The use of oil spill response vessels as a precaution is included in the emissions estimates for the proposed alternative. Fugitive emissions from oil spills are addressed in Section 4.10, and are not used as a criterion for comparing effects on air quality between alternatives.

Table 4.5-5. Estimated Annual Emission Inventory of Multiple Surveys on the Chukchi Sea OCS

Vessels	**Chukchi Sea OCS Three (3) - 2D/3D Seismic Surveys Annual Emissions** (tons per year)					
	PM	**NO_X**	**SO_2**	**CO**	**VOC**	**CO_2e***
Seismic Vessel	17.2	477.1	70.5	106.8	18.1	22,122
Receiver Vessel	8.4	288.8	48.7	66.2	8.6	13,962
Monitoring Vessel	5.5	186.9	31.5	42.8	5.6	8,196
Ice Breaker Vessel (for 1 of 3 Surveys)	2.81	96.28	16.22	22.07	2.87	3,830
Total	**33.85**	**1,049.10**	**166.91**	**237.89**	**35.14**	**44,761.02**
Vessels	**Chukchi Sea OCS Three (3) - Site Clearance and High Resolution Shallow Hazards Surveys Annual Emissions** (tons per year)					
	PM	**NO_X**	**SO_2**	**CO**	**VOC**	**CO_2e***
Monitoring Vessel	5.5	186.9	31.5	42.8	5.6	8,196

Notes: SO_x (sulfur oxides) includes emissions of sulfur dioxide (SO_2).
NO_x (nitrogen oxides) includes emissions of nitrogen dioxide (NO_2).

PM (particulate matter) includes emissions of coarse and fine particulate matter (PM_{10} and $PM_{2.5}$).
VOC is volatile organic compounds.
CO is carbon monoxide.
CO_2e (carbon dioxide equivalent) is a combination of emissions of the six most common greenhouse gases expressed as a rate in relation to the global warming potential of CO_2.
*CO_2e is expressed in metric tons; all other data are given in units of short tons.
Sources: BOEM, Alaska OCS Region. 2012.
BOEM. 2012. ION Seismic Survey.

Table 4.5-6. Estimated Annual Emission Inventory of Multiple Surveys on the Beaufort Sea OCS

Vessels	Beaufort Sea OCS Four (4) - 2D/3D Seismic Surveys Annual Emissions (tons per year)					
	PM	**NO_X**	**SO_2**	**CO**	**VOC**	**CO_2e***
Seismic Vessel	22.9	636.1	94.0	142.4	24.1	29,496
Receiver Vessel	11.2	385.1	64.9	88.3	11.5	18,616
Monitoring Vessel	7.3	249.2	42.0	57.1	7.4	10,928
Ice Breaker Vessel (for 1 of 4 Surveys)	2.81	96.28	16.22	22.07	2.87	3,830
Total	**44.20**	**1,366.71**	**217.14**	**309.82**	**45.89**	**58,405**
Vessels	**Beaufort Sea OCS Three (3) - Site Clearance and High Resolution Shallow Hazards Surveys Annual Emissions** (tons per year)					
	PM	**NO_X**	**SO_2**	**CO**	**VOC**	**CO_2e***
Monitoring Vessel	5.5	186.9	31.5	42.8	5.6	8,196
Equipment	**Beaufort Sea OCS One (1) – On-Ice Seismic Survey Annual Emissions** (tons per year)					
	PM	**NO_X**	**SO_2**	**CO**	**VOC**	**CO_2e***
Trucks (2 vehicles)	0.001	0.04	0.0002	0.24	0.02	2
Bulldozer	0.26	6.05	1.76	4.59	2.59	23
Total	**0.27**	**6.09**	**1.76**	**4.83**	**2.62**	**25**

Notes: SO_x (sulfur oxides) includes emissions of sulfur dioxide (SO_2).
NO_x (nitrogen oxides) includes emissions of nitrogen dioxide (NO_2).
PM (particulate matter) includes emissions of coarse and fine particulate matter (PM_{10} and $PM_{2.5}$).
VOC is volatile organic compounds.
CO is carbon monoxide.
CO_2e (carbon dioxide equivalent) is a combination of emissions of the six most common greenhouse gases expressed as a rate in relation to the global warming potential of CO_2.
*CO_2e is expressed in metric tons; all other data are given in units of short tons.
Sources: BOEM, Alaska OCS Region. 2012.
BOEM. 2012. ION Seismic Survey.

4.5.1.3.3 Air Quality Impact Analysis

Whether or not emissions from a proposed plan are exempt from the BOEM AQRP requirements for dispersion analysis depends on the distance of the proposed alternative from the shore. In any case, exempt status under the BOEM AQRP does not preclude the requirement for disclosure of the air quality impact of total project emissions under NEPA. The BOEM AOCSR requires lessees proposing operations on the Alaska OCS to perform dispersion analyses for any EP with a rate of total emissions greater than 250 tons per year for any regulated pollutant. Total emissions include the drillship or rig together with emissions from all support vessels, aircraft, and construction, thus the inventory is not limited to the stationary facility as under the BOEM AQRP. Emissions from seismic and other surveys would not likely require dispersion analysis because movement of the ships prevents transport and build-up of pollutants to occur continually over the same onshore area. However, proposed EPs generally generate emissions that exceed 250 tons per year if BACT is not provided for in the operational plan. Emissions of NO_x and CO will likely be the pollutants that exceed the 250-ton threshold. In most cases, the application of BACT will lower the emissions of NO_x and CO to a level below 250 tons per year for all pollutants and no dispersion analysis under NEPA would be required. Thus, an air quality impact analysis may be required under two conditions. First, a dispersion analysis is required under the BOEM AQRP when the emission rate caused by the stationary facility exceeds the calculated emission exemption thresholds (30 CFR 550.303(d)). Second, a dispersion analysis is required to discern the potential pollutant concentrations onshore resulting from the total project emissions disclosed under the NEPA process, which is not limited to emissions from the stationary facility evaluated under the BOEM AQRP or limited to sources evaluated for purposes of an Alaska air permit.

When an air quality impact analysis is required, the lessee will use a computer dispersion model approved by the EPA to predict the onshore concentration of pollutants and report potential adverse air quality impacts. The analysis would be conducted using the methods, and a preferred model, recommended in the EPA *Guideline on Air Quality Models* (40 CFR Part 51 Appendix W). A meteorological data set of sufficient length will be used to ensure that worst-case meteorological conditions are adequately represented in the model results.

Results of the dispersion analysis of total emissions would be used to determine the project's air quality level of effect onshore. The dispersion analysis, if required, would provide at a minimum, predicted pollutant concentrations on the nearest shore (under BOEM AQRP) and in the nearest community (under NEPA) for all the primary and secondary standards (except ozone) regulated by the Clean Air Act (i.e. the NAAQS). For NEPA purposes only, and in lieu of dispersion modeling of total emissions, the onshore air quality effect may be satisfied by a lessee who provides documentation of a previous oil and gas air quality impact analysis conducted for a project or plan of similar size and scope. The similar project would not be farther from shore than the proposed plan and the similar project would also be located on the Arctic OCS. Substitution of results from a similar analysis requires the approval of the BOEM Office of Environment. Otherwise, a dispersion analysis would be required.

Air Quality Related Values (AQRV) Analysis

In addition to human health, air pollutants can have an effect on visibility and vegetation, which is a particular concern for a project proposed near an EPA Class I wilderness area and national parks. The nearest Class I area to the proposed action is the Denali National Park, located approximately 650 kilometers (400 statute miles) distance from the project area. There would be no impact to Denali National Park from the activities proposed under this alternative and an Air Quality Related Values (AQRV) analysis is not required.

Emission Controls and Reduction Strategies

There would be no emission controls or pollution reduction strategies required for a stationary facility under the BOEM AQRP unless there is a potential for significant air quality impacts onshore. No controls or strategies are likely to be required for mobile sources operated for a seismic survey plan. When emissions from a stationary facility are not exempt, and dispersion analysis is conducted, a significant impact occurs when the predicted pollutant concentrations exceed one or more of the EPA SILs (40 CFR 51.165(b)(2) and 30 CFR 550.303(e)). Under NEPA, controls on emission-source engines may be required, particularly if sources generate emissions that cause "design concentrations" onshore to exceed the NAAQS; design concentrations are the sum of project-related pollutant concentrations together with background concentrations. The use of ultra low-sulfur diesel (ULSD) fuel to reduce emissions is discussed in Section 4.5.1.2 *Climate*.

4.5.1.3.4 Level of Effect

The annual rate of air emissions and onshore pollutant concentrations are the two basic measurements for assessing a proposal's level of effect on air quality. The emission inventory provided in this section discloses the rate of emissions likely to reflect a proposal under this alternative, expressed in short tpy. When necessary, an emission inventory is translated into pollutant concentrations expressed in micrograms per cubic meter ($\mu g/m^3$), a value that can be measured against the NAAQS, allowing the level of effect to be categorized relative to the conditions summarized in Table 4.5-7 Impact Levels for Effects on Air Quality.

The calculations for dispersion emission indicate the greater the rate of emissions offshore, the greater the impact onshore; however, many factors combine to affect the transport of air pollutants, including meteorological conditions, the temporary nature of the activities, the location on the OCS of any stationary sources of emissions, and whether the entire proposal includes only mobile sources and no stationary sources.

Generally, implementation of an EP would be expected to have a greater impact onshore compared to a geophysical seismic survey because of the stationary nature of the drillship that continuously streams air pollutants downwind and over the same onshore area each day of operation. Impacts would be reduced the farther the drilling location is from shore. The transient nature of survey vessels would impact an onshore area only momentarily as the vessels cruise past shore areas and move further out to sea and away from the shore. Thus, survey activities would likely have impacts of a lesser extent. Until a proposal is put forward under this alternative, the actual extent of air quality effects cannot be determined.

Due to the variability of exploration activities, potential effects of emissions from an EP at unique or sensitive locations are expected to be only a temporary occurrence. Therefore, the context of air quality effects is expected to be the same for any of the alternatives.

Table 4.5-7 Impact Levels for Effects on Air Quality

Impact Component	Effects Summary		
Magnitude or Intensity	**Low**: Effects are below air quality regulatory limits	**Medium**: Effects are equal to air quality regulatory limits	**High**: Effects are sufficient to exceed air quality regulatory limits
Duration	**Temporary**: Air quality would be reduced infrequently but not longer than the span of the project season and would be expected to return to pre-activity levels at the completion of the activity	**Long-term**: Air quality would be reduced throughout the life of the project and would return to pre-activity levels at some time after completion of the project	**Permanent**: Air quality would be reduced and would not be anticipated to return to previous level
Geographic Extent	**Local**: Affects air quality only locally	**Regional**: Affects air quality on a regional scale	**State-wide**: Affects air quality beyond a regional scale
Context	**Common**: Affects areas of common air quality or unclassified airsheds	**Important**: Affects unclassified airsheds with local air quality standards	**Unique**: Affects areas of very high or very low quality air: Class I airshed or EPA non-attainment area

4.5.1.3.5 Conclusion

Emissions from the drillship, proposed under Alternative 2 and shown in Table 4.5-4 (2,156.2 tons per year of NO_x), would be exempt under the BOEM AQRP only when drilling would occur at a distance greater than 65 statute miles from shore [30 CFR 550.303(d)]. Some lease areas within the U.S. Chukchi Sea OCS Planning Area are closer than 65 statute miles from shore and all the leases on the U.S. Beaufort Sea OCS Planing Area are closer than 65 statute miles. Thus, without emission reduction controls on the drillship engines, potential exists for one or more of the EPA SILs to be exceeded onshore, which must be determined by dispersion modeling. Should emission reduction strategies be used that reduce onshore effects so that levels do not exceed the EPA SILs, the air quality effect onshore would be minor. In addition, a dispersion analysis would be conducted to assess the onshore effect of the remaining mobile sources of emissions as compared to the NAAQS. Otherwise, there may be a moderate air quality effect onshore due to the drillship alone.

Emissions from the survey vessels are much lower when compared to an EP, and because of the transient nature of the activity and the distance from shore for the majority of the surveying time, emissions from surveys would have little chance of exceeding the NAAQS on the nearest onshore area. The need for a dispersion impact analysis would be unlikely, given the expected lack of potential for seismic survey operations to cause significant air quality impacts onshore; thus a negligible to minor level of effect on air quality is expected. Cumulatively, the total estimated emissions for each Arctic OCS planning area, when considering all plans and activities described under this alternative, are summarized in Table 4.5-8.

Control of oil and gas emission sources on the OCS, and levels of effect, are considered on a project-by-project basis, as each individual operator would have the responsibility to engage any engine emission controls required by BOEM AOCSR. Emission reduction strategies have the potential to reduce at least some emissions of all pollutant types, including CO_2e. Therefore, the data provided in Table 4.5-8 would represent a worst-case scenario for each Arctic OCS planning area.

Table 4.5-8. Estimated Annual Emission Inventory for Arctic OCS – Level 1 Activity

Plan/Activity	Chukchi Sea OCS Annual Emissions (tons per year)					
	PM	NO_X	SO_2	CO	VOC	CO_2e*
2D/3D Seismic Surveys (1 of 3 Surveys with an Ice Breaker Vessel) - Three (3)	33.85	1,049.10	166.91	237.89	35.14	44,761
Site Clearance and High Resolution Shallow Hazards Survey Programs - Three (3)	5.45	186.92	31.50	42.84	5.57	7,435
Exploration Plans - One (1)	215.13	6,255.55	3.27	1,371.46	230.03	93,007
Total	**254.43**	**7,491.57**	**201.68**	**1,652.18**	**270.74**	**145,203**
Plan/Activity	**Beaufort Sea OCS Annual Emissions** (tons per year)					
	PM	**NO_X**	**SO_2**	**CO**	**VOC**	**CO_2e***
2D/3D Seismic Surveys (1 of 4 Surveys with an Ice Breaker Vessel) - Four (4)	44.20	1,366.71	217.14	309.82	45.89	58,405
Site Clearance and High Resolution Shallow Hazards Survey Programs - Three (3)	5.45	186.92	31.50	42.84	5.57	7,435
On-Ice Seismic Surveys – One (1)	0.27	6.09	1.76	4.83	2.62	25
Exploration Plans - One (1)	215.13	6,255.55	3.27	1371.46	230.03	93,007
Total	**265.05**	**7,815.28**	**253.67**	**1,728.95**	**284.11**	**158,872**

4.5.1.4 Acoustics

The term acoustics for purposes of this EIS refers to the state of ensonification of the environments of the EIS project area by anthropogenic noise resulting from activities of the alternatives. The acoustic environment is an important habitat component for multiple species. For example, sound is critical to marine mammals for communication, prey and predator detection, and for detecting and interpreting other important environmental clues (e.g., navigation). The presence of increased sound levels from anthropogenic activity and consequent exposures of marine wildlife to these conditions could potentially cause effects. This section considers levels of ensonification (intensity), duration and spatial extent of anthropogenic noise produced by Alternative 2 to inform the wildlife effects assessments elsewhere in this EIS. Alternative 2 is the first alternative that introduces anthropogenic noise sources associated with oil and gas exploration. The acoustic characteristics of these sources are compiled and discussed in this section specifically for Alternative 2 but the same sources are used in other alternatives and the information presented here is also relevant for those.

The evaluations of acoustics effects in this section consider three criteria: intensity, duration, and extent, as defined in Table 4.5-9 below. The criteria are based on sound levels that have been associated with possible disturbance of marine mammals, although specific impacts are not considered here. Intensity considers the magnitude of the broadband acoustic source levels associated with the activity. Duration considers the time period over which sound sources operate. Extent considers the spatial area over which sound levels exceed the lowest marine mammal disturbance level relative to the Chukchi Sea and the EIS project areas; the impact category of context is not applicable to acoustics, as it is not a resource that can be classified as common, important, or unique (although context in a more general sense is critical to an assessment of acoustic impacts and is therefore discussed in relation to its importance to certain biological resources in those individual sections).

Table 4.5-9 Impact Criteria for Acoustics

Impact Category	Intensity Type	Definition
Intensity (Magnitude)	Low	Broadband acoustic source levels from anthropogenic sources are below 160 dB re 1 uPa @ 1 m (either continuous SPL or 90% rms SPL for impulsive sources).
	Medium	Broadband acoustic source levels from anthropogenic sources reach or exceed 160 and are below 200 dB re 1 µPa @ 1 m.
	High	Broadband acoustic source levels from anthropogencic sources reach or exceed 200 dB re 1 uPa @ 1 m.
Duration	Temporary	Acoustic levels are modified for one season or less.
	Long term	Acoustic levels are modified for multiple years, perhaps due to multi-year exploration in preparation for production.
	Permanent	Acoustic levels are increased for many years such as could occur with installation of a permanent structure such as CGBS production facilities.
Extent	Local	Anthropogenic noise levels are increased above 120 dB re 1 uPa over less than 10% of the EIS project areas.
	Regional	Anthropogenic noise levels exceed 120 dB re 1 uPa over at least 10% and less than 50% of the EIS project areas.
	State-wide	Anthropogenic noise levels exceed 120 dB re 1 uPa over 50% or more of the EIS project area.

Alternative 2 includes exploration activities that would likely require an ITA for possible harassment of marine mammals from noise produced by seismic survey sources, drill rigs and vessels. Other than the No Action Alternative, Alternative 2 contemplates the lowest level of activity.

Noise sources included in Alternative 2 include deep-penetration seismic airgun arrays, seismic survey vessels, including in-ice seismic vessels for winter programs, small airgun arrays for site clearance and high resolution shallow hazards surveys or for use during VSP surveys in conjunction with exploration drilling activities, vibroseis systems for on-ice surveys, and drilling rigs. With the exception of exploratory drilling rigs, all of the source types have operated in the EIS project area environments for commercial oil and gas exploration projects between 2006 and 2010. Most of these projects operated under IHAs that required acoustic measurements of underwater noise sources, and the results are cataloged in a series of monitoring reports submitted to NMFS (see references in Table 4.5-9). The reports dating back to 2006 are publicly available on NMFS' ITA website: http://www.nmfs.noaa.gov/pr/permits/incidental.htm.

Table 4.5-10 lists the specific programs conducted in the EIS project area and the sources included in the reported acoustic measurements that are relevant to understanding sound levels produced by airgun arrays and vessels as included in activities under the alternatives.

Table 4.5-10 O&G Exploration Projects in the EIS Project Area, 2006 to 2010, that have reported measurements of sound levels produced by their activities.

Project Operator and Year	Primary Survey Type	Location	Water Depths (m)	Airgun Array	Survey Vessel	Support Vessel	Sidescan/Multibeam	Sub-bottom Profier	Spark/Boom/Pulse	Reference
Shell Offshore Inc. 2006	3D 3D, SH	Chukchi, Beaufort	40 40-50	X X	X X	X X			 X	Blackwell 2007
GX Technology 2006	2D	Chukchi	30-3,800	X						Austin & Laurinolli 2007
ConocoPhillips Alaska 2006	3D	Chukchi	<50	X	X					MacGillivray & Hannay 2008
Shell Offshore Inc. 2007	3D, SH	Chukchi, Beaufort	40+	X	X	X		X	X	Hannay et al. 2008
Eni and PGS 2008	OBC	Beaufort	2-14	X	X	X				Warner et al. 2008
BP Alaska 2008	OBC	Beaufort	0.3-9.1	X	X	X				Aerts et al. 2008
ConocoPhillips Alaska 2008	SH	Chukchi	32		X				X	Turner and Trivers 2008
Shell Offshore Inc. 2008	3D, SH	Chukchi, Beaufort	19-44	X	X	X		X	X	Hannay et al. 2009
Shell Offshore Inc. 2009	SH	Chukchi	48, 41	X	X			X		Warner et al. 2010
Statoil 2010	3D	Chukchi	38-43	X						O'Neill et al. 2010
Shell Offshore Inc. 2010	SH,GT	Chukchi, Beaufort	46-51 15-38	 X	X X		X X	X X		Chorney et al. 2010
Statoil 2011	SH,GT, GC	Chukchi	37	X	X	X	X	X		Warner and McCrodan, 2012

Notes:

2D = 2-Dimensional seismic survey using airgun array sources

3D = 3-Dimensional seismic survey using airgun array sources

OBC = Ocean Bottom Cable survey using airgun array sources

SH = Site Clearance and high resolution shallow hazards surveys using small airgun arrays, sparkers or boomers or bubble pulsers.

GT = Geotechnical survey using sidescan, multibeam, single beam sonars

GC = Geotechnical Coring

4.5.1.4.1 Acoustic Propagation Environments

The Alternative 2 noise sources generate acoustic footprints that depend on the source type and location of operation. For this discussion, the overall EIS project area is divided into three primary acoustic environments introduced in Section 3.1.6.1. These environments are the Chukchi shelf, the Beaufort shelf, and Beaufort coastal area. Though the sediment type and water column features may vary across these environments, the primary distinguishing factor for influencing sound propagation in each environment is water depth. The EIS project area on the Chukchi Shelf is comprised of spatially-uniform water depths between approximately 25 m (82 ft) and 50 m (164 ft) in the areas of oil and gas activities. Bottom relief over the extent of individual seismic or site clearance survey areas is generally small, typically within 10 percent of the nominal location depth, but spatially-extended 2D surveys can cover larger depth intervals. The Beaufort shelf areas have a larger depth range, from approximately 15 m (50 ft) to a few hundred meters near the shelf edge; however, most recent exploration activity has occurred in less than 35 m (115 ft) water depth. The lower depth range limit of 15 m (50 ft) is due mainly to difficulties towing seismic streamers in shallower water. Surveys in shallower water are performed using OBC systems with hydrophones deployed on the seabed. OBC surveys were performed by Eni/PGS and BP in 2008 inside the barrier islands of the Beaufort Sea, in water depths less than 5 m (16 ft), to a few kilometers outside the islands in water depths to approximately 15 m (50 ft).

4.5.1.4.2 Relevant Acoustic Thresholds

Acoustic footprints will be considered in terms of areal extents and source-receiver distances to specific noise thresholds that are pertinent for assessing marine mammal acoustic impacts. NMFS currently consider thresholds of 190 and 180 dB re 1 µPa (rms) to be representative of the levels below which we can be confident that PTS (or injury) will not occur, based on TTS data in pinnipeds and cetaceans respectively. Thresholds for marine mammal disturbance are 120 dB and 160 dB re 1 µPa for continuous and pulsed noises, respectively. However, as discussed in Section 4.2.6 of this EIS, NMFS is considering revisions to its acoustic criteria. NMFS notes that marine mammals may respond to pulsed noise at levels below 160 dB re 1 µPa (potentially down to 120 dB) in a manner with the potential to impact subsistence uses of those animals, and, therefore, distances to the 120 dB re 1 µPa isopleths are typically identified for both continuous and pulsed sources. Richardson (1995) noted bowhead deflections at 35 km (21 mi) distance from a seismic survey airgun array source in the Alaskan Beaufort Sea, and estimated the corresponding exposure SPL between 125 and 133 dB re 1 µPa. Additionally, as noted earlier (Section 4.2.6), other studies also suggest that some portion of mysticetes may respond to seismic sources at received levels lower than 160 dB (potentially down to 120 dB) in a manner that NMFS would consider harassment, and therefore, we are currently considering revisions to the acoustic criteria. Therefore, acoustic information will be presented pertaining to the occurrence of sound levels at threshold values of 190 dB, 180 dB, 160 dB and 120 dB re 1 µPa.

4.5.1.4.3 Acoustic Footprints of Airgun Sources

Airgun array sources generate impulsive sound with source levels typically exceeding 200 dB re 1 µPa @ 1m. The SSV measurements for the oil and gas programs listed in Table 4.5-9 have determined the distances at which certain sound level isopleths from airgun sources are reached. The common approach to determine threshold distances has been to fit smooth curves through broadband rms SPL measurements and then to select the distances at which the curves cross the thresholds (Warner et al. 2008). Conservative estimates of the distances are obtained by shifting the best-fit curves upward in level so they exceed 90 percent of the measurement data values. The distances determined from the shifted curves are referred to as 90th percentile distances. Most of the measurements of airgun array sources have sampled sound levels in both the endfire direction (parallel to airgun array tow direction) and broadside direction (perpendicular to tow direction) to quantify direction-dependent sound emissions. Table 4.5-11 provides a summary of the airgun array measurements that have been performed for the programs listed in Table 4.5-10. Measured distances for sound, including seismic survey sound, change depending upon ambient conditions (i.e. wind, waves, salinity, temperature, etc.). Therefore, Table 4.5-11 provides a snapshot of one set of measurements taken at these sites rather than a static threshold.

Table 4.5-11 Measured distances for seismic survey sounds to reach threshold levels of 190, 180, 160 and 120 dB re 1 µPa (*rms*) at sites in the Beaufort and Chukchi seas

Airgun array Vol (in^3)	Distance (m) to sound level (90% rms SPL (dB re 1 µPa rms))							
	190		180		160		120	
	Best fit range (m)	*90th pctl fit (m)*	*Best fit range (m)*	*90th pctl fit (m)*	*Best fit range (m)*	*90th pctl fit (m)*	*Best fit range (m)*	*90th pctl fit (m)*
Shell Offshore Inc. 2009, Open Water Shallow Hazards and Site Clearance Surveys, Chukchi Sea								
Honeyguide Prospect site (survey vessel M/V Mt. Mitchell)								
10 (single airgun)	17[1]	23[1]	39[1]	52[1]	210[1]	280	5900	7900
20 (2x10in^3)	28[1]	37[1]	66[1]	86[1]	360	460	11000	14000
40 (4x10in^3)	32[1]	41[1]	78[1]	99[1]	470	600	17000	22000[2]
Burger Prospect site (survey vessel M/V Mt. Mitchell)								
10 (single airgun)	6[3]	8[3]	26[3]	34[3]	440	570	18000	19000
40 (4x10in^3)	32[4]	39[4]	120[4]	150[4]	1500	1800	29000[2]	31000[2]
Shell 2008, 3-D Seismic Surveys and Shallow Hazard Surveys, Alaskan Beaufort and Chukchi seas (Hannay and Warner 2009)								
Chukchi Sea, Kakapo Site (3-D seismic survey; vessel M/V Gilavar)								
3147 *Endfire*	370	450	1100	1400	7900	9100	110000	120000
3147 *Broadside*	540	610	1700	2000	12000	13000	75000[6]	77000[6]
30 (single airgun)	140[7]	160[7]	320[7]	370[7]	1600[7]	1900[7]	40000	47000
Alaskan Beaufort Sea, Como Prospect Site (3-D seismic survey; vessel M/V Gilavar)								
3147 *Endfire*	24[8]	51[8]	210	440	6700	9600	54000	58000
3147 *Broadside*	770	920	2,500	2,900	9,000	9,500	≤ 45000[9]	≤ 45000[9]
30 (single airgun)	10[8]	13[8]	46	59	910	1,100	23000	24000
Camden Bay Site (Shallow Hazards survey; vessel Alpha Helix)								
20 (2x10 in^3)	34[10]	45[10]	91[10]	120[10]	630	830	15000	18000
10 (single airgun)	40[10]	53[10]	90[10]	120[10]	440	590	11000	14000
Camden Bay Site (Shallow Hazards survey; vessel Henry Christofferson)								
20 (2x10 in^3)	7[15]	10[15]	27[15]	37[15]	370	490	15000	16000
10 (single airgun)	4[15]	4[15]	14[15]	18[15]	230	280	14000	16000
Chukchi Sea Site (Shallow Hazards survey; vessel Cape Flattery)								
40 (4 x 10 in^3)	45[11]	50[11]	140[11]	160[11]	1200	1400	23000[12]	24000[12]
20 (2 x 10 in^3)	14[13]	17[13]	50[13]	62[13]	730	830	24000[12]	25000[12]
10 (single airgun)	7[14]	8[14]	28[14]	32[14]	380	440	15000	16000[12]

Airgun array Vol (in^3)	Distance (m) to sound level (90% rms SPL (dB re 1 µPa rms))							
	190		180		160		120	
	Best fit range (m)	***90^{th} pctl fit (m)***	***Best fit range (m)***	***90^{th} pctl fit (m)***	***Best fit range (m)***	***90^{th} pctl fit (m)***	***Best fit range (m)***	***90^{th} pctl fit (m)***
Statoil USA E&P 2010, Open Water 3-D Seismic Survey, Chukchi Sea								
Approximately 190 km (118 mi) northwest of Wainwright (Survey vessel R/V Geo-Celtic)								
3000 *Endfire*	300	370	1000	1300	8600	10000	59000	61000
3000 *Broadside*	430	520	1400	1600	11000	13000	123000	130000
60 (single airgun)	11	13	57	68	1300	1500	25000	26000
ConocoPhillips 2006, Seismic Exploration Program, Alaskan Chukchi Sea								
Approximately 150 km west of Point Lay, (Survey vessel M/V Western Patriot)								
3390 *Endfire*	-	514	-	1112	-	5086	-	65634
3390 *Broadside*	-	517	-	1628	-	11431	-	75370
3035 *Endfire*	-	499	-	1103	-	5148	-	56887
3035 *Broadside*	-	461	-	1471	-	10307	-	65207
105 (single airgun)	-	62	-	179	-	1449	-	30988
Eni Petroleum Company and PGS Seismic Survey 2008, at the Nikaitchuq oil field, east of the Colville River Delta, Beaufort Sea								
Deep water site (nominal depth of 10 m; survey vessel MV Wiley Gunner)								
880 *Endfire*	67	100	170	260	1100	1600	13000	16000
880 *Broadside*	140[4]	180[4]	340	440	2000	2400	20000	21000
20 (single airgun)	59	87	140	210	750	1100	9800	12000
Deep water site (nominal depth of 10 m; survey vessel MV Shirley V)								
880 *Endfire*	66	180	320	640	1600	2200	11000	14000
880 *Broadside*	120[4]	160[4]	410	550	3200	3800	20000	22000
20 (single airgun)	52[4]	73[4]	110[4]	160[4]	510	720	7500	9400
Shallow water site (nominal depth of 2.5 m; Survey vessel MV Wiley Gunner)								
880 *Endfire*	140	220	220	340	510	800	2800	4400
880 *Broadside*	210[16]	270[16]	340[16]	430	870	1100	5700	7100
20 (single airgun)	27[17]	41[17]	81[17]	120	680	870	2200	2400
Shallow water site (nominal depth of 2.5 m; Survey vessel MV Shirley V)								
880 *Endfire*	190	270	290	420	680	970	3700	5300
880 *Broadside*	140	200	300	430	1200	1600	6900	7900
20 (single airgun)	2[18]	6[18]	29	67	500	640	2200	2300

Airgun array Vol (in^3)	Distance (m) to sound level (90% rms SPL (dB re 1 µPa rms))							
	190		180		160		120	
	Best fit range (m)	*90th pctl fit (m)*	*Best fit range (m)*	*90th pctl fit (m)*	*Best fit range (m)*	*90th pctl fit (m)*	*Best fit range (m)*	*90th pctl fit (m)*
Shell 2007 Open water seismic exploration in Beaufort and Chukchi Seas								
Chukchi Sea (Vessel Gilavar)								
3147 Endfire		450		1140		7150		58400
3147 Broadside		545		2470		8100		66000
30 (single airgun)	<10[19]	<10[19]	<10[19]	<10[19]	1121	1360	36817	41100
Camden Bay (Vessel Gilavar)								
3147 Endfire		757		2245		13405		74813[20]
3147 Broadside		857		2088		10084		61887
30 (single airgun)	<10[4]	<10[4]	15[4]	24[4]	1261	1439	22911	24600
Beechey Point (Vessel Henry C)								
20 (2x10)		12		51		597		10700
10 (single)		5		20		333		8130
Camden Bay (Vessel Henry C)								
20 (2x10)		1[4]		7[4]		1000		25200
GXT Chukchi Sea, October—November 2006								
MV Discoverer, 100 km offshore of the North coast of Alaska in the Chukchi Sea (west of Point Lay)in water depths of 40-46 m.								
3320 Endfire	620		1460		7280		57,530	
3320 Broadside	480		1770		10970		167000	
Shell 2006, open water seismic exploration in the Beaufort and Chukchi seas, July–September 2006. Chukchi measurements in 52 m water depth, Beaufort in 48 m.								
Seismic vessel M//V Gilavar operating in the Chukchi Sea								
3147 End-fire Bow	460		1270		7990		67620*	
3147 End-fire Stern	360		980		6770		82890*	
3147 Broadside	420*		1400		-		-	
1049 End-fire Bow	270*		650		-		-	
1049 End-fire Stern	170*		450		3240		61400*	
1049 Broadside	420		1350*		-		-	
Henry Christoffersen, about 54 km east of Kaktovik off the north coast of Alaska, in the Beaufort								
280 (4x70)	89		250		1750		22220*	

	Airgun array Vol (in³)	Distance (m) to sound level (90% rms SPL (dB re 1 µPa rms))							
		190		180		160		120	
		Best fit range (m)	***90th pctl fit (m)***	***Best fit range (m)***	***90th pctl fit (m)***	***Best fit range (m)***	***90th pctl fit (m)***	***Best fit range (m)***	***90th pctl fit (m)***
Statoil Shallow Hazards survey from M/V Duke at Amundsen Prospect in the Chukchi Sea, August-September 2011									
	40 (4x10)	32	37	110	130	1300	1500	28000[3]	30000[3]
	10	13	15	50	59	720	840	27000[3]	29000[3]

[1]Extrapolated from minimum measurement range of 240 m (0.15 mi).

[2]Extrapolated from maximum measurement range of 20000 m (1.2 mi).

[3]Extrapolated from minimum measurement range of 275 m (0.17 mi).

[4]Extrapolated from minimum measurement range of 200 m (0.12 mi).

[5]Extrapolated beyond maximum measured range of 20 km

[6]Extrapolated from maximum measurement range of 34.9 km

[7]Extrapolated from minimum measurement range of 8 km (5 mi).

[8]Distances to the 190 dB re µPa level were extrapolated from data at longer ranges.

[9]The level of the interfering airgun signals on OBH D was approximately 120 dB re µPa. Therefore the 120 dB re 1 µPa threshold range for was constrained to less than 45 km, or 28 mi, from the array.

[10]Extrapolated from minimum measurement range of 190 m (620 ft).

[11]Extrapolated from minimum measurement range of 194 m (640 ft).

[12]Extrapolated from maximum measurement range of 15000 m (9.3 mi).

[13]Extrapolated from minimum measurement range of 208 m (680 ft).

[14]Extrapolated from minimum measurement range of 199 m (653 ft).

[15]Extrapolated from minimum measurement range of 90 m (295 ft).

[16]Extrapolated from minimum measurement range of 375 m.

[17]Extrapolated from minimum measurement range of 85 m.

[18]Extrapolated from minimum measurement range of 14 m.

[19]Extrapolated from minimum measurement range of 980 m (260 ft).

[20]Extrapolated from maximum measurement range of 58.7 km (36.5 mi).

*Empirical distance was based on an extrapolation of the fitted curve beyond the range of the measured data

The results in Table 4.5-11 exhibit variability of the measured levels, even when considering similar sources in the same primary acoustic environment. This can arise due to differences of the sediment type or of the structure of the sound speed profile, both factors that influence sound propagation. For example, severe weather and surface waves can increase mixing in the water column and reduce the effect of a surface sound channel that can support strong sound propagation in calm conditions. Or, the sediment type may be more reflective in one measurement site enhancing the sound propagation. At present, there is not sufficient geoacoustic information available to quantify these differences and allow the primary acoustic environments to be further subdivided. Instead the measurements have been averaged to provide representative propagation ranges for each environment by size of source.

Representative distances to sound level thresholds of 190, 180, 160 and 120 dB re 1 µPa (rms) for airgun sources were obtained by averaging the Table 4.5-11 results for offshore and coastal surveys, and are presented in Table 4.5-12. The averages are based on the 90th percentile distances and the maxima of broadside and endfire measurements where both directions are sampled. These distances were used to assess the direct and indirect acoustic impacts from airgun sources for each action alternative.

Table 4.5-12 Average distances to sound level thresholds from measurements listed in Table 4.5-11 for several airgun survey systems.

The averages are based on 90th percentile distances, where available, and the maxima of broadside and endfire measurements are used where both directions were sampled.

		Average distance (m) to sound level (90% rms SPL (dB re 1 µPa rms))			
		190	180	160	120
Chukchi Sea Shelf 37 to 52 m depth					
	10 in^3	15	48	560	19000
	40 in^3	42	135	1300	27000
	~3200 in^3	530	1760	10700	95000
Beaufort Sea Shelf, 15 to 40 m depth					
	10 in^3	21	53	401	12700
	20 in^3	19	55	770	16400
	~3200 in^3	890	2570	11400	60000
Beaufort Coastal, inside and outside barrier islands to 10 m depth					
	20 in^3	52	140	832	6530
	880 in^3	220	463	2230	15300

4.5.1.4.4 Acoustic Footprints of Non-Airgun Sources

The non-airgun sources of Alternative 2 include seismic vessels, support vessels, drill rigs (drillships and jack-up rigs) and on-ice surveys using vibroseis. Site clearance surveys also employ high-resolution acoustic sources including multibeam and sidescan sonars, echosounders and sub-bottom profilers. The majority of these sources do not ensonify significant areas where sound levels exceed NMFS' injury criteria thresholds. However, they may produce sound levels that exceed NMFS' continuous and/or pulsed noise thresholds for marine mammal disturbance (i.e. Level B harassment). Sound source noise emissions are discussed here, and representative distances to the 120 dB re 1 µPa threshold are summarized in Table 4.5-13. This table only presents a representative sample, and other vessels will likely have different sound propagation characteristics.

Support vessel operations in the Chukchi and Beaufort Shelf environments may, depending on the type of vessels employed, generate 120 dB re 1 µPa zones extending approximately 1 km to 5.4 km (0.6 to 4 mi) (Chorney et al. 2010). For reference, open water ambient noise levels in the Chukchi Sea in the 10 Hz to 24 kHz frequency band can fall below 100 dB re 1 µPa (Fig 3.19 in O'Neill et al. 2010). Noise generated by research vessel *Mt. Mitchell*, transiting at 10 knots over the Burger prospect during Shell's 2010 Geotechnical Survey, reached 120 dB re 1 µPa at 1.6 km distance. Its sound emission levels increased when operating in dynamic positioning (DP) mode, and the estimated distance to 120 dB re 1 µPa increased to 5.6 km (Chorney et al. 2010).

Vessel operations in the shallower coastal areas of the Beaufort Sea produce smaller noise footprints due to reduced low frequency sound propagation in shallower water. Acoustic measurements of nine vessels, including two source vessels, three cable lay vessels, and two crew-change/support vessels were made in 9 m water depth during the Eni/PGS 2008 OBC project (Warner et al. 2008). Their 120 dB re 1 µPa threshold distances ranged from 280 m, for a cable lay vessel to 1,300 m (0.8 mi) for a crew change vessel. The average distance was 718 m (0.43 mi), and that value is considered as representative for support vessels in coastal operations.

Drillship sound levels are discussed in Section 2.3.3. For the purpose of this evaluation, the 120 dB re 1 µPa threshold distance is based on the source level measurements of the Shell drillship *Noble Discoverer* made in 2009 in the South China Sea (Austin and Warner 2010). Those measurements indicated drilling source levels from 178.5 to 185.4 dB re 1 µPa@1m (10 Hz to 24 kHz). Based on this information, the estimated 120 dB re 1 µPa threshold distance is likely between 1.5 and 2 km (0.9 and 1.2 mi).

Jack-up drill rigs produce lower level of sounds than vessels as the support legs do not effectively transmit vibrations from on-rig equipment into the water. For the purpose of this evaluation, the 120 dB re 1 µPa threshold distance is based on the source level measurements made by JASCO using the Marine Operations Noise Model in support of a 2014 exploration drilling program contemplated by ConocoPhillips' (O'Neill et al. 2012). The modeling efforts indicated a broadband source level of 167 dB re 1 µPa. Based on this information, the estimated 120 dB re 1 µPa threshold distance is estimated to be 210 m (689 ft).

Sounds from on-ice vibroseis systems are discussed in Section 2.3.2. Vibroseis source pressure waveforms are typically frequency sweeps below 100 Hz, though strong harmonics may exist to 1.5 kHz, and with signal durations of 5 to 20 seconds. They are presently categorized as continuous-type sounds (Richardson et al. 1995). The measurement of on-ice vibroseis source levels in shallow water is complicated by interference from bottom and surface reflections, and as a consequence there is considerable variability in the published source levels. Holliday measured an on-ice vibroseis source level of 187 dB re 1 µPa@1m, with bandwidth 10 to 70 Hz (Holliday et al. 1984 as discussed in Richardson et al. 1995), and that source level will be used for the present analysis. While the source level is several decibels higher than those of vessels, the low operating frequency will lead to shorter horizontal propagation distances. It is expected the maximum levels will be similar to or less than those from the larger vessels. The largest 120 dB re 1 µPa threshold distance for vessels in the Eni/PGS 2008 OBC study was 1,300 m (0.8 mi). That distance will be assumed also for the vibroseis in this analysis.

The measurements referenced in the preceding discussion are summarized in Table 4.5-13, providing the expected distances to the 120 dB disturbance criteria for each non-airgun source. These values are used in the impact assessments that follow for each alternative.

Table 4.5-13 Examples of empirically measured distances to 120 dB re 1 µPa for non-airgun sources, from discussion above.

Source Type	Distance to 120 dB re 1 µPa
Drillship	2 km (1.2 mi)
Jack-up rig	210 m (689 ft)
Support Vessel in Offshore Operation	1.6 km (1 mi)
Support Vessel in Coastal Operation	0.72 km (0.43 mi)
On-ice vibroseis	1.3 km (0.78 mi)

4.5.1.4.5 Direct and Indirect Effects

Under Alternative 2, underwater noise levels will increase in the vicinity of seismic survey and support vessels, drill rigs, and airgun sources. The effects considered here are based on the current NMFS rms sound level thresholds for PTS (injury) and disturbance that were discussed above.

Estimates of Total Surface Areas of Ensonification at Threshold Levels

Table 4.5-14 contains estimates of surface areas ensonified above given threshold levels under Alternative 2 based on the ranges provided in Table 4.5-11. For the purpose of computing these notional areas, the seismic survey activities listed in Table 4.2-1 for Activity Level 1 are distributed among the three environments considered in this EIS. The three exploration surveys and three site clearance or high resolution shallow hazards surveys in the Chukchi Sea are all assumed to be in the mid-depth shelf region; the four exploration surveys and three site clearance or high resolution shallow hazards surveys in the Beaufort Sea are divided between the mid-depth shelf and the shallow-depth coastal regions in the proportions of 3:1 and 2:1 respectively (giving greater representation to the shelf region makes the estimates more precautionary). The source array sizes in the three zones reflect the prevailing configurations for seismic surveys conducted in each region. The percentages are based on nominal surface areas of 263,500 km^2 for the Chukchi Sea portion of the EIS project area and 255,350 km^2 for the Beaufort portion. Of note, the total surface areas do not subtract out either overlap with other isopleths of concurrent source operation or land area where activities are closer to shore. For that reason, the area ensonified over 120 dB is likely a significant overestimate (see figures 4.3-1 through 4.5-3 illustrating conceptual examples to get a sense of this).

Table 4.5-14 Total Surface Areas Ensonified Above Sound Level Thresholds Under Alternative 2, From Averages Listed in Table 4.5-12.

		Total Surface Areas (km^2) to sound level (90% rms SPL (dB re 1 µPa			
		190	180	160	120
Chukchi Sea Shelf 40 to 52 m depth					
	3x ~3200 in^3	2.65	29.2	1,079	85,059
	3x 40 in^3	0.02	0.17	15.2	6,371
	drill/support*			521	521
	% Chukchi	**0.00%**	**0.01%**	**0.61%**	**35%**
Beaufort Sea Shelf, 15 to 40 m depth					
	3x ~3200 in^3	7.47	62.2	1,225	33,929
	2x 20 in^3	0.002	0.02	3.73	1,690
	drill/support*			521	521
Beaufort Coastal, inside and outside barrier islands to 10 m depth					
	1x 880 in^3	0.15	0.67	15.6	735
	1x 20 in^3	0.01	0.06	2.17	134
	% Beaufort	**0.00%**	**0.02%**	**0.69%**	**14%**
Entire Region					
		10.302	**92.32**	**2340.7**	**127918**
	% EIS area	**0.00%**	**0.02%**	**0.45%**	**25%**
*drill/support indicates area within 13-km radius around drill rig, notionally encompassing support					
vessels. Indicated area is within 120-dB radius, included in 160-dB column for assessment.					

<u>4.5.1.4.6 Conclusion</u>

Alternative 2 presents the lowest activity of the alternatives, but it represents an increase in activity above current levels. The distances to PTS thresholds are given in Table 4.5-11 (summarized in Table 4.5-12) for deep penetration airgun array sources and shallow hazards sources. The 180 dB re 1 µPa distance for deep penetration seismic sources extends out to 2,570 m for 2D and 3D surveys on the Beaufort Shelf based on measurements of 3147 in^3 arrays. All of the sound sources associated with Alternative 2 will ensonify nearby areas above the current marine mammal disturbance threshold of 120 dB re 1 µPa for continuous noise and 160 dB re 1 µPa (90 percent rms) for impulsive noise. Estimated distances to these thresholds for seismic airgun sources are given in Table 4.5-12 and for all other sources in Table 4.5-14. The largest expected distance to the 160 dB re 1 µPa disturbance threshold for airgun sources is 11.4 km (6.8 mi), and to the 120 dB re 1 µPa continuous SPL for non-airgun sources it is the drillship at 10 km (6 mi). The maximum measured 120 dB re 1 µPa radius from airgun sources is 167 km (104 mi) (Austin and Laurinolli, 2007), but the average distance for recent 3-D surveys in the Beaufort and Chukchi Sea is 95 km (59 mi) (Table 4.5-12). The relevance of these disturbance zones to specific marine mammal species is discussed in Sections 4.5.2.4.

The intensity rating of this alternative is high, as additional exploration activities will introduce sources with source sound levels that exceed 200 dB re 1 µPa. Because the exploration activities could continue for several years, the duration is considered as long term. The spatial extent of these activities is regional, since the distribution of exploration activities over the EIS project areas will lead to 25 percent of the EIS project area being exposed to sound levels in excess of 120 dB re 1 µPa. Therefore, the overall impact rating for direct and indirect effects to the acoustic environment under Alternative 2 would be moderate.

4.5.1.5 Water Quality

The EPA has the authority to regulate industrial discharges of pollutants to the surface waters of the Beaufort and Chukchi seas under the National Pollution Discharge Elimination Systems (NPDES) program. Wastes generated from activities within the EIS project area would be discharged in accordance with the conditions of the NPDES general permit. The Arctic NPDES General Permit for wastewater discharges from Arctic oil and gas exploration expired on June 26, 2011. On October 29, 2012, the EPA issued final Clean Water Act NPDES general permits for wastewater discharges from oil and gas exploration on the Beaufort Sea OCS and Contiguous State Waters (AKG 28-2100) and on the Chukchi Sea OCS (AKG 28-8100). ADEC issued a Clean Water Act Section 401 Certification for the Beaufort Sea general permit on October 9, 2012.

The water quality parameters most likely to be affected by the activities described in the alternatives fall into four categories: temperature and salinity; turbidity and total suspended solids; dissolved metals; and hydrocarbons and other organic contaminants. There are many additional metrics for water quality that could be applied to the EIS project area (e.g. pH, fecal coliform counts, residual chlorine concentrations), but considering the nature of the activities described in the alternatives, these four categories encompass the water quality parameters most likely to reflect the potential effects of the alternatives on long-term productivity and sustainability of valued ecosystem components.

The actions proposed in Alternatives 2, 3, 4, and 5 are defined by four action components and various combinations of mitigation measures. The action components are: seismic surveys, site clearance and shallow hazards surveys, on-ice seismic surveys, and exploratory drilling programs, which are described in detail in Chapter 2 of this EIS. The water quality effects of each action component are analyzed separately for each alternative. Overall, seismic surveys, site clearance and shallow hazards surveys, and on-ice seismic surveys are expected to have negligible impacts on water quality. Effects of exploratory drilling on water quality would depend upon the specific techniques used for exploratory drilling, the location of the activity, and mitigation measures implemented, such as reduced discharge. For example, construction of gravel artificial islands in nearshore waters would result in different impacts to water quality than would drilling from a floating vessel or a jackup rig in offshore waters (see Section 2.3.3).

In any case, exploratory drilling programs would involve discharges to the marine environment that could result in adverse impacts to water quality. The transport, dispersion, and persistence of materials discharged into the marine environment from exploratory drilling operations have been previously evaluated for several areas of the Alaska Arctic OCS. The general conclusions reached in these studies regarding the transport, dispersion, and persistence of drilling discharges are discussed below (from EPA 2006b):

> *The drilling mud discharge separates into an upper and lower plume. Physical descriptions of effluent dynamics and particle transport differ substantially for the two plumes. Drill cuttings (parent material from the drill hole) are generally coarse materials that are deposited rapidly following discharge and settle within the 100-m radius mixing zone. Discharged drilling materials typically settle in the immediate vicinity of the discharge area. However, deposition patterns are extremely variable and are strongly influenced by several factors, including the type and quantity of mud discharged, hydrographic conditions at the time of discharge, and height above the seafloor at which discharges are made.*
>
> *Although metals were enriched in the sediment, enrichment factors were generally low to moderate, seldom exceeding a factor of 10. The spatial extent of this enrichment also was limited. These considerations suggest that exploratory activities will not result in environmentally significant levels of trace metal contamination. However, other factors, such as the intensity of exploratory activities, normal sediment loading, and proximity either to commercial shell fisheries or to subsistence populations, could alter this conclusion. Analyses of sediment barium and trace metal concentrations have been used to examine nearfield fate of drilling fluids on the seafloor (e.g. the rate of dispersion of sedimented material). If high concentrations of barium are persistently found near a well site, this finding suggests it is in a lower energy area, which favors deposition. If elevated levels cannot be found, even soon after drilling, then this finding suggests a higher energy environment, where resuspension and sediment transport were promoted.*
>
> *Data from exploratory drilling operations have been used to examine deposition of metals resulting from drilling operations. These indicate that several metals are deposited, in a distance-dependent manner, around platforms, including cadmium, chromium, lead, mercury, nickel, vanadium, and zinc. At present, the area-wide large-scale distribution of drilling discharges is difficult to predict. However, it can be surmised that drilling discharges associated with short-term exploration operations will have little effect on the environment due to deposition of drilling-related materials on the seafloor.*

In October 2012, the EPA released updated analyses in conjunction with the new NPDES permits for the Beaufort and Chukchi seas (EPA 2012c, d). At that time, the EPA also released a technical memorandum on the "Results from Chukchi/Beaufort Seas Permit Dilution Modeling Scenarios" (EPA 2012h). This memorandum documents the simulation of mixing and dispersion of pollutant discharges authorized by the Beaufort and Chukchi general permits. The primary discharge type of interest is drilling fluid (mud) with dispersal in the water column and deposits on the sea bed producing smothering impacts and potentially exposing water column and benthic organisms to contaminants in the drilling fluid. The evaluation considered a range of expected discharge rates and physical configurations for the range of ambient environmental conditions including water depth, stratification, and tidal and non-tidal currents characterizing the areas. Mixing, dispersion, and deposition are simulated using version 2.5 of the Offshore Operators Committee Mud and Produced Water Discharge Model (OOC Model). Additional information can be found in the memorandum issued by the EPA and is incorporated herein by reference.

The level of impacts to water quality will be based on levels of intensity, duration, geographic extent, and context, as shown in Table 4.5-15.

Table 4.5-15 Impact Levels for Effects on Water Quality

Impact Component	Effects Summary		
Magnitude or Intensity	**Low**: Effects are below water quality regulatory limits	**Medium**: Effects are equal to water quality regulatory limits	**High**: Effects are sufficient to exceed water quality regulatory limits
Duration	**Temporary**: Water quality would be reduced infrequently but not longer than the span of the project season and would be expected to return to pre-activity levels at the completion of the activity	**Long-term**: Water quality would be reduced throughout the life of the project and would return to pre-activity levels at some time after completion of the project	**Permanent**: Water quality would be reduced and would not be anticipated to return to previous level
Geographic Extent	**Local**: Affects water quality only locally	**Regional**: Affects water quality on a regional scale	**State-wide**: Affects water quality beyond a regional scale
Context	**Common**: Affects areas of common water quality or where there is an abundance of water sources	**Important**: Affects areas with high water quality or water sources that are considered important in the region	**Unique**: Affects areas of high water quality that are protected by legislation

4.5.1.5.1 Direct and Indirect Effects

Water Temperature and Salinity

Seismic Surveys

Seismic surveys conducted from ships are not expected to have any measureable impact on water temperature or salinity in the proposed action area. Thermal inputs to the water from seismic survey activities would be extremely local in nature, and any effects on water quality resulting from such inputs are expected to be negligible. If there is coolant water withdrawn or water for desalination withdrawn, there would be negligible temperature and salinity effects in surface waters, as permitted and regulated under current NPDES general permits.

Site Clearance and Shallow Hazards Surveys

Site clearance and shallow hazards surveys are not expected to have any measureable impact on water temperature or salinity in the proposed action area. Thermal inputs to the water from site clearance and shallow hazards survey vessels would be local in nature, and any effects on water quality resulting from such inputs are expected to be negligible. If there is coolant water withdrawn or water for desalination withdrawn, there would be negligible temperature and salinity effects in surface waters, as permitted and regulated under current NPDES general permits.

On-ice Seismic Surveys

On-ice seismic surveys are not expected to have any measureable impact on water temperature or salinity in the proposed action area. Thermal inputs to the water from on-ice seismic surveys vehicles would cause some ice melt but would be extremely local in nature, and any effects on water quality resulting from such inputs are expected to be negligible. Likewise, on-ice seismic surveys are not expected to affect the salinity of waters within the proposed action area.

Exploratory Drilling Programs

Exploratory drilling programs can be conducted from a variety of different platforms (see Chapter 2). The choice of platform affects the type and magnitude of impacts on water temperature and salinity.

Certain discharges from oil and gas exploratory drilling programs in the Beaufort and Chukchi seas would be considered by the EPA under the Clean Water Act (CWA) Section 402, National Pollutant Discharge Elimination System (NPDES) permitting authority. Prior to issuance of NPDES discharge permits for these actions, EPA is required to comply with the Ocean Discharge Criteria (40 CFR 125 Subpart M) for preventing unreasonable degradation of ocean waters.

In addition to muds and cuttings, NPDES-permitted discharge streams may include deck drainage, sanitary wastes, domestic wastes, desalination unit wastes, blowout preventer fluid, boiler blowdown, fire control system test water, non-contact cooling water, uncontaminated ballast water, bilge water, excess cement slurry, and test fluids (EPA 2006).

Non-contact cooling water is comprised of seawater that would be pumped continuously to provide cooling for certain pieces of machinery associated with exploratory drilling activities. Heat transferred from the machinery to the water is expected to raise the temperature of the seawater in the system by about 1.5 degree Celsius (EPA 2012h). Chlorine, as calcium hypochlorite, or a similar biocide, would be added to the non-contact cooling water to reduce biofouling and would contribute to the overall salinity of the waste stream. Before discharge, water from the cooling system would generally be mixed with other discharges. After mixing, sodium metabisulfate may be added to the effluent to reduce total residual chlorine concentration to comply with regulatory limits (MMS 2002, EPA 2006b). Discharged waters would be slightly warmer and would contain higher concentrations of dissolved salts relative to the ambient waters of the Beaufort and Chukchi seas. Therefore, discharged waters would increase the temperature and salinity of the seawater in the immediate vicinity of the discharge. Effects on water quality resulting from increased temperature and salinity from exploratory drilling activities under Alternative 2 are expected to be low-intensity, temporary, local, and would affect a common resource as defined in the impact criteria in Section 4.1 of this EIS.

Turbidity and Total Suspended Solids

Seismic Surveys

Seismic surveys conducted using shipboard acoustic instruments generally do not involve chemical inputs, discharges to the marine environment, or contact with the seafloor. Therefore, in most instances, seismic survey activities would not be expected to affect turbidity or concentrations of total suspended solids within the proposed action area. If any of the vessels involved in seismic survey activities were to set an anchor within the action area, then suspension of seafloor sediments could result in localized increases in turbidity around the area where the anchor is set and retrieved. Ocean-bottom cable seismic surveys would result in localized, temporary increases in turbidity in the immediate vicinity of the survey area as the cables are laid on and retrieved from the seafloor. There is also the potential for the cables to affect turbidity if the cables move while on the seafloor. Effects on water quality resulting from increases in turbidity and/or total suspended solids as a result of conducting seismic surveys, if any, would be low-intensity, temporary, local, and would affect a common resource.

Site Clearance and Shallow Hazards Surveys

Site clearance and shallow hazards surveys are conducted using echosounders and various subbottom profiling instruments, as well as other acoustic sources, which would not affect turbidity or concentrations of total suspended solids in the proposed action area. If any of the vessels involved in site clearance or shallow hazard survey activity were to set an anchor within the action area, then suspension of seafloor sediments could result in localized increases in turbidity around the area where the anchor is set and retrieved. Effects on water quality resulting from potential increases in turbidity and/or total suspended solids as a result of conducting site clearance and shallow hazard surveys, if any, are expected to be low-intensity, temporary, local, and would affect a common resource.

On-ice Seismic Surveys

On-ice seismic surveys would not affect turbidity or concentrations of total suspended solids in the proposed action area, as they occur on the ice and not in the open-water environment. No contact is made with the seafloor during these types of surveys.

Exploratory Drilling Programs

Construction and maintenance of gravel islands for exploratory drilling would result in additional turbidity caused by increases in suspended particles and sediments in the water column. The release of sediments and drilling muds associated with exploratory drilling activity would also result in increased turbidity and concentrations of suspended solids in the water column. Increased turbidity and suspended solids resulting from artificial island construction or exploratory drilling discharges could have adverse impacts on water quality if increases persisted for extended periods of time. Direct toxicity from suspended sediments is not considered to be a regulatory issue, and neither state nor federal water quality standards have been established with regard to toxicity of suspended sediments in the marine environment. Expected toxicity for suspended sediments resulting from discharges of drill cuttings and water based drilling fluids is expected to be somewhere between that of a clay such as bentonite, and that of calcium carbonate (NRC 1983, MMS 2002). The LC_{50} (i.e. the concentration that is lethal to half of the organisms in a test population after a 96-hour exposure period) for bentonite is 7,500 parts per million (ppm) (test organism, eastern oyster (Daugherty 1951)), and because surface seawater is saturated with calcium carbonate (Chester 2003), it can be considered nontoxic.

For this analysis, 7,500 ppm suspended solids is used as an unofficial acute toxicity criterion for water quality. This value is the lowest (most toxic) LC_{50} for a clay or calcium carbonate reported in the National Research Council (1983) assessment of drilling fluids in the marine environment, and adoption of this unofficial criterion is consistent with previous analyses of the environmental effects of oil and gas activities in the proposed action area (MMS 2001, MMS 2002).

Increases in suspended solids resulting from construction of artificial islands are generally expected to be less than the 7,500 ppm suspended solids used in this analysis as an unofficial criterion for water quality (MMS 2002). The intensity, duration, and extent of the effects on water quality resulting from increased suspended sediment concentrations and turbidity levels depend on the grain-size distribution of the material being introduced to the water, the rate and duration of the activity, lateral transport and turbulence in the water column, local current speeds, and where applicable, the ice regime in the potentially affected area (MMS 2002). Data from site-specific studies in the Beaufort Sea indicate that concentrations of suspended sediments introduced as a result of construction activities decrease to well below the threshold values within 30 m (98 ft) of the activity (MMS 2002).

The release of drill cuttings and drilling muds associated with exploratory drilling activity would also result in increased turbidity and concentrations of total suspended solids in the water column. Drill cuttings and water-based drilling fluids are comprised of a slurry of particles with a wide range of grain sizes and densities, and various fluid additives may be water soluble, colloidal, or particulate in nature (Neff 1981, Neff 2005). Drill cuttings are particles of sediment and rock extracted from the bore hole as the drill bit penetrates the earth. Water-based drilling fluids consist of water mixed with a weighting agent (usually barium sulfate [$BaSO_4$]) and various additives to modify the properties of the mud (Neff 2005).

As a result of the physical and chemical heterogeneity of typical drill cuttings and drilling fluids, the mixture would undergo fractionation (separate into various components) as it is discharged to the ocean. The larger particles, which represent about 90 percent of the mass of drilling mud solids, would settle rapidly out of solution, whereas the remaining 10 percent of the mass of the mud solids consists of fine-grained particles that would drift with prevailing currents away from the drilling site (NRC 1983, Neff 2005). The fine-grained particles would disperse into the water column and settle slowly over a large area of the seafloor. Models, lab-scale simulations, and field studies suggest that discharged drilling muds and cuttings would be rapidly diluted to very low concentrations, and that suspended particulate matter concentrations would drop below effluent limitation guidelines within several meters of the discharge (Nedwed et al. 2004, Smith et al. 2004, Neff 2005). In well-mixed waters, particles discharged to the ocean from drilling activities are typically diluted by 100-fold within 10 m (33 ft) of the discharge and by 1,000-fold after a transport time of about 10 minutes at a distance of about 100 m (328 ft) from the platform (Neff 2005). Therefore, effects on water quality resulting from turbidity from discharged drill cuttings and drilling fluids are expected to be temporary, localized to the vicinity of the discharge, and would be low-intensity with regard to the overall water quality in the proposed action area.

Turbidity above ambient levels caused by increases in suspended particles in the water column would affect water quality in the proposed action area. Turbidity levels are generally expected to remain considerably below 7,500 ppm suspended solids, which is used as an acute toxicity criterion for water quality in this analysis (NRC 1983, MMS 2002). In the immediate vicinity of exploratory drilling and anchor handling activities, turbidity may locally exceed the 7,500 ppm threshold. Local effects on water quality may be high-intensity but would dissipate quickly with distance from the activity. Effects resulting from increased turbidity would be temporary and expected to end within a few days after drilling or anchor handling activity stops. Effects on water quality resulting from increased turbidity would be local and would generally be restricted to the areas within 100 m (328 ft) of the drilling or anchor handling activity (NRC 1983, Neff 2005).

Material discharged at the seafloor would be similar in composition to naturally-occurring seafloor sediments, and its contribution to turbidity from waves and currents would be about the same as the sediments existing at the seafloor surface before drilling activities (MMS 2002).

If floating vessels or jackup rigs were used for exploratory drilling, overall effects on water quality from normal operations would be low-intensity, temporary, local, and would affect a common resource. Construction of gravel artificial islands to support exploratory drilling activities could result in effects on water quality that are medium-intensity, long-term, local and would affect a common resource as defined in the impact criteria in Section 4.1 of this EIS. If oil and gas industry operators comply with EPA CWA requirements, then elevations in turbidity and concentrations of total suspended solids resulting from exploratory drilling activity would not result in unreasonable degradation of the marine environment.

Proposed mitigation measures intended to reduce/ lessen non-acoustic impacts on marine mammals (see Section 2.4.7(c)) have the potential to further reduce adverse impacts to water quality by reducing discharge of drill cuttings and drilling muds.

Metals

Seismic Surveys

Seismic surveys conducted from ships would not be expected to have any measureable impact on total or dissolved metal concentrations in the EIS project area. Inputs to the water from ship-based seismic survey activities would be local in nature, and any effects on water quality resulting from such inputs are expected to be negligible.

Site Clearance and Shallow Hazards Surveys

Site clearance and shallow hazards surveys conducted from ships would not be expected to have any measureable impact on total or dissolved metal concentrations in the EIS project area. Inputs to the water from ship-based site clearance and shallow hazards surveys would be local in nature, and any effects on water quality resulting from such inputs are expected to be negligible.

On-ice Seismic Surveys

On-ice seismic surveys would not be expected to have any measurable impact on total or dissolved metal concentrations in the EIS project area. Inputs to the water from on-ice seismic survey activities would be local in nature, and any effects on water quality resulting from such inputs are expected to be negligible.

Exploratory Drilling Programs

Discharge of drill cuttings and drilling fluids from exploratory drilling programs could result in elevated levels of metals in the water (Neff 1981, NRC 1983). Chromium, copper, mercury, lead, and zinc are the metals of greatest concern resulting from the discharge of drill cuttings and drilling fluids (Neff 1981). The EPA marine water quality criteria concentrations for these metals are given in Table 3.1-7 (EPA 2009b). Arsenic, nickel, vanadium, and manganese may also be present at elevated concentrations in some drill cuttings and drilling fluids. Barium, as $BaSO_4$, is usually present at high concentrations in drilling fluids, but due to its low solubility in seawater and low reactivity, barium sulfate would settle to the seafloor as it is discharged, and would not be expected to have any effects on water quality (DHHS 2007). Some metals are present in additives that may be mixed with the drilling mud to improve the physical and chemical properties of the mud, while other metals may be contaminants of major mud ingredients or may be present in drill cuttings (Neff 1981). Additives such as drill pipe dope, which contains 15 percent copper and seven percent lead, and drill collar dope, which can contain 35 percent zinc, 20 percent lead, and seven percent copper, may also contribute trace metals to discharges of drill cuttings and drilling fluids (EPA 2006b). Lignosulfonate compounds that are commonly added to drilling fluids as deflocculants and thinners are another source of metals in discharges from exploratory drilling programs. The concentrations of some metals commonly found in drill cuttings are given in Table 3.1-9.

A detailed discussion related to the environmental distribution of trace metals from exploratory drilling activities is available in the *Ocean Discharge Criteria Evaluation for Oil and Gas Exploration Facilities on the Outer Continental Shelf and Contiguous State Waters in the Beaufort Sea, Alaska (NPDES Permit No.: AKG-28-2100)* (EPA 2012c) and *Ocean Discharge Criteria Evaluation for Oil and Gas Exploration Facilities on the Outer Continental Shelf in the Chukchi Sea, Alaska (NPDES Permit No.: AKG-28-8100)* (EPA 2012d) and is incorporated here by reference.

As discussed in the section about turbidity and suspended solids, the discharge plume would undergo rapid fractionation as it is discharged to the ocean. Most of the discharged drill cuttings and drilling fluids would rapidly sink to the bottom near the discharge location (Neff 2005). The actual distance traveled by the discharge would depend on the water depth, lateral transport, particle size and the density of the discharged material (NRC 2003). A smaller fraction of the discharge plume, consisting of soluble components and fine-grained particles, is likely to remain in the water column longer, and may be transported considerable distances from the discharge site. Depending on the composition of the discharged drill cuttings and drilling fluids, as well as the rate of discharge, lateral transport, and dilution rates, concentrations of soluble metals may exceed EPA marine water quality criteria for dissolved metals within a small area around the site of discharge. Effects on water quality would be local and would generally be restricted to the areas within 100 m (328 ft) of the activity (NRC 1983, Neff 2005). Direct effects on water quality resulting from increased dissolved metal concentrations from exploratory drilling activities under Alternative 2 are expected to be low-intensity, temporary, local, and would affect a common resource as defined in the impact criteria in Section 4.1 of this EIS.

Indirect effects could result from resuspension of deposited sediments with elevated concentrations of trace metals. Metals from resuspended sediments could contribute to elevated concentrations of metals dissolved in the water. The magnitude of effects on water quality resulting from elevation of metal concentrations would depend on the composition of the sediments, concentrations of certain metal ions in the water column, and the uses of the affected water. As discussed in the previous paragraphs, concentrations of certain dissolved metals above the established threshold values would result in adverse effects on water quality within the proposed action area (Table 3.1-7, EPA 2009b). These effects could occur indirectly (i.e. at a later time than the proposed action) if deposited sediments with elevated concentrations of soluble metals were resuspended by tides, waves, or other natural or unnatural events. The magnitude of such indirect effects on water quality would depend on the composition of the deposited sediments, as well as other factors. Based on analysis of sediments discharged from oil and gas operations (NRC 1983) and chemical assessment of sediments in the Sivulliq Prospect around

Hammerhead drillsite (Trefry and Trocine 2009), concentrations of metals dissolved from resuspended sediments are unlikely to exceed the EPA Water Quality Criteria (EPA 2009b). If such indirect effects were to occur, the effects on water quality in the proposed action area under Alternative 2 are expected to be low-intensity, temporary, local, and would affect a common resource.

Hydrocarbons and Organic Contaminants

Seismic Surveys

Seismic surveys conducted from ships, as described in Section 2.3.2 of this EIS, would have negligible impacts on concentrations of hydrocarbons and organic contaminants in the waters of the proposed action area. Inputs to the water from seismic survey activities would be extremely local in nature, and effects on water quality resulting from such inputs, if any, are expected to be negligible.

Site Clearance and Shallow Hazards Surveys

Site clearance and shallow hazards surveys would have negligible impacts on concentrations of hydrocarbons and organic contaminants in the waters of the proposed action area. Inputs to the water from site clearance and shallow hazards survey activities would be extremely local in nature, and effects on water quality resulting from such inputs, if any, are expected to be negligible.

On-ice Seismic Surveys

On-ice seismic surveys would have minor impacts on concentrations of hydrocarbons and organic contaminants in the waters of the proposed action area. Contaminants from fluids entrained in the ice roads would be discharged every spring during breakup. Entrained hydrocarbons and other organic contaminants from vehicle exhaust, oil, grease, and other vehicle-related fluids would pass into the Beaufort Sea system at each breakup as a result of on-ice seismic surveys. The effects of these discharges on water quality would be temporary and local in nature, and overall impacts to water quality from on-ice seismic surveys are expected to be minor as defined in the impact criteria in Section 4.1 of this EIS.

Exploratory Drilling Programs

Inputs of hydrocarbons and other organic contaminants resulting from construction activities related to exploratory drilling programs are expected to be negligible. Other activities associated with exploratory drilling activities are addressed below.

Discharge of drill cuttings and drilling fluids from exploratory drilling programs would result in increased concentrations of hydrocarbons and other organic contaminants in the water (Neff 1981, NRC 1983, EPA 2012d). Although only water based drilling fluids would be used in the drilling of exploration wells within the proposed action area, organic additives are often used to modify the properties of the water based fluid (Neff 2005). These additives serve a variety of purposes. Petroleum products may be added to drilling fluid as lubricants and fluid loss agents, and blends of organic compounds, synthetic polymers, and salts may be added to the fluid as heat-stable dispersants and thinning agents (Neff 1981). In most cases, discharges of spent drilling fluids and cuttings coated by those fluids contain considerable amounts of relatively stable and potentially toxic hydrocarbon compounds (Patin 1999). Example concentrations of several organic compounds in drill cuttings are provided in Table 3.1-9 (Chapter 3).

Like metals and suspended sediments discharged as components of drilling fluid mixtures, the dispersion, distribution, and fate of discharged hydrocarbons and other organic contaminants would depend upon the chemical attributes of the compounds being discharged, as well as the rate of discharge, lateral transport, and dilution rates of the discharge plume in the environment. Also, because of the lack of applicable water quality criteria for some of the organic compounds present in drilling fluids, determination of potential exceedances resulting from drilling fluid organics in marine water is problematic.

Impacts to water quality resulting from hydrocarbons and other organic contaminants would be temporary and would dissipate soon after the discharge is stopped. Such impacts would be local in nature due to rapid dilution of discharged compounds into the ocean. It seems probable that inputs of hydrocarbons and other organic contaminants from exploratory drilling programs under Alternative 2 would have minor to moderate effects on water quality outside of the discharge plume area.

There is the potential that a small, accidental fuel spill of less than 50 bbl could occur (see Section 4.2.7). A fuel spill would introduce hydrocarbons and temporary toxicity to the surface water. The effects of a fuel spill would be limited by required deployment of booming equipment during fuel transfers and automatic shutdown of fuel lines triggered by decreased pressure. The effects are anticipated to be localized and short-term.

4.5.1.5.2 Conclusion

The effects of Alternative 2 on water quality are expected to be low-intensity, temporary, local, and would affect a common resource. The overall effects of the proposed activity described in Alternative 2 on water quality in the proposed action area are expected to be negligible.

4.5.1.6 Environmental Contaminants and Ecosystem Functions

"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 ecosystem functions (Costanza et al. 1997). A large number of Alaska Arctic Region OCS ecosystem functions can be identified, and many of the goods and services that depend on those functions are discussed in the other resource-specific sections of this document (e.g. subsistence, recreation, cultural resources). Some examples of relevant ecosystem goods and services from the Alaska Arctic region OCS and the functions from which they are derived are summarized in Section 3.1.8.1 of this EIS.

The values of ecosystem goods and services in the Alaska Arctic Region OCS are usually derived from interplay among various ecosystem components — the physical environment, chemical environment, and biological communities. Ecosystem goods and services are only rarely the product of a single species or component. Therefore, the interactions of various ecosystem components must be considered as important aspects of the affected environment. Environmental contaminants resulting from activities described in the alternatives have the potential to impact ecosystem goods and services by upsetting the synergies that exist between different components of the ecosystem and disrupting the ecosystem functions from which humans derive value. These contaminants of concern would be introduced to the environment through various pathways associated with the alternatives, as well as from sources outside of the action area via transport and deposition processes (Woodgate and Aagaard 2005). Many contaminants of concern are discussed in the resource specific sections of this document (e.g. water quality, air quality), and this section does not aim to repeat those discussions. Rather, in response to comments received during the scoping process, this analysis takes an integrated approach by assessing the effects of contaminants on ecosystem functions, which are derived from connectivity and interplay between ecosystem components. Comments from Scoping Report (Appendix C):

COR 11 *"The EIS should follow an ecosystem approach in its evaluation of impacts to biological resources and their habitats…"*

RME 1 *"The EIS needs to consider that the Arctic contains some of the world's last remaining intact marine ecosystems and impacts to this baseline from climate change, ocean acidification, and increasing industrial activities."*

Traditional Knowledge also suggests that an ecosystem approach is needed for assessment of effects of oil and gas activities in the Arctic. On March 11, 2010 at the Nuiqsut Scoping Meeting for this EIS, Rosemary Ahtuangaruak of the Iñupiat Community of the Arctic Slope stated:

> *The process with the issues related to the water quality, you know, I don't know how the process is still presented to us in the plan, dumping the muds into the water. I mean, where is the level of understanding of the importance of the biological diversity of the area, the increased risk factors we have because of our continued living in this area and the increased concentration in these animals because of the decades of lives that they live and the reactions that occur to us.*

Taking an "ecosystem approach", this section presents qualitative analyses of potential impacts under each alternative related to the influence of contaminants of concern on ecosystem functions. These analyses identify contaminants of concern, explore potential exposure pathways for habitat and biological resources, and assess the effects of contaminants on selected ecosystem functions.

Although a wide range of ecosystem functions have been described, they can generally be grouped into four basic categories based on definitions provided by DeGroot et al. (2002). **Regulation functions** relate to the capacity of natural systems to maintain essential ecological processes (such as nutrient cycles) and life support systems (such as provision of clean water). **Habitat functions** relate to provision of refuge and reproduction habitats and therefore contribute to the (*in situ*) conservation of biological diversity and evolutionary processes. **Production functions** relate to conversion of energy and nutrients into biomass by primary producers, as well as subsequent trophic transfers and biogeochemical processes, which create a diversity of living biomass, as well as non-living resources, from which a wide range of ecosystem goods and services are provided. **Information functions** contribute to the maintenance of human health by providing opportunities for spiritual enrichment, cognitive development, recreation, and aesthetic experience (DeGroot et al. 2002).

The level of impacts to environmental contaminants will be based on levels of intensity, duration, geographic extent, and context, as shown in Table 4.5-16.

Table 4.5-16 Impact Levels for Effects on Environmental Contaminants

Impact Component	Effects Summary		
Magnitude or Intensity	**Low**: Changes in ecosystem functions may not be measurable or noticeable	**Medium**: Noticeable changes in ecosystem functions	**High**: Acute or obvious changes in ecosystem functions
Duration	**Temporary**: ecosystem functions would be reduced infrequently but not longer than the span of the project season and would be expected to return to pre-activity levels at the completion of the activity	**Long-term**: ecosystem functions would be reduced through the life of the project and would return to pre-activity levels at some time after completion of the project	**Permanent**: Chronic effects; ecosystem functions would not be anticipated to return to previous levels
Geographic Extent	**Local**: Impacts limited geographically; <10% of EIS project area affected	**Regional**: Affects ecosystem functions beyond a local area, potentially throughout the EIS project area	**State-wide**: Affects ecosystem functions beyond the region or EIS project area
Context	**Common**: Affects usual or ordinary ecosystem functions; not impacted	**Important**: Affects impacted ecosystem functions within the	**Unique**: Affects unique ecosystem functions

Impact Component	Effects Summary		
		locality or region	

4.5.1.6.1 Direct and Indirect Effects

Contaminants of Concern

Organochlorines

Organochlorine contaminants, such as dichlorodiphenyltrichloroethane (DDT), polychlorinated biphenyl compounds (PCBs), chlorinated benzene isomers (ClBz), and hexachlorocyclohexane isomers (HCHs), would not be introduced into the EIS project area in substantial quantities as a result of the activities proposed under Alternative 2. The impacts of Alternative 2 on organochlorine contaminants in the EIS project area are expected to be negligible.

Petroleum hydrocarbons and polycyclic aromatic hydrocarbons (PAHs)

Petroleum hydrocarbons and PAHs would be introduced into the EIS project area in measureable quantities as a result of the actions proposed under Alternative 2. Petroleum hydrocarbons and PAHs would be discharged as a result of activities associated with exploration drilling, and would also be present in fuel and exhausts from vehicles and machinery associated with all components of Alternative 2. Due to their hydrophobic properties and persistence in the environment PAHs would partition into sediments and lipids in the marine environment, and their concentrations would increase at higher trophic levels as a result of persistence in biological systems and efficient transfer of lipids between trophic levels.

PAHs and petroleum hydrocarbons resulting from past oil and gas exploration activities have been measured in sediments in the vicinity of Prudhoe Bay (Neff 2010), and the activities proposed in Alternative 2 would lead to increases in concentrations of PAHs and total petroleum hydrocarbons in organisms and habitat matrices in the proposed action area. The cANIMIDA study found that PAH profiles in tissues of fish and invertebrates in the Beaufort Sea were consistent with a petrogenic and pyrogenic sources, and that PAHs in biological tissues of Beaufort Sea organisms originate from a combination of atmospheric deposition, industrial activity, erosion, and runoff from land (Neff 2010). A study specifically intended to determine concentrations of PAHs in bowhead whales harvested around Barrow found that no PAH compounds, nor PAH parent compounds or homologs, were present in detectable amounts in samples collected from different fractions of bowhead whales (Wetzel et al. 2008). Similarly, analyses to assess PAHs in stored samples of whale muscle and blubber produced no detectable levels of PAH compounds (Wetzel et al. 2008). The activities proposed under Alternative 2 would lead to measureable changes in PAH concentrations in some environmental matrices. Effects resulting from point-source discharges would be medium-intensity and local, and effects from atmospheric deposition would be low-intensity and widespread (i.e. state-wide as defined under the impact criteria). Proposed mitigation measures intended to reduce/ lessen non-acoustic impacts on marine mammals have the potential to reduce adverse impacts resulting from contaminants of concern.

Metals

Metals would be introduced into the EIS project area in measureable quantities as a result of the actions proposed under Alternative 2. Metals are also discussed under Section 4.1.5.6 (Water Quality); this discussion is based on the premise that not all metals of concern are water soluble, and as a result, water quality criteria do not necessarily account for all of the impacts associated with the introduction of metals to the EIS project area. While state and federal regulations establish criteria for concentrations of potentially toxic metals in water, these criteria do not account for concentrations of metals in other environmental matrices including sediments, which could lead to adverse effects in benthic organisms as well as effects on higher trophic levels. Chromium, copper, mercury, lead, and zinc would be the metals of greatest concern (Neff 1981). The major concerns associated with metals in the marine environment are that they could cause deleterious sublethal effects in sensitive organisms; and could accumulate to dangerous levels in higher trophic level organisms as a result of bioconcentration processes. Elevated concentrations of chromium, lead and zinc would occur in sediments in close proximity to discharges, however, concentrations of these metals in the sediments would likely decrease to background levels within several hundred meters of the discharge (Neff 1981).

Overexposure to chromium could lead to increases in the incidence of cancers in higher trophic level organisms and could interfere with the functioning of certain proteins (Cohen et al. 1993). Elevated levels of copper could interfere with the functioning of certain enzymes involved in respiration, and could cause delayed development of larval organisms (Flemming and Trevors 1989, Bianchini et al. 2004). Elevated concentrations of mercury, lead, and zinc could result in adverse effects to marine organisms (Bryan 1971, Boening 2000). The activities proposed under Alternative 2 would lead to measureable changes in concentrations of metals in some environmental matrices. Impacts resulting from point-source discharges would be medium-intensity and local, but the intensity of the impacts would decrease rapidly with distance from the point of discharge. Overall, effects of introduced metals resulting from the activities proposed in Alternative 2 would be minor.

Proposed mitigation measures intended to reduce/ lessen non-acoustic impacts on marine mammals have the potential to reduce adverse impacts resulting from contaminants of concern.

Exposure of Habitat and Biological Resources

In order for exposure of habitats and biological resources to occur, stressors (in this case contaminants of concern), and receptors (habitats and biological resources), would need to be present at the same time and at the same place (i.e. co-occurrence). Therefore, in order to assess the exposure of habitat and biological resources to contaminants of concern resulting from the actions proposed under Alternative 2, the behavior and partitioning of the contaminants in the environment should be considered. As described in Section 3.1.8.2, many of the contaminants of concern associated with the proposed action have low solubility in water as a result of their non-polar molecular structures. As a result of low aqueous solubility, these compounds would tend to associate with organic material or solid-phase particles (such as sediments) in the environment (Trefry et al. 2004, MMS 2004-031).

In general, because contaminants of concern partition into the organic and particulate phases, the concentrations of these contaminants in water would be low. Depending on their molecular structures and properties, organic contaminants originating from seismic and exploratory drilling activities would partition into sediments, which would settle out on to the seafloor. Therefore, in order for substantial exposure to occur, receptors would have to come into contact with sediments containing substantial levels of the contaminant of concern. We can conclude that the direct impact to pelagic organisms from contaminants of concern introduced to the EIS project area as a result of the activities proposed under Alternative 2 would be minor, with the exception of those organisms located directly in the plume of materials discharged from exploratory drilling operations.

Many of the contaminants of concern, including organic contaminants such as organochlorine compounds and PAHs, as well as metals such as chromium and mercury, have the potential to accumulate in higher trophic level organisms. With regard to such higher trophic level organisms, indirect effects could result from exposure to contaminants of concern through the food web, and the relevant pathway of exposure would involve trophic transfers of contaminants rather than direct exposure. Monitoring conducted as part of the ANIMIDA and cANIMIDA projects has shown that oil and gas developments in the Alaskan Beaufort Sea “are not contributing ecologically important amounts of petroleum hydrocarbons and metals to the near-shore marine food web of the area” (Neff 2010).

Effects on Ecosystem Functions

In response to comments and suggestions received as part of the scoping process for this EIS, effects of (contaminants of concern from) the proposed activities on ecosystem functions are assessed in the following section. Effects of the activities proposed under Alternative 2 on the four categories of ecosystem functions (defined in Section 4.4.1.6) are assessed below.

Regulation Functions

The actions proposed under Alternative 2 would affect regulation functions such as nutrient cycling and waste assimilation in the EIS project area. These ecosystem functions depend on biota and physical processes to facilitate storage and recycling of nutrients, and breakdown or assimilation of contaminants. The magnitude and extent of effects of Alternative 2 on regulation functions would depend upon interrelationships between impacts to biological and physical resources, which are addressed in other sections of this EIS.

Habitat Functions

Effects of Alternative 2 on habitat functions would include impacts to refugium functions and nursery functions (provision of suitable reproduction habitat) associated with benthic habitats resulting from discharges from exploratory drilling. Contaminants of concern, including hydrocarbons and metals, would affect benthic habitats in the vicinity of the discharges. Due to the relatively high octanol water partitioning ratios for most contaminants of concern, the contaminants of greatest concern would preferentially partition into sediments and the greatest impacts would be on functions associated with benthic habitats. Overall effects to benthic habitat functions would be temporary, local, and low-intensity. Effects would also occur to functions associated with pelagic and epontic habitats. Functions associated with terrestrial habitats would be affected to a lesser degree. Overall, effects of Alternative 2 on habitat functions would be medium-intensity, temporary and local. The functions affected could be common, important, or unique depending on the spatial location of the impact. On the spectrum from negligible to major, described in Section 4.1.3, the effects of Alternative 2 on habitat functions would be considered minor due to the limited spatial extent of the impacts.

Proposed mitigation measures intended to reduce/ lessen non-acoustic impacts on marine mammals have the potential to reduce adverse impacts to habitat functions and are described in greater detail below.

Production Functions

Effects of Alternative 2 on production functions would include not only impacts on primary productivity (discussed in the lower trophic levels section) but also impacts to higher-level trophic transfers, leading to indirect effects on a wide range of ecosystem goods and services. Impacts to production functions related to provision of raw materials and food (i.e. subsistence) could be affected by the activities proposed under Alternative 2. These impacts are described in the subsistence section of this EIS. In addition to introducing contaminants to secondary and tertiary consumers via trophic transfer processes, contaminants of concern could interrupt trophic transfer processes resulting in shorter food chains (less complex food webs) and reduced throughput of energy and nutrients at higher trophic levels.

Information Functions

Information functions contribute to the maintenance of human health by providing opportunities for spiritual enrichment, cognitive development, recreation, and aesthetic experience (DeGroot et al. 2002). The effects of Alternative 2 on information functions in the EIS project area would depend upon interrelationships between impacts to cultural resources, social resources and aesthetic resources, which are addressed in other sections of this EIS.

4.5.1.6.2 Conclusion

Direct and indirect impacts to ecosystem functions resulting from the implementation of Alternative 2 would be medium-intensity, temporary, localized, and common in context. The functional properties of ecosystems described in this section, such as nutrient cycling and habitat functions, are more robust (i.e. resistant to stressors) than are species composition and other structural properties. Overall effects of Alternative 2 on ecosystem functions would be negligible.

4.5.1.7 Mitigation Measures for the Physical Environment

Standard Mitigation Measures are outlined in Section 2.4.10 and Additional Mitigation Measures are outlined in Section 2.4.11, and both are described in detail in Appendix A. Requirements for implementation depend on type, time, and location of activities and co-occurrence of multiple activities. A combination of mitigation measures could be required for any one ITA. Of note, there are a large number of mitigation measures that are intended to reduce impacts to the acoustic environment with the ultimate goal of reducing impacts to a particular resource, such as marine mammals or subsistence hunts. These measures are evaluated within the context of those more targeted resources and are not repeated here.

4.5.2 Biological Environment

Table 4.5-17 indicates the mechanisms by which effects of oil and gas exploration activities identified in the alternatives on biological resources can be measured. This table summarizes the criteria for determining the level of impact to biological resources based on the magnitude, duration, extent, and context of occurrence.

Table 4.5-17 Impact Criteria for Effects on Biological Resources

Type of Effect	Impact Component	Effects Summary		
Behavioral Disturbance	Magnitude or Intensity	**High**: Acute or obvious/abrupt change in behavior due to exploration activity; animals depart from the EIS project area	**Medium**: Noticeable change in behavior due to exploration activity; animals move away from the specific activity area but remain in the EIS project area	**Low**: Changes in behavior due to exploration activity may not be noticeable; animals remain in the vicinity
	Duration	**Long-term**: Change in behavior patterns even if actions that caused the impacts were to cease; behavior not expected to return to previous patterns	**Interim**: Behavior patterns altered for several years and would return to pre-activity patterns at some time after actions causing impacts were to cease	**Temporary**: Behavior patterns altered infrequently but not longer than the span of one year and would be expected to return to pre-activity patterns after actions causing impacts were to cease
	Geographic Extent	**State-wide**: Affects resources beyond the region or EIS project area	**Regional**: Affects resources beyond a local area, potentially throughout the EIS project area	**Local**: Impacts limited geographically; <10% of Beaufort or Chukchi seas affected
	Context	**Unique**: Resources listed as threatened or endangered (or proposed for listing) under the ESA and/or depleted under the MMPA and the portion of the resource affected fills a unique ecosystem role within the locality or region	**Important**: Affects depleted resources within the locality or region or resources protected by legislation	**Common**: Affects usual or ordinary resources in the EIS project area; resource is not depleted in the locality or protected by legislation
Injury and Mortality	Magnitude or Intensity	**High**: Incident of mortality or multiple incidences of injury	**Medium**: Incident of injury	**Low**: No noticeable incidents of injury or mortality
	Duration	**Long-term**: Incidences of mortality or injury would continue to occur longer than five years or persist after actions that caused the disturbance ceased	**Interim**: Incidence of injury would continue for greater than one year to less than five years	**Temporary**: Interactions would occur for a brief, discrete period lasting less than one year
	Geographic Extent	**State-wide**: Impacts would occur beyond the EIS project area	**Regional**: Impacts would occur within the Beaufort or Chukchi seas	**Local**: Impacts would not extend to a broad region
	Context	**Unique**: Resources listed as threatened or endangered (or proposed for listing) under the ESA and/or depleted under the MMPA and	**Important**: Affects depleted resources within the locality or region or resources protected by legislation	**Common**: Affects usual or ordinary resources in the EIS project area; resource is not depleted in the locality or protected by legislation

Type of Effect	Impact Component	Effects Summary		
		the portion of the resource affected fills a unique ecosystem role within the locality or region		
Habitat Alterations	Magnitude or Intensity	**High**: Acute or obvious changes in resource character	**Medium**: Noticeable changes in resource character	**Low**: Changes in resource character may not be measurable or noticeable
	Duration	**Long-term**: Chronic effects; resource would not be anticipated to return to previous levels	**Interim**: Resource would be reduced for five to seven years and would return to pre-activity levels at some time after that point	**Temporary**: Resource would be reduced infrequently but not longer than the span of one year and would be expected to return to pre-activity levels
	Geographic Extent	**State-wide**: Affects resources beyond the region or EIS project area	**Regional**: Affects resources beyond a local area, potentially throughout the EIS project area	**Local**: Impacts limited geographically; <10% of Beaufort or Chukchi Sea affected
	Context	**Unique**: Resources listed as threatened or endangered (or proposed for listing) under the ESA and/or depleted under the MMPA and the portion of the resource affected fills a unique ecosystem role within the locality or region	**Important**: Affects depleted resources within the locality or region or resources protected by legislation	**Common**: Affects usual or ordinary resources in the EIS project area; resource is not depleted in the locality or protected by legislation

4.5.2.1 Lower Trophic Levels

The oil and gas exploration activities proposed in Alternative 2 can impact the lower trophic levels in a number of different manners. The direct and indirect effects may be caused by specific oil and gas exploration activities or a combination thereof. The categories of proposed exploration are: high resolution shallow hazard and site clearing surveys; 2D/3D deep penetration seismic surveys; and exploratory drilling (see Section 2.3 for a complete description of exploration activities). The effects most likely to be encountered during these activities are: disturbance of benthic 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; and introduction of invasive species, due to ship traffic. A brief summary of each is provided below. On-ice seismic surveys are not expected to have any effects on lower trophic levels since the activity occurs on top of the ice and not in the water column.

4.5.2.1.1 Direct and Indirect Effects

Oil and gas exploration activities under Alternative 2 include the use of a variety of small and large support vessels and icebreakers. Seismic airgun arrays, and associated gear such as sensor arrays in streamers, on cables, and nodes are deployed in the water column and on the ocean bottom. Drilling rigs, helicopters, fixed-wing aircraft, and on-shore support facilities are also associated with exploration activities. All of these can directly and indirectly cause behavioral disturbance of marine mammals and other higher trophic level animals, and/or habitat loss/alteration, which in turn would affect lower trophic level organisms in the EIS project area.

Behavioral Disturbance

There is not much direct evidence regarding how oil and gas exploration activities affect or disturb behavior in lower trophic level organisms. However, it can be assumed any activities that might directly impact the seabed could also disturb benthic infaunal and macrofaunal populations. These activities could include ice breaking efforts that could disturb ice-associated organisms. However, ice typically returns to fill the wake as the ship passes (NMFS 2010c). Benthic organisms could be displaced from locations where drilling, sediment sampling, ship anchoring, or platform installation would occur. Because these populations are typically impacted by seasonal displacement due to natural ice scour and because the areas impacted would be minor in relation to the overall available benthic habitat the anticipated effect would be localized, minor and short-term.

Injury and Mortality

Any exploration activities that directly impact the seafloor, such as anchoring of drill ships and support vessels, and creation of artificial drilling islands, could cause direct injury and mortality to lower trophic level organisms. Ice scouring is a naturally occurring event. It is not clear if scouring would be affected by the use of icebreaking vessels during oil and gas exploration because these ships are not used in shallow waters, although ice floes that could extend to the ocean floor could be set in motion by ice breakers. Ice scouring can also directly cause injuries and mortalities to the benthos as ice is dragged across the seafloor. In addition, organisms can be buried and smothered as the ice moves through the substrate. Activities that disturb the bottom habitat in areas such as Hanna Shoal, the shelf break of the Beaufort Sea, and the Western Beaufort Sea can be particularly damaging since these areas support biologically unique communities, as well as provide important feeding and resting grounds for demersal species and macrofauna.

Recent studies show that metals associated with water-based drilling fluids are not readily absorbed by living organisms, but they do carry organic additives that can result in oxygen depletion, which could adversely affect benthic organisms in the immediate area of discharge. Likewise, increased sedimentation by the discharges could adversely affect benthic organisms via physical smothering in the area of discharge. Modeling indicates that under most scenarios, the majority of the drill cuttings would settle within 100 m (328 ft) and the solids associated with the drilling fluids are deposited within 1,000 m (3,280 ft) of the discharge. Overall, the drilling fluid and cuttings deposition are predicted to deposit on the seafloor in substantially different patterns due to the difference in solids characteristics and current speed. The drilling fluids are predicted to deposit in a thinner layer, and over a larger area, than the cuttings deposits.

There is the potential for lower trophic levels to be exposed to small, accidental fuel spills of less than 50 bbl (see Section 4.2.7). The effects of a small fuel spill would be dependent upon sea conditions at the time of the spill. With high wind conditions and rough seas, the diesel would be rapidly diluted and dispersed, and effects of the spill would be negligible. In calmer waters, evaporation of the diesel would be rapid, and the area covered by dispersion of the remaining hydrocarbons would be dependent upon wind speed, wind direction, and water temperature. Loss of benthic organisms due to hydrocarbon poisoning would probably not occur due to dispersion of hydrocarbons before reaching benthic surface. Effects on pelagic organisms would be localized, and the level of effect would be negligible.

Habitat Loss/Alteration

The primary cause of habitat loss and alteration would be due to exploratory drilling activities, which can cause disturbance to the benthic habitat; the effect is highly localized and disparate and therefore difficult to quantify. Some species are quick to repopulate the disturbed area, but it can take a decade for the habitat to fully recover from disturbance. Some species, such as the large clams walrus feed on, have been shown to take 9 years to recolonize an area, and even then, they did not recover completely (Conlan and Kvitek 2005, BOEM 2010).

The other potential cause of habitat loss/alteration is invasive species. As vessel traffic increases, the potential for non-native species to be introduced and alter the habitat increases.

4.5.2.1.2 Conclusion

Using the criteria identified in Table 4.5-17, the direct and indirect effects discussed above would likely be low in intensity, temporary to long-term in duration, of local extent and would affect common resources; resulting in a summary impact level of negligible. The only exception to these levels of impacts would be the introduction of an invasive species due to increased vessel traffic, which could be of medium intensity, long-term or permanent duration, of regional geographic extent, and affect common or important resources, which could cause a summary impact of moderate.

4.5.2.2 Fish and Essential Fish Habitat

The oil and gas exploration activities covered in Alternative 2 can impact fish resources in a number of different ways. Some effects are specific to a certain activity, while others are common to multiple activities. For the purposes of this analysis, the mechanisms for each effect are first explained, and then the effects from each of the four main categories of activity are described. The four categories of activity are: 2D/3D Seismic Surveys including an In-Ice Survey, Site Clearance and High Resolution Shallow Hazard Surveys, On-ice Seismic Surveys, and Exploratory Drilling (see Section 2.3 for a complete description of the activities). The effects most likely to be encountered during these activities are: exposure of fish to noise caused by seismic surveys, exploratory drilling, and vessel traffic; and temporary or long term fish habitat loss and/or alteration from icebreaking and exploratory drilling activities. Effects to fish from site clearance and high resolution shallow hazard surveys that use airguns would be expected to be similar to the effects from 2D/3D seismic surveys, but to a lesser extent due to the much smaller volume of the airgun(s). On-ice seismic surveys could affect under-ice-shelter for various fish life stages, including arctic cod eggs and developing larvae. The effects on fish resources resulting from a potential very large oil spill in the Beaufort and Chukchi seas are analyzed in Section 4.10.6.9 and 4.10.7.9.

During the scoping process, a number of stakeholders identified concerns related to fish resources within the EIS project area. The major issue identified was the impact of noise from oil and gas activities on marine species. In regards to fish, the concerns specifically centered on the potential for hearing loss, behavioral disruptions, and mortality of fish eggs and larvae, in addition to the impacts from acute and chronic stress and reductions in availability of fish as prey for marine mammals. Subsistence concerns addressed the potential effects of oil and gas activities on the availability of saffron cod and salmon. Saffron cod (known as tomcod in Native communities along the Arctic coast), and salmon (particularly pink and chum) are important to Alaska Native residents both directly as subsistence species and indirectly as prey for marine mammal subsistence species such as beluga whales, ice seals, and walrus. A final concern was the overall scarcity of scientific data regarding biological resources in the action area, yet a desire for quantifiable impacts was expressed. The concerns identified in the scoping process have been addressed in the analysis below.

Exposure to Noise

The range of potential effects to fish from intense sound sources, such as seismic airguns, varies widely, but is primarily influenced by the level of sound exposure. Higher sound levels are more damaging, as shown in Table 4.5-18. Data in this table are based on information from reports of responses of fish species (both Arctic and non-Arctic species) to seismic airgun pulses. Although direct physiological effects such as hearing damage or loss, tissue damage, or death can occur, indirect effects that modify fish behavior are much more common and likely. These behavioral modifications are highly variable and are dependent on a range of factors, including species, life history stage, time of day, whether the fish have fed, and how sound propagates in a particular setting (CNLOPB 2007).

Table 4.5-18 Physical and Behavioral Effects of Seismic Airguns on Fish, Eggs and Larvae

Effect	Sound Level (dB re 1 μPa)
Avoidance Behavior	160
Hearing Damage	180
Temporary Stunning	192
Egg/Larval Damage	210
Egg/Larval Mortality	220
Internal Injuries (swimbladder rupture, haemorrhaging, eye damage)	220
Fish Mortality	230-240

Source:
Modified from Turnpenny and Nedwell 1994, Davis et al. 1998

Research on acoustic impacts to fish has been limited to relatively few species, and specific data regarding the effects of noise on the species encountered in the arctic environment are lacking. While a number of studies have been undertaken, the number of species and species groups of fish is vast, and results obtained in studies on one species may not directly apply to other species. Likewise, the response to different types of stimuli can vary greatly, even when applied to the same species. For example, seismic signals have been shown to have a more pronounced effect on larger fish than on smaller fish of the same species (CNLOPB 2007). Despite the recognized need for further study on the effects of oil and gas activities on specific arctic fish species, sufficient information is available to support sound scientific judgments and reasoned managerial decisions regarding potential impacts of anthropogenic sound on fish. Given the nature of the proposed action, no significant effects are expected to occur to these resources under any alternative. Moreover, the missing information pertains to impacts that would be common to all action alternatives, and would not aid the decision between those alternatives. More information of this type is not essential for a reasoned choice among alternatives.

Fish rely heavily on sensory perceptions of sound and pressure for many activities vital for survival, such as feeding, navigation, spatial orientation, predator avoidance, and even communication. They possess hearing organs roughly comparable to other vertebrates with which they hear sounds, and also utilize a lateral line system which detects pressure waves near the fish. Combined, these two sensory systems provide fish with the ability to survive in their complicated underwater environment.

For a fish to detect a sound, two conditions must be met. First, the frequency needs to fall within the fish's audible range, and second, the intensity needs to be sufficiently strong for the fish to detect. In other words, the fish has to have the ability to hear the sound in the first place (frequency), and the sound needs to be loud enough for the fish to register (intensity). Most fish can detect sounds ranging in frequency from 50 Hz to 1,500 Hz, with some able to detect sounds up to 3 kHz (Popper and Hastings 2009).

The lateral line system is common to all fish and detects pressure waves in the water near the fish. It senses pressure differences along a line running down the length of the fish and enables the fish to detect movement nearby. It allows fish to detect currents and is vital for schooling fish, enabling them to sense and adjust their proximity and velocity within the body of their school (Stocker 2002). This system also enables fish to detect sound waves at very low frequencies of 100 Hz or less.

Direct harm to fish through physiological damage or death is very seldom documented, usually only in relation to repeated, extremely loud activities such as pile driving (Popper and Hastings 2009). Focused studies have been able to cause measurable physiological harm to fish using acoustic sources, such as permanent hearing loss or swim bladder damage, typically with sound sources measured at or above 180 dB re 1 µPa (McCauley et al. 2003, Stocker 2002, Turnpenny and Nedwell 1994). However, these observations have been under controlled experimental conditions that do not represent wild behavior of fish, and exposure to seismic sound is considered unlikely to result in direct fish or invertebrate mortality (DFO 2004). This is because fish are unlikely to remain in an area where intense sounds sources are present long enough to be injured or killed, though this is difficult to demonstrate in field conditions. Death can eventually result from a reduction in fitness due to hearing loss or tissue damage, but direct harm is generally limited to within 5 m (16 ft) of the sound source, at levels in excess of 230 dB (Turnpenny and Nedwell 1994). There is no recorded evidence that airguns have killed fish or caused injuries during seismic survey operations (Turnpenny and Nedwell 1994).

Eggs and larvae are more vulnerable to effects from sound than juvenile and adult fish as they are much less mobile, instead typically relying on currents for locomotion. In some instances, eggs are fixed to the substrate and therefore completely stationary. Sound levels in the vicinity of 220 dB have been shown to be lethal to fish eggs and larvae (Davis et al. 1998) (see Table 4.5-18). These sound levels correspond to a distance of 0.6 to 3 m (2 to 10 ft) from an airgun. Visible damage to larvae can occur at 210 dB, which corresponds to a distance of approximately 5 m (16 ft) from an airgun (Turnpenny and Nedwell 1994, Davis et al. 1998).

A more relevant concern is the indirect effect of noise on fish behavior. Typical effects from introduced noise include displacement, avoidance, startle responses, and stress (Turnpenny and Nedwell 1994). Scientific evidence suggests that some species of fish may be displaced from or choose not to enter areas of intense underwater noise, while short exposures to seismic sound may drive some demersal species to the seabed (Turnpenny and Nedwell 1994). Furthermore, numerous studies have shown catch rates to decline significantly immediately following the use of airguns for seismic surveys, with a period of up to five days required for catch rates to return to normal (Hassel et al. 2004, Popper and Hastings 2009). Researchers noted avoidance behavior in squid at levels between 156 and 174 dB re 1 µPa, and the peak source levels of airgun impulses are typically between 250 to 255 dB re 1 µPa (Stocker 2002).

The effects of avoidance and displacement can be numerous. By forcing fish away from their preferred habitats, risk of predation increases, and potential impacts from less desirable feeding and spawning habitat are also possible. There is also potential for disruption of reproductive behavior and the alteration of migration routes. More persistent sound intrusions have the potential for greater impacts, as they can displace fish for longer periods of time. Stress can result in increased mortality as well. Studies suggest that if exposure to sound results in highly-stressed fish, they may be more susceptible to predation or other environmental effects than non-stressed fish (Popper and Hastings 2009).

There are numerous sources of noise generated from oil and gas exploration activities that can affect fish resources. These sources are detailed below, along with their impacts on fish resources. The primary concern is noise generated from seismic surveys and exploratory drilling, while secondary concerns consider a noise generated from regular vessel operations and icebreaking activities.

Seismic Surveys

Acoustic energy pulses emitted by airguns are the principal impacting agents attributable to seismic surveys. The surveys are typically transient, passing through the survey area in a grid pattern. The energy emitted by a typical airgun shot is anticipated to range in frequency from 10 Hz to 120 Hz. This falls within the hearing range of most fish; however the sound level of airgun arrays can be as high as 255 dB, which is well above the level that has been shown to impact fish (see Table 4.5-18). Ramp-up procedures are likely to mitigate many impacts from exposure to these high sound levels as the gradual introduction of sound allows fish to move away from the source before exposure to detrimental sound levels occur.

Fish eggs and larvae would be unable to escape exposure to airgun noise associated with seismic surveys. However the potential for impact is very low given that the airguns would need to pass within meters of the eggs or larvae to have any detrimental effect (see Table 4.5-18). Although it is likely that some eggs and larvae will be exposed to detrimental sound levels, the small fraction of sea area covered by seismic surveys and the widespread nature of the resource make a population level impact highly unlikely.

Exploratory Drilling

The noises generated from exploratory drilling differ from seismic surveys in two key ways: they are less intense but are more stationary and persistent. A drilling operation has a single source of sound emanating from a fixed location for up to 90 days at a time. The sound produced by the drilling operation consists of loud mechanical noises emitted over a range of frequencies and intensities (see Section 2.3.3 for details). While the intensity of the sound is less than airgun arrays, a potential stationary zone of displacement will be created around the well site. If this zone of displacement is located in important spawning, fish-rearing, or feeding habitat, fish could be negatively impacted over time. However, this impact could be naturally mitigated by habituation of fish to the noise produced by the drilling activity. Since the noise would be somewhat regular in type and source, it is possible that some fish species may become habituated to them and the zone of displacement may be reduced over time.

Vessel Noise

Vessels produce baseline levels of noise when under power. Engines, generators, propellers, and pumps, produce sound, much of which is transferred directly to the marine environment. Some of this noise falls within the range of fish sensory perception, and fish have been shown to exhibit avoidance behaviors when confronted with noisy vessels (Mitson and Knudson 2003). However, vessel noise constitutes a relatively small component of the overall soundscape, especially when compared to the amount of noise introduced by seismic survey sources.

Icebreaking

The noise levels resulting from icebreaking operations vary depending on ice thickness, ice condition, vessel used, and vessel speed. Despite the variations due to these factors, operations can reach peak levels of 190 dB, and are typically continuous in nature (Roth and Schmidt 2010). This sound level is above the threshold to initiate avoidance behavior in fish (see Table 4.5-18), although the transient nature of the operation is not likely to result in long term displacement.

Habitat Loss/Alteration

Habitat loss and alteration can result from several activities involved in oil and gas exploration and can be temporary or permanent. Most activities will result in very few habitat impacts, mostly of a temporary nature, although any structures created during exploratory drilling would be considered long term from a fish resource standpoint. Temporary habitat loss could result from displacement associated with introduced noise or from direct alteration of the seafloor. Long term habitat loss would be associated with the removal or addition of substrate to the seafloor, such as the construction of a gravel island.

The specific activities likely to result in habitat loss or alteration are icebreaking during fall or winter seismic surveys, anchoring of seismic or support vessels, mud cellar construction, and exploratory drilling and associated gravel island construction.

Icebreaking

Icebreaking from support vessels during fall and early winter for seismic in-ice surveys would result in the direct loss of habitat for the cryopelagic fish assemblage, particularly Arctic cod. Sea ice forms the centerpiece for the entire cryopelagic community, and any alteration to the sea ice has the potential to impact the entire community. As an icebreaking vessel passes through sea ice, the ship causes the ice to part and travel alongside the hull. This ice typically returns to fill the wake as the ship passes. The effects are transitory, hours at most, and constrained to a narrow swath of ~30 ft (10 m) to each side of the vessel (NMFS 2010c).

Icebreakers could cause rapid pack ice movement at a time of year when the ice may not normally be breaking and moving in some locations; these ice movements could affect ice-associated fish species, particularly arctic cod eggs and larvae.

Anchoring

Vessel anchoring, which may be necessary at times during the course of exploration activities, can cause fish habitat loss or alteration through direct seafloor contact. Demersal fish, larvae, or eggs can be impacted directly if the anchor or chain contacts them, causing injury or even mortality. They may also be indirectly impacted due to sediment displacement, suspension, and deposition downstream, and by the scars caused by deployment, setting, and retrieval of the anchors and chains. A more likely effect will result indirectly through destruction or alteration of habitat. Anchors and chains are capable of destroying or damaging fish habitat by crushing and dragging along the sea floor during deployment, movement, and retrieval. Anchoring in fragile areas valuable as fish habitat such as kelp beds and coral will result in more damage than anchoring in sand or mud. The few known kelp beds in the EIS project area are located in nearshore areas or coastal lagoons, unlikely sites for a vessel to anchor unless necessary for safety (BOEM 2011b). Likewise, there is a known boulder patch in Steffanson Sound that provides relief from predators in the form of a hiding area or refuge from predators. The magnitude of any damage to the seafloor will depend chiefly on the type of substrate the anchor is deployed in and whether any dragging occurs.

Exploratory Drilling

Exploratory drilling operations may involve the discharge of drilling fluids and cuttings directly into the ocean at the drill site. Discharges can be detected over a much broader area than the effects of those discharges; while the zone of detection for drilling discharges can be up to 8 km (5 mi) from the drill site, the impacts to benthic communities is typically not detected further than 1 km (0.6 mi) out (Hurley and Ellis 2004).

Most of the major ingredients of drilling fluids have a low toxicity to marine organisms (Luyeye 2005), and, although observed impacts of drilling wastes have generally been attributed to chemical toxicity or organic enrichment, there is increasing evidence to indicate that fine particles in drilling wastes, such as bentonite and barite, can have detrimental effects to filter feeders (Hurley and Ellis 2004).

Heavy particles tend to settle within a few meters of the discharge site and can form a pile on the seafloor. There is potential that the cutting piles resulting from the heavy particles can smother benthic communities and result in artificial reef effects where the piles attract marine organisms and epifaunal animals such as crabs to colonize (BOEM 2007). These measurable effects on benthic communities have the potential to impact fish resources, particularly benthic feeders. However, scientific evidence suggests that drilling discharges and cuttings have minor effects on fish health (Hurley and Ellis 2004). The mobility of fish species and the relevant scale of environmental change appear to be the primary reasons for a lack of documented effects in the fish species studied.

Gravel Island Construction

Gravel island construction involves the addition of gravel to the seafloor to create an artificial island to be used as a drilling platform. Gravel islands are typically constructed in shallow areas, and any construction would result in the long term loss of any spawning, rearing, or feeding habitat located within the impacted area.

4.5.2.2.1 Direct and Indirect Effects

Marine Fish (Cryopelagic, Nearshore Demersal, Nearshore Pelagic, Offshore Demersal, Offshore Pelagic)

Of the noise sources introduced by Alternative 2, most have been shown to have no long term impact on fish or fish resources. Because marine fish are widely dispersed and are largely unrestricted in their movements, noises associated with these activities are not expected to have a measurable effect on marine fish populations. All fish assemblages could potentially be exposed to noise, although pelagic and cryopelagic species are more likely to be affected, mainly through behavioral disturbance. However, the transient nature of the noise sources associated with seismic surveys, vessel traffic, and icebreaking minimize the exposure to fish and fish resources, with standard ramp up procedures allowing further opportunity for mobile fish to escape the area of impact before any detrimental effects are felt. For more stationary noises associated with exploratory drilling, habituation provides a mechanism for fish to eliminate any effects from displacement. Therefore, the effect on juvenile and adult fish would be negligible. Based on the small footprint of the seismic surveys relative to the amount of habitat over the entire EIS project area, the effect would be minor, as a mechanism for population change exists, but no measurable change would result.

General population trends and life histories are sufficiently understood to support sound scientific judgments, and expected impacts to fish resources are minor. While further study would provide a more complete understanding of the fish resources within the EIS project area, existing information on the distribution of eggs and larvae throughout the EIS project area is sufficient to make an informed choice among the alternatives. Given the nature of the proposed action, no significant impacts are expected to occur to these resources under any alternatives. Moreover, the missing information pertains to impacts that would be common to all action alternatives, and would not aid the decision between those alternatives. More information of this type is not essential for a reasoned choice among alternatives.

The opportunity for habitat loss or alteration resulting from Alternative 2 is very small. Direct effects to nearshore and offshore demersal fish and fish habitats from exploratory drilling, gravel island construction, icebreaking, and anchoring would be restricted to very limited areas, particularly when compared to the total area of benthic habitat available. Therefore, the negative impacts are considered minor.

Migratory Fish (Anadromous, Amphidromous)

The effects on migratory fish resulting from Alternative 2 would be similar to those described for marine fish, although on a lesser scale. As migratory fish spend substantial parts of their life cycles away from the marine environment, and therefore away from any potential effects, the risk of exposure is reduced substantially.

Within the broad classification of migratory fish, anadromous species (salmon) are more likely to be impacted than are amphidromous fish due to the increased time they spend in the ocean. As discussed in Section 3.2.2.3.3, amphidromous fish typically spend most of their lives in fresh or brackish waters, rarely venturing out to sea. Anadromous fish, however, spend the majority of their adult lives at sea, and are therefore more susceptible to impacts from oil and gas exploration activities. They would therefore be susceptible to effects from noise and loss of habitat, particularly if any important feeding areas were impacted. However, pink and chum salmon, the most commonly encountered salmon species in the Arctic, are not very abundant in the areas impacted by oil and gas activities. Chum salmon are known to migrate as juveniles to the Bering Sea to mature, and pink salmon have been very infrequently encountered in marine arctic surveys (see Section 3.2.2.6).

Therefore, as with marine fish, the potential for impacts to migratory fish are so small when compared to the overall size of the habitat area and population that the effects are considered to be minor.

Essential Fish Habitat

As discussed in Section 3.2.2.5, EFH has been identified for all five species of Pacific salmon in addition to Arctic cod and saffron cod. Large portions of the EIS project area fall within the boundaries of the described EFH for these species. However, the amount of habitat actually essential to the survival of these fish that falls within the boundaries of the described EFH is likely considerable smaller than what is described.

Of the activities described in Alternative 2, only those resulting in potential habitat loss or alteration are relevant to EFH. Effects to fish habitat from exploratory drilling, gravel island construction, and anchoring would be restricted to very limited areas, particularly when compared to the total area of benthic habitat available. Icebreaking would impact a small percentage of ice, which is essential for arctic cod. Salmon species spend much of their adult life at sea and therefore require feeding habitat. Saffron cod spend their entire lives in the marine environment and require spawning, rearing, or feeding habitat. However, as with the analysis for marine fish, the opportunity for habitat loss or alteration resulting from Alternative 2 is very small. Most impacts would be of such low intensity and of such small geographic extent that the effects would be considered minor.

There is the potential for fish and EFH to be exposed to small, accidental fuel spills of less than 50 bbl (see Section 4.2.7). A fuel spill of this size and type would introduce hydrocarbons and effects with respect to toxicity to the surface water. Pelagic fish adults, juveniles, eggs, and larvae would be exposed, and there could be acute effects on these various life stages for the fish species in the area. However, at these concentrations, the spill effects would be short-term and spatially limited.

4.5.2.2.2 Conclusion

Given the potential implementation of standard mitigation measures considered by NMFS in this EIS (discussed in Section 4.5.2.4), the effects on fish and EFH would likely be low in magnitude, temporary to interim in duration, of local extent, and would affect common resources. The direct and indirect effects resulting from Alternative 2 would therefore be considered minor for fish and fish resources.

4.5.2.3 Marine and Coastal Birds

This section describes the potential effects of oil and gas exploration activities on marine and coastal birds of the Beaufort and Chukchi seas. Four of these species are listed under the ESA: spectacled eider (threatened); Steller’s eider (threatened); Kittlitz’s murrelet (candidate species); and yellow-billed loon (candidate species). As a result of ESA Section 7 consultations with the USFWS, BOEM has required lessees and permittees to implement specific mitigation measures to protect listed eiders when conducting permitted activities. In recent years, NMFS has required the oil and gas industry to implement a number of mitigation measures to reduce potentially adverse impacts on marine mammals and subsistence users and is considering additional mitigation measures in this EIS. These measures are intended to protect marine mammals and to ensure no unmitigable adverse impact on the availability of marine mammals for subsistence uses, but these measures may also have direct and indirect effects on marine and coastal birds, including listed eiders.

The potential effects of oil and gas exploration activities of Alternative 2 on marine and coastal birds include:

- Disturbance from exploration vessels, seismic activities, and aircraft (fixed-wing and helicopter);
- Injury/mortality from collisions with vessels/structures and oil spills; and
- Habitat changes/contamination.

4.5.2.3.1 Direct and Indirect Effects

Exploration activities under Alternative 2 include the use of a variety of large and small vessels, icebreakers, seismic airgun arrays, associated gear such as hydrophones and sensor arrays on cables that are deployed in marine waters and on the ocean bottom, drilling rigs, helicopters and fixed-wing aircraft, and on-shore support facilities. These facilities and activities could have effects on marine and coastal birds through various mechanisms as discussed below.

This EIS includes a number of standard and additional mitigation measures as part of each alternative that are intended to reduce adverse effects on marine mammals and the availability of marine mammals for subsistence uses but these mitigation measures may also help to reduce adverse effects on marine and coastal birds, which are under the jurisdiction of the USFWS. In addition to the mitigation measures imposed by NMFS, the oil and gas industry operates under regulations and permits from BOEM that authorize oil and gas exploration activities. Because these authorizations are federal actions subject to Section 7 consultation requirements of the ESA, BOEM has consulted with the USFWS on the effects of the authorized exploration activities on the ESA-listed spectacled and Steller's eiders and candidate species yellow-billed loon and Kittlitz's murrelet. The USFWS issued a programmatic Biological Opinion (BiOp) for exploration activities in the Beaufort and Chukchi seas (USFWS 2012) that includes an Incidental Take Statement and required Reasonable and Prudent Measures to minimize incidental take of the two listed eider species. The implementing Terms and Conditions would also effectively reduce adverse effects on other marine and coastal bird species, especially those using the Ledyard Bay Critical Habitat Unit (LBCHU) after July 1. The Reasonable and Prudent Measures and Terms and Conditions contained in the BiOp are designed to avoid and minimize bird collisions and to avoid and minimize impacts of disturbance from aircraft, vessels, and drilling operations on listed eiders (USFWS 2012). NMFS does not include stipulations to explicitly protect birds in the ITAs they issue for exploration activities because the agency does not have the authority to do so within an MMPA authorization. However, the following measures are required by BOEM and BSEE for permitted oil and gas exploration activities on the Beaufort and Chukchi seas to minimize incidental take of listed eiders and are thus incorporated into the analysis of potential effects under Alternative 2. NMFS would work with MMPA applicants to ensure that MMPA authorizations do not conflict with any required USFWS measures to protect ESA-listed birds.

Disturbance

Birds' responses to disturbance vary according to the species, physiological and reproductive status of the individual, distance from the disturbance, and the type/intensity/duration of the disturbance. Reactions of birds to vessels associated with exploration activity would be expected to be the same as reactions noted for other vessels used in Arctic waters. Vessel traffic may cause localized, temporary displacement and disruption of feeding or resting for some species. However, other species such as gulls and fulmars often follow vessels to forage on small fish and invertebrates brought to the surface in their wakes.

The presence of seismic survey ships would likely increase disturbance from vessel traffic, but changes would be incremental since a variety of ships regularly transit the Beaufort and Chukchi Seas to supply goods and services to the communities or for military, search-and-rescue, or scientific purposes.

Seismic surveys with airgun arrays result in both horizontal and vertical sound propagation in the water column. There has been some directed research on the potential effects of these sounds on birds. Stemp (1985) observed birds in the proximity of seismic surveys and did not see noticeable disturbance of birds during airgun deployment. Stemp (1985) concluded that negative effects from seismic operations were not likely, as long as the activities were conducted away from the colonies of birds and their feeding concentrations.

Lacroix et al. (2003) examined the potential effects of seismic surveys on a particularly sensitive group of birds, molting long-tailed ducks, along barrier islands near Prudhoe Bay. Aerial surveys were conducted before, during, and after the seismic activity, which lasted 21 days, and the abundance of birds around islands near the seismic activities were compared to those around islands that were far from the seismic work. The number of birds recorded declined substantially between the pre-seismic survey (July 24) and during-seismic survey (August 6) at all locations, but the decline was greater at the near islands (89 percent) than at the far islands (42 percent). There was a further decline in numbers after the post-seismic survey (September 7), but the magnitude of decline was similar among all areas. Lacroix et al. (2003) also used radio-tagged ducks and a series of automated receiver stations to investigate movement patterns in relation to the seismic work and found essentially no difference between ducks around the near-seismic islands and those around the distant islands. These results indicated that even though ducks were moving away from the islands during the study period as they completed their molts, ducks did not move away from seismic areas any faster than they did from distant areas. The telemetry data also included information on diving rates (indicating feeding behavior), and there was no difference in the diving patterns between near-seismic birds and those far away. Lacroix et al. (2003) concluded that the similarity of data from near-seismic birds and distant birds meant that other factors determined the abundance and movement patterns of long-tailed ducks other than their proximity to the seismic survey. However, they cautioned that their study methods did not account for short-term or localized disturbance, such as those that occur from passing vessels and recommended additional behavioral studies to examine these potential effects.

There is a limited spatial/temporal overlap of ESA-listed eiders with seismic surveys in the Beaufort and Chukchi seas (USFWS 2009c). King eiders begin migrating through the spring lead system from the Chukchi Sea to the Beaufort Sea in April-May (males) and May-June (females) (Phillips 2005, Suydam et al. 2000, Quakenbush et al. 2009) and fly inland to nesting areas soon afterward. A similar pattern occurs for many other marine species. The great majority of birds are therefore not present in offshore waters when the ice recedes enough to allow seismic survey vessels to operate. The number of eiders and other marine and coastal birds that would likely be exposed to seismic survey vessel activity in offshore waters of the Beaufort and Chukchi seas in the early open-water season would be relatively small, but more birds would be expected to occur in the Chukchi Sea than the Beaufort Sea. Designated vessel travel routes for support vessels supporting stationary drilling structures could allow for habituation by some bird species (Schwemmer et al. 2011).

The number of birds in the Chukchi Sea increases later in the open-water season, after the breeding season as adults and hatch-year birds move west out of the Beaufort Sea towards molting and wintering areas. After breeding, tens of thousands of eiders move to nearshore marine areas to molt, with large concentrations using the LBCHU, which would not receive any OCS oil and gas industry traffic after July 1 of each year.

The potential effects on birds through disturbance and other mechanisms could be magnified if exploration activities occurred adjacent to nesting colonies, which occur on many barrier islands. However, because most nesting occurs in June and early July and most open-water activities in the Beaufort Sea occur later in the season, there may be little potential for overlap and disturbance of nesting birds on barrier islands. Similarly, the nesting season occurs after the conclusion of on-ice seismic activities, which usually end by May because of concerns over ice thickness.

Another situation where effects on birds could be magnified is if exploration activities occurred in areas and times used by high concentrations of birds or when they are especially vulnerable to disturbance. This would be the case if exploration activities occurred in coastal waters and lagoons used by molting waterfowl and seabirds. Many nearshore areas along the Beaufort Sea are used by birds staging during migration in the spring and fall, but, since vibroseis surveys would be completed before open leads developed in the spring and other exploration activities generally take place further offshore in late summer-fall during open-water season, disturbance of birds in fall staging areas would be limited.

In the Chukchi Sea, LBCHU was designated as a critical habitat for ESA-listed spectacled eiders in 2001 due to its importance for the persistence and recovery of spectacled eiders. Ledyard Bay is also important habitat for many other species of waterfowl and seabirds, including ESA-listed Steller's eider and ESA candidate species, yellow-billed loon, and Kittlitz's murrelet. Because of the importance of this area to spectacled eiders, no OCS-related vessel or low-level aircraft are allowed in the area after July 1 of each year, which eliminates the potential for disturbance and other effects in this important habitat.

Frequent low-level traffic can result in chronic stress responses that could harm birds, especially during sensitive life stages like molting. Low-flying aircraft used to support oil and gas exploration activities can cause temporary disturbance of nearby birds, but minimum flight altitudes (above 1,500 ft ASL) over the LBCHU by all OCS lessees/permittees (or their agents) considered as standard mitigation measure B1 should minimize potential disturbance. Helicopters may disturb nearby birds more than fixed-wing aircraft, at least at take-off and landing, because they hover in one place for some minutes, but birds are likely to recover soon after the source of disturbance has left.

Injury/Mortality

Seismic surveys with airgun arrays result in both horizontal and vertical sound propagation in the water column. As with other animals, there is some potential for a bird to be injured by a seismic airgun pulse if the bird was in very close proximity (<2 m [<6.6 ft]) to an operating airgun. This situation is anticipated to be rare because birds tend to avoid operating vessels and the airborne sound associated with an active airgun. During a start-up, birds on the water close to the seismic vessel would be alerted to the initiation of the airgun by the required ramping up procedure.

Many waterfowl and seabird species fly at low altitudes over water (Johnson and Richardson 1982), so the potential exists for these birds to collide with offshore structures and ships, especially under conditions of poor visibility such as fog, precipitation, and darkness. Some birds are also attracted to lights from the vessels, which can increase the risk of collisions and result in injury or death (Marquenie 2007).

As a result of Section 7 consultation with the USFWS, BOEM requires OCS lessees to explore and implement a suite of methods to reduce the amount of light directed outward and upward from exploration drilling structures to reduce the risk of bird collisions. These could include shading and/or light fixture placement, different types of lights, adjustment of the number and intensity of lights as needed during specific activities, dark paint colors for selected surfaces, low-reflecting finishes or coverings for selected surfaces, and refined facility or equipment configuration.

Studies in the North Sea indicated that different colored lights caused different responses. White lights caused attraction, red caused disorientation, and green and blue caused a weak response (Marquenie 2007). White lights were replaced with lights that appeared green, and this resulted in 2 to 10 times fewer birds circling the offshore platforms (Marquenie 2007).

A study on the effects of anti-collision lighting systems on Northstar Island for eiders and other birds found in the Beaufort Sea showed that there was a significant slowing of flight speeds at night and movement away from the island when strobe lights (40 flashes per minute) were used. The lights did not cause other bird species to avoid the island but caused attraction. Therefore, the effectiveness was not clear and was inconsistent (Day et al. 2003, Day et al. 2005).

The risk of birds colliding with vessels would increase incrementally. A full complement of vessels for a full season as considered under this alternative may result in a greater number of strikes than occurred during the 2012 drilling season. Based on the existing preliminary bird strike reports from 2012, two simultaneous future drilling operations could result in as many as 178 bird strikes per open-water season—this could include an estimated 98 passerines, 22 shearwaters/storm petrels/auklets, 9 shorebirds, and 48 seaducks. Of the seaducks, 24 could be king eiders, 16 could be long-tailed ducks, and 8 could be common eiders. This potential mortality for each species is small by comparison with the post-breeding population; thus, no species would experience a population-level effect. However, small flocks of eiders can strike a vessel, suggesting that the authorized incidental take of listed eiders could be exceeded in one strike event.

There is the potential for marine and coastal to be exposed to small accidental fuel spills of less than 50 bbl (see Section 4.2.7). As explained in greater detail in the Lease Sale 193 EIS (USDOI, MMS, 2007a) and the Lease Sale 193 SEIS (BOEMRE 2011a), spilled hydrocarbons can adversely affect marine and coastal birds because these species spend so much time on the water surface and are highly susceptible to mortality if contacted. It is assumed that any bird contacted by hydrocarbons would die. However, the most likely outcome is an accidental spill that is immediately contained and would have a negligible effect on marine and coastal birds. Moreover, if a small accidental spill of less than 50 bbl were to escape containment or response measures offshore, it would not persist very long, resulting in few opportunities to contact many marine and coastal birds.

Habitat Changes/Contamination

Seismic airguns may affect invertebrates and fish (prey species used by birds). However there are very few effects on invertebrates and fish from the airgun noise unless they are within a few feet of the sound source (McCauly 1994). These disturbance effects are highly localized and transient and not likely to decrease the availability of prey to any bird species. See Section 4.5.2.2 for effects on fish and Section 4.5.2.1 for effects on lower trophic level species.

Exploratory drilling could directly affect a very small area of benthic habitat with increased turbidity and discharge of drilling cuttings. Given the very small number of sites involved in exploratory drilling under Alternative 2 and the temporary nature of the habitat disturbance, the potential for effects on any bird species is considered negligible.

4.5.2.3.2 Conclusion

Most marine and coastal birds are legally protected under the Migratory Bird Treaty Act and several are protected under the ESA. Birds fulfill important ecological roles in the Arctic. Depending on the species, they are considered to be important or unique resources in a NEPA perspective. In the absence of a large oil spill, the effects of disturbance, injury/mortality, and changes in habitat for marine and coastal birds would likely be temporary, localized, and not likely to have population-level effects for any species. The overall effects of oil and gas exploration activities authorized under Alternative 2 on ESA-listed species would be considered minor and, for other marine and coastal birds, the effects would be considered negligible according to the impact criteria in Table 4.5-17. Conclusions about impacts to birds in the event of a large oil spill are described in Sections 4.10.6.10 and 4.10.7.10. Impacts are anticipated to be reduced based on the mitigation measures required by BOEM in G&G permits, which are described in Section 4.5.2.3.1.

4.5.2.4 Marine Mammals

Noise exposure, habitat degradation, and vessel activity (potentially causing displacement from preferred habitats or ship strikes) are the primary mechanisms by which activities associated with oil and gas exploration in the Beaufort and Chukchi Seas could directly or indirectly affect marine mammals. The impacts of anthropogenic noise on marine mammals has been summarized in numerous articles and reports including Richardson et al. (1995), Cato et al. (2004), NRC (2003, 2005), Southall et al. (2007), Nowacek et al. (2007), and Weilgart (2007). The following introduction to general effects of noise from oil and gas exploration activities on marine mammals is drawn largely from these and other available literature. Impacts specific to the marine mammal species of interest in the EIS project area are discussed and evaluated separately. Because the occurrence of a large oil spill is a highly unlikely event, it is not part of the proposed action for any alternative. However, in the highly unlikely event a large spill were to occur, it could result in adverse impacts on the following resources. The oil spill analysis is not contained in the sections that analyze direct and indirect effects of the alternatives on marine mammals; rather, it is discussed and analyzed separately in Section 4.10 of this EIS.

In this section of the EIS, a general discussion of the potential effects of the various activities on marine mammals is presented first. Following this general discussion, more specific examples and information are presented for the different species or marine mammal groups, where available. Finally, an analysis of the standard and additional mitigation measures is presented for each species or group of marine mammals. The impact criteria for marine mammals are outlined for magnitude or intensity, duration, extent, and context in Table 4.5-19.

Table 4.5-19 Impact Criteria for Marine Mammals

Type of effect	Impact Component	Effects Summary	
Behavioral disturbance	Magnitude or Intensity	Low	Changes in behavior due to exploration activity may not be noticeable; animals remain in the vicinity; Level B take of marine mammals is not anticipated
		Medium	Noticeable change in behavior due to exploration activity; animals move away from activity area; Level B take of marine mammals expected, number of individuals taken is less than 30% of population
		High	Level B take of more than 30% of the individuals in the population expected
	Duration	Temporary	Temporary effect that lasts days to 1 month; animals revert back to pre-activity condition
		Interim	Temporary effect that lasts 1 to 6 months; animals revert to pre-activity conditions
		Long-term	Effects that last more than 6 months in a given year (i.e. one season) and in which change in behavior patterns do not return to pre-activity condition even after cessation of actitivies that caused impacts have ceased
	Geographic Extent	Local	Impacts limited geographically; <10% of EIS project area affected
		Regional	Affects resources beyond a local area, potentially throughout the EIS project area
		State-wide	Affects resources beyond the region or EIS project area
	Context	Common	Affects usual or ordinary resources in the EIS project area; species are not listed as threatened or endangered (or proposed for listing) under the ESA and/or as depleted under the MMPA; impacts *will not* occur in times or areas of specific importance for affected spcies (e.g. feeding, calving areas, migratory corridor) or across a large portion of the range of a resident population
		Important	Species are not listed as threatened or endangered (or proposed for listing) under the ESA and/or as depleted under the MMPA; impacts *will* occur in times or areas of specific importance for affected spcies (e.g. feeding, calving areas, migratory corridor) or across a large portion of the range of a resident population
		Unique	Species are listed as threatened or endangered (or proposed for listing) under the ESA and/or as depleted under the MMPA or the population is decreasing; impacts *will* occur in times or areas of specific importance for affected spcies (e.g. feeding, calving areas, migratory corridor) or across a large portion of the range of a resident population
Injury and mortality	Magnitude or Intensity	Low	No noticeable incidents of injury or mortality
		Medium	Incident of injury
		High	Incident of mortality or multiple incidences of injury
	Duration	Temporary	Injury to affected animal(s) lasts days to 1 month; animal reverts back to pre-activity condition once healed from injury
		Interim	Incidences of injury of affected animal(s) lasts 1 to 6 months; animal reverts back to pre-activity condtion once healed from injury
		Long-term	Mortality of animal(s) or incidences of injury persist for more than 6 months; Injury is permanent in some cases
	Geographic Extent	Local	Impacts localized; would not extend to a broad region or sector of the population
		Regional	Impacts would occur beyond a local area
		State-wide	Affects resources beyond the region or EIS project area
	Context	Common	Affects usual or ordinary resources in the EIS project area; species are not listed as threatened or endangered (or proposed for listing) under the ESA and/or as

Type of effect	Impact Component	Effects Summary	
			depleted under the MMPA
		Important	Species is listed as threatened or endangered (or proposed for listing) under the ESA and/or as depleted under the MMPA but the population is stable or increasing
		Unique	Species are listed as threatened or endangered (or proposed for listing) under the ESA and/or as depleted under the MMPA or the population is decreasing
Habitat alterations	**Magnitude or Intensity**	**Low**	Changes in resource character may not be measurable or noticeable
		Medium	Noticeable changes in resource character
		High	Acute or obvious changes in resource character
	Duration	**Temporary**	Habitat would be impacted for days to 1 month; no permanent changes to habitat
		Interim	Habitat would be impacted from 1 to 6 months; minimal, temporary alterations to marine mammal habitat
		Long-term	Habitat would be impacted for more than 6 months (i.e. one season); potential for permanent changes to marine mammal habitat
	Geographic Extent	**Local**	Impacts limited geographically; <10% of EIS project area affected
		Regional	Affects resources beyond a local area, potentially throughout the EIS project area
		State-wide	Affects resources beyond the region or EIS project area
	Context	**Common**	Affects usual or ordinary resources in the EIS project area; species are not listed as threatened or endangered (or proposed for listing) under the ESA and/or as depleted under the MMPA
		Important	Species is listed as threatened or endangered (or proposed for listing) under the ESA and/or as depleted under the MMPA but the population is stable or increasing
		Unique	Species are listed as threatened or endangered (or proposed for listing) under the ESA and/or as depleted under the MMPA or the population is decreasing

4.5.2.4.1 General Effects of Noise on Marine Mammals

Marine mammals use hearing and sound transmission to perform vital life functions. Sound (hearing and vocalization/echolocation) serves four primary functions for marine mammals, including: (1) providing information about their environment; (2) communication; (3) prey detection; and (4) predator detection. Introducing sound into the ocean environment could disrupt those functions. The distance from oil and gas exploration activities at which noises are audible depends upon source levels, frequency, ambient noise levels, the propagation characteristics of the environment, and sensitivity of the receptor (Richardson et al. 1995, Nowacek et al. 2007).

In assessing potential effects of noise, Richardson et al. (1995) suggested four criteria for defining zones of influence:

Zone of audibility – the area within which the marine mammal might hear the noise. Marine mammals as a group have functional hearing ranges of 10 Hz to 180 kHz, with best thresholds near 40 dB (Ketten 1998, Kastak et al. 2005, Southall et al. 2007). These data show reasonably consistent patterns of hearing sensitivity within each of four groups: small odontocetes (such as the harbor porpoise), medium-sized odontocetes (such as the beluga and killer whales), large cetaceans (such as bowhead whales), and pinnipeds.

Zone of responsiveness – the area within which the animal reacts behaviorally or physiologically. The behavioral responses of marine mammals to sound depend on: 1) the acoustic characteristics of the noise source; 2) the physical and behavioral state of animals at time of exposure; 3) the ambient acoustic and ecological characteristics of the environment; and 4) the context of the sound (e.g. whether it sounds similar to a predator) (Richardson et al. 1995, Southall et al. 2007). Temporary behavioral effects, however, often merely show that an animal heard a sound and may not indicate lasting consequences for exposed individuals (Southall et al. 2007). Additionally, in the context of the MMPA, not all responses will rise to the level of a "take."

Zone of masking – the area within which the noise may interfere with detection of other sounds, including communication calls, prey sounds, or other environmental sounds.

Zone of hearing loss, discomfort, or injury – the area within which the received sound level is potentially high enough to cause discomfort or tissue damage to auditory or other systems. This includes temporary threshold shifts (TTS, temporary loss in hearing) or permanent threshold shifts (PTS, permanent loss in hearing at specific frequencies or deafness). Non-auditory physiological effects or injuries that theoretically might occur in marine mammals exposed to strong underwater sound include stress, neurological effects, bubble formation, resonance effects, and other types of organ or tissue damage.

4.5.2.4.2 Potential Effects of Noise from Airguns

The effects of airgun noise on marine mammals could include one or more of the following: tolerance; masking of natural sounds; behavioral disturbance; temporary or permanent hearing impairment; or non-auditory physical effects (Richardson et al. 1995).

Tolerance

Pulsed sounds from airguns are often detectable in the water at distances of several kilometers, without necessarily eliciting behavioral responses. Numerous studies have shown that marine mammals at distances over a few kilometers from operating seismic vessels may show no apparent response (Richardson et al. 1995). That is often true even when pulsed sounds must be readily audible to the animals based on measured received levels and the hearing sensitivity of that mammal group. Although various baleen whales, toothed whales, and (less frequently) pinnipeds have been shown to temporarily react behaviorally to airgun pulses under some conditions, at other times they have shown no overt reactions (Richardson et al. 1995).

Masking

Masking occurs when biologically meaningful sounds (e.g. communication, prey, other environmental cues) are obscured by ambient or anthropogenic noise (Richardson et al. 1995, Clark et al. 2009). Introduced underwater sound will, through masking, reduce the effective communication distance of a marine mammal species if the frequency of the source is close to that used by the marine mammal, and if the anthropogenic sound is present for a significant period of time (Richardson et al. 1995).

Marine mammals are highly dependent on sound, and their ability to recognize sound signals amid other noise is important in communication, predator and prey detection, navigation and sensing other important environmental cues, and, in the case of toothed whales, echolocation. Even in the absence of manmade sounds, the sea is usually noisy. Background ambient noise often interferes with or masks the ability of an animal to detect a sound signal even when that signal is above its absolute hearing threshold. Natural ambient noise includes contributions from wind, waves, precipitation, other animals, and (at frequencies above 30 kHz) thermal noise resulting from molecular agitation (Richardson et al. 1995). Based on autonomous acoustic recordings from September 2006 to June 2009 north of Barrow, Alaska, on the continental slope between the Beaufort and Chukchi Seas, mean monthly spectrum levels (selected to exclude impulsive events) show that months with open-water had the highest noise levels (80-83 dB re: 1 μPa^2/Hz at 20-50 Hz), months with ice coverage had lower spectral levels (70 dB at 50 Hz), and months with both ice cover and low wind speeds had the lowest noise levels (65 dB at 50 Hz). Background noise also can include sounds from human activities. Masking of natural sounds can result when human activities produce high levels of noise. Conversely, if the background level of underwater noise is high (e.g. on a day with strong wind and high waves), an anthropogenic noise source will not be detectable as far away as would be possible under quieter conditions and will itself be masked.

Although some degree of masking is inevitable when high levels of manmade broadband sounds are introduced into the sea, marine mammals have evolved systems and behavior that function to reduce the impacts of masking. Structured signals, such as the echolocation click sequences of small toothed whales, may be readily detected even in the presence of strong background noise because their frequency content and temporal features usually differ strongly from those of the background noise (Au and Moore 1988, 1990). The components of background noise that are similar in frequency to the sound signal in question primarily determine the degree of masking of that signal.

Redundancy and context can also facilitate detection of weak signals. These phenomena may help marine mammals detect weak sounds in the presence of natural or manmade noise. Most masking studies in marine mammals present the test signal and the masking noise from the same direction. The sound localization abilities of marine mammals suggest that, if signal and noise come from different directions, masking would not be as severe as the usual types of masking studies might suggest (Richardson et al. 1995). The dominant background noise may be highly directional if it comes from a particular anthropogenic source such as a ship or industrial site. Directional hearing may significantly reduce the masking effects of these noises by improving the effective signal-to-noise ratio. In the cases of high-frequency hearing by the beluga whale and killer whale, empirical evidence confirms that masking depends strongly on the relative directions of arrival of sound signals and the masking noise (Penner et al. 1986, Dubrovskiy 1990, Bain et al. 1993, Bain and Dahlheim 1994). Toothed whales and probably other marine mammals as well, have additional capabilities besides directional hearing that can facilitate detection of sounds in the presence of background noise. There is evidence that some toothed whales can shift the dominant frequencies of their echolocation signals from a frequency range with a lot of ambient noise toward frequencies with less noise (Au et al. 1974, 1985; Moore and Pawloski 1990; Thomas and Turl 1990; Romanenko and Kitain 1992; Lesage et al. 1999). A few marine mammal species are known to increase the source levels or alter the frequency of their calls in the presence of elevated sound levels (Dahlheim 1987; Au 1993; Lesage et al. 1993, 1999; Terhune 1999; Foote et al. 2004; Parks et al. 2007, 2009; Di Iorio and Clark 2009; Holt et al. 2009).

These data demonstrating adaptations for reduced masking pertain mainly to the very high frequency echolocation signals of toothed whales. There is less information about the existence of corresponding mechanisms at moderate or low frequencies or in other types of marine mammals. For example, Zaitseva et al. (1980) found that, for the bottlenose dolphin, the angular separation between a sound source and a masking noise source had little effect on the degree of masking when the sound frequency was 18 kHz, in contrast to the pronounced effect at higher frequencies. Directional hearing has been demonstrated at frequencies as low as 0.5 to 2 kHz in several marine mammals, including killer whales (Richardson et al. 1995). This ability may be useful in reducing masking at these frequencies. In summary, high levels of noise generated by anthropogenic activities may act to mask the detection of weaker biologically important sounds by some marine mammals. This masking may be more prominent for lower frequencies. For higher frequencies, such as that used in echolocation by toothed whales, several mechanisms are available that may allow them to reduce the effects of such masking.

Although there is little data describing the ultimate affects of masking on animals, there can be a measurable loss of communication space that would likely be of more concern for low-frequency species (mysticetes) from lower frequency sources, both because of the communication strategies used by mysticetes (they can communicate over 100s of kilometers for days) and the physical propagation properties of lower frequency sounds (less absorption). Some whales are known to continue calling in the presence of seismic pulses; however, observers typically note some proximity around the source within which the calls decrease in number or become less frequent (Richardson et al. 1986, McDonald et al. 1995, Greene et al. 1999, Nieukirk et al. 2004, Di Iorio and Clark 2009). Additionally, as described above, some marine mammals, such as the small toothed whales communicate within frequency bands that are quite different from the frequencies of background sounds. Marine mammals that are able to use directional hearing may also be less impacted by masking effects. The greatest limiting factor in estimating impacts of masking is a lack of understanding of the spatial and temporal scales over which marine mammals actually communicate, although some estimates of distance are possible using signal and receiver characteristics. Estimates of communication masking, however, depend on assumptions for which data are currently inadequate (Clark et al. 2009).

The *Cumulative Effects of Anthropogenic Underwater Sound on Marine Mammals* is a University of California project sponsored by British Petroleum (BP) for which an expert committee was convened and tasked with developing a model for systematically evaluating the potential effects of multiple sound sources. Although additional work is needed, the model provides a first step to better understanding the cumulative impacts of the sound sources associated with oil and gas exporation (Streever et al. 2012). After outlining a quantitative method, the committee conducted a trial to assess impacts to bowheads based broadly on operational conditions in the Alaskan Beaufort in September and October of 2008. The model results highlighted some of the limitations of the model, which primarily arose from the simplifying assumptions necessary due to the lack of empirical data. However, the model also illustrated how these types of tools can be used for improved, scenario-driven, evaluations of multiple-source sounds (e.g., to compare sound exposure or extra distance traveled off migration path given different individual sound avoidance strategies.) Further, the committee recognized the complexities and resource cost of developing and implementing a quantitative model-based framework, and how they may constrain the regular use of such models. However, the committee continues to work on a more qualitative method for more routine use and also to further flesh out the quantitative method.

Disturbance Reactions

Reactions to sound, if any, depend on species, state of maturity, experience, current activity, reproductive state, time of day, environmental conditions, and many other factors (Richardson et al. 1995). Responses also depend on whether an animal is less likely (habituated) or more likely (sensitized) to respond to sound exposure (Southall et al. 2007). Responses to anthropogenic sounds are highly variable. Meaningful interpretation of behavioral responses should not only consider the relative magnitude and severity of reactions but also the relevant acoustic, contextual variables (e.g. proximity, subject experience and motivation, duration, or recurrence of exposure), and ecological variables (Southall et al. 2007).

If a marine mammal does react briefly to an underwater sound by minimally changing its behavior or moving a short distance, the impacts of the change are unlikely to be substantial to the individual and will not impact the stock or the species as a whole. However, if a sound source displaces marine mammals from an important feeding or breeding area for a prolonged period, impacts on the animals could be noteworthy. Data on short-term reactions (or lack of reactions) do not necessarily provide information about long-term effects. It is not known whether impulsive noises affect marine mammal reproductive rate or distribution and habitat use in subsequent days or years. However, the Western Arctic stock of bowhead whales has been increasing at approximately 3.4 percent per year (George et al. 2004), despite exposure to exploration activities in the Beaufort and Chukchi seas since the late 1960s (MMS 2006). Additionally, enough information is available to make a reasoned choice among alternatives. Further, impacts to other marine mammal species’ reproductive rates or stock sizes have not been documented.

Disturbance includes a variety of effects, including subtle changes in behavior, more conspicuous changes in activities, and displacement. Observable reactions of marine mammals to sound include attraction to the sound source, increased alertness, modification to their own sounds, cessation of feeding or interacting, alteration in swimming or diving behavior (change direction or speed), short or long-term habitat abandonment (deflection, short or long-term avoidance), and, possibly, panic reactions, such as stampeding or stranding (Nowacek et al. 2007, Richardson et al. 1995, Southall et al. 2007).

Because the physiological and behavioral responses of the majority of the marine mammals exposed to anthropogenic sound cannot be detected or measured (not all responses visible external to animal, portion of exposed animals underwater (so not visible), many animals located many miles from observers and covering very large area, etc.) and because NMFS must authorize take prior to the impacts to marine mammals, a method is needed to estimate the number of individuals that will be taken, pursuant to the

MMPA, based on the proposed action. To this end, NMFS developed acoustic criteria that estimate at what received sound levels the Level B Harassment, Level A Harassment, and mortality of marine mammals would occur from different types of sounds. The current NMFS acoustic criterion for Level B behavioral harassment is 160 dB re 1 μPa rms received level for impulse noises (such as airgun pulses) and 120 dB re 1 μPa rms for continuous sounds (such as drill ships and icebreaking) (70 FR 1871, January 11, 2005). However, NMFS is in the process of revising these criteria and is considering how those revisions (if adopted) could potentially affect our analyses in this document, as described in Section 4.2.6.

Noise Induced Threshold Shift

Animals exposed to intense sound may experience reduced hearing sensitivity for some period of time following exposure. This increased hearing threshold is known as noise induced threshold shift (TS). The amount of TS incurred is influenced by amplitude, duration, frequency content, temporal pattern, and energy distribution of the noise (Kryter 1985, Richardson et al. 1995, Southall et al. 2007). It is also influenced by characteristics of the animal, such as behavior, age, history of noise exposure, and health. The magnitude of TS generally decreases over time after noise exposure and if it eventually returns to zero, it is known as temporary threshold shift (TTS). If TS does not return to zero after some time, it is known as permanent threshold shift (PTS). Sound levels associated with TTS onset are generally considered to be below the levels that will cause PTS, which is considered to be auditory injury.

NMFS has established acoustic thresholds that identify the received sound levels above which hearing impairment or other injury could potentially occur (Level A take), which are 180 and 190 dB re 1 μPa (rms) for cetaceans and pinnipeds, respectively (NMFS 1995, 2000). The established 180- and 190-dB re 1 μPa (rms) criteria are the received levels above which, in the view of a panel of bioacoustics specialists convened by NMFS before additional TTS measurements for marine mammals became available, one could not be certain that there would be no injurious effects, auditory or otherwise, to marine mammals. As discussed in Section 4.2.6, NMFS is considering revisions to these acoustic criteria, which, as currently proposed, would not significantly change (as compared to current criteria) the distance within which one would expect injury to potentially occur. Many marine mammal species avoid ships and/or seismic operations at distances that likely avoid TTS onset. In addition, monitoring and mitigation measures often implemented during seismic surveys are designed to detect marine mammals near the airgun array to avoid exposure to sound pulses that may cause hearing impairment. If animals do incur TTS, it is a temporary and reversible phenomenon unless exposure exceeds the TTS-onset threshold by an amount sufficient to cause PTS.

In a study on monkeys, Lonsbury-Martin et al. (1987) found that the long-lasting nature of changes in neural responsiveness suggests that each TTS episode may produce an increment of damage to the ear and eventually contribute to measurable PTS. This was tested by exposing monkeys to short-lasting TTS sound repeatedly for many months and then comparing their cochlear ducts for hearing loss damages. Hamernik et al. (2002) compared the inferior colliculus in chinchillas that were exposed to three different thresholds of noise exposure and found there was a consistent relationship between PTS and TTS. The following subsections summarize the available data on noise-induced hearing impairment in marine mammals.

Temporary Threshold Shift

TTS is the mildest form of hearing impairment that can occur during exposure to loud sound (Kryter 1985). It is not considered to represent physical injury, as hearing sensitivity recovers relatively quickly after the sound ends. It can, however, indicate the potential for physical injury if the animal is exposed to higher levels of sound, especially on a repetitive, constant basis. The onset of TTS is defined as a temporary elevation of the hearing threshold by at least 6 dB (Schlundt et al. 2000). Several physiological mechanisms are thought to be involved with inducing TTS. These include reduced sensitivity of sensory hair cells in the inner ear, changes in the chemical environment in the sensory cells, residual middle-ear muscular activity, displacement of inner ear membranes, increased blood flow, and post-stimulatory reduction in efferent and sensory neural output (Kryter 1994, Ward 1997).

The magnitude of TTS depends on the level and duration of noise exposure and to some degree on frequency (Kryter 1985, Richardson et al. 1995, Southall et al. 2007). Very few data are available regarding the sound levels and durations that are necessary to cause TTS in marine mammals. TTS has only been studied in captive odontocetes and pinnipeds (reviewed in Southall et al. 2007). No data are available for mysticete species. No data are available for any wild marine mammals or for exposure to multiple pulses of sound during seismic surveys (Southall et al. 2007). However, simulation modeling based on extrapolations of TTS in odontocetes by Gedamke et al. (2011) suggests that baleen whales 1 km (0.62 mi) or more from seismic surveys could potentially be susceptible to TTS. For species or groups of marine mammals for which studies have been conducted, those data or information are presented in the specific subsections below. It is extremely difficult for researchers to collect such information in the wild, and it is not possible to conduct laboratory experiments on large baleen whales. Using extrapolated data from other species is considered an acceptable proxy for determining TTS in baleen whales.

Permanent Threshold Shift

PTS is defined as "irreversible elevation of the hearing threshold at a specific frequency" (Yost 2000). It involves physical damage to the sound receptors in the ear and can result in either total or partial deafness or impaired ability to hear sounds in specific frequency ranges (Kryter 1985). Some causes of PTS are severe extensions of effects underlying TTS (e.g. irreparable damage to sensory hair cells). Others involve different mechanisms, for example, exceeding the elastic limits of certain tissues and membranes in the middle and inner ears and resultant changes in the chemical composition of inner ear fluids (Ward 1997, Yost 2000). The onset of PTS is determined by pulse duration, peak amplitude, rise time, number of pulses, inter-pulse interval, location, species and health of the receivers ear (Ketten 1994).

The relationships between TTS and PTS thresholds have not been studied in marine mammals, and there is currently no evidence that exposure to airgun pulses can cause PTS in any marine mammal, however there has been speculation about that possibility (e.g. Richardson et al. 1995, Gedamke et al. 2008).

Southall et al. (2007) used available marine mammal TTS data and precautionary extrapolation procedures based on terrestrial mammal data to estimate exposures that may be associated with PTS onset. They assumed PTS would be likely if the hearing threshold increased by more than 40 dB and there was an increase of 2.3 dB in TTS with each additional dB of sound exposure. This translates to an injury criterion for pulses that is 15 dB above the Sound Exposure Level (SEL) of exposures causing TTS onset. The PTS threshold would, therefore, be approximately 198 dB re 1 $\mu Pa^2 s$ for a single pulse. Table 4.5-20 outlines the in-water SELs and Sound Pressure Levels (SPLs) thought to cause auditory injury to cetaceans and pinnipeds presented in Southall et al. (2007). These levels are higher than the 180 and 190 dB re 1 µPa (rms) criteria currently used by NMFS.

There are no data on the sound level of pulses that would cause TTS onset in pinnipeds. Southall et al. (2007) therefore assumed that known pinniped-to-cetacean differences in TTS-onset for non-pulsed sounds also apply to pulsed sounds. Harbor seals experience TTS onset at received levels that are 12 dB lower than those required to elicit TTS in beluga whales (Kastak et al. 2005, Finneran 2002a). Therefore, TTS onset in pinnipeds exposed to a single underwater pulse was estimated to occur at an SEL of 171 dB re 1 $\mu Pa^2 s$. Adding 15 dB results in a PTS onset of 186 dB re 1 $\mu Pa^2 s$ for pinnipeds exposed to a single pulse (Kastak et al. 1999, 2005).

It is unlikely that a marine mammal would remain close enough to a large airgun array long enough to incur PTS. The levels of successive pulses received by a marine mammal will increase and then decrease gradually as the seismic vessel approaches, passes and moves away, with periodic decreases also caused when the animal goes to the surface to breath, reducing the probability of the animal being exposed to sound levels large enough to elicit PTS.

Table 4.5-20 Proposed injury criteria (as described in Section 4.2.6 of this EIS) for cetaceans and pinnipeds exposed to "discrete" noise events (Finneran and Jenkins 2012)

Draft Proposed Injury Criteria		
	PTS Onset (Received Level)	
Hearing Group	**Impulsive**	**Non-impulsive**
Low-Frequency Cetaceans	*Cell 1* *230 dB_{peak}* **&** *187 dB cSEL***	*Cell 2* *230 dB_{peak}* **&** *198 dB cSEL***
Mid-Frequency Cetaceans	*Cell 3* *230 dB_{peak}* **&** *187 dB cSEL***	*Cell 4* *230 dB_{peak}* **&** *198 dB cSEL***
High-Frequency Cetaceans	*Cell 5* *201 dB_{peak}* **&** *161 dB cSEL***	*Cell 6* *201 dB_{peak}* **&** *171 dB cSEL***
Phocid Pinnipeds **(Underwater)**	*Cell 7* *224 dB_{peak}* **&** *181 dB cSEL***	*Cell 8* *224 dB_{peak}* **&** *186 dB cSEL***
Otariid Pinnipeds **(Underwater)**	*Cell 9* *230 dB_{peak}* **&** *215 dB cSEL***	*Cell 10* *230 dB_{peak}* **&** *220 dB cSEL***

* Dual criteria: Use on one [dB_{peak} or dB cSEL] exceeded first.

** NOTE – When comparing these thresholds to existing 180/190-dB rms thresholds, two important differences must be kept in mind: 1) these thresholds are based on the frequency of highest sensitivity for each taxa and are intended to be used in conjunction with frequency weighting, and 2) the metric of these thresholds are SEL instead of SPL.

Non-Auditory Physiological Effects

Non-auditory physiological effects or injuries could include stress, neurological effects, bubble formation, and other types of organ or tissue damage. If any such effects do occur, they may be limited to unusual situations when animals might be exposed at close range for unusually long periods. Issues that may arise from stress responses over a period of time include accelerated aging, sickness-like symptoms, suppression of the immune system, elevated stress hormones, and suppression of reproduction (physiologically and behaviorally) (Wright et al. 2008).

There are times during an animal's life when they have lower reserves and are more vulnerable to impacts from stressors. For example, if a mammal is stressed at the end of a feeding season just prior to a long distance migration, it may have sufficient energy reserves to cope with the stress. If stress occurs at the end of a long migration or fasting period, energy reserves may not be sufficient to adequately cope with the stress (Tyack 2008, McEwen and Wingfield 2003, and Romano et al. 2004).

Young animals (and fetuses) are sensitive to neurological consequences of the stress response and can suffer permanent neurological alterations. Deep diving marine mammals may also be more sensitive to neurological consequences of stress responses (Wright et al. 2008).

In an examination of beaked whales (which are not found in the Beaufort and Chukchi seas) that were stranded in association with military exercises involving sonar (psychological stressor), intracellular globules composed of acute phase proteins were found in cells in six out of eight livers examined, therefore, there is some indication that a stress response was partly involved (Wright et al. 2008). Hypoxia may also pose an issue for marine mammals being exposed to stressors at depth, due to increases in heart rate, which in turn causes an increase in oxygen consumption. This added oxygen demand could push the whales over the physiological edge. The combination of both the psychological stressor and the physiological stressor may have detrimental consequences (Wright et al. 2008). Classic stress responses begin when an animal's central nervous system perceives a potential threat to its homeostasis. That perception triggers stress responses regardless of whether a stimulus actually threatens the animal; the mere perception of a threat is sufficient to trigger a stress response (Moberg 2000, Sapolsky et al. 2005, Seyle 1950). Once an animal's central nervous system perceives a threat, it mounts a biological response or defense that consists of a combination of the four general biological defense responses: behavioral responses; autonomic nervous system responses; neuroendocrine responses; or immune responses.

In the case of many stressors, an animal's first and most economical (in terms of biotic costs) response is behavioral avoidance of the potential stressor or avoidance of continued exposure to a stressor. An animal's second line of defense to stressors involves the sympathetic part of the autonomic nervous system and the classical "fight or flight" response which includes the cardiovascular system, the gastrointestinal system, the exocrine glands, and the adrenal medulla to produce changes in heart rate, blood pressure, and gastrointestinal activity that humans commonly associate with "stress." The frequency of such short-term exposures and responses may have an important role on whether or not there would be a significant short- or long-term effect on an animal's welfare. Baker et al. (1983) described two avoidance techniques whales used in response to vessels: horizontal avoidance (faster swimming, and fewer long dives) and vertical avoidance (swimming more slowly but remaining submerged more frequently. Watkins et al. (1981) found that humpback and fin whales appeared startled and increased their swimming speed to move away from the approaching vessel. Johada et al. (2003) studied responses of fin whales in feeding areas when they were closely approached by inflatable vessels. The study concluded that close vessel approaches caused the fin whales to swim away from the approaching vessel and to stop feeding. These animals also had increases in blow rates and spent less time at the surface. This suggests increases in metabolic rates, which may indicate a stress response. All these responses can manifest as a stress response in which the mammal undergoes physiological changes with chronic exposure to stressors, it can interrupt essential behavioral and physiological events, alter time budget, or a combination of all these stressors (Frid and Dill 2002, Sapolsky 2000). All of these responses to stressors can cause an abandonment of an area, reduction in reproductive success, and even death (Mullner et al. 2004, and Daan et al. 1996).

An animal's third line of defense to stressors involves its neuroendocrine or sympathetic nervous systems; the system that has received the most study has been the hypothalmus-pituitary-adrenal system (also known as the HPA axis in mammals or the hypothalamus-pituitary-interrenal axis in fish and some reptiles). Unlike stress responses associated with the autonomic nervous system, virtually all neuro-endocrine functions that are affected by stress – including immune competence, reproduction, metabolism, and behavior – are regulated by pituitary hormones. Stress-induced changes in the secretion of pituitary hormones have been implicated in failed reproduction (Moberg 1987, Rivier 1995), altered metabolism (Elasser et al. 2000), reduced immune competence (Blecha 2000), and behavioral disturbance. Increases in the circulation of glucocorticosteroids (cortisol, corticosterone, and aldosterone in marine mammals; see Romano et al. 2004) have been equated with stress for many years.

The primary distinction between stress (which is adaptive and does not normally place an animal at risk) and distress is the biotic cost of the response. During a stress response, an animal uses glycogen stores that can be quickly replenished once the stress is alleviated. In such circumstances, the cost of the stress response would not pose a risk to the animal's welfare. However, when an animal does not have sufficient energy reserves to satisfy the energetic costs of a stress response, energy resources must be diverted from other biotic functions, which impair those functions that experience the diversion. For example, when mounting a stress response diverts energy away from growth in young animals, those animals may experience stunted growth. When mounting a stress response diverts energy from a fetus, an animal's reproductive success and fitness will suffer. In these cases, the animals will have entered a pre-pathological or pathological state which is called "distress" (sensu Seyle 1950) or "allostatic loading" (sensu McEwen and Wingfield 2003). This pathological state will last until the animal replenishes its biotic reserves sufficient to restore normal function. Note that these examples involved a long-term (days or weeks) stress response exposure to stimuli.

Relationships between these physiological mechanisms, animal behavior, and the costs of stress responses have also been documented fairly well through controlled experiment; because this physiology exists in every vertebrate that has been studied, it is not surprising that stress responses and their costs have been documented in both laboratory and free-living animals (for examples see, Holberton et al. 1996, Hood et al. 1998, Jessop et al. 2003, Krausman et al. 2004, Lankford et al. 2005, Reneerkens et al. 2002, Thompson and Hamer 2000). Although no information has been collected on the physiological responses of marine mammals to anthropogenic sound exposure, studies of other marine animals and terrestrial animals would lead one to expect some marine mammals to experience physiological stress responses and, perhaps, physiological responses that would be classified as "distress" upon exposure to anthropogenic sounds.

For example, Jansen (1998) reported on the relationship between acoustic exposures and physiological responses that are indicative of stress responses in humans (e.g. elevated respiration and increased heart rates). Jones (1998) reported on reductions in human performance when faced with acute, repetitive exposures to acoustic disturbance. Trimper et al. (1998) reported on the physiological stress responses of osprey to low-level aircraft noise, while Krausman et al. (2004) reported on the auditory and physiology stress responses of endangered Sonoran pronghorn to military overflights. Smith et al. (2004a, 2004b) identified noise-induced physiological transient stress responses in hearing-specialist fish (i.e. goldfish) that accompanied short- and long-term hearing losses. Welch and Welch (1970) reported physiological and behavioral stress responses that accompanied damage to the inner ears of fish and several mammals.

Hearing is one of the primary senses marine mammals use to gather information about their environment and communicate with conspecifics. Although empirical information on the relationship between sensory impairment (TTS, PTS, and acoustic masking) on marine mammals remains limited, it seems reasonable to assume that reducing an animal's ability to gather information about its environment and to communicate with other members of its species would be stressful for animals that use hearing as their primary sensory mechanism. Therefore, NMFS assumes that acoustic exposures sufficient to trigger onset PTS or TTS would be accompanied by physiological stress responses because terrestrial animals exhibit those responses under similar conditions (NRC 2003). More importantly, marine mammals might experience stress responses at received levels lower than those necessary to trigger onset TTS. Based on empirical studies of the time required to recover from stress responses (Moberg 2000), NMFS also assumes that stress responses could persist beyond the time interval required for animals to recover from TTS and might result in pathological and pre-pathological states that would be as significant as behavioral responses to TTS.

There is little information available on sound-induced stress in marine mammals or on its potential to affect the long-term health or reproductive success of marine mammals (Fair and Becker 2000, Hildebrand 2005, Wright et al. 2007a, 2007b). Potential long-term effects, if they occur, would be mainly associated with chronic noise exposure (Nieukirk et al. 2009). Disruption in feeding, especially within small populations could have impacts on whales, their reproductive success and even the survival of the species (NRC 2005).

The National Research Council (NRC) developed a model; [the population consequences of acoustic disturbance] (NRC 2005); which includes a conceptual framework that outlines several stages required to relate acoustic disturbance, through effects on life functions and vital rates, to effects on marine mammal populations, and identifies the transfer functions that specify the relationships between the stages. Case studies, including one based on an analysis of energy changes during foraging trips by northern and southern elephant seals and the effects this change had on pup survival (Walmsley 2007), are used to illustrate the potential for population-level effects from disturbance. Anthropogenic noise, by itself or in combination with other stressors, can reduce fitness of individuals and decrease the viability of some marine mammal populations (Wright et al. 2008).

Available data on potential stress-related impacts of anthropogenic noise on marine mammals are extremely limited; research on the stress responses of marine mammals and the technologies for measuring hormonal, neuroendocrinological, cardiological, and biochemical indicators of stress in marine mammals are in the early stages of development (ONR 2009). Obtaining samples from free-ranging marine mammals is complicated by the brief periods of time most are visible while either hauled-out or at the surface to breath, by home ranges that may include expansive and inaccessible areas of ocean which limits the potential for continued or repeated monitoring, and many species cannot be easily captured or sampled using traditional methods (ONR 2009). Blood sampling is not currently possible for large, free-swimming whales. Conducting stress research on marine mammals, therefore, requires novel approaches to obtaining physiologic data and samples. Real time measurement of existing stress hormones and biomarkers are further limited by the invasive nature of many of the sampling methods (e.g., chase, restraint), which may, themselves, be stressors that could mask the physiological signal of interest (ONR 2009).

Recent novel, non-invasive approaches developed for collecting corticosteroid and hormone samples from free-swimming large whales include fecal sampling (Hunt et al. 2006) and sampling whale blows (Hogg et al. 2009, NEA 2011). Both techniques have been used to collect samples from North Atlantic right whales (Eubalaena glacialis) and show promise. The former, however, is limited by the frequency with which feces are encountered. Methods for sampling whale blows, obtaining sufficiently large samples, and measuring stress hormones were being developed and tested by the New England Aquarium during 2011 (NEA 2011). These methods are still being developed and their practicability and viability have not been tested on Arctic species.

Stranding and Mortality

Causes of strandings and mortality related to sound could include: 1) swimming into shallow water to avoid sound; 2) a change in dive behavior; 3) a physiological change; and 4) tissue damage directly from sound exposure, such as through acoustically mediated bubble formation and growth or acoustic resonance of tissues. Some of these are unlikely to apply to airgun impulse sounds.

Seismic pulses and mid-frequency sonar signals are quite different, and some mechanisms by which sonar sounds have been hypothesized to affect beaked whales are unlikely to apply to airgun pulses. Sounds produced by airgun arrays are broadband impulses with most of the energy below 1 kHz. Typical military mid-frequency sonar emits non-impulse sounds at frequencies of 2 to 10 kHz, generally with a relatively narrow bandwidth at any one time. A further difference between seismic surveys and naval exercises is that naval exercises can involve sound sources on more than one vessel. Thus, it is not appropriate to assume that there is a direct connection between the effects of military sonar and seismic surveys on marine mammals. However, evidence that sonar signals can, in special circumstances, lead (at least indirectly) to physical damage and mortality (e.g. Balcomb and Claridge 2001, NOAA and USN 2001, Jepson et al. 2003, Fernández et al. 2004, 2005, Hildebrand 2005, Cox et al. 2006) suggests that caution is warranted when dealing with exposure of marine mammals to any high-intensity "pulsed" sound.

There is no conclusive evidence of cetacean strandings or deaths at sea as a result of exposure to seismic surveys, but a few cases of strandings in the general area where a seismic survey was ongoing have led to speculation concerning a possible link between seismic surveys and strandings. Suggestions that there was a link between seismic surveys and strandings of humpback whales in Brazil (Engel et al. 2004) were not well founded (IAGC 2004, IWC 2007). In September 2002, there was a stranding of two Cuvier's beaked whales in the Gulf of California, Mexico, when the Lamont-Doherty Earth Observatory vessel *R/V Maurice Ewing* was operating a 20 airgun (8,490 in^3) array in the general area. The link between the stranding and the seismic surveys was inconclusive and not based on any physical evidence (Hogarth 2002, Yoder 2002).

4.5.2.4.3 Potential Effects from Other Acoustic Sources Used during Surveys

In addition to a single airgun or airgun arrays, the industry typically uses additional acoustic devices during survey activities, such as single and multi-beam echosounders, sub-bottom profilers, and side scan sonars (many of which operate at frequencies outside of the ranges of best hearing for many baleen whales and pinnipeds). The majority of these sources is smaller and emits sounds at higher frequencies than airguns. The source levels of these devices range from 180 dB re 1 µPa at 1 m to 250 dB re 1 µPa at 1 m and have frequency ranges from 0.2 kHz to 1,600 kHz. Section 2.3.2 of this EIS describes each of these sound sources, with source levels and frequency ranges, in more detail.

Given the directionality and small beam widths for these sources, marine mammal communications are not anticipated to be masked appreciably. Because of the small beam widths, marine mammals would not be in the direct sound field for more than one to two pulses. Additionally, many of these sources emit sounds at frequencies higher than that used by marine mammals for hearing and/or vocalizing.

Behavioral reactions of free-ranging marine mammals to sonars, echosounders, and other sound sources appear to vary by species and circumstance. Observed reactions have included silencing and dispersal by sperm whales (Watkins et al. 1985) and increased vocalizations and no dispersal by pilot whales (Rendell and Gordon 1999). When a 38 kHz echosounder and a 150 kHz acoustic Doppler current profiler were transmitting during studies in the Eastern Tropical Pacific, baleen whales showed no significant responses, while spotted and spinner dolphins were detected slightly more often and beaked whales less often during visual surveys (Gerrodette and Pettis 2005). Very few data are available on the reactions of pinnipeds to echosounder sounds at frequencies similar to those used during seismic operations. Hastie and Janik (2007) conducted a series of behavioral response tests on two captive gray seals to determine their reactions to underwater operation of a 375 kHz multibeam imaging echosounder that included significant signal components down to 6 kHz. Results indicated that the two seals reacted to the signal by significantly increasing their dive durations.

4.5.2.4.4 Potential Effects of On-ice Seismic Surveys

Because these activities occur during the winter and early spring months over the ice, no impacts to cetaceans are anticipated, as cetaceans are typically not present in the Beaufort Sea during this time period. Impacts to pinnipeds could potentially occur when they are hauled out on the ice or inside subnivean lairs. Disturbance from noise produced by the seismic survey equipment is expected to include localized displacement from lairs by the seals in proximity (within 150 m [492 ft]) to seismic lines (Kelly et al. 1988). Impacts would only occur to pinnipeds in the Beaufort Sea, as no such surveys are expected to occur in the Chukchi Sea. See Sections 4.5.2.4.9 through 4.5.2.4.14 for details regarding potential effects on bowhead whales, beluga whales, other cetaceans, pinnipeds, walrus, and polar bears, respectively.

4.5.2.4.5 Potential Effects of Aircraft Activities

Potential effects to marine mammals from aircraft activity could involve both acoustic and non-acoustic effects. It is uncertain if the animals react to the sound of the aircraft or to its physical presence flying overhead. Minor and short-term behavioral responses of cetaceans to helicopters have been documented in several locations, including the Beaufort Sea (Richardson et al. 1985a, b, Patenaude et al. 2002). Reactions of hauled out pinnipeds to aircraft flying overhead have been noted, such as looking up at the aircraft, moving on the ice or land, entering a breathing hole or crack in the ice, or entering the water (Born et al. 1999, Blackwell et al. 2004a). Reactions depend on several factors including the animal's behavioral state, activity, group size, habitat, and flight pattern (Richardson et al. 1995). Additionally, a study conducted by Born et al. (1999) found that wind chill was also a factor in level of response of ringed seals hauled out on ice, as well as time of day and relative wind direction. Marine mammal reactions to helicopter disturbance are difficult to predict and may range from no reaction to minor course changes or, occasionally, leaving the immediate area of the activity. Currently, NMFS' threshold for determining if an aircraft overflight may take a marine mammal or not is 1,000 ft altitude (except for takeoffs, landings, and emergency situations).

4.5.2.4.6 Potential Effects of Icebreaking and Ice Management Activities

Icebreakers produce more noise while breaking ice than when transiting open waters primarily because of the sounds of propeller cavitation (Richardson et al. 1995). Icebreakers typically ram into heavy ice until losing momentum, then back off to build momentum before ramming again. The highest noise levels usually occur while backing full astern in preparation to ram forward through the ice. Overall, the noise generated by an icebreaker pushing ice is typically 10 to 15 dB greater than the noise produced by the ship underway in open water (Richardson et al. 1995). Roth and Schmidt (2010) noted a source level of 200 dB re 1 µPa at 1 m during backing and ramming of ice. Industry in-ice seismic surveys recently conducted in the U.S. Arctic did not employ the "backing and ramming" approach described above but rather required continuous forward progress at 3-4 knots in mostly newly forming juvenile first year ice or young first year ice less than 0.5 m (1.6 ft) thick instead of in thick, multi-year ice (ION 2012). Sounds generated by the icebreaker moving through relatively light ice conditions are expected to be far below the high sound levels often attributed to "backing and ramming" icebreaking in very heavy ice conditions, which are created by cavitation of the propellers as the vessel is slowed by the ice or reverses direction (Erbe and Farmer 1998, Roth and Schmidt 2010). Icebreaking is considered by NMFS to be a continuous sound. Haley et al. (2010a) estimated that as the icebreaker travels through the ice, a swath 3,500 m (2.17 mi) wide would be subject to sound levels ≥120 dB, based on the source level of 185 dB attenuating to 120 dB in about 1,750 m (1.09 mi).

Icebreaking activities may also have non-acoustic effects such as the potential for causing injury, ice entrapment of animals that follow the ship, and disruption of ice habitat (reviewed in Richardson et al. 1989:315). The species of marine mammals that may be present and the nature of icebreaker activities are strongly influenced by ice type. Some species are more common in loose ice near the margins of heavy pack ice while others appear to prefer heavy pack ice. Propeller cavitation noise of icebreaking ships in loose ice is likely similar to that in open water while noise is expected to be much greater in areas of heavier pack ice or thick landfast ice where ship speed will be reduced, power levels will be higher, and there will be greater propeller cavitation (Richardson et al. 1995).

There is little information available about the effect on marine mammals of the increased sound levels due to icebreaking, although beluga whales have been documented swimming rapidly away from ships and icebreakers in the Canadian high Arctic (Richardson et al. 1995). Little information is available regarding the effects of icebreaking ships on baleen whales, but a similar behavioral response would be expected as those mentioned above. Whales could be diverted or could rapidly swim away from the source. Please refer to Sections 4.5.2.4.9 through 4.5.2.4.14 for details regarding potential effects on bowhead whales, beluga whales, other cetaceans, pinnipeds, walrus, and polar bears, respectively.

4.5.2.4.7 Potential Effects of Vessel Activity

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

Collisions with seismic or support vessels are possible but highly unlikely. Ship strikes with marine mammals can lead to death by massive trauma, hemorrhaging, broken bones, or propeller wounds (Knowlton and Kraus 2001). Massive propeller wounds can be immediately fatal. If more superficial, whales may be able to survive the collisions (Silber et al. 2009). Vessel speed is a key factor in determining the frequency and severity of ship strikes, with the potential for collision increasing at ship speeds of 15 kn and greater (Laist et al. 2001, Vanderlaan and Taggart 2007).

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

4.5.2.4.8 Potential Effects of Exploratory Drilling

Exploratory drilling could affect marine mammals through noise, discharge of drilling waste, and accidental discharges such as oil spills. Sounds from exploratory drilling are different from airgun sounds. As described in Section 4.5.1.4 (Acoustics), most drilling sounds from vessels produce sounds at relatively low frequencies below 600 Hz with tones up to around 1,850 Hz (Greene 1987). The potential effects of noise from drilling operations are very similar to airguns, although at a lesser magnitude because source levels of drilling units are not as high as airgun arrays.

Exploratory drilling operations may involve the discharge of drill cuttings and drilling fluids directly into the ocean. As described in Section 4.5.1.5 (Water Quality) these discharges could result in elevated concentrations of metals such as chromium, copper, mercury, lead, and zinc, as well as increased concentrations of hydrocarbons and other organic compounds in the water. Some of the discharge streams that may be permitted for oil and gas activities in the proposed action area have been associated with impacts to marine resources, yet, despite a considerable amount of investment in research of exposures of marine mammals to organochlorines or other toxins, there have been no marine mammal deaths in the wild that can be conclusively linked to the direct exposure to such substances (O'Shea 1999). However, the impact of drill cuttings and drilling mud discharges would be localized and temporary. Discharged drilling fluid should be well diluted within 100 m (330 ft) so that any impacts would be localized and temporary, assuming that whales continue to swim through and past the discharge plume. If toxic contaminants are present in discharges, only a small area of potential habitat and prey base for marine mammals might be contaminated.

Many of the contaminants of concern, including organic contaminants such as organochlorine compounds and PAHs, as well as metals such as chromium and mercury, have the potential to accumulate in marine mammals. Indirect effects to marine mammals could result from exposure to contaminants of concern through the food web and the relevant pathway of exposure would involve trophic transfers of contaminants rather than direct exposure. Monitoring conducted as part of the ANIMIDA and cANIMIDA projects has shown that oil and gas developments in the Alaskan Beaufort Sea "are not contributing ecologically important amounts of petroleum hydrocarbons and metals to the near-shore marine food web of the area" (Neff 2010). Additional mitigation measures C3, C4, and C5 include requirements to ensure reduced discharge of the specific discharge streams identified with potential impacts to marine mammals or marine habitat. Those discharge streams include drill cuttings, drilling fluids, sanitary waste, domestic waste, ballast water, and bilge water. Elimination or reduction of those discharge streams is expected to reduce the potential for adverse impacts to marine mammals. Additional mitigation measures requiring operators to recycle drilling muds may also reduce the potential for adverse impacts to marine mammals and other organisms within the EIS project area.

Accidental discharges of oil or other contaminants could also occur during exploratory drilling and would likely adversely affect marine mammals. Standard mitigation measures requiring operators to have plans in place to minimize the likelihood of a spill would reduce the potential for adverse impacts from such discharges. The effects of a very large oil spill on marine mammals are analyzed in Sections 4.10.6.11 and 4.10.7.11.

4.5.2.4.9 Bowhead Whales

4.5.2.4.9.1 Direct and Indirect Effects

The primary direct and indirect effects on bowhead whales from activities associated with oil and gas exploration in the Beaufort and Chukchi seas considered under Alternative 2 would result from noise exposure. Ship strikes and habitat degradation are also possible, but low probability. Sources of noise include 2D/3D seismic survey equipment (airgun arrays), echosounder and sonar devices associated with site clearance and shallow hazards surveys, support, monitoring and receiving vessels associated with these surveys, icebreaking activities, on-ice vibroseis seismic surveys (Beaufort Sea only), exploratory drilling, and helicopter and fixed wing aircraft associated with the different programs. Details of these activities and associated components can be found in Chapter 2.

Behavioral Disturbance

Anthropogenic noise from oil and gas exploration activities may elicit behavioral responses from bowhead whales. The suite of possible reactions is listed above; known reactions by bowhead whales are included here and described and assessed by region and activity.

Beaufort Sea Activities

2D/3D Seismic Surveys (July through November)

Airgun arrays are the most common source of seismic survey noise. Baleen whales generally avoid operating airguns, but avoidance distances vary by species, locations, behavioral activities, as well as environmental conditions that influence sound propagation (Richardson et al. 1995, Gordon et al. 2004).

Airgun sounds can propagate horizontally for many kilometers (Greene and Richardson 1988). In waters 25 to 50 m (82 to 164 ft) deep, airgun sound can be detected 50 to 75 km (31 to 46 mi) away; in deeper water, ranges can exceed 100 km (62 mi) (Richardson et al. 1995). Ranges from airgun arrays to SPL thresholds between 190 and 120 dB re 1 μPa rms were calculated from different directions from the source vessel for 3D seismic surveys in the Beaufort Sea in 2008 using a 30 in^3 single airgun and an arry of up to 3,147 in^3. Ranges were 10 to 770 m (33 to 2,526 ft) for 190 dB re 1 μPa rms, 46 to 2,500 m (151 to 8,202 ft) for 180 dB re 1 μPa rms, 910 to 9,000 m (2,986 ft to 5.29 mi) for 160 dB re 1 μPa rms, and 23 to 120 km (14 to 74.5 mi) for 120 dB re 1 μPa rms. Ranges from airgun arrays to SPL thresholds between 190 and 120 dB re 1 μPa rms were calculated from different directions from the source vessel for a 3D seismic survey in the Chukchi Sea in 2010 using a 60 in^3 single airgun and an array of up to 3,000 in^3. Ranges were 11 to 430 m (36 to 1,411 ft) for 190 dB re 1 μPa rms, 57 to 1,400 m (187 to 4,593 ft) for 180 dB re 1 μPa rms, 1,300 to 11,000 m (4,265 ft to 6.8 mi) for 160 dB re 1 μPa rms, and 25 to 123 km (15.5 to 76.4 mi). (Refer to Table 4.5-11 in Section 4.5.1.4, Acoustics, for additional details on measurements.)

Observed responses of bowhead whales to seismic noise depend on whether the whales are feeding or migrating. Feeding bowheads tend to show less avoidance of sound sources than do migrating bowheads.

Bowhead whales feeding in the Canadian Beaufort Sea in the 1980s showed no obvious behavioral changes in response to airgun pulses from seismic vessels 6 to 99 km (3.7 to 61.5 mi) away, with received sound levels of 107 to 158 dB rms (Richardson et al. 1986). They did, however, exhibit subtle changes in surfacing–respiration–dive cycles. Seismic vessels approaching within approximately 3 to 7 km (1.9 to 4.3 mi), with received levels of airgun sounds of 152 to 178 dB, usually did not elicit strong avoidance reactions (Richardson et al. 1986, 1995, Ljungblad et al. 1988, Miller et al. 2005). Richardson et al. (1986) observed feeding bowheads start to turn away from a 30-airgun array with a source level of 248 dB re 1 µPa at a distance of 7.5 km (4.7 mi) and swim away when the vessel was within about 2 km (1.2 mi); other whales in the area continued feeding until the seismic vessel was within 3 km (1.9 mi). More recent studies have similarly shown greater tolerance of feeding bowhead whales to higher sound levels than migrating whales (Miller et al. 2005, Harris et al. 2007). Koski et al. (2008) observed several groups of bowhead whales that continued feeding near a seismic survey in the central Beaufort Sea in 2007 where received sound levels reached between 150 and 180 dB re 1 µPa. Data from an industry aerial monitoring program in the Alaskan Beaufort Sea during 2006 through 2008 and 2010 noted that bowhead whale mean distance from the center of active seismic operations increased for traveling but not for feeding whales; however, ice conditions appear to be a factor as well (Funk et al. 2011). This apparent tolerance, however, should not be interpreted to mean that bowheads are unaffected by the noise. Feeding bowheads may be so highly motivated to stay in a productive feeding area that they remain in an area with noise levels that could, with long term exposure, cause adverse effects (NMFS 2010c).

Migrating bowhead whales respond behaviorally more strongly to seismic noise pulses than do feeding whales. Bowhead whales migrating west across the Alaskan Beaufort Sea in autumn showed avoidance out to 20 to 30 km (12.4 to 18.6 mi) from a medium-sized airgun source at received sound levels of around 120 to 130 dB re 1 µPa rms (Miller et al. 1999, Richardson et al. 1999). Avoidance of the area did not last more than 12 to 24 hours after seismic shooting stopped. Deflection might start as far as 35 km (21.7 mi) away and may persist 25 to 40 km (15.6 to 24.9 mi) to as much as 40 to 50 km (24.9 to 31.1 mi) after passing seismic-survey operations (Miller et al. 1999). Analyses of data on traveling bowheads in the Alaskan Beaufort Sea also showed a stronger tendency to avoid operating airguns than was evident for feeding bowheads (Christie et al. 2009, Koski et al. 2009). Richardson et al. (1999) suggests that migrating bowheads start to show significant behavioral disturbance from multiple pulses at received levels around 120 dB re 1 µPa.

The effect of seismic airgun pulses on bowhead whale calling behavior has been extensively studied in the Beaufort Sea. During the autumn season in 2007 and 2008, calling rates decreased significantly in the presence (<30 km [<18.6 mi]) of airgun pulses (Blackwell et al. 2010a). There was no observed effect when seismic operations were distant (>100 km [>62 mi]). Call detection rates dropped rapidly when cumulative sound exposure levels (CSELs) were greater than 125 dB re 1 $\mu Pa^2 \cdot s$ over 15 minutes. The decrease was likely caused by a combination of less calling by individual whales and by avoidance of the area by some whales in response to the seismic activity. Calls resumed near the seismic operations area shortly after operations ended. Aerial surveys showed high sighting rates of feeding, rather than migrating, whales near seismic operations (Blackwell et al. 2010a). In contrast, reduced calling rates during a similar study in 1996 to 1998 were largely attributed to avoidance of the area by whales that were predominantly migrating, not feeding (Miller et al. 1999, Richardson et al. 1999).

The open water season (July through October) during which proposed seismic activities would occur (for up to 90 days), overlaps with summer feeding and the late-summer/fall westward migration of bowhead whales across the Alaskan Beaufort Sea. Therefore, the potential for exposure and disturbance is high during this time period. Data available from the Bowhead Whale Aerial Survey Project (BWASP) and other surveys (Ashjian et al. 2010, Clarke et al. 2011a, 2011b, 2011c, Koski and Miller 2009, Moore et al. 2010, Okkonen et al. 2011) reveal areas where concentrations, including feeding aggregations and/or aggregations of females and calves, are more likely to occur in the Beaufort Sea. These areas include a bowhead whale feeding "hotspot" during late summer to fall from Point Barrow to Smith Bay and the

Kaktovik area where whales are occasionally observed feeding as early as July, and often occur in higher concentrations beginning in late-August and September.

Seismic activity in the Beaufort Sea would likely impact bowhead whales, although the level of disturbance will depend on whether the whales are feeding or migrating, as well as other factors such as the age of the animal, whether or not is is habituated to the sound, etc. Responses can range from apparent tolerance to interrupted communication, minor displacement, or avoidance of an area. If multiple 2D/3D seismic surveys occurred in areas with concentrations of bowheads present, large numbers of bowheads could potentially be disturbed or potentially excluded by avoidance from feeding habitat for the duration of the survey period. Most observed disturbance reactions appear to be short-term (meaning the length of the exposure to seismic pulses or less time), and short-term reactions to airgun noises are not necessarily indicative of long-term or biologically significant effects. It is not known whether impulsive sounds affect reproductive rate or distribution and habitat use over periods of days or years. The Western Arctic stock of bowhead whales has, however, been increasing at approximately 3.4 percent per year (George et al. 2004), despite exposure to exploration activities in the Beaufort and Chukchi seas since the late 1960s (MMS 2006). In addition, the potential for increased stress, and the long-term effects of stress, are unknown, as research on stress effects in marine mammals is limited (see discussion above). The level of available information is sufficient to support sound scientific judgments and reasoned managerial decisions, even in the absence of additional data of this type.

In terms of the impact criteria of Table 4.5-19, the disturbance effects of exploratory activity under Alternative 2 would be considered of medium intensity. Additionally, contextually, these impacts take place within a known migratory corridor through which these endangered whales must travel with calves and some may be temporarily displaced from preferred feeding areas. The EIS project area encompasses a large portion of bowhead whale habitat between the Bering Strait and Canadian border, so leaving the area entirely to avoid impacts is not a likely option. The duration of exposures from these surveys, which is considered interim, would be limited to the open water season, and any behavioral responses by bowhead whales to activities is expected to be temporary and contained primarily within the time-period that an individual is exposed to the sounds. The extent of the impact will depend on the number of seismic activities and associated support vessels in an area, but, for individual sound source vessels, impacts are expected to be localized. Multiple activities in one area or in several areas across the migratory corridor could result in a broader, regional impact.

In-ice Seismic Survey (2D/3D) with Icebreaker Support (October to mid-December)

Disturbance effects from seismic activities are anticipated to be the same as described above. The difference with this activity is the additional noise input from icebreaking activities and the extended period of activity into late fall and early winter. The temporal component of this activity and the potential effects of icebreakers are addressed here.

Increased noise from icebreaking activities may present concerns for bowhead whales (NMFS 2010c). Estimated source levels for an icebreaker range from 177 to 191 dB re 1 μPa (Richardson et al. 1995). A study by Miles et al. (1987) used models to predict responses of bowhead whales to icebreaker noise and determined that response was likely at distances of 2 to 25 km (1.24 to 15.53 mi). Zones of responsiveness for intermittent sounds, such as an icebreaker pushing ice, were not studied. They further predicted that approximately half of the bowhead whales exhibited avoidance behavior to a traveling icebreaker in open water at 2 to 12 km (1.25 to 7.46 mi) when the sound-to-noise ratio is 30 dB and to an icebreaker pushing ice at a distance of 4.6 to 20 km (2.86 to 12.4 mi) when the sound-to-noise ratio is 30 dB. Migrating bowhead whales avoided an icebreaker-accompanied drillship (with nearly daily icebreaking) by >25 km (>15.5 mi) in 1992 (Brewer et al. 1993).

The additional sound from an icebreaker accompanying seismic activity could cause temporary avoidance of bowhead whales from areas where the vessels are operating and potentially cause temporary deflection of the migration corridor (NMFS 2010c). BWASP surveys flown in September and October of 2006 through 2010 of the Alaskan Beaufort Sea include sightings of bowhead whales through at least mid-October, with sightings occurring from the U.S./Canadian border to Point Barrow (Clarke et al. 2011b, 2011c, 2011d). It is during this time period that the likelihood of co-occurrence of bowhead whales and icebreaker-accompanied seismic activity is most probable. Avoidance by bowhead whales of important feeding areas and displacement during migration are possible. The likelihood of interaction diminishes by late October as most bowheads will have migrated out of the Beaufort Sea; therefore, impacts to bowhead whales from this type of activity are only anticipated for the first few weeks of the survey.

Because in-ice seismic surveys are designed to begin in early to mid-October towards the end of the bowhead whale fall migration westward through the Beaufort Sea, anticipated impacts of in-ice activities would be anticipated to be somewhat lower than those described for 2D/3D seismic surveys above (see Table 4.5-19 for impact criteria definitions). Surveys utilizing icebreakers could, however, cause avoidance and displacement over a larger radius with the additional noise input from the icebreaking activities, but the period of time over which this activity would overlap with bowhead whales in the Beaufort Sea is much shorter. Based on these factors, anticipated impacts of in-ice activities are anticipated to be of medium intensity, interim duration, local in extent, and would affect a unique resource for any bowhead whales that may occur in vicinity at the beginning of in-ice operations. However, as operations continue, bowheads would no longer occur in the project area, as they overwinter south of the EIS project area.

Ocean-Bottom-Cable Survey (July to October)

Ocean-bottom-cable (OBC) seismic surveys are used in nearshore areas where water is too shallow (≤14 m [≤45.9 ft]) for a towed marine streamer seismic survey vessel and too deep to have bottomfast ice in the winter. An OBC seismic survey typically covers a smaller area than the streamer surveys discussed above and may spend several days in an area. One such survey is anticipated in the Beaufort Sea under Alternative 2. OBC surveys require the use of multiple vessels (see Chapter 2, Table 2.4). Noise and disturbance effects of support vessels are discussed separately below.

Reactions to sounds from OBC surveys are similar to those reported for 2D/3D streamer seismic surveys. A partially-controlled study of the effect of OBC seismic surveys on westward-migrating bowhead whales was conducted in late summer and fall in the Alaskan Beaufort Sea in 1996 to 1998. Whales avoided the sound source out to 20 to 30 km (12.4 to 18.6 mi) at received sound levels of around 120 to 130 dB re 1 μPa rms (Miller et al. 1999, Richardson et al. 1999). Miller et al. (1999) estimated that deflection may have begun about 35 km (22 mi) to the east. Several bowheads moved into the area close to the seismic vessel during periods when airguns were inactive. Avoidance of the area of seismic operations did not persist beyond 12 to 24 hours after seismic shooting stopped.

The open water season of July to October, during which OBC surveys are likely to occur, coincides with summer feeding and late-summer/fall migration periods for bowhead whales in the Beaufort Sea. Although most bowhead whales feed in the Canadian Beaufort and Amundson Gulf during the summer months, some may occur near Kaktovik as early as July (Koski and Miller 2009). From late-summer through October, bowhead whales commonly occur in nearshore, shallow waters. The median depths of bowhead sightings during 2006 to 2009 BWASP surveys ranged from 15 to 44 m (49.2 to 144.4 ft) (Clarke et al. 2011b, 2011c). In addition, the distance from which migrating bowheads appear to deflect from OBC sound sources suggest possible disturbance to whales traveling or feeding farther offshore.

Anticipated impacts of OBC surveys, in terms of magnitude (medium), duration (interim), extent (local), and context (unique) would be similar to those described for 2D/3D seismic surveys above. See Table 4.5-19 for impact criteria definitions. Although disturbance effects may extend 20 to 30 km (12.4 to 18.6 mi) from the sound source, with one OBC survey anticipated in the Beaufort Sea, short-term effects should remain localized.

Site Clearance and High Resolution Shallow Hazards Survey Programs (July to November)

High-resolution shallow hazards surveys are of short duration, and the airguns are smaller, generating lower energy sounds and a smaller zone of influence than the larger airgun arrays used for 2D/3D seismic surveys (NMFS 2010b). The radii of ensonification at 120, 160, 180, and 190 dB re 1 μPa rms were calculated for sound sources proposed for use in 2010. Radii calculated for the 40 in^3 airgun were 14,000 m (45,932 ft), 1,220 m (4,003 ft), 125 m (410 ft), and 35 m (115 ft) for the respective sound source levels. Additional information on measured sound radii for such sound sources in the Beaufort and Chukchi seas between 2006 and 2010 is contained in Table 4.5-10. Ensonified zones were not calculated for side scan sonar, single-beam or multi-beam echosounders, or for the bathymetric sonar (NMFS 2010b), as many of these sources are outside the range of best hearing for mysticetes and possibly for other marine mammals. Additionally, as mentioned above, the beam widths of these sources are quite narrow, which would only expose marine mammals to the sounds for one or two pulses, at most, if the animal swims in the direct beam width of the source.

Bowheads appear to continue normal behavior when exposed to noise generated by high-resolution seismic surveys. Richardson et al. (1985) tested this by firing a single 40 in^3 airgun at a distance of 2 to 5 km (1.2 to 3.1 mi) from whales. Some bowheads continued feeding, surfacing, diving, or traveling when the airgun began firing 3 to 5 km (1.9 to 3.1 mi) away (received noise levels at least 118 to 133 dB re 1 μPa rms. In other tests, some whales oriented away at 2 to 4.5 km (1.2 to 2.8 mi) and at 0.2 to 1.2 km (0.12 to 0.75 mi) (received noise levels at least 124 to 131 and 124 to 134 dB, respectively). Turning, diving, surfacing, respiration and calling were similar with or without airguns (Richardson et al. 1985a, b).

Site clearance and high resolution shallow hazards surveys on active leases in the Beaufort Sea could overlap spatially and temporally with feeding bowhead whales in some years from Harrison Bay to Camden Bay, particularly during their migration from the eastern Beaufort Sea to the Chukchi Sea.

Based on the criteria defined in Table 4.5-19, anticipated impacts of these surveys, in terms of magnitude (medium), duration (interim), extent (local), and context (unique) would be similar to those described for 2D/3D seismic surveys above.

On-ice Vibroseis Survey (January to May)

The presence of bowhead whales are not likely to overlap with an on-ice vibroseis survey due to their absence from the Beaufort Sea during the winter months. If, however, the activity continues into April and May, it could coincide with the spring migration through the nearshore lead system from the Chukchi Sea into the Beaufort Sea. The migratory pathway of bowheads is more narrowly defined during the spring migration largely due to constraints imposed by ice configurations and leads and fractures. The migration corridor through the Beaufort Sea extends farther offshore than that through the Chukchi Sea (Figure 3.2-12), so migrating whales may be sufficiently distant from noise produced from vibroseis to not be disturbed.

Bowhead whales are sensitive to sound, including on-ice sounds, during the spring migration, as noted by Iñupiat whalers:

> *The whales are very sensitive to noise and water pollution. In the spring whale hunt, the whaling crews are very careful about noise. In my crew, and in other crews I observe, the actual spring whaling is done by rowing small boats, usually made from bearded sealskins. We keep our snow machines well away from the edge of the ice so that the machine sound will not scare the whales* (NMFS 2013).

Exploratory Drilling (July through October)

Exploratory drilling is anticipated to initially occur on active leases offshore of Camden Bay. In addition to a drillship or steel drilling caisson (SDC), there will be additional vessels for support and ice management (potentially as many as 11 or 12). Potential impacts from additional vessel traffic will be discussed separately from the effects of the drillship operations (see Associated Vessels and Aircraft below). Multiple sites could be drilled each season with up to three wells being a reasonable number for analysis purposes. This is based on the amount of time needed to drill each individual well and the available amount of time to conduct such operations during the ice free months. See Chapter 2 for details of this activity.

Reaction of bowhead whales to drillship operation noises varies. Whales exhibiting apparently normal behavior were observed several times within 10 to 20 km (6.2 to 12.4 mi) of drillships in the eastern Beaufort Sea, and whales have been sighted within 0.2 to 5 km (0.12 to 3 mi) of drillships (Richardson et al. 1985a, b, Richardson and Malme 1993). Bowheads may, however, avoid drillships and accompanying support vessels at 20 to 30 km (12.4 to 18.6 mi) (MMS 2003). The presence of actively operating icebreakers in support of drilling operations introduces additional noise into the marine environment and affects responses of whales. In 1992, Brewer et al. (1993) noted that migrating bowhead whales avoided an icebreaker-accompanied drillship by >25 km (>15.5 mi). Richardson et al. (1995) observed avoidance behavior in half of the bowhead whales exposed to 115 dB re 1 μPa rms broadband drillship noises. Reaction levels depended on whale activity, noise characteristics, and the physical situation, similar to that observed with seismic sounds. Richardson and Greene (1995) concluded that the observed playback effects of drilling noise were localized and temporary and that effects on distribution, movements, and behavior were not biologically important. Continued long-term monitoring of effects may be needed to better address the issue of biological importance.

Continuous noise emitted from stationary sources, such as drillships, elicits less dramatic behavioral reactions (e.g. changes in swim speed, dive behavior, etc.) by bowhead whales than do moving sources, particularly ships (Richardson and Malme 1993). Most observations of bowheads apparently tolerating noise from stationary operations were opportunistic sightings of whales near oil-industry operations; whether more whales would have been present in the absence of those operations is not known.

Some bowheads likely avoid closely approaching drillships by changing their migration speed and direction, making distances at which reactions to drillships occur difficult to determine. In a study by Koski and Johnson (1987), one whale appeared to alter course to stay 23 to 27 km (14.3 to 16.8 mi) from the center of the drilling operation. Migrating whales passed both north and south of the drillship, apparently avoiding the area within 10 km (6.2 mi) of the drillship. No bowheads were detected within 9.5 km (5.9 mi) of the drillship, and few were observed within 15 km (9.3 mi). They concluded that westward migrating bowheads appeared to avoid the offshore drilling operation during the fall of 1986, and some may avoid noise from drillships at 20 km (12.4 mi) or more.

Monitoring of the Kuvlum drilling site north of Point Thompson occurred during the 1993 fall bowhead whale migration by Hall et al. (1994). These data were later reanalyzed by Davies (1997) and Schick and Urban (2000). Davies (1997) concurred with Hall et al. (1994) that the whales were not randomly distributed in the study area, and that they avoided the area around the drill site at a distance of approximately 20 km (12.4 mi). Hall et al. (1994) noted that the distribution of whales observed in the Kuvlum drilling site is consistent with previous studies (Moore and Reeves 1993), where whales were observed farther offshore in this part of the Beaufort Sea than they were to the east of Barter Island, and that it was difficult to separate the effect of the drilling operation from other independent variables, such as water depth. However, Davies (1997) noted that whales were closer to shore and in shallower water. Results in Schick and Urban (2000) indicated that whales within hearing range of the drillship (<50 km [<31.1 mi]) were distributed farther from the rig than they would be under a random scenario. They concluded that spatial distribution was strongly influenced by the presence of the drillship but lacked data to assess noise levels. Other factors that could influence distribution relative to the drillship were support vessels and icebreakers operating in the vicinity, as well as ice thickness (Schick and Urban 2000). All of these studies noted some level of bowhead whale deflection from active drilling operations.

Bowhead whales, including mothers and calves, may occur in Camden Bay as early as July but more typically from late-August through September (Koski and Miller 2009). It appears to be part of the fall migration corridor. There is, therefore, a high likelihood that drilling operations would coincide with bowhead whale occurrence in the area, with reactions ranging from apparent tolerance (mostly by feeding whales) to displacement and avoidance of the drilling operations.

Based on the impact criteria defined in Table 4.5-19, anticipated impacts of exploratory drilling activities, in terms of magnitude (medium), duration (interim), extent (local), and context (unique) would be similar to those described above for seismic surveys. The zone of possible displacement around a drillship would also be influenced by accompanying support vessel and icebreaker activity and their respective working distances from the drill rig.

Associated Vessels and Aircraft

Bowhead whales react to approaching vessels at greater distances than they react to most other activities. Vessel-disturbance experiments in the Canadian Beaufort Sea by Richardson and Malme (1993) showed that most bowheads begin to swim rapidly away when fast moving vessels approach directly. Avoidance usually begins when a rapidly approaching vessel is 1 to 4 km (0.62 to 2.5 mi) away. Whales move away more quickly when approached closer than 2 km (1.2 mi) (Richardson and Malme 1993). A few whales reacted at distances of 5 to 7 km (3.1 to 4.3 mi), while others did not react until the vessel was <1 km (<0.62 mi) away. Received noise levels as low as 84 dB re 1 μPa, or 6 dB above ambient, elicited strong avoidance of an approaching vessel from 4 km (2.5 mi) away. During the experiments, vessel disturbance temporarily disrupted activities, and socializing whales moved apart from one another. Fleeing from a vessel usually stopped soon after the vessel passed, but scattering lasted for a longer time period. Some bowheads returned to their original locations after the vessel disturbance (Richardson and Malme 1993). Bowheads react less dramatically to and appear more tolerant of slow-moving vessels, especially if they do not approach directly.

Data are not sufficient to determine sex, age, or reproductive characteristics of bowhead whale response to vessels. Data are also not available to determine whether female bowheads with calves react differently than other segments of the population.

Iñupiat whalers expressed concern over vessel impacts on bowhead whales, noting observed displacement caused by barge activity:

> *Bowhead whales have a different view of how they interact with things. For instance, I want to say, again, I've met with you guys, and I explained when I was a whaling captain in '05 was my first year, I saw 100 -- over 100 whales diverted from one barge, and there was no other whales beyond that for the next 15 miles. So I've seen the activity and the diversion of bowhead whales from industry* (testimony provided by Thomas Napageak, Jr. at Nuiqsut Public Scoping Meeting for this EIS, March 11, 2010).

Data on reactions of bowheads to helicopters are limited. Most bowheads showed no obvious response to helicopter overflights at altitudes above 150 m (500 ft) (Richardson and Malme 1993). Patenaude et al. (2002) found that most reactions by bowhead whales to a Bell 212 helicopter occurred when the helicopter was at altitudes of ≤150 m (500 ft) and lateral distances of ≤250 m (820 ft). Reactions included abrupt dives, short surfacings, and breaching, and, most, if not all, reactions seemed brief. The majority of bowheads, however, showed no obvious reaction to single passes, even at those distances. Data were insufficient to analyze effects of repeated low-altitude passes (Patenaude et al. 2002).

Fixed-wing aircraft flying at low altitude often cause bowheads to dive rapidly. Reactions to circling aircraft may be conspicuous at altitudes <300 m (1,000 ft), uncommon at 460 m (1,500 ft), and generally undetectable at 600 m (2,000 ft). Repeated low-altitude overflights at 150 m (500 ft) during aerial photogrammetry studies of feeding bowheads sometimes elicited abrupt turns and quick dives (Richardson and Malme 1993). Aircraft on a direct course are audible only briefly, and whales are likely to resume their normal behavior within minutes after the plane passes (Richardson and Malme 1993). Only 2.2 percent of bowheads during the spring migration reacted to Twin Otter overflights at altitudes of 60 to 460 m (197 to 1,509 ft) (Patenaude et al. 2002). Reactions diminished with increasing lateral distance and altitude. Most observed reactions by bowheads occurred when the Twin Otter was at altitudes of ≤182 m (597 ft) and lateral distances of ≤250 m (820 ft). There was little, if any, reaction when the aircraft circled at an altitude of 460 m (1,509 ft) and a radius of 1 km (0.62 mi) (Patenaude et al. 2002). The effects from an encounter with aircraft are brief, and the whales generally resume their normal behavior within minutes.

During their study, Patenaude et al. (2002) observed one bowhead whale cow-calf pair during four passes totaling 2.8 hours of the helicopter and two pairs during Twin Otter overflights. All of the helicopter passes were at altitudes of 15 to 30 m (49 to 98 ft). The mother dove both times she was at the surface, and the calf dove once out of the four times it was at the surface. For the cow-calf pair sightings during the Twin Otter overflights, the authors did not note any behaviors specific to those pairs. Rather, the reactions of the cow-calf pairs were lumped with the reactions of other groups that did not consist of calves.

The likelihood of spatial and temporal overlap between support vessels and aircraft with bowhead whales in the Beaufort Sea is high. The degree of overlap and interaction depends on the spatial and temporal distribution of activities and whether they are broadly dispersed or clustered. The greatest potential for helicopter or fixed-wing aircraft to cause adverse effects on bowhead whales is in areas where whales are aggregated, especially if aggregations contain large numbers of cow/calf pairs. Activities, such as exploratory drilling, will utilize multiple support vessels, as well as resupply trips and flights to the dock at Prudhoe Bay (see Chapter 2, Tables 2.2 and 2.4). The number of kilometers transited by seismic and various types of support vessels in the Beaufort Sea in 2006 to 2008 ranged from 9,580 km (5,953 mi) in 2006 to 67,627 km (42,021 mi) in 2008 (Funk et al. 2010). During operations, most source vessel speeds are relatively slow, in the range of 3 to 5 kn, although transit speeds are likely to be much higher. Source vessel transit speeds for 2D/3D seismic surveys are estimated at 8 to 20 kn (refer to Chapter 2 for details). If such activity coincides with aggregations of whales, then disruption is likely.

Most observed disturbance reactions to vessel and aircraft activity appear to be short-term. The longer term effects of repeated vessel interactions over a broad area or in a localized area where there are concentrations of whales are unknown. Based on the impact criteria for marine mammals defined in Table 4.5-19, disturbance effects of vessel and aircraft activity would likely be considered of medium intensity since at least some whales would be displaced, but they are not likely to leave the EIS project area entirely. The duration of disturbance is expected to be interim; long term effects are unknown. The extent of the impact would depend on the number of support vessels in an area, but, for individual activities, impacts are expected to be localized. Multiple activities in one area or in several areas across the migratory corridor could result in a broader, regional impact. Bowhead whales are considered unique in context, given both their endangered species status and protection and importance to North Slope communities as a subsistence resource.

Chukchi Sea Activities

2D/3D Surveys (July through November)

Effects of 2D/3D seismic noise on bowhead whales in the Chukchi Sea would likely be similar to those described above for the Beaufort Sea. There may be regional differences in sound propagation and areas of ensonification due to bathymetric and water property differences between the two areas (see Tables 4.5-10 and 4.5-11, Section 4.5.1.4, Acoustics) that would affect distances at which noise impacts may occur. Differences also exist regionally within the Chukchi Sea Lease Sale 193 area. For example, endfire sound level threshold distances for 180, 160, and 120 dB re 1 μPa rms were 1.27 km (0.79 mi), 6.69 km (4.16 mi), and 104.3 km (64.8 mi), respectively, at the Kakapo Prospect and 1.14 km (0.71 mi), 7.15 km (4.44 mi), and 58.4 km (36.3 mi), respectively, at the Burger Prospect (Martin et al. 2010).

Most bowhead whales that encounter airgun sounds from seismic operations in the Chukchi Sea would be migrating. At the onset of seismic operations in July, few bowhead whales will likely be in the Chukchi Sea. Whales are occasionally seen feeding during summer in the northeast Chukchi Sea, although those observed in June and July 2009 were in the nearshore waters between Point Franklin and Barrow (Clarke et al. 2011a), well inshore of the federal lease sale areas. In September and October, bowhead whales migrate west from the Beaufort Sea into the Chukchi Sea, and most traverse the lease sale area (Figure 3.2-13). It is during this time that disturbance is most probable. Satellite-tagged bowhead whales were most common in the Chukchi Sea Lease Sale 193 Area in September. The areas with the greatest probability of use were in the northeastern part of the Lease Area, not in the area of the currently leased blocks. Leased blocks contained only 2 percent of the total probability of use by bowhead whales (Quakenbush et al. 2010a).

As detailed above, migrating bowhead whales in the Beaufort Sea respond to seismic noise pulses at lower received levels than do feeding whales, with avoidance out to 20 to 30 km (12.4 to 18.6 mi) from a medium-sized airgun source at received sound levels of around 120 to 130 dB re 1 μPa rms (Miller et al. 1999, Richardson et al. 1999). The estimated 120 dB re 1 μPa rms sound level threshold distances for seismic operations on the Kakapo and Burger Prospects in the Chukchi Sea were two to three times this distance (Martin et al. 2010). Haley et al. (2010b) found a lower percentage of cetacean sightings near source vessels in the Chukchi Sea, suggesting cetacean avoidance of underwater seismic sound. The small sample size of cetaceans exposed to received sound levels ≥160 dB rms was too small to make strong conclusions. The migration corridor in the Beaufort Sea is more concentrated in a relatively narrow band along the Alaskan coast, whereas the migration through the Chukchi Sea is less defined and spread out over a broader area, thereby providing more area for the whales to migrate through on their way to the overwintering grounds (see Figures 3.2-14 and 3.2-15).

Avoidance at some distance from the sound sources is likely and depends on spatial and temporal overlap with migrating bowhead whales. Operations commencing in July may be complete before the peak of migration in September and October. Surveys starting later in the summer or fall, however, would likely ensonify some portion of the bowhead whale migratory corridor with sounds levels known to elicit avoidance responses.

Based on the impact criteria defined in Table 4.5-19, anticipated impacts of these activities, in terms of magnitude (medium), duration (interim), extent (local), and context (unique) would be similar to those described above for the Beaufort Sea.

In-ice Seismic Survey (2D/3D) with Icebreaker Support (October to mid-December)

Disturbance effects on bowhead whales that may occur in the vicinity of in-ice seismic surveys with icebreaker support in the Chukchi Sea would likely be similar to those described above for the Beaufort Sea. In-ice seismic surveys could occur both on- and off-lease.

The additional sound from icebreakers accompanying seismic activity could cause temporary avoidance of bowhead whales from areas where the vessels are operating and potentially cause temporary deflection of the migration corridor (NMFS 2010c). Bowhead whales are migrating into and through the Chukchi Sea during September and October and typically traverse the Lease Sale 193 area at that time (Clarke et al. 2011a, Brueggeman et al. 2009, Brueggeman et al. 2010, Quakenbush et al. 2010b). Based on satellite-tag data, most bowheads are along the Chukotka coast by November and December (Quakenbush et al. 2010b), and no bowhead whales have been detected during limited COMIDA aerial surveys in November (Clarke et al. 2011a). Small numbers of bowhead whales have been acoustically detected in the Chukchi Sea until early January during low ice years (Delarue et al. 2009). There are limited data on the distribution and abundance of bowhead whales in the Beaufort Sea from mid-October to mid-December. Migrating bowhead whales and icebreaker-accompanied seismic activity are most likely to co-occur during October. Displacement during migration is possible, although the migratory corridor across the Chukchi Sea is broad and spans approximately 3 degrees of latitude (Quakenbush et al. 2010b).

Anticipated impacts of in-ice activities, in terms of magnitude (medium), duration (interim), extent (local), and context (unique) would be similar to those described for the Beaufort Sea despite the less defined migratory corridor in the Chukchi Sea. However, impacts are anticipated on a smaller number of animals based on the fact that seismic operations and bowhead whale migration would only co-occur for a short period of time at the beginning of operations. If a similar survey were occurring at the same time in the Beaufort Sea, there is a potential for some later migrating bowhead whales to encounter survey activities in both seas. However, there would likely be considerable distance between the two operating programs.

Site Clearance and High Resolution Shallow Hazards Survey Programs (July to November)

Disturbance effects on bowhead whales from site clearance and high resolution shallow hazards surveys in the Chukchi Sea would likely be similar to those described above for the Beaufort Sea.

Bowhead whales are most likely to coincide with these operations in the Chukchi Sea during fall migration. Few bowhead whales occur in the Chukchi Sea in July and August (Clarke et al. 2011a). In September and October, bowhead whales migrate west from the Beaufort Sea into and across the Chukchi Sea (Figure 3.2-13). Potential disturbance depends on spatial and temporal overlap with migrating bowhead whales. Operations commencing in July may be complete before the peak of migration in September and October. Surveys starting later in the summer or fall, however, would likely ensonify some portion of the bowhead whale migratory corridor. However, the ensonified zones for these types of surveys are much smaller than those for the 2D/3D seismic surveys.

Based on the impact criteria defined in Table 4.5-19, anticipated impacts of these activities, in terms of magnitude (medium), duration (interim), extent (local), and context (unique) would be similar to those described for the Beaufort Sea.

Exploratory Drilling (July through October)

Known effects of drilling operations on bowhead whales are as described above for the Beaufort Sea and would be expected to be similar for the Chukchi Sea. Drilling operations in the Chukchi Sea would likely initially occur in areas on federal leases for which exploration plans have recently been submitted or would be submitted during the time period of this EIS and where there have been recent requests for approval of ancillary activities. It is anticipated that either a drillship or jackup rig with six to eight support vessels would be used for exploratory drilling, which is anticipated to start in early July and continue through October.

The drilling unit and support vessels typically do not enter the Chukchi Sea until after July 1 when most of the spring bowhead migration is complete. Few bowheads are expected to be encountered during the early season drilling operations, minimizing any effects at that time. Drilling operations occurring during September and October could potentially disturb and displace bowheads migrating through and across the Chukchi Sea.

Anticipated impacts of these activities, in terms of magnitude (medium), duration (interim), extent (local), and context (unique) would be similar to those described above for the Beaufort Sea.

Associated Vessels and Aircraft

Known and potential effects of support vessel and aircraft on bowhead whales in the Chukchi Sea are as described above for the Beaufort Sea and would be expected to be similar for the Chukchi Sea.

Bowhead whales feeding and migrating in the Chukchi Sea could encounter numerous seismic vessels, support vessels, and associated aircraft. The number of kilometers transited by seismic and various types of support vessels in the Chukchi Sea in 2006 to 2008 ranged from 48,100 km (29,888 mi) (2007) to 106,838 km (66,386 mi) (2006) (Funk et al. 2010). The extent of disturbance depends on the areas in which vessels are transiting or operating, the number in a given area, and the time of operation.

Bowheads feeding near shore in the northeast Chukchi Sea may be in the flight path for support flights and transits between Wainwright and Nome and possibly more susceptible to disturbance.

Based on the criteria defined in Table 4.5-19, anticipated impacts of these activities, in terms of magnitude (medium), duration (interim), extent (local), and context (unique) would be similar to those described above for the Beaufort Sea.

Hearing Impairment, Injury, and Mortality

Although the likelihood of such impacts occurring is considered highly unlikely, the primary direct mechanisms of potential hearing impairment, injury, or mortality due to oil and gas exploration activities are hearing loss or damage (auditory injury) and collisions with vessels. The potential effects of a very large oil spill, which is considered improbable and for which incidental take would not be authorized by NMFS under any alternative, are discussed separately in Section 4.10.

Auditory Impairment (TTS and PTS)

Noise induced TS (including TTS and PTS) is described above. The potential for seismic airgun pulses to cause acoustic injury in marine mammals is not well understood (Gedamke et al. 2011), and data on levels or properties of sound that are required to induce TTS are lacking for baleen whales. Recent simulation models, using data extrapolated from TTS in toothed whales, suggest the possibility that baleen whales 1 km (0.62 mi) or more from seismic surveys could potentially be susceptible to TTS (Gedamke et al. 2011). There is no information on TTS or PTS specifically for bowhead whales.

Because bowhead whales generally respond to loud noise by moving away, they are less likely to suffer hearing loss from increased noise. They are not likely to remain close enough to a large airgun array long enough to incur TTS, let alone PTS. The levels of successive pulses received by a marine mammal would increase and then decrease gradually as the seismic vessel approaches, passes and moves away, with periodic decreases also caused when the animal goes to the surface to breath, reducing the probability of the animal being exposed to sound levels large enough to elicit PTS. However, data suggest that exposures of longer duration and lower levels can lead to more TTS (i.e. onset at lower level and greater amount of TTS) compared to exposures of higher level and short duration with the same cumulative sound exposure level (Finneran et al. 2010, Kastak et al. 2005, 2007, Kastelein et al. 2012a, b, Mooney et al. 2009), and seismic airguns can ensonify larger areas to higher levels in which whales may remain in the proximity of for longer times. This, in combination with the fact that monitoring reports include occasional observations of bowheads within the 180-dB zone of seismic surveys suggests that TTS and PTS, though unlikely, cannot be entirely ruled out.

Since bowhead whales appear to be more tolerant of noise when feeding, work is needed to determine potential effects of repeated exposure to loud noise at distances tolerated in feeding areas. The potential for increased noise to cause physiological stress responses should also be considered, as it is not currently known (NMFS 2011a). Obtaining data on stress responses in large free-swimming whales would require potentially disruptive invasive techniques.

Assessing whether or not TTS or PTS is occurring is not currently possible. There is no information on these thresholds specific to bowheads, and the likelihood of obtaining the information is low. Hearing and hearing damage can only be readily analyzed in smaller cetaceans, primarily in captivity, or through studying ears of dead whales. Determining intensity is not possible, unless noise exposure were severe enough to result in observed mortality where cause of death could be attributed to sound impulses. There are no known such incidences with bowhead whales. The duration of impact would be temporary for TTS but permanent if PTS were to occur. The extent of such impacts would be local and the context unique, since bowhead whales are listed as endangered.

Ship Strikes

Marine vessels could potentially strike bowhead whales, causing either injury or death. Incidence of ship strikes appears low, but could rise with increasing vessel traffic. Only three ship-strike injuries were documented in the 236 bowhead whales examined from the subsistence harvest from 1976 to 1992 (George et al. 1994). All of the injuries indicate the whales were struck by propellers of large (>30 m [>98.4 ft]) ships.

The low incidence of observed ship strikes, as of the early-1990s, was likely an artifact of the comparatively low rate of vessels passing through most of the bowhead's range or that many bowheads struck by ships do not survive (George et al. 1994). Ship strikes are a major cause of mortality and serious injury in North Atlantic right whales, accounting for 35 percent of deaths from 1970 to 1999 (Knowlton and Kraus 2001). Experimental playback studies revealed that right whales did not respond to sounds of approaching vessels or to actual vessels, suggesting habituation to engine sounds that are ubiquitous throughout most of their range (Nowacek et al. 2004). Most bowhead whales, in contrast, show strong avoidance reactions to approaching ships. Eskimo hunters report that bowheads are less sensitive to approaching boats when they are feeding (George et al. 1994), leaving them more vulnerable to vessel collisions.

The frequency and severity of ship strikes is influenced by vessel speed. The potential for collision increases at speeds of 15 kn and greater (Laist et al. 2001, Vanderlaan and Taggart 2007). For the activities considered under Alternative 2, speeds for most source vessels are relatively slow (approximately 3 to 5 kn) during oil and gas exploration activities. Transit speeds, however, are likely to be much higher. Seismic survey source vessel transit speeds are, for example, estimated at 8 to 12 kn (refer to Chapter 2, Alternatives for details), suggesting that, if collisions were to occur, they are more likely when vessels are in transit than when conducting active exploration operations. Vessels transiting to the Beaufort or Chukchi seas from Dutch Harbor at the start of the open water season, or returning across these areas to the Bering Strait at the end of the season, transiting between sites, or for resupply in and out of Nome or Wainwright in the Chukchi Sea or Prudhoe Bay in the Beaufort have the highest chance of encountering migrating bowheads or aggregations feeding in more coastal regions of the northeast Chukchi and between Point Barrow and Smith Bay in the Beaufort Sea.

The reported incidence of ship strikes is low, but, since collisions have occurred in the past, the intensity of the impact should be considered medium. The impact would be temporary, although the results (injury or mortality) would be permanent for the whale. The extent of impact would be local, given the infrequency of occurrence and the non-random distribution of both bowhead whales and exploration activity in the EIS project area. The context would be unique, since bowhead whales are listed as endangered. Refer to Table 4.5-19 for marine mammal impact criteria definitions.

Habitat Alterations

Oil and gas exploration activities that may result in alteration of habitat include disturbance of sea ice from icebreaking, disturbance of benthic sediments during drilling, and contamination of the marine environment from discharge of drilling muds and other waste streams from ships and support facilities. Effects of icebreaking and exploratory drilling are discussed above in the introduction to effects on marine mammals (Section 4.5.2.4). Potential effects of a very large oil spill, including long-term displacement from areas impacted by oil, are discussed in Section 4.10. Additional details and impact assessments are provided here.

Potential impacts of drilling mud discharged into the marine environment are among concerns expressed by Iñupiat subsistence hunters:

> *I've experienced drilling mud on an iceberg north of Northstar at that time when Northstar was in a stage of being developed. So there were quite a few drilling muds being caught at -- on Northstar on a real calm, calm day. Not even one marine mammal was inside it. And you could*

> *hear that Northstar drill rig pounding away. Not one marine mammal, not even one waterfowl was sighted. And the only thing we encountered was an iceberg totally covered with drilling mud. It's not a natural mud.* (Testimony provided by Archie Ahkiviana at the Nuiqsut Public Scoping Meeting for this EIS, March 11, 2010).

Adverse effects of discharges on bowhead whales are directly related to whether or not any potentially harmful substances are released into the marine environment and whether they rapidly dilute or bioaccumulate through the food chain. Bowhead whales are long lived, and some individuals potentially could accumulate contaminants. Bowhead whales, however, feed on lower trophic level organisms (zooplankton) so are considered at lower risk of bioaccumulation of contaminants, such as persistent organic compounds, than higher level consumers. Levels of persistent organic compound concentrations in samples collected from bowhead whales in Alaska are low compared to other marine mammals (O'Hara and Becker 2003).

Drill cuttings and drilling mud discharges are regulated by the EPA NPDES Permits. The impact of drill cuttings and drilling mud discharges would be localized and temporary. Drill cuttings and mud discharges could temporarily displace marine mammals a short distance from the drilling site. The EPA modeled a hypothetical 750 bbl/hr discharge of drilling fluids in 20 m (66 ft) of water in the Beaufort and Chukchi seas and predicted a minimum dilution of 1,326:1 at 100 m (330 ft) from the discharge point (Shell 2011a). Discharged drilling fluid should be well diluted within 100 m (330 ft) so that any impacts would be localized and temporary assuming that whales continue to swim through and past the discharge plume. If toxic contaminants are present in discharges, only a small area of potential habitat and prey base might be contaminated. Population-level effects would, therefore, be negligible.

Bottom-founded drilling units or gravel islands could impact small areas of benthic habitat that support epibenthic invertebrates that bowhead whales feed on, including through increased turbidity or sediment suspension in marine waters. Exploration drilling on past and current leases would add incrementally to potential discharges into the Beaufort and Chukchi seas but would remain localized to areas immediately surrounding exploration drilling activity.

Additionally, the acoustic habitat, within which whales use sound to communicate and detect prey, predators, and other environmental cues, can be temporarily altered by the presence of sounds in the frequency bands of the signals of interest for the whales. Depending on the level, frequency, and duration of these sounds, these acoustic habitat alterations can result in reduced ability to detect or interpret important sounds. Acoustic habitat alterations would be expected to be more of a potential issue for mysticetes and low frequency sound sources (than other taxa and sound source types) because of the long distances and times over which these species communicate, combined with the physical properties of low frequency sounds, which are not absorbed nearly as quickly underwater as higher frequency sounds, and therefore travel much longer distances.

Effects on Zooplankton

In a review of available information on the effects of seismic sound on invertebrates, the Canadian Department of Fisheries and Oceans reported that, under experimental conditions, lethal and/or sublethal effects have sometimes been observed in invertebrates (e.g., crustaceans, gastropods) exposed to airgun sounds at distances of <5 m (<16.4 ft) (DFO 2004). They considered exposure to seismic sound unlikely to result in direct invertebrate mortality, although invertebrates may exhibit short-term behavioral reactions to sound (DFO 2004). They found few studies on the effects of seismic noise on zooplankton. Zooplankton very close to the seismic source may react to the shock wave, but effects are expected to be localized (LGL 2010). Potential non-seismic effects on zooplankton are noted above and in the respective sections on Lower Trophic Levels (see, for example, 4.5.2.1).

Potential impacts to bowhead whale habitat (including from discharge and to zooplankton and acoustic habitat) from oil and gas exploration activities permitted under Alternative 2 would, based on the criteria defined in Table 4.5-19, be of medium intensity. Most impacts would be localized in the area immediately adjacent to the impacts (discharges, sediment disruption, or icebreaking), but disruptions to acoustic habitat could be over a regional scale. Most impacts would also be temporary, although longer-term and regional effects could occur through the process of bioaccumulation through the food chain. The context would be unique, since bowhead whales are listed as endangered.

Small Fuel Spill

There is the potential for bowhead whales to be exposed to small accidental fuel spills of less than 50 bbl (see Section 4.2.7). If a small accidental spill were to escape containment or response measures, it would not persist very long, resulting in few opportunities to contact bowhead whales. Further, vessel activity associated with spill response would likely keep bowhead whales out of the spill area, and individual whales would likely avoid the spill by leaving the area during spill response activities. Oil generally poorly adheres to the skin of mysticete whales, and cetaceans are believed to have the ability to detect and avoid oil spills (Geraci, 1990; St. Aubin, 1990). Moreover, the weathering process should act to quickly break up or dissipate oil/fuel through the local environment to harmless residual levels that would eventually become undetectable. Therefore, accidental small spills are anticipated to have no more than a negligible level of effect on bowhead whales.

4.5.2.4.9.2 Conclusion

Like in other resource sections, consideration of the effects of implementation of the required standard mitigation measures is included in the conclusion immediately below. Unlike in other resource sections, the Standard Mitigation Measure section is *not* included immediately prior to this Conclusion section, but rather, the separate section analyzing the measures themselves is included once at the end of the Marine Mammal section after all of the individual species sections because the measures apply to multiple species and including them multiple times in separate species sections would be repetitive and potentially confusing.

Oil and gas exploration activities in the Beaufort and Chukchi seas, as analyzed under Alternative 2, would likely cause behavioral disturbance to bowhead whales, including varying degrees of disturbance to feeding, resting, or migrating bowhead whales depending on actual level of effort, type of activity, time of year, and whether activities run concurrent in the Beaufort and Chukchi seas. Disturbance could lead to displacement from and avoidance of areas of exploration activity. The EIS project area encompasses a large portion of bowhead whale habitat between the Bering Strait and Canadian border, so leaving the area entirely to avoid impacts is not likely. The duration of disturbance (and acoustic habitat disturbance) from oil and gas activities is expected to be of interim duration, lasting less than six months, but repeating over multiple years. Surveys utilizing icebreakers could cause avoidance and displacement over a larger radius with the additional noise input from the icebreaking activities, but the period of time over which this activity would overlap with bowhead whales is much shorter. Although bowhead whales react to approaching vessels at greater distances than they react to most other activities, most observed disturbance reactions to vessels and aircraft appear to be short-term. The extent of the impact will depend on the number of exploration activities and associated support vessels in an area, but, for individual sound sources, impacts are expected to be localized. However, over the course of the season and considering the maximum level of activity potentially conducted under this activity, and considering areas that are potentially ensonified above 120 dB, the geographic scale could be considered regional.

Because whales respond behaviorally to loud noise, and because of the required standard mitigation measures, they are less likely to suffer auditory damage from increased noise due to oil and gas exploration activities.

The geographic area and extent of the population over which effects would be felt (especially considering the distances over which bowhead whales communicate and seismic sounds travel) would likely increase with multiple activities occurring simultaneously or consecutively throughout much of the summer-fall range of this population. Potential long-term effects from repeated disturbance, displacement or habitat disruption on an extremely long-lived species such as the bowhead whale are unknown. The Western Arctic stock of bowhead whales has, however, continued to increase at an estimated 3.4 percent per year despite past and present exploration activities within their range (George et al. 2004). It is not currently possible to predict which behavioral responses to anthropogenic noise might result in significant population consequences for marine mammals, such as bowheads, in the future (NRC 2005).

Bowhead whales are listed as endangered, which places them in the context of being a unique resource in the region. Potential impacts of individual activities associated with oil and gas exploration considered under Alternative 2 on bowhead whales would be mostly of medium intensity, interim duration, and on a localized to regional geographic scale. Evaluated collectively, and with consideration given to reduced adverse impacts through the implementation of the standard mitigation measures, as appropriate, the overall impact to bowhead whales is likely to be moderate.

Type of effect	Impact Component	Effects Summary	
Behavioral disturbance	Magnitude or Intensity	Low	
		Medium	Behavioral harassment occurring, but likely < 30% of population disturbed
		High	Impacts from max level activity might exceed take of 30% of population
	Duration	Temporary	
		Interim	All activity types last more than month, but combination < 6 months
		Long-term	
	Geographic Extent	Local	Lower to mid-level of ativities considered local
		Regional	Impacts from max levels of activity might be considered regional when consider area over which travel and which is ensonified over 120 dB (>10% EIS area)
		State-wide	
	Context	Common	
		Important	
		Unique	ESA-listed species, impacts across migratory corridor through which mother/calve pairs traverse, potential disruption of feeding and resting
Injury and mortality	Magnitude or Intensity	Low	Injury or death unlikley
		Medium	Though unlikely, cannot rule out PTS
		High	
	Duration	Temporary	
		Interim	Type of potential injury (though unlikely) would likely have moderate effects
		Long-term	
	Geographic Extent	Local	Since unlikely, any few impacts would be considered local
		Regional	
		State-wide	
	Context	Common	
		Important	ESA listed species, but population is increasing
		Unique	

Type of effect	Impact Component	Effects Summary	
Habitat alterations	Magnitude or Intensity	**Low**	
		Medium	Combination of potential habitat impacts, including acoustic habitat, are medium
		High	
	Duration	**Temporary**	
		Interim	Although other alterations shorter, acoustic habitat is altered for duration of activities
		Long-term	
	Geographic Extent	**Local**	Lower to mid-level of ativities considered regional
		Regional	Impacts from max levels of activity might be considered regional, especially when consider area over which sound exceeds 120 dB, and the communication distances of baleen whales.
		State-wide	
	Context	**Common**	
		Important	ESA listed species, but population is increasing
		Unique	

4.5.2.4.10 Beluga Whales

4.5.2.4.10.1 Direct and Indirect Effects

The primary direct and indirect effects on beluga whales from activities associated with oil and gas exploration in the Beaufort and Chukchi seas considered under Alternative 2 would result from noise exposure. Ship strikes and habitat degradation are also possible. Sources of noise include 2D/3D seismic survey equipment (airgun arrays), CSEM electromagnetic signals, echosounder and sonar devices associated with site clearance and shallow hazards surveys, support, monitoring and receiving vessels associated with these surveys, icebreaking activities, on ice vibroseis seismic surveys (Beaufort Sea only), exploratory drilling, and helicopter and fixed wing aircraft associated with the different programs. Details of these activities and associated components can be found in Chapter 2.

Behavioral Disturbance

2D/3D Seismic Surveys (July through November)

Anthropogenic noise from oil and gas exploration activities may elicit behavioral responses from beluga whales. The possible reactions by marine mammals are listed above; known reactions by beluga whales are included here and described and assessed by region and activity. Most of these mechanisms are common to both seas and these potential effects will be discussed together. Where activities or mechanisms are unique to one sea or the other, they will be discussed separately. Beluga whales are observed in both seas. Vessels associated with the exploration activities identified in Chapter 2 introduce sound into the water and have a physical presence that could affect beluga whales. Although many of these vessels carried PSOs in the past, beluga whales are rarely seen from these vessels, particularly in the Chukchi Sea.

Miller et al. (2005) reported, based on observations collected during two years of seismic studies in the Beaufort Sea, that beluga whale sightings were unexpectedly high 20-30 km (12.4-18.6 mi) from the seismic vessel, and significantly lower 10-20 km (6.2-12.4 mi) from the vessel, indicating that whales may be avoiding operations by 10-20 km (6.2-12.4 mi). Studies of captive beluga whales have shown that they exhibit changes in behavior when exposed to strong, pulsed sounds similar in duration to those used in seismic surveys (Finneran et al. 2000, 2002a), but the received sound levels were relatively high before aversive behaviors were observed (peak to peak level >200 dB re 1 µPa). Behaviors such as vocalizing after the exposure and reluctance to station at the test site were observed (Finneran et al. 2002). Similar behaviors were observed by a beluga whale exposed to a single underwater pulse similar to those produced by distant underwater explosions (Finneran et al. 2000). The applicability of these observations in trained, captive beluga whales exposed to a single transient sound to the natural environment of free-ranging animals exposed to multiple pulses over time, is unknown.

Most of the energy from airgun arrays is below 100 Hz, which is below the frequencies of calling and best hearing of beluga whales, however, behavioral observations indicate that they are not insensitive to sounds produced by these activities.

Anticipated impacts of 2D/3D surveys would be expected to be of medium magnitude (behavioral disturbance, but less than 30% of population effected), interim duration (between 1 and 6 months), local extent (not spanning more than 10% of the EIS area), and important context as, although beluga whales are not ESA-listed, industry activities will overlap with areas of importance for belugas.

In-ice Seismic Survey (2D/3D) with Icebreaker Support (October to mid-December)

While not many studies have been conducted to evaluate the potential interference of icebreaking noise with marine mammal vocalizations, a few studies have looked specifically at icebreaking noise and beluga whales. Erbe and Farmer (1998) reported that the Canadian Coast Guard ship, *Henry Larsen*, ramming ice in the Beaufort Sea, masked recordings of beluga vocalizations at a signal-to-noise ratio of 18 dB. However, an in-ice seismic survey cannot be conducted in ice thick enough to require ramming to break it up.

Erbe and Farmer (2000) modeled zones of impact for the bubbler system noise in addition to the propeller cavitation (ramming) noise. The propagation model predicted that icebreaker bubbler system noise could mask beluga whale communication out to 14 km (8.7 mi) from the vessel over the continental slope, as measured near the surface. The modeled zone of behavioral disturbance for the bubbler system noise extended to approximately 32 km (19.9 mi). Based on historical modeled estimates, in-ice surveys likely result in a larger number of harassed belugas than other activity types.

Ocean-Bottom-Cable Survey (July to October)

Ocean-bottom-cable (OBC) seismic surveys are used in nearshore areas where water is too shallow (≤14 m [≤45.9 ft]) for a towed marine streamer seismic survey vessel and too deep to have bottomfast ice in the winter. An OBC seismic survey typically covers a smaller area than the streamer surveys discussed above and may spend several days in an area. One such survey is anticipated in the Beaufort Sea under Alternative 2. Beluga whales are present throughout the Beaufort Sea during this time period and may be concentrated in nearshore areas. Reactions to sounds from OBC surveys are similar to those reported for 2D/3D steamer seismic surveys. Anticipated impacts of OBC surveys, in terms of magnitude (medium), duration (interim), extent (local), and context (important) would be similar to those described for 2D/3D seismic surveys above. Although disturbance effects may extend 20 to 30 km (12.4 to 18.6 mi) from the sound source, with one OBC survey anticipated in the Beaufort Sea, short-term effects should remain localized.

Site Clearance and High Resolution Shallow Hazards Survey Programs (July to November)

High-resolution shallow hazards surveys are of short duration, and the airguns generate lower energy sounds and have a smaller zone of influence than the larger airgun arrays used for 2D/3D seismic surveys (NMFS 2010b). The radii of ensonification at 120, 160, 180, and 190 dB re 1 μPa rms were calculated for sound sources proposed for use in 2010. Radii calculated for the 40 in^3 airgun were 14,000 m (45,932 ft), 1,220 m (4,003 ft), 125 m (410 ft), and 35 m (115 ft) for the respective sound source levels. The beam widths of these sources are quite narrow, which would only expose marine mammals to the sounds for one or two pulses at most if the animal swims in the direct beam width of the source. Ensonified zones were not calculated for side scan sonar, single-beam or multi-beam echosounders, or for the bathymetric sonar (NMFS 2010b). The higher frequency sub-bottom profilers, side scan sonar, and echosounders often produce sounds at high enough energy to result in disturbance, primarily masking, to beluga whales. Captive bottlenose dolphins and a beluga whale exhibited changes in behavior when exposed to 1 s tonal signals at frequencies similar to those emitted by some of these higher frequency sound sources and to shorter broadband pulsed signals. Behavioral changes typically involved what appeared to be deliberate attempts to avoid the sound exposure (Schlundt et al. 2000, Finneran et al. 2002, Finneran and Schlundt 2004).

Based on results of noise studies on captive and wild populations of beluga whales, belugas would likely avoid the area directly around the shallow hazard operations using the higher frequency equipment, resulting in a temporary, localized effect. If such types of shallow hazard operations were conducted in areas where belugas are feeding or nursing, continued operations may result in displacement from these important habitats. Anticipated impacts of these surveys, in terms of magnitude (medium), duration (interim), extent (local), and context (important) would be similar to those described for 2D/3D seismic surveys above.

On-ice Vibroseis Survey (January to May)

Beluga whales are not likely to experience impacts resultant from an on-ice survey due to their absence from the Beaufort Sea during the winter months. If, however, the activity continues into April and May, it could coincide with the spring migration.

Exploratory Drilling (July through October)

Reactions of beluga whales to drillship operation noises vary. As summarized in Richardson et al. (1995), belugas are often observed near drillsites within 100 to 150 m (328.1 to 492.1 ft) from artificial islands, which are production islands and are different than exploratory drilling platforms. However, belugas swimming in the spring leads change course when they came within 1 km (0.62 mi) of a drillship and exhibited aversive behavior when support vessels were operating near the drillship (Richardson et al. 1995). Reactions of belugas (captive and wild) to playbacks of the semisubmersible drillship *SEDCO 708* indicate that belugas exhibit slight avoidance reactions to drillship sounds (Richardson et al. 1995). Furthermore, belugas may not be able to detect the lower frequency sounds of drillships, which usually emit sounds below 1 kHz because they are below their best hearing sensitivity.

Associated Vessels and Aircraft

Helicopter noise may be a source of disturbance to beluga whales, particularly during exploratory drilling crew transfers. During spring migration in the Beaufort Sea, beluga whales reacted to helicopter noise more frequently and at greater distances than did bowhead whales (Patenaude et al. 2002). Most reactions occurred when the helicopter passed within 250 m (820 ft) lateral distance at altitudes <150 m (492 ft). Neither species exhibited noticeable reactions to single passes at altitudes >150 m (492 ft). Belugas within 250 m (820 ft) of stationary helicopters on the ice with the engine running showed the most overt reactions. Whales were observed to make only minor changes in direction in response to sounds produced by helicopters, so all reactions to helicopters were considered brief and minor. Patenaude et al. (2002) noted that fewer belugas reacted to a Twin Otter than to a helicopter (3.2% instead of 38%).

Lesage et al. (1999) report that beluga whales changed their call type and call frequency when exposed to vessel noise. Beluga whales have been documented swimming rapidly away from ships and icebreakers in the Beaufort Sea when a ship approached to within 35 to 50 km (21.7 to 31.1 mi) and received levels ranged from 94 to 105 dB re 1 µPa in the 20 to 1,000 Hz band, and they may travel up to 80 km (49.7 mi) from the vessel's track (Finley et al. 1990). In addition to avoidance, changes in dive behavior and pod integrity were also noted.

Hearing Impairment, Injury, and Mortality

The primary mechanisms of potential hearing impairment, injury, or mortality of beluga whales due to oil and gas exploration activities are hearing loss or damage (auditory injury) and collisions with vessels.

Auditory Impairment

Noise-induced threshold shift, including TTS and PTS, is described in Section 4.5.2.4.

NMFS currently considers the appropriate metric for TTS levels to be the rms received level, which is typically 10 to 15 dB higher than the SEL for the same pulse, therefore, a single airgun pulse would need to have a received level of ~196 to 201 dB to result in a brief, mild TTS in beluga whales. As also noted, NMFS is considering revisions to these injury criteria, although even with the changes, the 180-dB rms mitigation zone is still expected to protect mid-frequency hearing specialists from potential injury. As reported in the Section 4.5.1.4 (Acoustics), distances to the 180 dB rms received level from various sizes of airgun arrays are <2,570 m (8,432 ft). Therefore, TTS would be expected if beluga whales remained within this distance from the source vessel during airgun operations. However, beluga whales have been observed to avoid seismic vessels. Some beluga whales summering in the Eastern Beaufort Sea may have avoided the area around seismic program using 2 arrays with 24 airguns per array by 10 to 20 km (6.2 to 12.4 miles), although some occurred as close as 1,540 m (5,052 ft) to the operations (Miller et al. 2005). Based on these observed reactions, the likelihood of beluga whales being exposed to adverse sound levels is low. Recent seismic monitoring studies have confirmed that belugas remained further away from seismic operations than has been shown for other odontocetes (Harris et al. 2007).

Researchers have derived TTS information for odontocetes from studies on the bottlenose dolphin and beluga. For the one harbor porpoise tested, the received level of airgun sound that elicited onset of TTS was lower (Lucke et al. 2009). If these results from a single animal are representative, it is inappropriate to assume that onset of TTS occurs at similar received levels in all odontocetes (cf. Southall et al. 2007). Some cetaceans apparently can incur TTS at considerably lower sound exposures than are necessary to elicit TTS in the beluga or bottlenose dolphin.

Exploratory drilling activities are not anticipated to induce TTS or PTS, as source levels for the drill ship and other equipment are typically between 175 and 185 dB re 1 µPa rms.

Ship Strikes

Marine vessels could potentially strike beluga whales, causing either injury or death. Incidence of ship strikes appears low but could rise with increasing vessel traffic.

The frequency and severity of ship strikes is influenced by vessel speed. The potential for collision increases at speeds of 15 kn and greater (Laist et al. 2001, Vanderlaan and Taggart 2007). Most source vessel speeds are relatively slow (approximately 3 to 5 kn) during oil and gas exploration activities. Transit speeds, however, are likely to be much higher. Seismic survey source vessel transit speeds are, for example, estimated at 8 to 20 kn (refer to Chapter 2, Alternatives for details), suggesting that, if collisions were to occur, they are more likely when vessels are in transit. Vessels transiting to the Beaufort or Chukchi seas from Dutch Harbor at the start of the open water season, or returning across these areas to the Bering Strait at the end of the season, transiting between sites, or for resupply in and out of Nome or Wainwright in the Chukchi Sea or Prudhoe Bay in the Beaufort have the highest chance of encountering migrating and feeding beluga whales.

Habitat Loss/Alteration

Oil and gas exploration activities that may result in the alteration of beluga whale habitat include drill cuttings and drilling mud discharges from exploratory drilling. The impact of drill cuttings and drilling mud discharges would be localized and temporary. Drill cuttings and mud discharges could temporarily displace marine mammals a short distance from the drilling location. Based on a hypothetical EPA model in the Beaufort and Chukchi seas, the potential source of an impact, the discharged drilling fluid is diluted to the extent that any impacts would be minimal and temporary, due to the whale’s motility, assuming that the animal continues to swim through the discharge plume (Shell 2011a).

Discharges related to drilling would occur and, if released into the marine environment, effects would remain localized in relation to affecting whale habitat and prey populations. The effects of such discharges are anticipated to remain localized as a result of rapid deposition and dilution and potential contamination (if toxic contaminants are present in discharges) of an extremely small proportion of the habitat or the prey base available to beluga whales; thus, population-level effects would be negligible.

Additionally, the acoustic habitat, within which whales use sound to communicate and detect prey, predators, and other environmental cues, can be temporarily altered by the presence of sounds in the frequency bands of the signals of interest for the whales. Depending on the level, frequency, and duration of these sounds, these acoustic habitat alterations can result in reduced ability to detect or interpret important sounds. Acoustic habitat alterations would be expected to be more of a potential issue for mysticetes and low frequency sound sources (than other taxa and sound source types) because of the long distances and times over which these species communicate combined with the physical properties of low frequency sounds, which are not absorbed nearly as quickly underwater as higher frequency sounds, and therefore travel much longer distances.

Small Fuel Spill

There is the potential for beluga whales to be exposed to small accidental fuel spills of less than 50 bbl (see Section 4.2.7). However, few beluga whales are anticipated to occur in the vicinity of oil and gas activities and few would be exposed to an accidental spill. Moreover, if a small accidental spill were to escape containment or response measures, it would dissipate over a few days, resulting in few opportunities to contact beluga whales. Also, vessel activity associated with spill response would likely keep beluga whales out of the spill area, and individual whales would likely avoid the spill by leaving the area during spill response activities. Accidental small spills are anticipated to have no more than a negligible level of effect on beluga whales.

4.5.2.4.10.2 Conclusion

Like in other resource sections, consideration of the effects of implementation of the required standard mitigation measures is included in the conclusion immediately below. Unlike in other resource sections, the Standard Mitigation Measure section is *not* included immediately prior to this Conclusion section, but rather, the separate section analyzing the measures themselves is included once at the end of the Marine Mammal section after all of the individual species sections because the measures apply to multiple species and including them multiple times in separate species sections would be repetitive and potentially confusing.

Oil and gas exploration activities in the Beaufort and Chukchi seas, as analyzed under Alternative 2, would likely cause behavioral disturbance to beluga whales, including varying degrees of disturbance to feeding, calving, or migrating whales depending on actual level and location of effort, type of activity, time of year, and whether activities run concurrent in the Beaufort and Chukchi seas. Disturbance could lead to displacement from and avoidance of areas of exploration activity. The EIS project area encompasses a large portion of beluga whale habitat between the Bering Strait and Canadian border, so leaving the area entirely to avoid impacts is not likely. The duration of disturbance, and acoustic habitat disturbance, from oil and gas activities is expected to be of interim duration, lasting less than six months, but repeating over multiple years. Surveys utilizing icebreakers could cause avoidance and displacement over a larger radius with the additional noise input from the icebreaking activities. The extent of the impact will depend on the number of exploration activities and associated support vessels in an area, but, for individual sound sources, impacts are expected to be localized.

Because whales respond behaviorally to loud noise, and because of the required standard mitigation measures, they are less likely to suffer auditory damage from increased noise due to oil and gas exploration activities. Of note also, although they still respond to these sources, the low frequency sounds form most exploration activiites are outside of the range of highest hearig sensitivity for belugas and less likely to overlap with important interspecies communication. The magnitude of impacts is moderate.

The geographic area and extent of the population over which effects would be felt would likely increase with multiple activities occurring simultaneously or consecutively throughout much of the summer-fall range of this population, however, considering the range of acoustic impacts, the extent would likely be considered local.

Beluga whales in the Arctic are not listed under the ESA but do have a couple of feeding and calving areas that are important to the popoulations, making their context important.

The intensity and duration of the various effects and activities considered are mostly medium and temporary. However, potential long-term effects from repeated disturbance are unknown. Currently, population trends for the Beaufort stock cannot be estimated, and are not thought to be declining in the Chukchi stock. Although, individually, the various activities may elicit local effects on beluga whales, the area and extent of the population over which effects occur will likely increase with multiple activities occurring simultaneously or consecutively throughout much of the spring-fall range of the Arctic populations. The summary impact level of Alternative 2 on beluga whales would be considered moderate.

Type of effect	Impact Component	Effects Summary	
Behavioral disturbance	Magnitude or Intensity	**Low**	
		Medium	Behavioral harassment occurring, but likely < 30% of population disturbed
		High	
	Duration	**Temporary**	
		Interim	All activity types last more than month, but combination < 6 months
		Long-term	
	Geographic Extent	**Local**	Activities considered local
		Regional	
		State-wide	
	Context	**Common**	
		Important	Non-ESA listed, population status not well known, but thought not to be declining in Chukchi, important feeding and calving areas
		Unique	
Injury and mortality	Magnitude or Intensity	**Low**	Injury or death unlikley
		Medium	Though unlikely, cannot rule out PTS
		High	
	Duration	**Temporary**	
		Interim	Type of potential injury (though unlikely) would likely have moderate effects
		Long-term	
	Geographic Extent	**Local**	Since unlikely, any few impacts would be considered local
		Regional	
		State-wide	
	Context	**Common**	Not ESA listed, populations not thought to be decreasing
		Important	
		Unique	
Habitat alterations	Magnitude or Intensity	**Low**	
		Medium	Combination of potential habitat impacts, including acoustic habitat, are medium
		High	
	Duration	**Temporary**	
		Interim	Although other alterations shorter, acoustic habitat is altered for duration of activities
		Long-term	
	Geographic Extent	**Local**	Lower to mid-level of ativities considered regional
		Regional	
		State-wide	
	Context	**Common**	Not ESA listed, populations not thought to be decreasing
		Important	
		Unique	

4.5.2.4.11 Other Cetaceans

This section discusses the potential direct and indirect effects of Alternative 2 on Other Cetaceans, excluding bowhead and beluga whales. Bowhead whales and beluga whales are addressed individually in Section 4.5.2.4.9 and Section 4.5.2.4.10, respectively, as they are both important subsistence species and common in the EIS project area. Other Cetaceans include all other cetaceans known to frequent the EIS project area and have been combined into two groups: baleen whales and toothed whales. The baleen whales include gray, humpback, fin, and minke whales, while the toothed whales include harbor porpoise, killer whale, and narwhal. Cetaceans are a diverse group with varied life histories and migratory patterns (see Chapter 3, Section 3.2.4.2 for more information). However, they share many important traits and exhibit similar physiological and behavioral responses. Each group is analyzed collectively where appropriate, as the individual species within each group share many similar characteristics which are correlated with potential impacts from offshore oil and gas exploration activities. Where sufficient research exists for species-specific analysis, or unique effects or susceptibilities exist, individual species have been discussed separately.

4.5.2.4.11.1 Direct and Indirect Effects

In general, potential direct and indirect effects on Other Cetaceans resulting from exploration activities in the Beaufort and Chukchi seas authorized under Alternative 2 are similar to those discussed for bowhead whales (Section 4.5.2.4.9) and beluga whales (Section 4.5.2.4.10). The primary direct and indirect effects on other cetaceans would result from noise exposure. Direct and indirect effects arising from ship strikes and habitat degradation are also possible. Potential noise sources include 2D/3D seismic survey equipment (airgun arrays), echosounder and sonar devices associated with site clearance and shallow hazards surveys, support, monitoring and receiving vessels associated with these surveys, icebreaking activities, on-ice vibroseis seismic surveys (Beaufort Sea only), exploratory drilling, and helicopter and fixed wing aircraft associated with the different programs. Details of these activities and associated components can be found in Chapter 2. For a general discussion of the types of effects of oil and gas exploration activities can have on marine mammals, see Section 4.5.2.4.

Behavioral Disturbance

Anthropogenic noise from oil and gas exploration activities has been shown to elicit behavioral responses from baleen and toothed whales. These responses include subtle changes in behavior, more conspicuous changes in activities, and displacement. Observable reactions of marine mammals to sound include attraction to the sound source, increased alertness, modification to their own sounds, cessation of feeding or interacting, alteration in swimming or diving behavior (change direction or speed), short or long-term habitat abandonment (deflection, short or long-term avoidance), and, possibly, panic reactions, such as stampeding or stranding (Nowacek et al. 2007, Richardson et al. 1995, Southall et al. 2007). Most research on oil and gas exploratory activities have focused on the effects from seismic surveys. Although this research can also be applied to other activities covered in this EIS, the analyses of these other activities is therefore lacking in comparison.

2D/3D Seismic Surveys (July through November)

Baleen Whales (gray, humpback, fin, minke): Airgun arrays are the most common source of seismic-survey noise and would be employed for most exploratory activities. Baleen whales generally avoid operating airguns, but avoidance distances vary by species, locations, behavioral activities, as well as environmental conditions that influence sound propagation (Richardson et al. 1995, Gordon et al. 2004, Bain and Williams 2006). Some research has shown that airguns can interrupt feeding behavior in gray whales. Malme et al. (1986) studied the responses of feeding eastern gray whales to pulses from a single 100 in3 airgun off St. Lawrence Island in the northern Bering Sea. They estimated, based on small sample sizes, that 50 percent of feeding gray whales ceased feeding at an average received pressure level of 173 dB re 1 μPa, and that 10 percent of feeding whales interrupted feeding at received levels of

163 dB. However, findings in Russia and British Columbia have shown that gray whales have no apparent change in feeding patterns resulting from seismic surveys (Yazvenko et al. 2007, Bain and Williams 2006).

Studies examining the response of humpback whales to seismic surveys during migration and at summer feeding grounds have likewise observed very few effects. Limited avoidance is the primary reaction, with avoidance behavior first noted at distances of 4 to 8 km (2.5 mi to 5 mi) from the sound source, with stand-off ranges of 7 to 12 km (4.3 mi to 7.5 mi) noted for sensitive resting pods including cow-calf pairs (McCauley et al. 2000, Malme et al. 1986, Weir 2008). Typically, pods including females showed greater avoidance behavior than pods without. Malme et al. (1986) found that humpback whales on their summer feeding grounds in southeast Alaska did not exhibit persistent avoidance when exposed to seismic pulses from a 1.64 L (100 in^3) airgun and concluded that there was no clear evidence of avoidance, despite the possibility of subtle effects.

Fin whales have also been shown to demonstrate very little behavioral change resulting from seismic surveys. Sightings by observers on seismic vessels during many large-source seismic surveys off the U.K. from 1997 to 2000 suggest that, during times of good visibility, sighting rates for fin and sei whales were similar when large arrays of airguns were shooting versus when they were silent (Stone 2003, Stone and Tasker 2006). However, the whales did tend to exhibit localized avoidance, remaining significantly further from the airgun array during seismic operations compared with non-seismic periods and were more likely to swim away from the vessel than in any other direction while shooting (Stone and Tasker 2006). Baleen whales, as a group, were more often oriented away from the vessel while a large airgun array was shooting compared with periods of no shooting (Stone and Tasker 2006). In addition, fin and sei whales were less likely to remain submerged during periods of seismic shooting (Stone 2003). In contrast to the general trend of avoidance, minke whales have occasionally been observed to approach active airgun arrays where received sound levels were estimated to be near 170–180 dB re 1 μPa (MacLean and Haley 2004). This example highlights the variation in behavior between species and individuals within populations.

Behavioral effects on baleen whales from 2D/3D seismic surveys are therefore expected to result primarily in avoidance. Gray whales are the only baleen whale regularly observed within the EIS project area. Should any interactions occur, effects would be of low intensity, interim duration, local in extent, and important in context. The summary impact level would therefore be negligible.

Odontocetes (harbor porpoise, killer whales, narwhals): Toothed cetaceans typically display similar behavior to baleen whales in response to noise generated from seismic surveys. Various studies have shown that toothed whales head away or maintain a somewhat greater distance from the vessel, and stay further away from seismic sources, during periods of airgun operation versus silent periods (Stone and Tasker 2006, Weir 2008).

Observers' records suggested that fewer cetaceans were feeding and fewer were interacting with the survey vessel (e.g. bow-riding) during periods with airguns operating, and small odontocetes tended to swim faster during periods of shooting (Stone and Tasker 2006). For most types of small odontocetes sighted by observers on seismic vessels, the median observed distance was ≥0.5 km (≥0.3 mi) larger during airgun operations than during silent periods (Stone and Tasker 2006). Killer whales appeared to be more tolerant of seismic shooting in deeper waters.

Porpoises show variable reactions to seismic operations, and reactions depend on species. Limited available data suggests that harbor porpoises show stronger avoidance of seismic operations than Dall's porpoises (Stone 2003, Bain and Williams 2006). In Washington State waters, the harbor porpoise—despite being considered a high-frequency specialist—appeared to be the species affected by the lowest received level of airgun sound (<145 dB re 1 μParms at a distance >70 km [43.5 mi]; Bain and Williams 2006). Similarly, during seismic surveys with large airgun arrays off the U.K. in 1997–2000, there were significant differences in directions of travel by harbor porpoises during periods when the airguns were shooting vs. silent (Stone 2003, Stone and Tasker 2006). A captive harbor porpoise exposed to single sound pulses from a small airgun showed aversive behavior upon receipt of a pulse with received level above 174 dB re 1 μPapk-pk or SEL >145 dB re 1 μPa2 s (Lucke et al. 2009). In contrast, Dall's porpoises seem relatively tolerant of airgun operations (Bain and Williams 2006), although they too have been observed to avoid large arrays of operating airguns (Bain and Williams 2006). The apparent tendency for greater responsiveness in the harbor porpoise is consistent with their relative responsiveness to boat traffic and some other acoustic sources (Richardson et al. 1995, Southall et al. 2007).

Behavioral effects on toothed whales from 2D/3D seismic surveys are therefore expected to result primarily in avoidance. Due to the limited distribution of toothed whales within the EIS project area, there is a low likelihood of these encounters occurring. Should they occur, effects would be of low intensity, temporary to interim duration, local in extent, and important in context. The summary impact level would therefore be negligible.

On-ice Vibroseis Survey (January to May) and In-ice Seismic Survey (2D/3D) with Icebreaker Support (October to mid-December)

Winter exploratory activities, including on-ice vibroseis surveys, are not likely to overlap with baleen whale presence due to their southern migration for the winter months. Although toothed whales do not migrate as far as baleen whales, they are not typically associated with sea ice. Any activities occurring on or above sea ice would therefore be unlikely to impact either group. Should in-ice seismic surveys with icebreaker support overlap with whale presence, effects would be similar to those described for summer seismic survey activities, described above.

Ocean-Bottom-Cable Survey (July to October)

Ocean Bottom Cable Surveys are used to acquire seismic data in water that is too shallow for large marine vessels or too deep to have grounded ice during the winter. The areas within the EIS project area meeting this criteria are primarily the nearshore waters of the Beaufort Sea. Therefore, gray whales are the only species expected to be exposed to any effects from these types of surveys, as all other species are so rarely observed in that region. Past surveys of this type have typically not encountered any baleen whales (73 FR 40529).

Reactions to sounds from OBC surveys would be similar to those reported for 2D/3D steamer seismic surveys. Limited research has been conducted on the effects of OBC surveys on baleen whales, focusing exclusively on bowheads. Observed behavioral effects include deflection and avoidance (Miller et al. 1999, Richardson et al. 1999). The open water season of July to October, during which OBC surveys are likely to occur, coincides with summer feeding and late-summer/fall migration periods for gray whales in the Beaufort Sea. Anticipated impacts of OBC surveys, in terms of magnitude (medium), duration (temporary), extent (local), and context (unique) would be similar to those described for 2D/3D seismic surveys above. Although disturbance effects may extend 20 to 30 km (12.4 to 18.6 mi) from the sound source, with only one OBC survey anticipated in the Beaufort Sea, short-term effects would remain localized.

Site Clearance and High Resolution Shallow Hazards Survey Programs (July to November)

High-resolution shallow hazards surveys are of short duration, and the airguns generate lower energy sounds and have a smaller zone of influence than the larger airgun arrays used for 2D/3D seismic surveys (NMFS 2010b). The radii of ensonification at 120, 160, 180, and 190 dB re 1 μPa rms were calculated for sound sources proposed for use in 2010. Radii calculated for the 40 in^3 airgun were 14,000 m (45,932 ft), 1,220 m (4,003 ft), 125 m (410 ft), and 35 m (115 ft) for the respective sound source levels. Ensonified zones were not calculated for side scan sonar, single-beam or multi-beam echosounders, or for the bathymetric sonar (NMFS 2010b), as many of these sources are outside the range of best hearing for mysticetes and possibly for other marine mammals. Additionally, as mentioned above, the beam widths of these sources are quite narrow, which would only expose marine mammals to the sounds for one or two pulses at most if the animal were to swim in the direct beam width of the source.

The limited sound levels combined with the low frequency of most cetaceans within the anticipated survey area result in a low likelihood of any adverse effects occurring. Any effects would be similar to those resulting from 2D/3D seismic surveys, but likely of a lower magnitude.

Exploratory Drilling (July through October) and Associated Vessels and Aircraft

Humpbacks whales respond behaviorally to anthropogenic noises, including vessels, aircraft, and active sonar (Richardson et al. 1995, Frankel and Clark 2000). Responses include alterations of swimming speed and decreased surface blow rates. Gray whales have also been shown to deflect from their course when exposed to industrial noise. Up to 50 percent of migrating gray whales deflected from their course when the received level of industrial noise reached 116-124 dB re 1 μPa, and disturbance of feeding activity may occur at sound levels as low as 110 dB re 1 μPa (Malme et al. 1986).

Studies of behavioral reactions of whales to aircraft are limited, but indicate that whales react little, if at all, to fixed-wing aircraft operating at an altitude of 460 m (1,509 ft) and that most reactions to helicopters occur when the helicopter was at altitudes of ≤150 m (500 ft) (Patenaude et al. 2002, Richardson and Malme 1993, Richardson et al. 1991, Richardson et al. 1995).

Findings detailing the short-term responses of cetaceans to anthropogenic noises do not necessarily infer information about long-term effects. It is not known whether noises affect reproductive rates or distribution and habitat use in subsequent days or years. However, findings seem to suggest that long term impacts when taken at a population level, are mild. Despite decades of on-going seismic and vessel traffic in well-known cetacean habitats, gray whales have continued to migrate annually along the west coast of North America (Malme et al. 1986), and bowhead whales have continued to migrate in and out of the eastern Beaufort Sea each summer (Patterson et al. 2007). Furthermore, both populations have increased during this period (Allen and Angliss 2010). As the noise sources are located on moving ships, the brief exposures to sound pulses from the proposed airgun source are highly unlikely to result in prolonged effects. The history of coexistence between seismic surveys and baleen whales also suggests that brief exposures to sound pulses from any single seismic survey are unlikely to result in prolonged effects.

Hearing Impairment, Injury, and Mortality

The potential for seismic airgun pulses to cause acoustic injury in marine mammals, particularly noise induced threshold shift, is not well understood (Gedamke et al. 2011) and data on levels or properties of sound that are required to induce TTS are lacking for baleen whales. Recent simulation models, using data extrapolated from TTS in toothed whales, suggest the possibility that baleen whales 1 km (0.62 mi) or more from seismic surveys could be susceptible to TTS (Gedamke et al. 2011). Noise induced threshold shift, including TTS and PTS, is described in Section 4.5.2.4.

Because baleen whales generally respond to loud noise by moving away, they are less likely to suffer hearing loss from increased noise. They are not likely to remain close enough to a large airgun array long enough to incur PTS. The levels of successive pulses received by a marine mammal will increase and then decrease gradually as the seismic vessel approaches, passes and moves away, with periodic decreases also caused when the animal goes to the surface to breath, reducing the probability of the animal being exposed to sound levels large enough to elicit PTS. Since baleen whales appear to be more tolerant of noise when feeding, work is needed to determine potential effects of repeated exposure to loud noise at distances tolerated in feeding areas. The potential for increased noise to cause physiological stress responses should also be considered, as it is not currently known (NMFS 2011a). Obtaining data on stress responses in large free-swimming whales would require potentially disruptive invasive techniques.

Although data revealing the occurrence of acoustic injury in toothed whales is limited, some studies have found that in general, they are more sensitive than baleen whales. Acoustic testing performed on harbor porpoises have shown that the received level of airgun sound that elicited onset of TTS was lower than for baleen whales. A harbor porpoise was exposed to single pulses from a small (20 in^3) airgun, and auditory evoked potential methods were used to test the animal's hearing sensitivity at frequencies of 4, 32, or 100 kHz after each exposure (Lucke et al. 2009). Based on the measurements at 4 kHz, TTS occurred upon exposure to one airgun pulse with received level ~200 dB re 1 μPapk-pk or an SEL of 164.3 dB re 1 μPa2 s. If these results from a single animal are representative, it is inappropriate to assume that onset of TTS occurs at similar received levels in all odontocetes (toothed whales). Some cetaceans may incur TTS at lower sound exposures than are necessary to elicit TTS in beluga whales or bottlenose dolphins (Southall et al. 2007).

Assessing whether or not TTS or PTS is occurring is not currently possible. There is no information on these thresholds specific to baleen whales and the likelihood of obtaining the information is low. Hearing and hearing damage can only be readily analyzed in smaller cetaceans, primarily in captivity, or through studying ears of dead whales. Determining intensity is not possible, unless noise exposure were severe enough to result in observed mortality where cause of death could be attributed to sound impulses. The duration of impact would be temporary for TTS, but permanent if PTS were to occur. The extent of such impacts would be local and the context important.

Ship strikes are a major cause of mortality and serious injury in whales in North America (Knowlton and Kraus 2001). In a study of reported ship strikes from 1975 to 2002 (Jensen and Silber 2003), baleen whales were the most commonly struck; fin, humpback, gray, and minke whales were four of the five most commonly struck cetaceans. Toothed whales are much less commonly struck, with killer whales the only species identified from that group, in addition to being the least commonly struck of all 12 species identified.

The frequency and severity of ship strikes is influenced by vessel speed. The potential for collision increases at speeds of 15 kn and greater (Laist et al. 2001, Vanderlaan and Taggart 2007). Most source vessel speeds are relatively slow (approximately 3 to 5 kn) during oil and gas exploration activities. Transit speeds, however, are likely to be much higher. Seismic survey source vessel transit speeds are, for example, estimated at 8 to 12 kn (see Chapter 2, Alternatives for details), suggesting that, if collisions were to occur, they are more likely when vessels are in transit.

The reported incidence of ship strikes is low, but, since collisions have occurred in the past, the intensity of the effect should be considered medium. The likelihood of other types of injury arising from the described activities is low. The duration would be would be temporary to permanent for the impacted whale, depending on the injury. The extent of the effect would be local, given the infrequency of occurrence and the non-random distribution of both cetaceans and exploration activity in the EIS project area. The summary impact level resulting from hearing impairment, injury, or mortality is therefore negligible.

Habitat Alterations

Oil and gas exploration activities that may result in alteration of habitat include drill cuttings and drilling mud discharges from exploratory drilling. Drill cuttings and drilling mud discharges are regulated by the EPA NPDES General Permit. The impact of drill cuttings and drilling mud discharges would be localized and temporary. Drill cuttings and mud discharges could temporarily displace marine mammals a short distance from the drilling site. The EPA modeled a hypothetical 750 bbl/hr discharge of drilling fluids in 20 m (66 ft) of water in the Beaufort and Chukchi seas and predicted a minimum dilution of 1,326:1 at 100 m (330 ft) from the discharge point (Shell 2011a). Discharged drilling fluid should be well diluted within 100 m (330 ft) so that any impacts would be localized and temporary assuming that whales continue to swim through and past the discharge plume. If toxic contaminants are present in discharges, only a small area of potential habitat and prey base might be contaminated. Population-level effects would, therefore, be negligible.

Bottom-founded drilling units or gravel islands could impact small areas of benthic habitat that support epibenthic invertebrates that baleen whales feed on, including through increased turbidity or sediment suspension in marine waters. Exploration drilling on past and current leases would add incrementally to potential discharges into the Beaufort and Chukchi seas, but would remain localized to areas immediately surrounding exploration drilling activity.

The results of habitat alterations caused by oil and gas exploratory activities on other cetaceans would be negligible. Effects would be of low intensity, and very local in extent. Although some habitat alteration, such as those from the construction of gravel islands, would be permanent, most would be temporary, and only and affect common benthic resources.

Additionally, the acoustic habitat, within which whales use sound to communicate and detect prey, predators, and other environmental cues, can be temporarily altered by the presence of sounds in the frequency bands of the signals of interest for the whales. Depending on the level, frequency, and duration of these sounds, these acoustic habitat alterations can result in reduced ability to detect or interpret important sounds. Acoustic habitat alterations would be expected to be more of a potential issue for mysticetes and low frequency sound sources (than other taxa and sound source types) because of the long distances and times over which these species communicate combined with the physical properties of low frequency sounds, which are not absorbed nearly as quickly underwater as higher frequency sounds, and therefore travel much longer distances.

Small Fuel Spill

There is the potential for other cetaceans to be exposed to small accidental fuel spills of less than 50 bbl (see Section 4.2.7). The potential effects of a small fuel spill (<50 bbl) on other cetaceans are anticipated to be the same as those described for bowhead whales. No more than a negligible level of effect is anticipated.

4.5.2.4.11.2 Conclusion

Like in other resource sections, consideration of the effects of implementation of the required standard mitigation measures is included in the conclusion immediately below. Unlike in other resource sections, the Standard Mitigation Measure section is *not* included immediately prior to this Conclusion section, but rather, the separate section analyzing the measures themselves is included once at the end of the Marine Mammal section after all of the individual species sections because the measures apply to multiple species and including them multiple times in separate species sections would be repetitive and potentially confusing.

Many of the species in this resource group are relatively uncommon within the EIS project area, particularly in the Beaufort Sea. Although fin and humpback whales are endangered, they are very rarely seen in the Chukchi Sea and almost never in the Beaufort Sea. Gray whales are the only species with an established range spanning the entire EIS project area that are encountered with any regularity, especially in the Chukchi Sea. Therefore, the probability of interactions from oil and gas exploration activities is low.

There have been no documented impacts from previous oil and gas exploration activities within the EIS project area. The intensity and duration of the various effects and activities considered are mostly medium and interim. However, potential long-term effects from repeated disturbance are unknown. Although, individually, the various activities may elicit local effects on particular whales, the area and extent of the population over which effects occur will likely increase with multiple activities occurring simultaneously or consecutively throughout the EIS project area.

If seismic operations overlap in time, the zone of seismic influence could potentially be quite large, depending on the number, and the relative proximity of the surveys. The impact to individual gray whales would likely be related to the importance of the food source or resting area to the component of the population that would have utilized it had not the disturbance caused them to avoid the area. This is likely to remain unknown. Potential impacts to the population could be related to the numbers and types of individuals that were affected (e.g. juvenile males versus females with calves) and to the relative importance of the habitats from which they may be excluded.

The potential total adverse effects of long-term added noise, disturbance, and related avoidance of feeding and resting habitat in long-lived species such as whales are unknown. Available information does not indicate any long-term adverse effects on any of the existing cetacean populations resulting from the high level of seismic surveys and exploration drilling during the 1980s in the Beaufort and Chukchi seas. This is likely most relevant to gray whales that have used the Chukchi area, in particular, for a long time, certainly when early OCS activities occurred. Despite vessel and industrial activity throughout much of the range of eastern North Pacific gray whales, the population steadily increased to a level that warranted delisting (Rugh et al. 1999) and may even be approaching carrying capacity (Rugh et al. 2005). Many of the other baleen whales and the harbor porpoise occurrences appear to have increased in recent years and may be possible range extensions.

Sub-lethal impacts on health (such as reduced hearing or increased stress) cannot be measured. There has been no documented evidence that noise from previous OCS operations has served as a barrier to migration or any other spatial use resources within the EIS project area. Because whales respond behaviorally to loud noise, they are less likely to suffer hearing loss from increased noise. However, whales appear to be more tolerant of noise when feeding, and future work is needed to determine potential effects on hearing due to long periods over many years of exposure to loud noise at distances tolerated in feeding areas. Similarly, concern needs to be given to other potential physiological effects of loud noise, including the potential for increased noise to cause physiological stress responses.

Evaluated collectively, and with consideration given to reduced adverse impacts through the implementation of the standard and additional mitigation measures, as appropriate, the overall impact to other cetaceans, not including bowhead and beluga whales, is likely to be minor. For the most part, effects will be of low to medium magnitude, interim in duration, and local in extent. The resources affected are either common or important.

Type of effect	Impact Component	Effects Summary	
Behavioral disturbance	**Magnitude or Intensity**	**Low**	Possible that some other species may not come into contact with activities or be impacted
		Medium	If behavioral harassment occurs, would be < 30% of population disturbed
		High	
	Duration	**Temporary**	
		Interim	All activity types last more than month, but combination < 6 months
		Long-term	
	Geographic Extent	**Local**	Effects primarily considered local
		Regional	Impacts from max levels of activity might be considered regional for gray whales when consider area ensonified over 120 dB (>10% EIS area) and fact that gray whales are more likely to be encountered than other species.
		State-wide	
	Context	**Common**	
		Important	Although not ESA listed, important areas exist for gray whales.
		Unique	
Injury and mortality	**Magnitude or Intensity**	**Low**	Injury or death unlikley
		Medium	Though unlikely, cannot rule out PTS
		High	
	Duration	**Temporary**	
		Interim	Type of potential injury (though unlikely) would likely have moderate effects
		Long-term	

Type of effect	Impact Component	Effects Summary	
	Geographic Extent	Local	Since unlikely, any few impacts would be considered local
		Regional	
		State-wide	
	Context	Common	Not ESA listed species, but trends of some species not known
		Important	Not ESA listed species, but trends of some species not known
		Unique	
Habitat alterations	Magnitude or Intensity	Low	
		Medium	Combination of potential habitat impacts, including acoustic habitat, are medium
		High	
	Duration	Temporary	
		Interim	Although other alterations shorter, acoustic habitat is altered for duration of activities
		Long-term	
	Geographic Extent	Local	Lower to mid-level of ativities considered regional
		Regional	
		State-wide	
	Context	Common	
		Important	Not ESA listed species, but trends of some species not known
		Unique	ESA listed species, trends of some species not known

4.5.2.4.12 Ice Seals

4.5.2.4.12.1 Direct and Indirect Effects

This section discusses the potential direct and indirect effects of Alternative 2 on four species often collectively called “ice seals:” ringed seal; spotted seal; ribbon seal; and bearded seal. These species are all highly dependent on sea ice for critical life functions, and their seasonal distributions are heavily influenced by seasonal ice movement in Arctic waters. They are treated collectively because they share many similar characteristics which are correlated with potential impacts from offshore oil and gas exploration activities. Where unique effects or susceptibilities exist, individual species are discussed separately.

Potential direct and indirect effects on ice seals from exploration activities authorized under Alternative 2 are similar to those discussed for other cetaceans (Section 4.5.2.4.11) and Pacific walrus (Section 4.5.2.4.13). These include disturbance in water and on the surface of the ice due to sounds and physical movements of vessels and equipment, risks of injury or mortality, and changes in habitat.

Behavioral Disturbance

There are several mechanisms for potential disturbance to ice seals associated with each of the different types of exploration activities considered under Alternative 2. Most of these mechanisms are common to both the Beaufort and Chukchi seas, and these potential effects are discussed together. Where activities or mechanisms are unique to one sea or the other, they are discussed separately.

Marine vessels associated with exploration activities all introduce sounds into the marine environment (see Acoustics, Section 4.5.1.4) and have a physical presence that could affect ice seals in the water or on sea ice. Many of these vessels have carried PSOs in the past, and the data they have collected about ice seals and other marine mammals forms the basis of much of this discussion. Ice seals are by far the most commonly observed marine mammals in both the Beaufort and Chukchi seas, with ringed seals making up the majority and ribbon seals being rare (Savarese et al. 2010, Haley et al. 2010a). Seismic surveys often include PSOs on monitoring ships that are deployed at various distances from the seismic source ships, sometimes over 75 km (47 mi) away. Sightings from these ships when they are at great distance from the source vessel or when the seismic arrays are not active (non-seismic conditions) provide a measure of ice seal reactions to typical vessel traffic rather than the seismic source (discussed below). When monitoring ships are traveling under non-seismic conditions, the average closest point of approach to seals ranged from 160 to 180 m (525 to 590 ft) (Savarese et al. 2010, Haley et al. 2010a). Seismic source vessels traveling under non-seismic conditions appear to disturb seals at greater distances, perhaps in part because of their larger physical presence, with the average closest point of approach to seals ranging from 200 to 400 m (556 to 1,312 ft) (Savarese et al. 2010, Haley et al. 2010a). However, these averages are derived from seal observations that span a very wide range of distances at which the seals were first detected, which depends greatly on weather and sea conditions that determine visibility conditions. At least half of the seals observed did not swim away from an approaching vessel, and some seals actually swam toward the vessel, and a small number bow ride. There appears to be a range of sensitivities among seals to ships, including many that are not noticeably disturbed by their passing.

Icebreaking vessels, whether used for in-ice seismic surveys or for ice management near exploratory drilling ships, introduce an additional type of disturbance to ice seals than non-icebreaking vessels. These activities would take place in late fall-early winter under Alternative 2, a time period when ice seals are often on top of sea ice and in the water but not in subnivean structures. Ringed seals give birth in lairs beginning in mid-March (Smith and Stirling 1975), months after the latest time icebreakers could operate in the Arctic. The process of breaking through ice increases the amount of sound produced by the ship, primarily by increasing cavitation from props under high power but restricted motion (Richardson et al. 1995). The sounds of the ship and breaking ice likely combine with the physical presence of the ship to disturb ice seals and cause them to move away from the path of the ship. Data on how close seals allow icebreakers to approach are limited, but ringed and bearded seals on pack ice typically dove into the water within 0.93 km (0.58 mi) of the vessel. Ringed seals have also been seen feeding among overturned ice floes in the wake of icebreakers (Brewer et al. 1993), so not all disruptions may be adverse. The pack ice is a highly dynamic environment in late fall to early winter when icebreaking activities would occur. Ice seals are adapted to moving frequently to accommodate changing ice conditions so displacement due to a passing icebreaker is likely to be temporary and well within the normal range of ability for ice seals at this time of year.

The greatest concern for seals and other marine mammals from exploration activities is the potential for disturbance from seismic airgun arrays, especially the larger and more powerful 2D/3D arrays (16 to 36 airguns) which cover large areas. OBC surveys and shallow hazard/site clearance seismic surveys cover smaller geographic areas but more intensely and thus present more localized disturbance potential, although shallow hazard/site clearance surveys use much smaller seismic arrays (1 to 4 airguns). For the purposes of calculating “take by harassment” under the MMPA, NMFS considers any marine mammals exposed to pulsed sound levels at or above 160 dB to experience Level B behavioral harassment. Operators are required to monitor out to this distance for seismic surveys to record actual numbers of animals detected within the ensonified zone. They are also required to calculate how many animals may be exposed but were not detected, generally based on the density of animals in the area and the size of the ensonified zone. Because ice seals are common and widespread in the Beaufort and Chukchi seas, the numbers of seals detected and calculated to be within the 160 dB radii are quite large. However, as mentioned above, seals often do not react strongly to passing seismic ships, at least by what visual observers can detect. Seals keep further away from seismic source vessels with active arrays than they do monitoring vessels within the 160 dB zone but by about the same amount as they do when the array is not active (Savarese et al. 2010, Haley et al. 2010a). This may be due to the more imposing physical characteristics of the source vessel, which causes the seals to maintain a greater distance, or the ability of PSOs on the taller source vessels to detect seals at greater distances than PSOs on the smaller monitoring vessels, resulting in a data set more skewed to greater distances. Seals have been noted to tolerate high levels of sounds from airguns (Arnold 1996, Harris et al. 2001, Moulton and Lawson 2002). In any case, the observable behavior of seals to passing active source vessels is often to just watch it go by or swim in a neutral way relative to the ship rather than swimming away. Seals at the surface of the water would experience less powerful sounds than if they were the same distance away but in the water below the seismic source. This may also account for the apparent lack of strong reactions in ice seals.

In addition to airguns, site clearance and high resolution shallow hazards surveys utilize smaller, higher frequency sound sources. Very few data are available on the reactions of pinnipeds to echosounder sounds or other devices at frequencies similar to those used during seismic operations. Hastie and Janik (2007) conducted a series of behavioral response tests on two captive gray seals to determine their reactions to underwater operation of a 375 kHz multibeam imaging echosounder that included significant signal components down to 6 kHz. Results indicated that the two seals reacted to the signal by significantly increasing their dive durations. However, because of the brevity of exposure of pinnipeds to such sound sources, pinniped reactions are anticipated to be limited to startle or otherwise brief responses of no lasting consequence to the animals.

Any two deep penetration seismic surveys cannot be conducted concurrently from closer than 24 km (15 mi). This restriction, based on the need of the surveys not to interfere with each other to preserve the quality of the data, provides an effective limit on the intensity of disturbance effects on ice seals no matter where the activities take place. Ice seals traveling across a broad area may encounter more than one exploration activity in a season and may therefore be disturbed repeatedly by the presence of vessels or seismic survey sound or both. If exploration activities are more concentrated near the pack ice edges where seals are more common, the chances are greater that more seals would experience multiple disturbances in a season than if exploration activities were clustered away from the ice. It is not known if multiple disturbances within a certain timeframe add to the stress of an animal and, if so, what frequency and intensity may result in biologically important effects. There is likely to be a wide range of individual sensitivities to multiple disturbances, with some animals being more sensitive than others. However, given the limited potential for multiple disturbances in the same general area from the level of activity authorized under Alternative 2 and the generally minor to negligible intensity and duration of effects on ice seals from any of these activities, it is not likely that additive effects from multiple activities will become a concern for any species of ice seals.

On-ice surveys (vibroseis) are typically conducted only in the shallower, near shore waters of the Beaufort Sea and take place during the winter months. Ringed seals are the only species likely to be in these areas at the time, although bearded seals may also be present in deeper waters further offshore. At this time of year, seals excavate a series of cavities under the snow (subnivean structures), accessed from holes they maintain in the ice from below, for pupping and to provide protection from predators (Smith and Stirling 1975). Ringed seals use multiple breathing holes (Smith and Stirling 1975, Kelly and Quakenbush 1990) and are not expected to be adversely affected by the loss of one to two breathing holes within the thickened ice road. Ringed seals near BP’s Northstar Island have demonstrated an ability to open new holes and create new structures throughout the winter, and ringed seal use of landfast ice near Northstar did not appear to be much different than that of ice 1.2 to 2.2 mi away (2 to 3.5 km; Williams et al. 2002).

Vibroseis surveys involve a large number of heavy tracked vehicles, but many of them are associated with camp facilities that are established on land-fast ice that does not support ringed seals. Survey vehicles with vibrators and sensors are often deployed in shallow water areas and may disturb seals in their subnivean lairs or animals hauled out on top of the ice. Standard mitigation measures require advance scouting of routes and survey lines to minimize impacts to seals by avoiding areas more likely to have lairs (pressure ridges and deep snow accumulations). These mitigation measures also require use of various methods to detect and avoid seal lairs, thereby greatly reducing the chance of destroying an active lair from ice road construction or on-ice survey activities. If an active lair is not detected and is incidentally impacted by heavy survey equipment, the adult female could likely escape into the water but the pup could be killed by crushing or premature exposure to the water. Disturbed adults may remain in their lairs or move to other nearby lairs or swim to different breathing holes (Kelly et al. 1988). Because the survey vehicles move to new locations every few minutes, the disturbance is likely very temporary in nature and not likely to drive animals out of their normal territory.

Potential effects to pinnipeds from aircraft activity could involve both acoustic and non-acoustic effects. It is uncertain if the seals react to the sound of the helicopter or to its physical presence flying overhead. The available information describes reactions of hauled out pinnipeds and not of pinnipeds in the water. Typical reactions of hauled out pinnipeds to aircraft that have been observed include looking up at the aircraft, moving on the ice or land, entering a breathing hole or crack in the ice, or entering the water. Blackwell et al. (2004b) observed 12 ringed seals during low-altitude overflights of a Bell 212 helicopter at BP’s Northstar Island in June and July 2000 (9 observations took place concurrent with pipe-driving activities). One seal showed no reaction to the aircraft while the remaining 11 (92%) reacted, either by looking at the helicopter (n=10) or by departing from their basking site (n=1). Blackwell et al. (2004b) concluded that none of the reactions to helicopters were strong or long lasting, and that seals near Northstar in June and July 2000 probably had habituated to industrial sounds and visible activities that had occurred often during the preceding winter and spring. Born et al. (1999) determined that 49% of ringed seals escaped (i.e. left the ice) as a response to a helicopter flying at 492 ft (150 m) altitude. Seals entered the water when the helicopter was 4,101 ft (1,250 m) away if the seal was in front of the helicopter and at 1,640 ft (500 m) away if the seal was to the side of the helicopter. The authors noted that more seals reacted to helicopters than to fixed-wing aircraft. The study concluded that the risk of scaring ringed seals by small-type helicopters could be substantially reduced if they do not approach closer than 4,921 ft (1,500 m). Spotted seals hauled out on land in summer are unusually sensitive to aircraft overflights compared to other species. They often rush into the water when an aircraft flies by at altitudes up to 984 to 2,461 ft (300 to 750 m). They occasionally react to aircraft flying as high as 4,495 ft (1,370 m) and at lateral distances as far as 1.2 mi (2 km) or more (Frost and Lowry 1990, Rugh et al. 1997).

Exploratory drilling involves the establishment of a large drill ship or jackup rig in one location for some weeks and the deployment of numerous support vessels. The level of disturbance to seals is likely more intense in terms of the physical presence of the ships than any types of exploratory surveys, but the geographic area involved is much smaller. The noise generated from drilling is also not as loud as seismic airguns, but it is produced on an almost continual basis, making it more of a chronic sound source in one location. Given the mild reaction of seals to marine vessels, drilling activities are likely to deter seals from venturing too close to the rig and support vessels while it is in that particular area. This displacement would cover a very small area and be considered short-term.

Hearing Impairment, Injury, and Mortality

Although mortality of seals due to ship strikes has been reported off the coast of Scotland where numerous seals apparently died after being sucked through large ducted propellers (BBC News 2010), similar mortalities or injuries have not been observed in the Chukchi and Beaufort seas. PSOs on many vessels in both seas have logged thousands of hours monitoring vessel transit and have recorded the presence of thousands of seals, but there have been no suspected or documented cases of seals being injured or killed by the type of large vessels used in Arctic oil and gas exploration activities. These species are able to swim much faster than such ships and have been observed to easily swim away from vessels traveling at full speed. Some seals have even been observed to swim to the front of the vessels to bow ride on their wake (Reiser et al. 2011). Given these observations, the risk of ship strikes for ice seals is considered negligible.

TTS is the mildest form of hearing impairment that can occur during exposure to loud sound (Kryter 1985). It is not considered to represent physical injury, as hearing sensitivity recovers relatively quickly after the sound ends. It is, however, an indicator that physical injury is possible if the animal is exposed to higher levels of sound. The onset of TTS is defined as a temporary elevation of the hearing threshold by at least 6 dB (Schlundt et al. 2000). Several physiological mechanisms are thought to be involved with inducing TTS. These include reduced sensitivity of sensory hair cells in the inner ear, changes in the chemical environment in the sensory cells, residual middle-ear muscular activity, displacement of inner ear membranes, increased blood flow, and post-stimulatory reduction in efferent and sensory neural output (Kryter 1994, Ward 1997).

Very few data are available regarding the sound levels and durations that are necessary to cause TTS in pinnipeds. TTS has been measured for only three pinniped species: harbor seals; California sea lions; and northern elephant seals, and only one study has examined TTS in response to exposure to underwater pulses (Finneran et al. 2003). No data are available for any free ranging marine mammals or for exposure to multiple pulses of sound during seismic surveys. Kastak et al. (1999) reported TTS of approximately 4 to 5 dB in three species of pinnipeds (harbor seal, California sea lion, and northern elephant seal) after underwater exposure for approximately 20 minutes to noise with frequencies ranging from 100 to 2,000 Hz at received levels 60 to 75 dB above hearing threshold. This approach allowed similar effective exposure conditions to each of the subjects, but resulted in variable absolute exposure values depending on subject and test frequency. Recovery to near baseline levels was reported within 24 hours of noise exposure (Kastak et al. 1999). Kastak et al. (2005) followed up on their previous work using higher sensitivity levels and longer exposure times (up to 50-min) and corroborated their previous findings. The sound exposures necessary to cause slight threshold shifts were also determined for two California sea lions and a juvenile elephant seal exposed to underwater sound for a similar duration. The sound level necessary to cause TTS in pinnipeds depends on exposure duration, as in other mammals; with longer exposure, the level necessary to elicit TTS is reduced (Schusterman et al. 2000; Kastak et al. 2005, 2007). For very short exposures (e.g. to a single sound pulse), the level necessary to cause TTS is very high (Finneran et al. 2003). For pinnipeds exposed to in-air sounds, auditory fatigue has been measured in response to single pulses and to non-pulse noise (Southall et al. 2007), although high exposure levels were required to induce TTS-onset (SEL: 129 dB re: 20 µPa2.s; Bowles et al. unpub. data).

There is the potential for seals to be exposed to small accidental spills of oils, lubricants, and other compounds used by vessels, vehicles, and equipment during exploration activities. Spills in the offshore or onshore environments could occur during normal operations (e.g. transfer of fuel, handling of lubricants and liquid products, and general maintenance of equipment). Exposure of seals to oil products could lead to irritation of eyes, mouth, lungs, and anal and urogenital surfaces (St. Aubin 1990). The effects of an oil spill on ringed or bearded seals would depend largely on the size, season, and location of the spill. If a spill were to occur during the ice free, open water season, seals may be exposed to oil through direct contact, or perhaps through contaminated food items. However, St. Aubin (1990) notes that with their keen sense of olfaction and good sense of vision ringed and bearded seals may be able to detect and avoid oil spills in the open water season (St. Aubin 1990).

Immersion studies by Smith and Geraci (1975) found ringed seals may develop mild liver injury, kidney lesions and eye injury from immersion in crude oil. The eye damage was often severe, suggesting permanent eye damage might occur with longer periods of exposure to crude oil, and the overall severity of the injuries was most likely associated with the exposure duration to crude oil. Geraci and Smith (1976a) concluded the direct effects of an oil blow-out or spill may result in transient eye damage to healthy seals in open water.

However if breathing holes, polynyas, or leads become fouled with oil, permanent damage may occur. Geraci and Smith (1976a) noted their findings pointed to stress as instrumental in their convulsive behavior and subsequent death when exposed to crude oil, suggesting exposure to crude oil was additive to pre-existing stress levels in ringed seals in their experiment where all of the test animals died. Geraci and Smith (1976a) also found ringed seals exposed to a slick of light crude oil showed no impairment in locomotion or breathing.

Ringed seal pups in their lanugo coats could be particularly vulnerable to the cold if they become oiled and have not yet established adequate fat reserves.

Reports of the effects of oil spills have shown that some mortality of seals may have occurred as a result of oil fouling; however, large-scale mortality has never been observed (St. Aubin 1990). Flippers of young harp seal pups were impeded by a coating of Bunker C fuel oil (Sergeant 1991). Oiling of both mother and pups does not appear to interfere with nursing (Lowry et al. 1994) although disturbances associated with oil spill response and clean-up may do so (Geraci and St. Aubin 1988). Jenssen (1996) reported that oil has produced few visible effects to gray seal behavior and there has been little mortality despite the fact that approximately 50% of gray seal pups at Norway's largest breeding rookery are polluted each year by oil.

Investigations into the effects of crude oil ingestion and exposure on ringed seals (Smith and Geraci 1976) indicate the probability of ringed seals accidentally ingesting large amounts of oil by way of contaminated food items is very low. Moreover, only small, transient effects were found to have occurred during necropsies of ringed seals deliberately fed potent fractions of carbon tetrachloride.

St. Aubin (1990) found ingestion of hydrocarbons can irritate and destroy epithelial cells in the stomach and intestine, affecting motility, digestion, and absorption, which may result in death or reproductive failure; however, after being returned to clean water, contaminated animals can depurate this internal oil (Engelhardt 1978; 1982; 1985). Harbor seals observed immediately after oiling appeared lethargic and disoriented, which may be attributed to lesions observed in the thalamus of the brain (Spraker et al. 1994).

Subsequent studies (Engelhardt et al. 1977, Engelhardt 1982) indicate that ringed seals may accumulate compounds from hydrocarbons in their tissues, but that they are rapidly excreted via renal pathways. Engelhardt (1983) further states that exposure studies in ringed seals revealed they have a great capability to excrete accumulated hydrocarbons via renal and biliary excretion mechanisms, clearing blood and most other tissues of the residues within seven days. Ringed seals probably have the ability to purge their bodies of some harmful oil residues, depending on the duration and extent of exposure. Based on morphological similarities, the physiological impacts in bearded seals are expected to be similar to those of ringed seals.

Direct ingestion of oil, ingestion of contaminated prey, or inhalation of volatile hydrocarbons transfers toxins to body fluids and tissues causing effects that may lead to death, as suspected in dead gray and harbor seals found with oil in their stomachs (Engelhardt et al. 1977, Engelhardt 1982, St. Aubin 1990, Frost et al. 1994, Lowry et al. 1994, Spraker et al. 1994, Jenssen 1996). Seals exposed to an oil spill and especially a blowout are unlikely to ingest enough oil to cause serious internal damage (Geraci and St. Aubin 1980; 1982) and any effects are probably reversible (Spraker et al., 1994). Zooplankton may engulf petroleum droplets when in direct contact and retain metabolized and unmetabolized petroleum for 7-10 days (Geraci and St. Aubin 1990).

Similarly, marine fish are able to metabolize hydrocarbons and are therefore not a source of hydrocarbon contamination for marine mammals during extended periods.

Bivalve molluscs however, tend to accumulate hydrocarbons from prolonged or repeated exposure, posing a threat to benthic-feeding seals. Spilled oil has caused major disruptions to benthic communities inducing substantial contamination of tissues, failed spawning, significantly lower densities, and transfer of oil through the food web from invertebrates to larger fish (Koyama et al. 2004, Elmgren et al.,1983). Ingestion of small quantities of oil through feeding is usually not harmful to ringed seals because they are able to metabolize hydrocarbons (Payne 1992).

Ice seals are commonly observed near exploratory activities during the open-water season and could be exposed to spills in the water or on ice. If a small spill did occur, cleanup efforts would begin immediately and those activities would likely include the presence of PSOs to monitor for ice seals and other marine mammals and deter them from entering the spill area if possible. Given the mitigation measures in place to prevent and clean up spills, the risk of ice seals being exposed to small spills during exploration activities is considered to be minor. The potential effects of a very large oil spill are much more serious and are discussed in Sections 4.10.6.11 and 4.10.7.11.

Habitat Alterations

There are four potential mechanisms for habitat changes that may affect ice seals: 1) disturbance/dispersion of prey species by seismic surveys; 2) disturbance of sea ice habitat from icebreakers; 3) disturbance of sea ice habitat from ice-road construction and on-ice survey activities; and 4) contamination of the marine environment from discharge of drilling muds and other waste streams from ships and support facilities.

Seismic airgun technology has been adopted in part because of its lack of substantial effects on marine invertebrates and fish (see Sections 4.5.2.1 and 4.5.2.2, respectively). Prey fields for ice seals may experience temporary disturbance due to passing ships and towed seismic equipment, much as the seals themselves, but the marine waters are not altered so fish and invertebrates are expected to resume their normal behavior and movement patterns within minutes or a few hours after seismic vessels pass. Given the wide distribution and dynamic nature of prey fields for ice seals, it is unlikely that seals would experience any changes to their foraging success as a result of seismic surveys in open water.

Icebreaking ships intentionally disrupt ice floes in order to conduct in-ice seismic surveys or to help manage ice flows around exploratory drilling equipment. These activities would take place in late fall to early winter under Alternative 2, a time period when ice seals are often on top of sea ice but not in subnivean structures. Seals have been observed to dive into the water and move out of the way well before icebreakers approach. Seals often appear in the open water/broken ice channels behind ice breakers, and some of them appear to be feeding on fish exposed by the broken ice (Haley et al. 2011). Sea ice in these seasons moves continually, opening leads and closing them very quickly at times. The channels cut by icebreakers often close up very soon after the ship passes, mimicking the natural dynamics of the ice in many respects. The effects on ice seal habitat are therefore temporary and may be reduce adverse impacts if prey becomes easier to catch.

In the Beaufort Sea, on-ice seismic surveys (vibroseis) typically take place in mid-winter to early spring (January to May) because thick ice is required to support the vehicles and to ensure personnel safety. These surveys involve the use of large tracked vehicles to pull heavy seismic equipment and associated support facilities (crew camps) across the ice. Convoy travel routes and camp locations are selected based on ice conditions (land-fast for camps) and avoidance of pressure ridges and deep snow accumulations. Sensor cables and vibrator vehicles travel along pre-surveyed and groomed routes across the ice. Ringed seals are the only species likely to be encountered by these surveys, which are conducted relatively close to shore in the shallow waters of the Beaufort Sea. Bearded seals prefer deeper waters and broken ice, which must be avoided by the heavy vehicles. The potential for habitat effects during these surveys involve the potential destruction or damage to subnivean lairs and breathing holes in the ice (disturbance effects are discussed above). The operational and safety requirements for this type of seismic survey require industry to avoid the types of areas where seals are likely to build lairs. Ringed seals typically build and maintain a series of lairs and breathing holes and move between them on a regular basis to help avoid predation and accommodate changing ice conditions (Kelly and Quakenbush 1990, Lydersen and Hammill 1993). The potential loss or displacement of a small number of lairs and breathing holes because of on-ice survey activity would be temporary and readily replaceable by ringed seals in the same way as they relocate under natural conditions, which are highly dynamic.

The discharge of drilling muds and other waste streams from drilling rigs and other exploration vessels could affect ice seal habitat by contaminating ice floes, the water column, and prey. There have been no comprehensive studies conducted on the potential distribution and persistence of the many compounds and substances that could be released accidentally or under discharge permits by the myriad exploration vehicles and vessels involved in the activities authorized under Alternative 2. The potential effects on the habitats of the different ice seal species are therefore unknown. The scope of research needed to track any one discharge compound through the Arctic marine environment and to measure its potential effects in seals would likely be prohibitive and very difficult to interpret given the many other factors that can influence an animals' health.

Additionally, the acoustic habitat, within which pinnipeds use sound to communicate and detect prey, predators, and other environmental cues, can be temporarily altered by the presence of sounds in the frequency bands of the signals of interest for the whales. Depending on the level, frequency, and duration of these sounds, these acoustic habitat alterations can result in reduced ability to detect or interpret important sounds. Acoustic habitat alterations would be expected to be more of a potential issue for mysticetes and low frequency sound sources (than other taxa and sound source types) because of the long distances and times over which these species communicate combined with the physical properties of low frequency sounds, which are not absorbed nearly as quickly underwater as higher frequency sounds, and therefore travel much longer distances.

4.5.2.4.12.2 Conclusion

Like in other resource sections, consideration of the effects of implementation of the required standard mitigation measures is included in the conclusion immediately below. Unlike in other resource sections, the Standard Mitigation Measure section is *not* included immediately prior to this Conclusion section, but rather, the separate section analyzing the measures themselves is included once at the end of the Marine Mammal section after all of the individual species sections because the measures apply to multiple species and including them multiple times in separate species sections would be repetitive and potentially confusing.

The four species of ice seals would likely not be affected to the same extent by exploration activities in the Beaufort and Chukchi seas based on their respective abundance and distribution. Ringed seals and bearded seals have been the most commonly encountered species of any marine mammals in past exploration activities, and their reactions have been recorded by PSOs onboard source vessels and monitoring vessels. These data indicate that seals do tend to avoid on-coming vessels and active seismic arrays but their behavioral responses are often neutral rather than swimming away, and they do not appear to react strongly even as ships pass fairly close with active arrays. They also do not appear to react strongly to icebreaking or on-ice surveys, keeping their distance or moving away at some point to an alternate breathing hole or haulout, but the scope of these behavioral responses appears to be within their natural abilities and responses to their naturally dynamic environment. Studies of ringed and bearded seals have noted the most common reaction to aircraft flying overhead is looking at the aircraft. Reactions become more pronounced when aircraft fly below 150 m (492 ft). However, reactions have been noted to be short-term in nature. None of the behavioral reactions observed to date indicate that any of the ice seal species would be displaced from key areas or resources for more than a few minutes or hours and would therefore be unlikely to experience any measurable effects on their reproductive success or survival. Additionally, impacts from any discharges or accidental, small fuel spills are anticipated to be negligible. Ice seals are legally protected, with ringed and bearded seals listed as threatened under the ESA, have unique ecological roles in the Arctic, and are important subsistence resources and are therefore considered to be unique resources. Given the standard and additional mitigation measures considered in this EIS, the effects of exploration activities that could be authorized under Alternative 2 on ice seals would likely be low in magnitude, distributed over a wide geographic area, and temporary to interim in duration. Reliable data with which to estimate population trends is not available. The effects of Alternative 2 would therefore be considered minor for all ice seal species according to the criteria established in Section 4.1.3.

Type of effect	Impact Component		Effects Summary
Behavioral disturbance	Magnitude or Intensity	Low	
		Medium	Behavioral harassment occurring, but likely < 30% of population disturbed for all species but ringed seals
		High	When maximum activities considered, more than 30% ringed seals may be taken
	Duration	Temporary	
		Interim	All activity types last more than month, but combination < 6 months
		Long-term	
	Geographic Extent	Local	Effects of activities considered local
		Regional	
		State-wide	
	Context	Common	
		Important	ESA-listed species, but impacts not occurring in areas specifically important for feeding/pupping, etc.
		Unique	
Injury and mortality	Magnitude or Intensity	Low	Injury or death unlikley
		Medium	Though unlikely, cannot rule out PTS
		High	
	Duration	Temporary	
		Interim	Type of potential injury (though unlikely) would likely have moderate effects
		Long-term	
	Geographic Extent	Local	Since unlikely, any few impacts would be considered local
		Regional	
		State-wide	
	Context	Common	
		Important	ESA listed species, no reliable data available to assess population trends
		Unique	
Habitat alterations	Magnitude or Intensity	Low	
		Medium	Combination of potential habitat impacts are medium
		High	
	Duration	Temporary	
		Interim	Although other alterations shorter, acoustic habitat is altered for duration of activities
		Long-term	
	Geographic Extent	Local	Lower to mid-level of ativities considered regional
		Regional	
		State-wide	
	Context	Common	
		Important	ESA listed species, population status unknown, no reliable data on trends
		Unique	

4.5.2.4.13 Pacific Walrus

4.5.2.4.13.1 Direct and Indirect Effects

This section discusses the potential direct and indirect effects of Alternative 2 on Pacific walrus. This species is highly dependent on sea ice for critical life functions, and seasonal distributions are heavily influenced by seasonal ice movement in Arctic waters. Potential direct and indirect effects on Pacific walrus from exploration activities authorized under Alternative 2 are similar to those discussed for cetaceans (Sections 4.5.2.4.9 to 4.5.2.4.11) and pinnipeds (Section 4.5.2.4.12). These include disturbance in water and on the surface of the ice due to sounds and physical movements of vessels and equipment, risks of injury or mortality, and changes in habitat. Walrus are distributed widely across the Chukchi Sea but are uncommon in the deeper offshore waters of the Beaufort Sea. Therefore activities that occur in the Beaufort Sea are not anticipated to impact Pacific walrus.

This EIS considers a number of standard and additional mitigation measures as part of each alternative that are intended to reduce adverse effects on marine mammals, especially bowhead whales and other species under the jurisdiction of NMFS, but these mitigation measures may also help to reduce adverse effects on Pacific walrus and polar bears, which are under the jurisdiction of the USFWS. In addition to the mitigation measures imposed by NMFS, the oil and gas industry operates under LOAs for incidental take of Pacific walrus and polar bears issued by the USFWS which contain mitigation measures specific to these species. A series of LOAs have been issued since 1993 for the Beaufort Sea (USFWS 2011a) and since 1991 for the Chukchi Sea (USFWS 2008a). The following mitigation measures are typically required by the USFWS for oil and gas exploration activities in the Beaufort and Chukchi seas to minimize impacts on Pacific walrus and are thus incorporated into the analysis of potential effects under Alternative 2:

- Seismic source and support vessels must be staffed with dedicated PSOs to alert the crew to the presence of Pacific walrus and initiate adaptive mitigation measures.
- Except under emergency situations, vessels must maintain the maximum distance possible from concentrations of Pacific walrus and never get closer than 805 m (0.5 mi) to Pacific walrus or 1,610 m (1 mi) from terrestrial walrus haul outs.
- Vessel operators must take every precaution to avoid harassment of concentrations of feeding walrus when a vessel is operating near these animals. Vessels should reduce speed and maintain a minimum 805 m (0.5 mi) operational exclusion zone around feeding walrus groups. Vessels may not be operated in such a way as to separate members of a group of walrus from other members of the group. When weather conditions require, such as when visibility drops, vessels should adjust speed accordingly to avoid the likelihood of injury to walrus.
- Operators of support aircraft should, at all times, conduct their activities at the maximum distance possible from concentrations of walrus.
- Under no circumstances, other than an emergency, should aircraft operate at an altitude lower than 457 m (1,500 ft) within 805 m (0.5 mi) of walrus observed on ice or land. Helicopters may not hover or circle above such areas or within 805 m (0.5 mi) of such areas. When weather conditions do not allow a 457 m (1,500 ft) flying altitude, such as during severe storms or when cloud cover is low, aircraft may be operated below the 457 m (1,500 ft) altitude stipulated above. However, when aircraft are operated at altitudes below 457 m (1,500 ft) because of weather conditions, the operator must avoid areas of known walrus concentrations and should take precautions to avoid flying directly over or within 805 m (0.5 mi) of these areas.
- All seismic surveys will establish and monitor an acoustically verified exclusion zone for walrus surrounding seismic airgun arrays or sound source where the received level would be ≥180 dB re 1 μPa and an acoustically verified walrus disturbance zone ahead of and perpendicular to the seismic vessel track where the received level would be ≥160 dB re 1 μPa.
- Immediately power-down or shut-down the seismic airgun array and/or other acoustic sources whenever any walrus are sighted approaching close to or within the area delineated by the 180 dB re 1 μPa walrus exclusion zone. If the power-down operation cannot reduce the received sound pressure level to 180 dB re 1 μPa the operator must immediately shut-down the seismic sound sources.
- Whenever an aggregation of 12 or more walrus is detected within the 160 dB re 1 μPa disturbance zone ahead of or perpendicular to the seismic vessel track, the holder of an LOA must: (A) Ensure sound pressure levels at the shortest distance to the aggregation do not exceed 160 dB re 1 μPa by powering down the seismic airgun array and/or other acoustic sources or by altering vessel course; and (B) Not proceed with powering up the seismic airgun array and/or other seismic sound sources, or resuming the original course, until it can be established that there

are no walrus aggregations within the 160 dB re 1 μPa walrus disturbance zone based upon ship course, direction and distance from last sighting.

- Ramp-up Procedures - (A) Prior to commencing ramp-up, the exclusion zone for walrus must be visible and observed by a MMO watch for at least 30 minutes when: At the commencement of operations using airguns or sound sources; a complete shut-down has occurred; any time operation of the airgun array or sound source(s) is discontinued for a period of 10 minutes or more; or the MMO watch has been suspended; (B) If the exclusion zones are not completely visible for at least 30 minutes prior to ramp-up in either daylight or nighttime, ramp up may commence following established procedures which must include: Ramp-up airgun arrays slowly over a period of at least 30 minutes, start with one airgun or sound source in the array and then gradually add additional guns or sound sources, until the full array is firing.
- Poor Visibility Conditions - (A) During poor visibility conditions (fog, rain, snow, darkness, etc.), if the entire 180 dB re 1 μPa walrus exclusion zone is visible using vessel lights and/or night vision devices, then ramp-up procedures of airguns or sound sources may occur following a 30 minute period of observation by MMOs with no sighting of walrus in their exclusion zone; (B) If during poor visibility conditions, the full exclusion zone is not visible, the airguns cannot commence a ramp-up procedure from a full shutdown; (C) If, however, one or more airguns have been operational since before the onset of poor visibility conditions, they may continue to operate under the assumption that walrus will have been alerted by the sounds from the single airgun and have moved away.

In addition to these mitigation measures designed to reduce impacts on walrus, the MMPA contains provisions to protect subsistence hunting of walrus by requiring plans of cooperation and communication channels between industry and subsistence communities when activities have the potential to impact subsistence hunting. Industry is also required to participate in monitoring programs intended to measure the effectiveness of mitigation measures and advance knowledge about the species. LOAs also have established protocols for reporting interactions with walrus and the results of monitoring programs.

Behavioral Disturbance

There are several mechanisms for potential disturbance to Pacific walrus associated with each of the different types of exploration activities that would be authorized under Alternative 2.

Marine Vessels

Marine vessels associated with exploration activities all introduce sounds into the marine environment (see Section 4.5.1.4 on Acoustics) and have a physical presence that could affect Pacific walrus in the water or on sea ice. Many of these vessels have carried PSOs in the past and the data they have collected about walrus and other marine mammals forms the basis of much of this discussion. Walrus are frequently observed from exploration ships in the Chukchi Sea but they are rarely observed in the Beaufort Sea. The majorities of all sightings are of animals in the water rather than on ice but sightings were more common the closer the vessel was to the pack ice. In the Beaufort Sea from 2006 through the 2008 open-water season, PSOs recorded only six sightings of Pacific walrus with a total of 10 individual walrus (Savarese et al. 2010). Five of these sightings occurred in 2007. In the Chukchi Sea from 2006 through the 2008 open-water season, PSOs recorded 575 Pacific walrus sightings comprised of 4821 individual walrus (Haley et al. 2010a). There were many more walrus sightings in the Chukchi in 2007 (n=351) than in other years, with about 40 percent of these being sighted in one day (24 August). This concentration of walrus was suspected of abandoning the ice pack after it retreated beyond the shelf break and heading to haulouts on the coasts of Alaska and Russia (Savarese et al. 2010). This situation may occur more frequently in the future as the ice pack thins and recedes further due to warming temperatures in the Arctic.

Seismic surveys often include PSOs on monitoring ships that are deployed at various distances from the seismic source ships, sometimes over 75 km (47 mi) away. Sightings from these ships when they are at great distance from the source vessel or when the seismic arrays are not active (non-seismic conditions, <120 dB rms) provide a measure of walrus reactions to typical vessel traffic rather than the seismic source (discussed below). When monitoring ships are traveling under non-seismic conditions, the average closest point of approach to walrus was 265 m (869 ft) (Haley et al. 2010a). Seismic source vessels traveling under non-seismic conditions appear to disturb walrus at greater distances, perhaps in part because of their larger physical presence, with the average closest point of approach to walrus being 822 m (2,700 ft) (Haley et al. 2010a). However, these averages are derived from walrus observations that span a very wide range of distances at which they were first detected, and detection distances were greater from source ships probably because of their larger size and higher observation platforms above the sea surface relative to monitoring ships. Another measure of walrus reactions to vessels is their movements relative to an approaching vessel under non-seismic conditions. About half of the walrus observed showed no obvious movement pattern relative to a passing ship. Of those animals that did move, more than twice as many swam away from the vessel than swam toward the vessel (Haley et al. 2010a). This data indicates that there is a range of sensitivities among walrus to ships, including many that are not noticeably disturbed by their passing at some distance. Because they can easily swim faster than exploration vessels, it is likely that more sensitive walrus move away from approaching ships before they react more strongly to the disturbance. Disturbance of walrus in the water from passing vessels would be temporary and unlikely to cause meaningful displacement.

Icebreaking

Icebreaking vessels, whether used for in-ice seismic surveys or for ice management near exploratory drilling ships, introduce an additional type of disturbance to walrus than non-icebreaking vessels. These activities would take place in late fall to early winter under Alternative 2, a time period when walrus are often closely associated with the pack ice edge or are hauled out on coastal shores. Walrus resting on ice floes may also be disturbed by ice management vessels if the floe is too close to an exploratory drilling rig and needs to be moved. Past monitoring efforts indicated that most groups of hauled out walrus showed little reaction to icebreaking activities beyond 805 m (0.5 mi), although some walrus groups may be disturbed up to several kilometers away (Brueggeman et al. 1990). Given the dispersed distribution of walrus on the ice and the short time period and limited geographic extent of icebreaking activities authorized under Alternative 2, it is unlikely that many walrus would be affected in the Chukchi Sea and unlikely that any would be affected in the Beaufort Sea. Such disturbance would be temporary as the icebreaker moved through an area and the ice reformed relatively quickly. Only one in-ice seismic survey could be authorized in the Chukchi Sea under Alternative 2 so there would be no potential for multiple in-ice surveys to affect the same group of walrus.

Seismic Surveys

The greatest concern for most marine mammals from exploration work has been the potential for disturbance from seismic airgun arrays, especially the larger and more powerful 2D/3D surveys (16 to 36 airgun arrays) which cover large areas. Walrus hear sounds both in air and in water. Kastelein et al. (1996) tested the in-air hearing of a walrus from 125 Hz to 8 kHz and determined the best sensitivity was between 250 Hz and 2 kHz. Walrus were able to hear at all frequency ranges tested. Kastelein et al. (2002) tested the underwater hearing and determined that the best sensitivity was at 12 kHz. Their best range of hearing was between 1 and 12 kHz. Most of the noise sources discussed, other than the very high frequency seismic profiling, would be audible to walrus.

During the 2006 to 2008 open-water seasons, 10 walrus were observed in the water from seismic source or monitoring vessels in the Beaufort Sea. None of these animals were detected within the 180 dB re 1 µPa rms safety radius for walrus (Savarese et al. 2010). In the Chukchi Sea, 32 walrus were detected within this safety radius in 2006 and 53 walrus were seen within this radius in 2007 (Haley et al. 2010a). These situations triggered power-down responses of the seismic arrays. These data represent the minimum number of animals that were exposed to these sound levels because some animals detected outside of this radius could have moved away before being detected and some animals may not have been detected by observers. The great majority of observable behavioral reactions of walrus to passing active source vessels was either no reaction or to just watch it go by rather than swimming away (Haley et al. 2010a). Walrus at the surface of the water would experience less powerful sounds than if they were the same distance away but in the water below the seismic source. This may also account for the apparent lack of strong reactions in walrus that were visible to observers. Given the short time period in which seismic vessels would be operating in any one area, potential disturbance of walrus by seismic surveys would likely be temporary and affect very small numbers of animals.

Aircraft Traffic

The behavioral response of walrus to aircraft traffic varies with distance, type of aircraft, flight pattern, age, sex, and group size. Richardson et al. (1995) reviewed responses of walrus to aircraft and summarized that individual responses to aircraft can range from orientation (i.e. looking at the aircraft) to leaving a haulout. In general, small herds on haulout sites (terrestrial and pack ice) seem more easily disturbed than large groups, and adult females with calves are more likely to enter the water during an aircraft disturbance. Stronger reactions occur when the aircraft is flying low, passes overhead, or causes abrupt changes in sound. The greatest potential impact of aircraft is when the disturbance causes walrus at a haulout site to stampede into the water, which may result in the crushing of calves. However, flight restrictions imposed by USFWS LOAs greatly reduce the risk of aircraft disturbance to walrus hauled out on ice or on land. Given the limited amount of activities likely to require over-ice aircraft support under Alternative 2, the numbers of walrus potentially affected would be very small.

On-ice Vibroseis Survey

On-ice vibroseis surveys only take place in the shallow near-shore waters of the Beaufort Sea in the winter when Pacific walrus are not present in the area. Therefore, no impacts to Pacific walrus from this activity are anticipated to occur.

Exploratory Drilling

Exploratory drilling involves the establishment of a large drill ship in one location for some weeks and the deployment of numerous support vessels. The physical presence and chronic noise from multiple ships in the same area may result in displacement of walrus from a small geographic area. The importance of that displacement would depend on the quality of the benthic habitat for feeding walrus and its proximity to the ice pack or haulouts on land. Potential displacements would be short-term, lasting a few weeks to a few months.

Hearing Impairment, Injury, and Mortality

The noise levels required to cause TTS or PTS have not been determined for walrus. NMFS and USFWS have adopted a 180 dB re 1 µPa rms safety radius for walrus as a precautionary measure to reduce the risk of seismic sounds on walrus in lieu of actual data on TTS and PTS levels.

PSOs on many vessels in both seas have logged thousands of hours monitoring vessel transit and have recorded thousands of walrus in the water. There have been no suspected or documented cases of walrus being injured or killed by the type of large vessels used in Arctic oil and gas exploration activities. Given this historical record, the risk of ship strikes for walrus is considered negligible. It is also unlikely that any walrus would be exposed to very loud sounds from seismic operations to the point where they might be injured.

There is a potentially dangerous situation with walrus on land-based haulouts. Due to pack ice receding beyond the shelf break in low-ice years, thousands of walrus have been using haulouts on land in recent years, primarily on the Chukchi coast from Point Lay to Barrow. If they are strongly disturbed by polar bears or low-flying aircraft or nearby vessels, the herd may stampede into the water. Walrus may be injured during stampedes, and injuries may be severe enough to result in mortalities. Juveniles and calves are particularly susceptible, but adults may be injured or killed as well. USFWS LOA mitigation measures for exploration aircraft and vessels are intended to monitor and avoid such haulouts to avoid causing such deadly disturbance.

There is the potential for walrus to be exposed to small accidental spills of oils, lubricants, and other compounds used by vessels, vehicles, and equipment during exploration activities. Spills in the offshore or onshore environments could occur during normal operations (e.g. transfer of fuel, handling of lubricants and liquid products, and general maintenance of equipment). The direct effect of oil on walrus is probably similar to other pinnipeds. This includes irritation of eyes, mouth, lungs, and anal and urogenital surfaces (St. Aubin 1990). Kidney and liver damage could occur from ingestion of petroleum products while feeding (Cornelius and Kaneko 1963, Geraci and Smith 1977, Holden 1978). Because walrus are gregarious, any one animal that is exposed to a spill could spread that contact to other walrus. Walrus could also be affected through damage to their benthic food sources. If a small spill did occur, cleanup efforts would begin immediately, and those activities would likely include the presence of PSOs to monitor for walrus and other marine mammals and deter them from entering the spill area if possible. Given the occurrence of walrus primarily on or near the pack ice rather than swimming in open water where most exploration activities take place and the mitigation measures in place to prevent and clean up spills, the risk of walrus being exposed to small spills during exploration activities is considered to be minor. The potential effects of a very large oil spill are much more serious and are discussed in Sections 4.10.6.11 and 4.10.7.11.

Habitat Alterations

There are three potential mechanisms for habitat changes that may affect walrus: disturbance/mortality of prey species by exploration activities; disturbance of sea ice habitat from icebreakers; and contamination of the marine environment from discharge of drilling cuttings and other waste streams from ships and support facilities.

Benthic prey of walrus may experience disturbance/mortality from bottom-contact equipment used in exploration activities such as ocean bottom cable surveys, vessel anchors, and exploratory drilling. All of these activities could displace benthic mollusks and crustaceans temporarily and may cause small amounts of mortality. Given the wide distribution and dynamic nature of prey fields for walrus, these activities would be unlikely to affect the availability of prey to walrus. In addition, ocean bottom cable surveys would only occur in the Beaufort Sea where few walrus feed.

Icebreaking ships intentionally disrupt pack ice in order to conduct seismic surveys or to help manage ice floes around exploratory drilling equipment. These activities would take place in late fall to early winter under Alternative 2, a time period when walrus are on the pack ice or on shore waiting for the ice to return. Sea ice in these seasons moves continually, opening leads and closing them very quickly at times. The channels cut by icebreakers often close up very soon after the ship passes, mimicking the natural dynamics of the ice in many respects, and would not offer any hindrance to walrus movement.

The discharge of drilling cuttings and other waste streams (such as ballast water, waste water, and sewage) from drilling rigs and other exploration vessels could affect walrus habitat by contaminating benthic prey and fouling ice floes. Exploration wells generally include digging a large mud line cellar (MLC) and the release of cuttings onto the seafloor. Benthic prey items, such as bivalves and other invertebrates, would be buried during this process. This may result in the loss of several acres of benthic feeding habitat until the area is recolonized. The size of the area covered by the MLC and cuttings would depend upon the depth of the well and the deposition pattern.

4.5.2.4.13.2 Conclusion

Walrus have been regularly encountered during vessel-based exploration activities in the past, primarily in late summer as the pack ice recedes, as recorded by PSOs on board seismic source vessels and monitoring vessels. These data indicate that walrus do not react strongly to vessels and active seismic arrays and their behavioral responses are often neutral rather than swimming away. They tend to dive into the water as icebreaking ships approach from some distance and are therefore not exposed to the loudest of sounds generated by the ships. Mitigation measures required for walrus by USFWS LOAs since the early 1990s have reduced the risk of close encounters with seismic and other exploration vessels and have reduced the risk of accidental spills that may affect walrus or their prey. None of the data collected to date on walrus reactions to exploration activities indicate that they would be displaced from key areas or resources for more than a few minutes or hours. Careful avoidance of vessel and aircraft traffic around walrus haulouts on land would minimize the risk of mortality from stampedes. Walrus are legally protected, fulfill an important ecological role in the Arctic, and are an important subsistence resource and are therefore considered to be a unique resource for NEPA purposes. For the level and type of exploration activities that would be authorized under Alternative 2, given the mitigation measures that would be required by USFWS LOAs and NMFS as considered in this EIS, the effects on Pacific walrus would likely be low in magnitude, distributed over a wide geographic area, and temporary in duration. The effects of Alternative 2 would therefore be considered minor for walrus according to the criteria established in Section 4.1.3.

4.5.2.4.14 Polar Bears

4.5.2.4.14.1 Direct and Indirect Effects

This section discusses the potential direct and indirect effects of Alternative 2 on polar bears. Polar bears were listed as a threatened species under the ESA in 2008 (73 FR 28211, 15 May 2008), primarily on the basis of concerns about shrinking ice cover in Arctic seas due to climate change. Polar bears depend on pack ice for much of their denning habitat and for hunting seals. Thinning and receding ice cover threatens to greatly reduce suitable habitat for polar bears and could have serious population-level effects.

This EIS considers a number of standard and additional mitigation measures as part of each alternative that are intended to reduce adverse effects on marine mammals, especially bowhead whales and other species under the jurisdiction of NMFS, but these mitigation measures may also help to reduce adverse effects on polar bears and Pacific walrus, which are under the jurisdiction of the USFWS. In addition to the mitigation measures imposed by NMFS, the oil and gas industry operates under LOAs for incidental take of polar bears and Pacific walrus issued by the USFWS which contain mitigation measures specific to these species. A series of LOAs have been issued since 1993 for the Beaufort Sea (USFWS 2011a) and since 1991 for the Chukchi Sea (USFWS 2008a). The following mitigation measures are typically required by the USFWS for oil and gas exploration activities in the Beaufort and Chukchi seas to minimize impacts on polar bears and are thus incorporated into the analysis of potential effects under Alternative 2:

- Seismic source and support vessels must be staffed with dedicated PSOs to alert the crew to the presence of polar bears and initiate adaptive mitigation measures.
- Except under emergency situations, vessels must maintain the maximum distance possible from polar bears and never get closer than 805 m (0.5 mi) from polar bears.
- Operators of support aircraft should, at all times, conduct their activities at the maximum distance possible from polar bears.
- Under no circumstances, other than an emergency, should aircraft operate at an altitude lower than 457 m (1,500 ft) within 805 m (0.5 mi) of polar bears observed on ice or land. Helicopters may not hover or circle above such areas or within 805 m (0.5 mi) of such areas. When weather conditions do not allow a 457 m (1,500 ft) flying altitude, such as during severe storms or when cloud cover is low, aircraft may be operated below the 457 m (1,500 ft) altitude stipulated above. However, when aircraft are operated at altitudes below 457 m (1,500 ft) because of weather conditions, the operator must avoid areas of known polar bear concentrations and should take precautions to avoid flying directly over or within 805 m (0.5 mi) of these areas.

- All seismic surveys will establish and monitor an acoustically verified exclusion zone for polar bears surrounding seismic airgun arrays or sound source where the received level would be ≥190 dB re 1 μPa.
- Immediately power-down or shut-down the seismic airgun array and/or other acoustic sources whenever any polar bears are sighted approaching close to or within the area delineated by the 190 dB re 1 μPa polar bear exclusion zone. If the power-down operation cannot reduce the received sound pressure level to 190 dB re 1 μPa the operator must immediately shut-down the seismic sound sources.
- Ramp-up Procedures - (A) Prior to commencing ramp-up, the exclusion zone for polar bears must be visible and observed by a PSO watch for at least 30 minutes when: at the commencement of operations using airguns or sound sources; a complete shut-down has occurred; any time operation of the airgun array or sound source(s) is discontinued for a period of 10 minutes or more, or the PSO watch has been suspended; (B) If the exclusion zones are not completely visible for at least 30 minutes prior to ramp-up in either daylight or nighttime, ramp up may commence following established procedures which must include: Ramp-up airgun arrays slowly over a period of at least 30 minutes, start with one airgun or sound source in the array and then gradually add additional guns or sound sources, until the full array is firing.
- Poor Visibility Conditions - (A) During poor visibility conditions (fog, rain, snow, darkness, etc.), if the entire 190 dB re 1 μPa polar bear exclusion zone is visible using vessel lights and/or night vision devices, then ramp-up procedures of airguns or sound sources may occur following a 30 minute period of observation by PSOs with no sighting of polar bears in their exclusion zone; (B) If during poor visibility conditions, the full exclusion zone is not visible, the airguns cannot commence a ramp-up procedure from a full shutdown; (C) If, however, one or more airguns have been operational since before the onset of poor visibility conditions, they may continue to operate under the assumption that walrus will have been alerted by the sounds from the single airgun and have moved away.
- Holders of LOAs will be required to develop and implement an approved, site-specific polar bear interaction plan for on-shore and on-ice exploration activities. Polar bear awareness training will also be required of certain personnel. For on-ice surveys, trained polar bear monitors are often required to alert crew of the presence of polar bears and initiate adaptive mitigation responses.
- Activities in known or suspected polar bear denning habitat during the denning season (November to April) must include efforts to locate occupied polar bear dens within and near proposed areas of operation with FLIR imagery and/or polar bear scent-trained dogs.
- Operators must observe a 1.6 km (1 mi) operational exclusion zone around all known polar bear dens during the denning season. Should previously unknown occupied dens be discovered within one mile of activities, work in the immediate area must cease. The USFWS will evaluate these instances on a case-by-case basis to determine the appropriate action. Potential actions range from cessation or modification of work to conducting additional monitoring, and the holder of the authorization must comply with any additional measures specified.

In addition to these mitigation measures designed to reduce impacts on polar bears, the MMPA contains provisions to protect subsistence hunting of polar bears by requiring plans of cooperation and communication channels between industry and subsistence communities when the activities have the potential to impact subsistence hunting. Industry is also required to participate in monitoring programs intended to measure the effectiveness of mitigation measures and advance knowledge about the species. LOAs have also established protocols for reporting interactions with polar bears and the results of monitoring programs.

Behavioral Disturbance

There are several mechanisms for potential disturbance to polar bears associated with each of the different types of exploration activities that would be authorized under Alternative 2. Most of these mechanisms are common to both the Beaufort and Chukchi seas, and these potential effects are discussed together. Where activities or mechanisms are unique to one sea or the other, they are discussed separately.

Marine Vessels

Exploration activities during the open water season are limited to vessel-based exploration activities. Because most polar bears tend to remain on the ice pack as it moves north, there is a limited potential for exploration vessels to encounter polar bears on ice floes or swimming in open water. The physical presence of a vessel is more likely to cause disturbance to a polar bear rather than the airborne noise generated by the vessel but observer data indicates that bears generally do not react strongly to the presence of vessels, with most animals exhibiting neutral or ambiguous movements in relation to the ship (Savarese et al. 2010). In the Beaufort Sea, polar bear sightings from exploration vessels are uncommon and most of these have been of polar bears on or near barrier islands in the fall (Savarese et al. 2010). In the Chukchi Sea, polar bear sightings from vessels have been relatively rare (Haley et al. 2010a). About half of the sightings have been of bears in the water.

Icebreaking

Icebreaking vessels, whether used for in-ice seismic surveys or for ice management near exploratory drilling ships, introduce an additional type of disturbance to polar bears than non-icebreaking vessels. These activities would take place in late fall to early winter under Alternative 2, a time period when polar bears are often hunting seals along leads in the ice and in broken ice. Bears resting on ice floes may also be disturbed by ice management vessels if the floe is too close to an exploratory drilling rig (USFWS 2008b). However, given the dispersed distribution of bears on the ice and the short time period and limited geographic extent of icebreaking activities, it is unlikely that more than a few bears would be affected in either of the Arctic seas and such disturbance would be temporary to both the bears and their ice seal prey.

Seismic Surveys

There is limited information on the hearing of polar bears. Polar bears are not known to communicate underwater and studies have not been conducted to determine the effects, if any, on polar bears from underwater noise. The greatest concern for most marine mammals from exploration work has been the potential for disturbance from seismic airgun arrays, especially the larger and more powerful 2D/3D arrays (16 to 36 airguns) which cover large areas. During the 2006 to 2008 open-water seasons, 15 polar bears were observed in the water from exploration vessels in the Beaufort Sea (n=11) and the Chukchi Sea (n=4). Of these animals, one was observed within the 170 dB re 1 µPa rms safety radius (which initiated a power-down situation as a precaution before the bear potentially entered the 190 dB re 1 µPa rms safety radius) and the rest were outside the 160 dB re 1 µPa rms safety radius (Savarese et al. 2010, Haley et al. 2010a). Most of these animals exhibited neutral or ambiguous behavior rather than clear avoidance behavior (moving away from the exploration vessel). Given the short time period in which seismic vessels would be operating in any one area, potential behavioral reactions of bears to seismic surveys would likely be temporary.

Aircraft Traffic

Behavioral reactions of polar bears to aircraft depend on distance and type of aircraft. Polar bears may run away from aircraft passing at low altitudes. Most polar bears in dens continue to occupy the dens after close approaches by aircraft (Amstrup 1993). Although the snow attenuates some aircraft noise (Blix and Lentfer 1992), it is possible that repeated overflights may cause polar bears to abandon or depart their dens. However, minimum flight altitudes and flight restrictions around known polar bear dens would reduce the potential for bears to be disturbed by aircraft. Given the limited amount of activities likely to require over-ice aircraft support under Alternative 2, the numbers of bears potentially affected would be very small.

On-ice Vibroseis Survey (January to May)

On-ice vibroseis surveys are typically conducted only in the shallower, near shore waters of the Beaufort Sea and take place during the winter. This type of survey is the only type of exploratory activity authorized under Alternative 2 that has a realistic potential for direct bear-human encounters. The noise produced by on-ice activities such as ice-road construction and vibroseis surveys could attract curious bears rather than deter them. Encounters with humans can be dangerous for both polar bears and humans and are the subject of polar bear interaction plans developed in collaboration with and approved by the USFWS. The plans provide guidance for minimizing polar bear encounters through personnel training, polar bear guards, lighting, snow clearance, waste management and garbage control, agency communication, site clearance, and site-specific safety briefings for polar bear awareness. Employee training programs are designed to educate field personnel about the dangers of human-bear encounters and to implement safety procedures in the event of a bear sighting. Personnel are instructed to leave an area when bears are seen in the vicinity. As described in the LOA mitigation measures above, special emphasis is placed on finding and protecting polar bear dens with a 1.6 km (1 mi) buffer zone from all exploration activities. These efforts involve radio-collaring female bears, FLIR surveys, scent-trained dogs, and cooperative GIS efforts among the USFWS and all companies covered under exploratory and development LOAs.

Noise and vibrations produced by vibroseis activities could potentially result in impacts on denning and non-denning polar bears. The best available scientific information indicates that female polar bears entering dens, or females in dens with cubs, are more sensitive than other age and sex groups to noises. The proactive and adaptive nature of the LOA mitigation measures regarding den sites are designed to avoid and minimize the potential adverse effects on denning polar bears. Given the limited number and extent of the on-ice activities authorized under Alternative 2, the number of bears potentially affected would be very small.

Exploratory Drilling

Exploratory drilling involves the establishment of a large drill ship or ice island in one location for some weeks and the deployment of numerous support vessels. The physical presence of multiple ships in the same area may result in a greater potential for disturbance to polar bears than seismic surveys but the geographic area involved is much smaller. The noise generated from drilling is also not as loud as seismic airguns but it is produced on an almost continual basis, making it more of a chronic sound source in one location. Given the mild reaction of polar bears to marine vessels, drilling activities are unlikely to be a source of more than temporary displacement. (Polar bears are curious and will approach vessels and drilling vessels but do not appear to be particularly disturbed by their presence in most instances.) This displacement would be temporary and would not involve loss of feeding opportunity since bears typically do not hunt from the water.

Hearing Impairment, Injury, and Mortality

The noise levels required to cause TTS or PTS have not been determined for polar bears. However, polar bears typically swim with their heads above water or encounter exploration vessels while on ice or land, where sound levels from seismic surveys would be greatly reduced and they are unlikely to experience injurious sound levels.

PSOs on many vessels in both seas have logged thousands of hours monitoring vessel transit and have recorded only a few dozen polar bears in the water. There have been no suspected or documented cases of polar bears being injured or killed by the type of large vessels used in Arctic oil and gas exploration activities. Given the infrequency of polar bear observations at sea and the presence of observers on board, the risk of ship strikes for polar bears is considered negligible. It is also very unlikely that any polar bears would be exposed to very loud sounds from seismic operations to the point where they might be injured.

There is the potential for polar bears to be exposed to small accidental spills of oils, lubricants, and other compounds used by vessels, vehicles, and equipment during exploration activities. Spills in the offshore or onshore environments could occur during normal operations (e.g. transfer of fuel, handling of lubricants and liquid products, and general maintenance of equipment). The USFWS has determined that, based upon the reported effects of crude oil and refined oil products exposure on polar bears, any bear that makes contact with such a spill would probably die (USFWS 2008b). However, few polar bears are likely to be near exploratory activities during the open-water season, and the spatial separation that vessels and on-ice vehicles are required to maintain between themselves and bears should minimize the potential for close contact. In addition, if a small spill did occur, cleanup efforts would begin immediately and, if it occurred on land or on ice, would require the presence of PSOs to monitor for polar bears and to deter them from a dangerous situation by means of approved hazing methods. The risk of polar bears being exposed to small spills during exploration activities is therefore considered to be minor. The potential effects of a very large oil spill are much more serious and are discussed in Sections 4.10.6.11 and 4.10.7.11.

The main concern for the safety of polar bears during exploration activities is to minimize the risk of bear-human encounters and to manage encounters appropriately so neither bears nor humans suffer injury or death. Oil industry encounters with polar bears in Alaska that have resulted in mortality of bears have been rare, with one case in the winter of 1968 to 1969 and another in 1990 (USFWS 2008b). More recently, a female polar bear was shot and killed by a security guard near employee housing at the Endicott oil field (Reuters 2011). The USFWS began issuing LOAs for exploratory activities on the North Slope in the early 1990s that included mitigation measures and polar bear safety/interaction plans. Polar bears are curious about new things in their environment, however, so there is always the potential for bear-human interactions during oil and gas exploration in the Arctic, even if the activities are temporary. Continual preparation, training, and vigilance are required to maintain the excellent record of avoiding lethal encounters with polar bears, especially as more bears spend more time on shore as the ice pack recedes due to climate change and bears have to fast for longer time periods. It is in the industry's best interest to place a high priority on safety regarding polar bears and it is likely they will continue to work closely with the USFWS to improve and update their procedures to maintain the safest possible working conditions for the sake of people and bears.

Habitat Alterations

There are three potential mechanisms for habitat changes that may affect polar bears: disturbance/dispersion of prey species (ice seals) by seismic surveys or other industry activities; disturbance of sea ice habitat from icebreakers; and ice-road construction and on-ice survey activities.

The analysis of effects on ice seals (Section 4.5.2.4.12) indicates that most of the effects on these species from seismic surveys, icebreaking, and vessel traffic under Alternative 2 would be temporary and would not have population-level effects. None of the effects are likely to displace ice seals for more than a few hours and typically much less. It is therefore unlikely that the availability of seals to polar bears would be affected at all and would continue to be determined primarily by ice conditions and distribution, which are not affected by exploration activities.

Icebreaking ships intentionally disrupt ice floes in order to conduct seismic surveys or to help manage ice flows around exploratory drilling equipment. These activities would take place in late fall to early winter under Alternative 2, a time period when polar bears are on the pack ice or on shore waiting for the ice to return. Sea ice in these seasons moves continually, opening leads and closing them very quickly at times. The channels cut by icebreakers often close up very soon after the ship passes, mimicking the natural dynamics of the ice in many respects, and would not offer any hindrance to polar bear movement. On-ice seismic surveys in the Beaufort Sea require the construction of ice-roads on shore-fast ice and the removal of snow in some places to prepare for vibroseis equipment but these activities would not affect the abundance of seal breathing holes or dens, which polar bears seek out for hunting purposes. The effects on polar bear habitat are therefore temporary and of low intensity.

4.5.2.4.14.2 Conclusion

Polar bears have been infrequently encountered during vessel-based exploration activities in the past, as recorded by PSOs on board source vessels and monitoring vessels. These sparse data indicate that polar bears do not react strongly to vessels and active seismic arrays and their behavioral responses are often neutral rather than running or swimming away. They also do not appear to react strongly to icebreaking or on-ice surveys. Some bears keep their distance or move away at some point but others may approach vehicles and equipment out of curiosity. The types of effects of most concern for polar bears during exploration activities involve the risk of bear-human encounters. Mitigation measures and polar bear safety/interaction plans required by USFWS LOAs since the early 1990s have reduced the risk of these encounters for both people and bears. None of the data collected to date on polar bear reactions to exploration activities indicate that polar bears would be displaced from key areas or resources for more than a few minutes or hours and they are unlikely to experience any measurable effects on their reproductive success or survival as a result. Polar bears are legally protected, have a unique ecological role in the Arctic, and are an important subsistence resource and are therefore considered a unique resource. Given the mitigation measures that would be required by USFWS LOAs and NMFS as considered in this EIS, the effects of exploration activities that could be authorized under Alternative 2 on polar bears would likely be low in magnitude, distributed over a wide geographic area, and temporary in duration. The effects of Alternative 2 would therefore be considered minor for polar bears according to the criteria established in Section 4.1.3.

4.5.2.4.15 Standard Mitigation Measures for Marine Mammals

Standard Mitigation Measures are outlined in Section 2.4.10 and described in detail in Appendix A. These measures are required by all permits and authorizations issued under Alternative 2 for the noted activities. Many of them are similar or identical to mitigation measures required by the USFWS in the LOAs for polar bears and walrus. Therefore, while the measures considered by NMFS would only be included in authorizations for species under NMFS' jurisdiction, there is the potential for these measures to reduce impacts to polar bears and walrus, which are species under the jurisdiction of the USFWS. The following standard mitigation measures could be implemented to reduce adverse effects of oil and gas exploration activities on marine mammals.

Additionally, as noted above in the Conclusion sections for several species, because they are required under this alternative, the anticipated effects of the implementation of these Standard Mitigation Measures are included in the conclusions.

A1. Establishment and execution of 180 & 190-dB shutdown/power down radius for cetaceans & ice seals, respectively. The indicated radius is established, and monitored by PSOs, and the airguns are either powered down or shutdown if an animal approaches or comes within the distance associated with received levels of 180 or 190 dB rms (which is established based through acoustic modeling or on-site verification tests).

Applicable Activities: 2D/3D, in-ice, and OBC seismic surveys, site clearance and high resolution shallow hazards surveys

Purpose: The purpose of this measure is to avoid the injury of marine mammals through PTS and to reduce the likelihood of TTS or more intense behavioral responses that might be expected to occur as a result of exposures at these higher levels.

Science, Support for Reduction of Impacts, and Likely Effectiveness: Section 4.2.6 discusses NMFS' current acoustic critera and references upcoming revisions to the criteria based on Southall et al. (2007), as well as Finneran and Jenkins (2012). Additionally, the sections above include more information regarding the levels above which and durations beyond which animals would be expected to incur acoustic injury. NMFS does not expect that every animal exposed to this level of sound would experience PTS, especially from periodic pulsed sounds that move through an area such as occur from seismic surveys. However, as noted above, hearing impairment can also result from exposure to lower levels over a longer time.

The 180-dB rms zone should contain the area of potential injury for cetaceans, with the possible exception of high-frequency cetaceans – for which the area may be slightly larger. For phocid seals, the 190-dB rms zone likely contains the majority of the area in which injury could occur, but the area could be slightly larger based on the draft revised acoustic criteria (see Section 4.2.6 of this EIS). Because the metrics are different (cSEL vs. SPL rms), allowing for an accumulation of sound over time, and because frequency weighting should be applied to the specific sound source, it is difficult to pre-determine exactly how big the area of conern will be in advance of modeling for any particular source, but preliminary calculations suggest that the areas would not far exceed the 180 or 190-dB isopleths.

The safety radius serves to provide a basis for reducing the level of sound exposure before PTS occurs. Associated mitigation measures, e.g. ramp up and PSO requirements, are intended to either give marine mammalss a chance to swim away from potentially harmful sound sources or to minimize their risk of accidental exposure to such sounds. Data from PSOs indicate that most seals tend to move out of the way before they enter this safety radius, and others do not appear to be disturbed to any noticeable extent as active seismic vessels approach close by, even as these close approaches require power-down/shutdown procedures.

The majority of marine mammals likely avoid the source at these distances. The majority of animals entering these zones are likely detected before they have been exposed above 180 or 190 dB for significant amounts of time, and then further continued exposure at those levels is avoided by power-down or shutdown.

The ability of PSOs to effectively monitor these radii depends on their experience, state of alertness, and visibility/sea conditions, all of which vary over time, as well as the size of the zone. Distances out to which observers can detect marine mammals also depend on the height of the observation platform above water. For example, Haley et al. (2010b) calculated an effective strip half-width (the distance from the centerline of the transect outside of which the number of animals detected equals the number not detected inside) of 1,618 to 3,136 m (1,767 to 3,430 yds) for vessels higher than 11 m (12 yds) and 1,191 to 1,893 m (1,302 to 2,070 yds) for those lower than 11 m (12 yds). Additionally, although the 190-dB zone is smaller than the 180-dB zone, pinnipeds are often more difficult to detect visually than cetaceans.

One limitation and concern regarding monitoring of the exclusion radii is that the 180-dB zone may extend beyond the detection limits of the PSOs, so that cetaceans may enter within the exclusion radii and be exposed to sound sources ≥180 dB rms. Funk et al. (2010) found that the size of ≥180 dB rms exclusion radius around the seismic vessel *Gilavar* in the Chukchi Sea 2007 and 2008 approached the limit of the distance to which PSOs could reliably detect marine mammals. A protocol utilizing additional monitoring vessels was, therefore, employed to observe the exclusion zone. However, there is also the possibility of marine mammals avoiding or being disturbed by the presence of additional vessels, as noted earlier in this document.

For pinnipeds, the 190 dB radius for 2D/3D seismic arrays (24 airguns) in the Beaufort Sea is 860 to 920 m (2,821 to 3,018 ft) (Savarese et al. 2010). In the Chukchi Sea, the typical range for the 190 dB radius for 2D/3D seismic arrays (16 to 36 airguns) is 460 to 610 m (1,509 to 2,001 ft) (Haley et al. 2010a). For site clearance and high resolution shallow hazards surveys (1 to 4 airguns) this radius typically ranges from 5 to 50 m (16 to 164 ft) (Savarese et al. 2010, Haley et al. 2010a). Ice seals are the most common marine mammals sighted by PSOs, and the detection of seals within the 190 dB exclusion zone radius has resulted in numerous powerdown/shut down situations in both the Beaufort and Chukchi seas. During the most active years for seismic work in recent years, 35 seals were detected within the

190 dB radius in the Beaufort Sea in 2008 (Savarese et al. 2010) and 65 seals were detected within the radius in the Chukchi Sea in 2006 (Haley et al. 2010a). These numbers are likely underestimates of the number of seals exposed to these sound levels because some animals may have moved away before coming into the range of visual observers and others could have been underwater or otherwise escaped detection by PSOs.

Frequency of implementation of shutdown and powerdown zones varies but appears generally higher for pinnipeds (190 dB radius) than cetaceans. In 2008, 41 of 44 power downs requested during seismic surveys in the Beaufort Sea were for pinnipeds; the remainder was for one bowhead whale and two unidentified mysticetes (Ireland et al. 2009).

Despite observer effort to mitigate exposure to sounds ≥180 dB re 1 μPa rms, some cetaceans may enter within the exclusion radii. In the Chukchi Sea in 2006 to 2007, 13 cetaceans were sighted within the ≥180 dB re 1 μPa rms radius and exposed to noise levels above that range before appropriate mitigation measures could be implemented (Haley et al. 2010b). Acoustic impairment or injury is, therefore, unlikely for the cetaceans that briefly enter within the 180 dB exposure radius before the mitigation measure can be implemented.

History of Implementation: Power-down and shutdown procedures are currently used, and have been consistently used for years, during exploration activities in the Beaufort and Chukchi seas.

Practicability: To date, this measure has proven practicable to industry operators, as it has been implememted consistently for years.

Recommendation: Based on the feasibility and likely avoidance of injury or more severe behavioral impacts, it makes sense to continue requiring this measure of industry operators.

***Walrus* –** USFWS adopted this safety radius for walrus as a precautionary measure *in lieu* of direct evidence regarding sound source characteristics that would cause TTS (NMFS 2000). NMFS does not expect that every animal exposed to this level of sound would experience TTS, especially from periodic pulsed sounds that move through an area such as occur from seismic surveys. The safety radius serves to provide a basis for reducing the level of sound exposure before TTS occurs. Associated mitigation measures, e.g. ramp up and PSO requirements, are intended to either give walrus a chance to swim away from potentially harmful sound sources or to minimize their risk of accidental exposure to such sounds. The 180 dB radius is established through acoustic modeling or on-site verification tests, which have become routine operational practices for the industry, and is monitored by PSOs on board the sound source vessels and sometimes on support vessels. This measure has been implemented many times in the past due to the presence of walrus in the water near seismic vessels, primarily in the Chukchi Sea.

***Polar Bears* –**USFWS adopted this safety radius for polar bears as a precautionary measure *in lieu* of direct evidence regarding sound source characteristics that would cause TTS in polar bears. The 190 dB radius is established through acoustic modeling or on-site verification tests, which have become routine operational practices for the industry, and is monitored by PSOs on board the sound source vessels and sometimes on support vessels. There are no records of polar bears being exposed to this intensity of sound from seismic surveys.

A2. Specified ramp-up procedures for airgun arrays. This technique involves the gradual increase (usually approximately 5-6 dB per 5-minute increment) in emitted sound levels, beginning with firing a single airgun and gradually adding airguns over a period of 20 to 40 minutes, until the desired operating level of the full array is obtained.

Applicable Activities: 2D/3D seismic surveys, including in-ice surveys, and site clearance and high resolution shallow hazards surveys.

Purpose: The purpose of a ramp-up (soft-start) procedure when starting airgun operations is to provide a gradually (from low levels) increasing sound (vs. sudden high level sound) so that marine mammals near the vessel have the opportunity to move away before being exposed to sound levels that might be strong enough to cause injury. The 180- and 190-dB exclusion zones described in the previous measure are used for the ramp-up procedures as well. The means by which this mitigates injury is by causing deflection from or avoidance of the sound source so, in effect, causing disturbance to mitigate harm.

Science, Support for Reduction of Impacts, and Likely Effectiveness: There have been no documented cases where cetaceans have been observed to move away from a survey vessel during ramp-up. Efficacy is assumed, based on studies of effects of airgun sounds on marine mammals, although the degree to which ramp-up protects marine mammals from exposure to intense noises is unknown (75 FR 49760, August 13, 2010).

Single-airgun experiments show that bowheads typically move away when a single airgun starts firing nearby (Richardson et al. 1986, Ljungblad et al. 1988). Startup of a single airgun is equivalent to the start of a ramp-up, suggesting that bowhead whales would begin to move away during the initial stages of a ramp-up. Hannay et al. (2011b) conducted a model-based assessment of underwater noise from a soft-start operation. In shallow water (50 m (164 ft) depth), the cumulative SEL levels for steps one through three (30 shots into the 230 shot ramp-up procedure) were below the proposed injury criteria for cetaceans at 100 m (328 ft) to the side of the sound source. Any bowhead whales in the vicinity would presumably move away during these early steps in the ramp-up procedure. NMFS requires that ramp-up of acoustic sources occur at a rate of no more than 6 dB per 5 min. This ramp-up rate would prevent marine mammals from being exposed to high levels of noise without warning (75 FR 49760, August 13, 2010). The entire procedure generally takes 20 to 40 minutes to accomplish, depending on the size of the array, and is therefore easy to implement.

Mitigation Measure A2 could impact other cetaceans the same as it would bowhead whales. Single-airgun experiments with three species of baleen whales (gray, humpback, and bowhead) have shown that they tend to move away when a single airgun starts firing nearby, which simulates the onset of a ramp up (Malme et al. 1984, 1985, 1986, 1988; Richardson et al. 1986, Ljungblad et al. 1988, McCauley et al. 2000). Since startup of a single airgun is equivalent to the start of a ramp-up, this strongly suggests that many baleen whales will begin to move away during the initial stages of a ramp-up. It is assumed that toothed whales would react similarly. However, there have been no documented cases where ice seals have been observed to move away from a survey vessel during ramp up. The effectiveness of the measure and its reduction of adverse effects on ice seals are therefore unknown. NMFS has required this measure as a conservative approach to conservation based on its potential for reducing adverse effects on a variety of species and its ease of application.

As noted above, logic and our understanding of how most marine mammals avoid loud sound would suggest that ramp up procedures would likely be effective to some degree in preventing the sudden exposure of marine mammals to injurious sounds. As noted above, cetaceans have been detected moving away from the sound source during a ramp up, but pinnipeds have not. Typically, though, not enough animals are detected during ramp ups of actual seismic surveys to perform a meaningful evaluation of the full effectiveness of the measure.

History of Implementation: Ramp-up procedures have been consistently required for years during exploration activities in the Beaufort and Chukchi seas.

Practicability: To date, this measure has proven practicable to industry operators, as it has been implememted consistently for years.

Recommendation: Based on the feasibility and potential reduction of injury or more severe behavioral impacts, it makes sense to continue requiring this measure of industry operators.

Walrus – This standard mitigation measure applies to all seismic surveys and is the same as the USFWS LOA measures. The rationale for this measure is that walrus in the vicinity of a seismic survey would hear the low sound levels during ramp up and have a chance to move away before potentially damaging sound levels are reached. This procedure may take 20 to 40 minutes to accomplish depending on the size of the array, and is therefore easy to implement. There have been no documented cases where walrus have been observed to move away from a survey vessel during ramp up. The effectiveness of the measure and its reduction of adverse effects on walrus are therefore unknown.

***Polar Bears* –** This standard mitigation measure applies to all seismic surveys and is the same as the USFWS LOA measures. The rationale for this measure is that polar bears in the vicinity of a seismic survey would hear the low sound levels during ramp up and have a chance to move away before potentially damaging sound levels are reached. This procedure may take 20 to 40 minutes to accomplish depending on the size of the array, and is therefore easy to implement. There have been no documented cases where polar bears have been observed to move away from a survey vessel during ramp up. The effectiveness of the measure and its reduction of adverse effects on polar bears are therefore unknown.

A3. PSOs required on all seismic source vessels and icebreakers, as well as on dedicated monitoring vessels.

Applicable Activities: 2D/3D seismic surveys, including in-ice surveys, and site clearance and high resolution shallow hazards surveys.

Purpose: Presence of and observations by PSOs on the source vessels are crucial for implementing many of the other mitigation measures, such as the shutdown and power down measures, and for estimating potential impacts (see Measure A1 above). PSOs are also sometimes used to collect required monitoring information from sources vessels, although this requirement is separate and may be executed from a separate platform. PSOs are trained in species identification and many other operational and data recording procedures. Data collected during visual observations include species identification, bearing and distance to the initial sightings, estimated closest point of approach of animals relative to source vessels or support vessels, movement of animals relative to vessel movements, and behavioral reactions of animals in response to vessel movements. Behavioral data are often limited by the brief time most marine mammals are at the surface where they can be observed and by distance from the vessel (Haley et al. 2010b). Crew members of all vessels are also instructed to watch for marine mammals and to notify the PSOs immediately if any are sighted. While it is not a job requirement, many PSOs are Iñupiat or Yupik hunters that live in Arctic coastal communities and bring a wealth of experience and traditional knowledge to the position.

Science, Support of Reduction of Impacts, and Likely Effectiveness: Distance out to which observers can detect marine mammals depends on the height of the observation platform above water. For example, Haley et al. (2010b) calculated an effective strip half-width (the distance from the centerline of the transect outside of which the number of animals detected equaled the number not detected inside) of 1,618 to 3,136 m (1,767 to 3,430 yds) for vessels higher than 11 m (12 yds) and 1,191 to 1,893 m (1,302 to 2,070 yds) for those lower than 11 m (12 yds).

Visually detecting marine mammals during periods of low to poor visibility, including fog and darkness, may also be challenging. Extensive ice cover, particularly during icebreaking activities, could hinder detectability of marine mammals in water. However, despite limitations, PSOs are invaluable for the purposes of mitigation and data collection aboard industry vessels.

History of Implementation: PSOs on source vessels have been consistently required for years during exploration activities in the Beaufort and Chukchi seas.

Praacticability: To date, this measure has proven practicable to industry operators, as it has been implememted consistently for years.

Recommendation: Based on the feasibility and likely reduction of injury or more severe behavioral impacts, it makes sense to continue requiring this measure of industry operators.

***Walrus* –** The use of the phrase PSOs is synonymous with the term MMOs in the USFWS LOAs. This mitigation measure applies to seismic surveys and icebreaking. PSOs are trained in species identification and many other operational and data recording procedures. Their presence and observations are crucial for implementing many of the other mitigation measures. Crew members of all vessels are also instructed to watch for marine mammals and to notify the PSOs immediately if any are sighted. While it is not a job requirement, many PSOs are Iñupiat or Yupik hunters that live in Arctic coastal communities and bring a wealth of experience and traditional knowledge to the position.

***Polar Bears* –** The use of the phrase PSOs is synonymous with the term MMOs in the USFWS LOAs. This standard mitigation measure applies to seismic surveys and icebreaking. PSOs are trained in species identification and many other operational and data recording procedures. Their presence and observations are crucial for implementing many of the other mitigation measures. Crew members of all vessels are also instructed to watch for marine mammals and to notify the PSOs immediately if any are sighted. While it is not a job requirement, many PSOs are Iñupiat or Yupik hunters that live in Arctic coastal communities and bring a wealth of experience and traditional knowledge to the position.

A4. All activities must be conducted at least 152 m (500 ft) from any observed ringed seal lair. This measure requires survey crews to be trained in seal detection and to search for ringed seal lairs around intended seismic survey operation sites and prohibits seismic activities within a 152 m (500 ft) radius of ringed seal lairs. Additionally, while traveling on ice roads, the area shall be monitored for marine mammals, especially ringed seal lairs.

Applicable Activities: on-ice seismic surveys

Purpose: The purpose of this measure is to avoid disturbing ice seals when they are in their lairs. Additionally, this requirement helps to ensure that machinery is not placed directly over a lair, thereby crushing the lair. If a lair is crushed, an animal inside the lair could be injured or killed. If the animal survives, it could be forced into the water. Pups are more susceptible to hypothermia, so forcing them into the water before their insulation layers are fully formed could result in mortality. This measure is meant to reduce both disturbance and the potential for injury or mortality of ringed seals.

Science, Support of Reduction of Impacts, and Likely Effectiveness: At this 152 m (500 ft) distance, sound source levels from vibroseis gear are not likely to appreciably affect ringed seals (Burns and Kelly 1982, Kelly et al. 1988). Crew at BP's Northstar Island have searched for and marked ringed seal lairs over the last decade prior to ice road construction activities.

History of Implementation: Avoidance of ringed seal lairs has been consistently required for years during on-ice exploration activities in the Beaufort Sea.

Practicability: To date, this measure has proven practicable to industry operators, as it has been implememted consistently for years.

Recommendation: Based on the feasibility and likely reduction of injury or more severe behavioral impacts to ringed seals, it makes sense to continue requiring this measure of industry operators.

***Polar Bears* –** This standard mitigation measure applies only to on-ice surveys and requires survey crews to be trained in seal detection and to search for ringed seal lairs around intended seismic survey operation sites and to prohibit seismic activities within a 152 m (500 ft) radius of ringed seal lairs. This measure helps reduce potential effects on the main prey of polar bears in the Beaufort Sea.

A5. No energy source may be placed over a ringed seal lair. A 152 m (500 ft) exclusion zone must be established around all located active subnivean seal structures, within which no seismic or impact work may be conducted.

Applicable Activities: On-ice seismic surveys

Purpose: The purpose is to avoid injury or severe disturbance of ringed seals.

Science, Support of Reduction of Impacts, and Likely Effectiveness: See the discussion for standard mitigation measure A4 above.

History of Implementation: Avoidance of ringed seal lairs has been consistently required for years during exploration activities in the Beaufort Sea.

Feasibility: To date, this measure has proven feasible to industry operators, as it has been implememted consistently for years (usually in conjunction with the pre-survey scouting for ice-seal structures).

Recommendation: Based on the feasibility and likely reduction of injury or more severe behavioral impacts to ringed seals, it makes sense to continue requiring this measure of industry operators.

***Polar Bears* –** This measure applies only to on-ice surveys and also helps reduce potential effects on the main prey of polar bears in the Beaufort Sea.

A6. PSOs required on all drill ships and ice management vessels.

Applicable Activities: exploratory drilling and in-ice seismic surveys

Purpose: The purpose is the same as standard mitigation measure A3, described above, to implement the mitigation measures and collect data for monitoring requirements.

Science, Support of Reduction of Impacts, and Likely Effectiveness: See discussion in standard mitigation measure A3, above. PSOs on the ice-breaking vessels associated with seismic vessels are in a good position to detect marine mammals in front of, or near, the source vessel and implement mitigation measures. However, for drilling ships, historically the source level has been low enough that it has not been necessary to have power-down and shutdown zones to avoid injury (i.e., at no distance would a marine mammal be close enough to incur PTS). As noted in Section 4.2.6, if the acoustic criteria are modified as outlined, this distance may increase and necessitate the implementation of shutdowns.

History of Implementation: Use of PSOs on drillships and ice-breaking vessels has been consistently required for years during exploration activities in the Beaufort and Chukchi Seas.

Practicability: To date, this measure has proven practicable to industry operators, as it has been implememted consistently for years.

Recommendation: Based on the practicability and likely reduction of injury or more severe behavioral impacts to marine mammals, it makes sense to continue requiring this measure of industry operators for ice-breaking vessels. For drilling vessels, depending on the distance from the vessel to where injurious effects might be expected, the utility of PSOs for implementing mitigation may be limited, however, their value in collecting important monitoring information likely still remains.

B1. Specified flight altitudes for all support aircraft except for take-off, landing, and emergency situations.

Applicable Activities: 2D/3D seismic, including in-ice, surveys, site clearance and high resolution shallow hazards surveys, and exploratory drilling activities

Purpose: Aircraft flight paths and altitudes are restricted to reduce the chance of disturbing marine mammals in the water or hauled out on the ice or land. There are exceptions for landing, takeoff, emergency situations, and unsafe flying conditions (such as poor weather or low visibility).

Science, Support of Reduction of Impacts, and Likely Effectiveness: Studies of behavioral reactions of bowhead whales to aircraft are limited but indicate that whales react little, if at all, to fixed-wing aircraft operating at an altitude of 460 m (1,509 ft) and that most reactions to helicopters occur when the helicopter was at altitudes of ≤150 m (500 ft) (Patenaude et al. 2002, Richardson and Malme 1993). NMFS requires that marine mammal monitoring survey flights be conducted at 305 m (1,000 ft) or greater to avoid adverse impacts to bowhead whales (and other marine mammal species). USFWS requires a minimum altitude of 457 m (1,500 ft) in the LBCHU and when flying over walrus and polar bears on ice or land. In the LBCHU and when over walrus or polar bear, the oil and gas industry conducting operations under MMPA ITAs from both NMFS and the USFWS would be required to implement the more stringent flight altitude. The altitude restrictions associated with this mitigation measure should, therefore, adequately reduce most adverse impacts from aircraft overflights.

Reactions of beluga whales to aircraft vary. Richardson et al. (1991) reported no overt response of beluga whales, even when the aircraft was 100 to 200 m (328 to 656 ft); other responses included looking up, diving abruptly, or turning sharply away from the aircraft. As summarized in Richardson et al. (1995), beluga whales often react to aircraft by swimming or diving. The altitude restrictions associated with this mitigation measure should, therefore, adequately reduce most adverse impacts from aircraft fly overs.

History of Implementation: Altitude restrictions have been consistently required for years during exploration activities in the Beaufort and Chukchi seas.

Practicability: To date, this measure has proven practicable to industry operators, as it has been implememted consistently for years. The flight stipulations are standard operating procedures and coincide with normal safety considerations for air support of offshore activities so they generally do not "cost" more to implement.

Recommendation: Based on the practicability and likely reduction of behavioral impacts to marine mammals, it makes sense to continue requiring this measure.

***Walrus* –** This standard mitigation measure applies to all exploration activities and is the same as the USFWS LOA measures. Aircraft flight paths and altitudes are restricted to reduce the chance of disturbing walrus and other marine mammals in the water or on the ice or land. This restriction would be especially important for avoiding walrus concentrations hauled out on land or on ice where panic reactions could cause injuries or mortality of animals. There are exceptions for landing, takeoff, emergency situations, and unsafe flying conditions. There is no direct evidence about how effective this mitigation measure has been for reducing disturbance to walrus but the flight stipulations are standard operating procedures and coincide with normal safety considerations for air support of offshore activities.

***Polar Bears* –** This standard mitigation measure applies to all exploration activities and is the same as the USFWS LOA measures. Aircraft flight paths and altitudes are restricted to reduce the chance of disturbing polar bears and other marine mammals in the water or on the ice or land. There are exceptions for landing, takeoff, emergency situations, and unsafe flying conditions. There is no direct evidence about how effective this mitigation measure has been for reducing disturbance to polar bears but the flight stipulations are standard operating procedures and coincide with normal safety considerations for air support of offshore activities. NMFS has required this measure as a conservative approach based on its potential for reducing adverse effects on a variety of species and its ease of application.

C1. Specified procedures for changing vessel speed and/or direction to avoid collisions with marine mammals.

Applicable Activities: 2D/3D seismic including in-ice surveys, site clearance and high resolution shallow hazards surveys, exploratory drilling activities, and all associated support vessels

Purpose: This measure is primarily designed specifically to mitigate vessel collision, although it may also indirectly reduce the risk of disturbance to whales.

Science, Support of Reduction of Impacts, and Likely Effectiveness: The circumstances under which the few reported ship strikes and vessel injuries to bowhead whales occurred are unknown, but, given that speeds above 15 kn are known to increase the likelihood of vessel collisions elsewhere for other species (Laist et al. 2001, Vanderlaan and Taggart 2007), this mitigation measure should prove effective. Recent modeling of speed restriction impacts to lethality of vessel collision found that a speed restriction of 10 kn reduced the predicted probability of lethality by 56.7 percent (Wiley et al. 2011). The effectiveness of this measure is, however, partly dependent on the ability of PSOs to adequately detect whales at the distance within which these measures apply and the vessels can adequately reduce speed.

Reducing sudden or multiple changes in vessel direction and requiring vessels to slow down under conditions of poor visibility would also reduce noise levels and the sudden appearance of fast vessels approaching whales in poor visibility. There are no data by which to determine the effectiveness of this measure to indirectly reduce adverse effects of vessel disturbance on bowhead whales, but bowheads appear to be less reactive to and tolerant of slow-moving vessels (Richardson and Malme 1993).

Beluga whale reactions to vessels are highly variable and depend on the habitat, type and behavior of boat, the whales' previous experience with vessels, and the behavioral activities of the whales during the vessel interaction. It is not known whether there have been any ship strikes involving beluga whales and exploration vessels in the Arctic, but given that speeds above 15 kn are known to increase the likelihood of vessel collisions elsewhere (Laist et al. 2001, Vanderlaan and Taggart 2007), this mitigation measure should prove effective and impact belugas whales as it would bowhead whales (see Section 4.5.2.4.9).

While ship strikes are known to affect most of the cetaceans within the EIS project area, it is difficult to draw conclusions regarding causes. Behavior varies within and among species, and there is an overall lack of quality data surrounding ship strikes (Jensen and Silbur 2003). However, this measure would be expected to be as helpful in avoiding ship strikes to other species as to bowheads and belugas.

The risk of vessel collisions with seals is much less than for slower moving whales. There is no evidence that any ice seals have been struck by any vessels associated with exploration activities in the Arctic.

History of Implementation: Use of speed or direction changes in the presence of marine mammals has been consistently required for years during exploration activities in the Beaufort and Chukchi Seas.

Practicability: To date, this measure has proven practicable to industry operators, as it has been implemented consistently for years. Additionally, it is in the best interest of any vessel not to hit a marine mammal or any other object in the water.

Recommendation: Based on the practicability and likely reduction of injury or death of marine mammals, it makes sense to continue requiring this measure of industry operators.

***Walrus* –** This standard mitigation measure applies to seismic surveys, icebreaking, and exploratory drilling. Although this mitigation measure is intended to reduce the risk of collisions with whales, it may also indirectly reduce the risk of disturbance to walrus by reducing sudden changes in vessel direction and requiring vessels to slow down under conditions of poor visibility, thereby reducing noise levels and the sudden appearance of vessels fast approaching walrus in the dark or obscured conditions.

***Polar Bears* –** This standard mitigation measure applies to seismic surveys, icebreaking, and exploratory drilling. Although this mitigation measure is intended to reduce the risk of collisions with whales, it may also indirectly reduce the risk of disturbance to polar bears by reducing sudden changes in vessel direction and requiring vessels to slow down under conditions of poor visibility, thereby reducing noise levels and the sudden appearance of vessels fast approaching bears in the dark or obscured conditions.

4.5.2.4.15.1 Standard Mitigation Measures Summary for Marine Mammals

The incorporation of all of these standard mitigation measures discussed above into future permits and authorizations would work to reduce any adverse impacts to marine mammals that could result from oil and gas exploration activities. Measures to reduce impacts to subsistence uses of marine mammals are discussed in detail in Section 4.5.3.2.3. Several measures are designed with a particular species in mind, but could result in a reduction of adverse indirect impacts to an additional marine mammal species as well. As noted above, the requirement of Standard Mitigation Measures is considered in the conclusion sections of the marine mammal impact analyses included above.

4.5.2.4.16 Additional Mitigation Measures for Marine Mammals

Additional mitigation measures are outlined in Section 2.4.11 and described in detail in Appendix A. These measures may, or may not, be incorporated in future permits and authorizations, depending on the specific activity and the analysis conducted pursuant to the MMPA and the OCS Lands Act. See Sections 2.4.2 and 4.3 for an explanation of how specific measures would be chosen for inclusion in any future permits or authorizations. The following are applicable to mitigating effects of oil and gas exploration activities on marine mammals.

Additional Mitigation Measure A1. Prior to conducting the authorized survey, the seismic array operator shall conduct sound source verification (SSV) tests for their airgun array configurations in the area in which the survey is proposed to occur and report the broadband received levels of 190 dB, 180 dB, 160 dB, and 120 dB radii from the array to the authorizing entity within 5-10 days of completion.

Applicable Activities: 2D/3D seismic including in-ice surveys, site clearance and high resolution shallow hazards surveys

Purpose: The purpose of this mitigation measure is to accurately establish the distances from the airguns that a marine mammal will receive certain sound levels instead of relying on modeling and extrapolation from different known source levels or datasets. These measurements would be used to:

- refine the shutdown zone for that season, which would ensure that animals are not exposed to received levels associated with PTS (injury);
- allow for a more accurate post-operation estimate of the number of animals exposed to levels associated with Level B Harassment in that season; and
- help systematically populate a body of similar estimates (for different airgun array sizes/types, different areas, and different seasons) that could bound the likely propagation ranges and eventually allow for more reasonable and defensible estimates of shutdown and harassment zones in the future for surveys similar to those previously measured, so that SSVs need not be conducted prior to every survey.

Science, Support for Reduction of Impacts, and Likely Effectiveness: Estimating underwater sound levels at different distances from the airgun source should be based on empirical measurement where practicable. The radii of the monitoring zones will vary in size based on the characteristics of the arrays and environmental features, such as bathymetry, bottom type, and the temperature and salinity of the water.

It is generally acknowledged that modeled received levels will be more accurate if they are based on measurements taken of the given source in the same environment and season. However, the accuracy of predictions can vary based on the technology and methods used, so acoustic experts should be consulted. Although larger shut down zones may be considered more conservative by theoretically increasing the area at which animals may not be exposed to sound, these larger zones are often difficult to monitor due to the extent of the area, poor visibility conditions, and difficulty in observing animals such as bowhead whales because of the amount of time they spend underwater. This measure is not required throughout the season but rather at the beginning of the exploration activity and often gives industry a more useful zone for monitoring that season.

SSV measurements have been conducted for several years now with similar types of vessels and sound sources in the same general locations. Over time, it may be possible to collect a broad set of sound source measurements that cover the range of variability in sound source and environmental characteristics (location, depth, bottom type, ice, etc.), which can then be applied in appropriate scenarios in the future without needing to collect new data prior to every survey. NMFS is keeping records of the sound source verification measurements that have been taken and will use it to evaluate the need for source specific measurements in future authorizations.

Because of the high variability in measured isopleths for seismic vessels, it is not clear whether there is consistently a practical reduction of adverse effects to marine mammals. However, we have noted that as more SSVs have been conducted, and more measurements are available for reference, the difference between pre-season modeled/estimated isopleths and field measurements has decreased, allowing for better industry planning and a reduced likely of injurious take as a result of underestimated injury isopleths.

History of Implementation: This mitigation measure has been required in the recent past for most oil and gas exploration projects in the Arctic. However, a 2011 University of Alaska Seismic survey did not require an SSV. The previously required measure required results to be provided to NMFS within five days. However, because of an incident during the 2012 season where rushing the results caused an error in the data analysis, NMFS is considering that applicants would have 5-10 days to submit the results.

Practicability: While this mitigation measure would not be difficult to implement because there is existing expertise and adequate equipment, there are significant costs and planning associated.

Recommendation: Our current analysis suggests that SSVs should be required of authorization-holders unless pre-existing SSVs in the same area/time and for the same array configuration have adequately characterized the expected propagation. If implemented in this manner, it would be necessary to make a case-specific decision regarding whether to require an SSV based on the the airgun configuration of that survey, the area, and the time of year. Once an appropriate representation of the likely propagation of a particular airgun configuration has been estimated in a given region and season (which will take more than one measurement), additional measurements of that airgun configuration will likely not be needed. To support this measure, BOEM and the industry should develop a systematic plan that identifies the categories of airgun configuration, area, and time that need to be populated with SSVs and indicates where data have already been gathered or still need to be collected

Walrus – The effects of this additional mitigation measure on walrus would be the same as described for pinnipeds in Section 4.5.2.4.12.

Polar Bears – The effects of this additional mitigation measure on polar bears would be the same as described for pinnipeds in Section 4.5.2.4.12.

Additional Mitigation Measure A2. All PSOs shall be provided with and use appropriate 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 in order to detect marine mammals within the exclusion zones.

Applicable Activities: All activities requiring PSOs

Purpose: The purpose of this measure is to improve the ability of a PSO to observe marine mammals in safety zones during poor visibility (darkness or inclement weather), which would in turn result in shutdowns for a higher percentage of exposed animals and increased protection from injury (if effective).

Science, Support of Reduction of Impacts, and Likely Effectiveness: One FLIR system was tested by ION in summer of 2012. Monitoring results suggest that the system was fairly good at detecting animals on the ice (i.e., pinnipeds), but less useful at detecting animals in the water (Beland et al. 2013). In 2011, this technology was tested by industry for additional measures to improve detection capabilities but has not yet proven to be successful.

In 2010, Statoil tested the use of an infrared camera to detect marine mammals and found that the usable view was 280 degrees, with blows of large whales visible out to 2,000 m (6,562 ft) and smaller blows (porpoise) out to 500 m (1,640 ft) (NMFS 2011b). Its effectiveness is weather dependent, with fog and poor sea state hampering visibility (white caps caused false positives). However, NMFS encourages industry to continue testing the use of such technologies. George (1999) reports that the surface of bowheads' skin is roughly the same temperature as the surrounding water, so only the blow would be useful – and that would only be useful under conditions with very little wind or if the animal is relatively close the monitoring vessel. Smaller blows of beluga whales would not be detected at as great a distance as those of bowhead whales.

Discussions at the 2012 Open-water Meeting (March 6-8, 2012 in Anchorage, Alaska) suggest these devices can hamper near-source monitoring (the area of greatest radiated sound) because the PSO is attempting to observe more distant areas. Several methods have been attempted but none have been shown to be effective. Plus, the efficacy of these various pieces of equipment in detecting marine mammals would likely vary substantially under different sets of conditions and with the experience of PSOs in operating them.

History of Implementation: NMFS has previously issued a few IHAs that required the authorization holder to use and evaluate the effectiveness of FLIR but has not yet required it as a mitigation measure that assumes effectiveness.

Practicability: Can be expensive, and the technologies are still developing.

Recommendation: Infrared technologies appear to be continuing to improve. Because of the limitations to otherwise detecting marine mammals in low-light situations, companies should continue to test these technologies and target their use to augment other methods of detection, where practicable, especially on ice.

***Walrus* –** The effects of this additional mitigation measure on walrus would be the same as described for pinnipeds in Section 4.5.2.4.12.

***Polar Bears* –** This measure is designed to better protect marine mammals in the water, especially cetaceans, and may improve the capacity of observers to detect polar bears in the water. However, polar bears are rarely encountered in the open water where most seismic surveys would occur and they swim at the surface of the water so they are less likely to be exposed to loud seismic sounds. The USFWS has required the use of FLIR through the LOA process during in-ice seismic surveys to test its utility in identifying polar bears in water or on ice in low light and low visibility conditions. Polar bears are more likely to be encountered during in-ice seismic surveys. However, few seismic surveys occur in ice covered waters. As FLIR systems become better, this measure may have some utility in decreasing the potential for interactions with polar bears during in-ice seismic surveys.

Additional Mitigation Measure A3. Operators shall limit seismic airgun operations in situations of low visibility when the entire safety radius cannot be observed (e.g., nighttime or bad weather). These limitations could mean cease airgun operations entirely, reduce the time that operations are conducted in this limited visibility situation, or reduce the number of airguns operating so that the exclusion radius is entirely visible.

Applicable Activities: 2D/3D seismic including in-ice surveys, CSEM surveys, site clearance and high resolution shallow hazards surveys

Purpose: The purpose of this measure is to limit airgun operations when darkness or inclement weather hampers PSO observations of marine mammals in exclusion zones, thus reducing the likelihood that a marine mammal would enter the exclusion radius unobserved, which could potentially result in an injury if the animal were exposed to high sound levels over a period of time.

Science, Support of Reduction of Adverse Impacts, and Likelihood of Effectiveness: Although studies show that many marine mammals avoid close-approaches of seismic airguns (Richardson et al. 1999), studies also show that some subset of marine mammals have sometimes approached operating ariguns at distances that may be within the exclusion zone, and previous IHA monitoring reports indicate that marine mammals have occassionally been detected within the exclusion zone (Savarese et al. 2010, Haley et al. 2010a, b). Additionally, although the relationship is not entirely linear, studies suggest that marine mammals are also more likely to have a more severe behavioral response if exposed to higer levels such as those within the safety zone.

While implementing this additional measure may prevent some number of marine mammals from being exposed to higher sound levels for longer times, it may also result in seismic surveys taking longer, requiring multiple seasons, or requiring some operators to work during periods where marine mammals are more common or sensitive. If a survey effort is delayed because of poor visibility due to light or weather conditions, some vessels may have to maintain their position until conditions improve. While reducing some types, implementation of this measure could also increase other types of adverse effects to marine mammals.

History of Implementation: Because of the consideration of practicability in the mitigation requirements, measures of this sort have been applied differently in different situations. For example, nighttime operations have been prohibited entirely, prohibited unless accompanied be PAM detection capabailiities (or FLIR or other nighttime enhancing devices), or allowed (with no PAM or other device) as long as they were initiated when the entire safety radius was visible.

Practicability: In the beginning of the open water season (July/August), light conditions are usually sufficient to monitor a large area because the sun does not set. However, in the latter parts of the open water season (September to October), daylight is decreasing rapidly, which would reduce the amount of time for the activities. This measure would likely be expensive to implement and could cause logistical complications that affect survey completion.

Recommendation: As noted above, this measure could result in some protection of marine mammals from exposure to higher levels of sound, but could also potentially result in exposure to sounds over longer total periods of time or in periods of time of particular importance. Additionally, the continuing development of technologies to aid in the detection of marine mammals in low visibility influences how this measure can be implemented. The decision of how to best manage times of low visibility should be made on a case-by-case basis, and based on factors such as the total length of the survey, history of observations within the safety zone in the area, temporal and spatial habitat use of the area by the species being impacted, and whether supplemental equipment is available to assist with nighttime detections.

***Walrus* –** The effects of this additional mitigation measure on walrus would be the same as described for pinnipeds in Section 4.5.2.4.12.

***Polar Bears* –** The effects of this additional mitigation measure on polar bears would be the same as described for pinnipeds in Section 4.5.2.4.12.

Additional Mitigation Measure A4. Seismic operators shall use passive (or active) acoustic monitoring systems, in addition to visual monitoring, to detect marine mammals approaching or within the exclusion zone and trigger the shutdown of airguns.

Applicable Activities: 2D/3D seismic including in-ice surveys, CSEM surveys, site clearance and high resolution shallow hazards surveys

Purpose: The purpose of this mitigation measure is to improve the ability of a PSO to detect marine mammals within the safety zone in times of low visibility (e.g., darkness or inclement weather), thus ensuring shutdowns as appropriate and further minimizing their exposure to higher levels of sound potentially associated with injury or more severe behavioral responses

Science, Support of Reduction of Adverse Impacts, and Likelihood of Effectiveness: Three key components are necessary in order for a PAM system to be able to function as a mitigation aid by triggering the shutdown: detection, localization, and classification. Certain hardware and software are needed in order to support realtime localization, and a regional call library is needed to support species classification (lack of an extensive library can be offset by experienced PAM operators). Also, depending on the sound sources in use in the vicinity of the PAM, it may be challenging to sort out marine mammal vocalizations real-time.

The efficacy of real-time passive acoustic monitoring (PAM) in the Arctic depends on species, frequency and source level of calls, how often the marine mammals call, and choosing the right array and software to match these variables. PAM has been successful at detecting higher frequency clicks of toothed whales where the frequency is well above that of the seismic and tow ship. In the Arctic, most of the calls are low frequency calls, such as from bowheads, which overlap with the seismic sounds (NMFS 2011b – JASCO). Bearded seals often vocalize and can be detected during the spring-summer breeding season but other seals do not vocalize frequently and could be missed even if present. These technologies have the potential to improve the detection of marine mammals, particularly in such a large area where visual sightings are often limited. However, there are significant technical challenges for using this system from moving vessels with their own noise source within the frequency range of the bowhead whales. There has been success in detecting bowhead whale calls from long-term passive acoustic recording devices that are placed on the seafloor bottom for a certain amount of time. However, these devices are not monitored in real-time.

In the Gulf of Mexico, the industry has successfully utilized systems with hardware and software that allow for real-time detection, localization (PAMGUARD), and classification such that shutdowns can be implemented as a result of realtime detections. Monitoring reports for oil and gas vessels in the Gulf, as well as the R/V *Langseth* in different regions, show that PAM sometimes detects marine mammals that were not otherwise detected by visual observers. However, real time PAM was tried in the Arctic by ION in 2006 and Statoil in 2010 and was not found to be effective in detecting bowhead whales because the frequency range of bowhead vocalizations was the same as that of the ship engines. For this reason, unless the technology or methodology is improved, this method may be less effective in areas where bowhead is the target species.

PAM systems only work if an animal produces a sound that can be detected by the system. An active acoustic monitoring (AAM) system circumvents this limitation, as it can detect animals that are not producing sounds. To do so, however, requires introducing sound into the environment, which can cause behavioral disturbances. Additional limitations include only being able to detect a whale ≥7 m (23 ft in length) out to a distance of about 1 km (0.62 mi), difficulty detecting whales at depth when their lungs are collapsed and at the surface when there is interference from signal reflections off of surface waves. Use of AAM remains in the realm of research and development (Bingham 2011).

The Sound and Marine Life Joint Industry Programme (JIP) is currently funding ongoing research on the use of real-time acoustic identification of cetaceans and the use of active acoustics technologies for use in mitigation and monitoring marine mammals during offshore exploration activities (JIP 2009). The technology, although not yet proven in Arctic conditions, has the potential for future application, pending continued research and modifications.

History of Implementation: PAM has been previously required, in a few cases, by NMFS for real-time use with seismic surveys both in the Arctic and in other areas (Langseth), although it has been used to augment visual detections and not to directly trigger shutdowns. AAM has not previously been required with the use of seismic airguns, rather, only in combination with the use of the US Navy's tactical low frequency active sonar, and separately considered in situations where physical injury might occur (fisheries gear entanglement).

Practicability: As discussed at the 2012 Open-water Meeting (March 6-8, 2012 in Anchorage, Alaska;

University of Alaska 2011 seismic survey 90-day report: http://www.nmfs.noaa.gov/pr/pdfs/permits/uagi_90day_report2011.pdf, Statoil 2011 marine survey program 90-day report: http://www.nmfs.noaa.gov/pr/pdfs/permits/statoil_90day_report2011.pdf) these techniques have proven feasible, although in those two casesbut have not achieved the anticipated mitigation benefits.

Recommendation: For PAM, the decision of whether to require realtime use of PAM or AAM systems to trigger shutdown should be made on a case by case basis in consideration of the continuing development of PAM systems and their ability to detect bowhead whales during operation, the specific environment/habitat that the airguns are operating in and its importance to particular species, and the availability and cost of the necessary equipment. For AAM, until more is known about the potential added impacts on marine mammals of using AAM, we recommend not requiring its use with seismic airgun operation.

***Walrus* –** The effects of this additional mitigation measure on walrus would be the same as described for pinnipeds in Section 4.5.2.4.12.

***Polar Bears* –** The effects of this additional mitigation measure on polar bears would be the same as described for pinnipeds in Section 4.5.2.4.12.

Additional Mitigation Measure A5. Enhancement of monitoring protocols and mitigation shutdown zones to minimize impacts in specific biologic situations (e.g. expansion of shutdown zone to 120 dB or 160 dB when cow/calf groups and feeding or resting aggregations are detected, respectively).

Applicable Activities: Any activity that implements standard shutdown zones

Purpose: These additional measures were originally designed with the intent of detecting bowhead whales in feeding or social aggregations or with calves and then ceasing seismic airgun operations until the animals leave the area, potentially reducing the likelihood of interfering with cow/calf social interactions or incurring additional energetic costs during an important time period.

Science, Support of Reduction of Adverse Impacts, and Likelihood of Effectiveness: Disturbance that causes behavioral reactions that affect life functions, such as migration, feeding, and nurturing or parental care, can affect vital rates (e.g. survival and reproduction), which could, ultimately, lead to population level effects (NRC 2005). Disruption of cow-calf pairs, possibly through physical separation of dependent young from their mothers, or of feeding aggregations during late summer and fall when bowheads are building fat and energy reserves prior to migrating could, therefore, be considered effects with potential biological significance.

However, during the few times that these types of measures were implemented in the Beaufort Sea beginning in 2006, there were no shutdowns of operations, as bowhead whales have not been detected in the groupings that would trigger the implementation of these measures. In particular, the 120 dB zone is often so large (>20 km [12.4 mi] radius, 126-km circumference, and an area of 1256 km^2) from the source, monitoring this large of an area from one or two aircraft is ineffective, if not impossible. Although much smaller than the 120 dB zone, the average distance to the 160 dB sound level threshold can be >10 km (6.2 mi) (Table 4.5-11). The aircraft or additional monitoring vessels are sources of potential disturbance themselves, particularly when attempting to identify calves or feeding whales, when behavioral disturbance is more likely and potentially more biologically significant. If this measure has not been previously triggered during the necessary monitoring, then it did not reduce impacts to the species.

History of Implementation: Measures of this nature (specifically shutting down for 4 cow/calf pairs within the 120-dB isopleths, and shutting down for ro aggregations of feeding whales within the 160-dB isopleths) were required a couple of times in 2006 and 2007, but have not been required since.

Practicability: The 120 dB zone is often so large that monitoring by one or two aircraft is ineffective, if not impossible. Additionally, industry has often noted that implementation of this measure is not practicable, as they have serious concerns regarding the overall safety of conducting fixed-wing aircraft monitoring flights in the Arctic, especially in the Chukchi Sea, where the nearest landing field can be quite distant from the location of the source vessel.

Recommendation: The two examples of this type of measure cited above have been shown to not be effective and should not be considered further. However, there could be other specific measures of this nature (highlighting different biological situations) that could be proposed by the public during the MMPA process that could be worthy of case-by-case consideration.

Other Cetaceans – This additional measure was designed with the intent of detecting bowhead whales in aggregations or with calves and could indirectly affect other cetaceans in the vicinity of these groups. However, groupings that would trigger implementation of these measures have not been detected in the Beaufort Sea since this was first required in 2006. In addition, the 120 dB zone is often so large (>20 km [>12.4 mi]) from the source, monitoring this large of an area from one or two aircraft is extremely difficult, if not impossible. The aircraft or additional monitoring vessels are sources of potential disturbance themselves, particularly when attempting to identifying calves or feeding whales, when behavioral disturbance is more likely and potentially more biologically important. The effectiveness of this mitigation measure for reducing potential adverse impacts on other cetaceans is questionable, given the infrequency with which large groups occur. Refer to Section 4.5.2.4.9 for a more thorough description and analysis of the efficacy and practicability of this mitigation measure.

Ice Seals – This additional mitigation measure is oriented primarily at avoiding impacts on groups of whales. Ice seals in the vicinity of these whale groups may have some indirect reduction of adverse impacts if nearby seismic surveys are halted or delayed. However, this situation is similar to that described for Additional Mitigation Measure A3 in that overall seismic efforts could remain the same but be stretched out over time. The indirect effects of the measure on ice seals cannot be determined ahead of time nor is it likely they could ever be measured in the field. This measure could necessitate additional aerial and/or vessel surveys which may be costly and would be potential sources of disturbance themselves.

Walrus – The effects of this additional mitigation measure on walrus would be the same as described for ice seals in Section 4.5.2.4.12.

Polar Bears – The effects of this additional mitigation measure on polar bears would be the same as described for ice seals in Section 4.5.2.4.12.

Additional Mitigation Measure B1. Temporal/spatial limitations to minimize impacts in particular important habitats, including Kaktovik, Barrow Canyon, Hanna Shoal, the shelf break of the Beaufort Sea, Kasegaluk Lagoon, and Ledyard Bay. All, or a subset of, oil and gas activities would be limited (e.g., either completely prohibited, or the overall time reduced) in the areas specified here during the listed timeframes. 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 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 do not propagate into the area. In the event that a buffer zone of this size was impracticable, a buffer zone avoiding the ensonification of the important habitat above 180 dB could be used.

Applicable Activities: All activities that occur during the open-water season (i.e. 2D/3D seismic surveys including in-ice seismic, CSEM surveys, site clearance and high resolution shallow hazards surveys, and exploratory drilling activities, as well as all support vessels and minimum flight altitudes for aircraft activity)

Purpose: These mitigation areas are each designed to achieve one or both of the following purposes:1) to minimize the effects of acoustic disturbances on marine mammals by reducing either the *number* of individuals (in higher density areas) exposed to sound levels above certain thresholds or by reducing the duration or levels of sound that individuals are exposed to during times when they may be more susceptible to adverse impacts (such as when inter-species communication is especially critical or when they are utilizing a preferred habitat and the inability to do so as a result of temporary displacement could result in adverse energetic impacts), or 2) to avoid or minimize adverse impacts to subsitence uses of marine mammals. Table 4.5-21 outlines the proposed dates for these time/area closure locations, as well as the reasons for the proposed closures (i.e. minimize effects on marine mammals or to avoid or minimize adverse impacts to subsistence uses of marine mammals.

Table 4.5-21 Proposed Time/Area closure locations under Additional Mitigation Measure B1. This table identifies the species and subsistence hunts that would be mitigated by implementing these closures.

	Kaktovik	Barrow Canyon and the Western Beaufort Sea	Beaufort Sea Shelf Break	Hanna Shoal	Kasegaluk Lagoon and Ledyard Bay
Proposed closure period	August 25 - September 15	Mid-July - October	Mid-July - late September	September 15 - early October	Mid-June - mid-July for the Lagoon and July 1 – November 15 for the LBCHU
Bowhead Whale	Migrating and feeding: late August - October	Migrating and feeding: late August - October	Migrating: late August - October	Part of migratory corridor: September - October	Do not occur (migrate offshore)
Beluga Whale	Uncommon	Migrating and feeding: mid-July - late August	Feeding: mid-July - late September	Unknown	Feeding, molting, calving: June and July
Spotted Seal	Present	Present	Present	Present	Present; Some feeding habitat
Walrus	Not present	Not present	Not Present	Feeding: July - August	Resting habitat: Spring and early winter
Whaling Hunts	bowheads: late August - mid-September	bowheads: September - October	Uncommon	None	belugas: mid-June - mid-July in the Lagoon only
Sealing Hunts	Mostly October - June	Mostly November - January and spring	Uncommon	None	Mostly October - June

Science, Support of Reduction of Adverse Impacts, and Likelihood of Effectiveness:

Kaktovik: Data collected during ASAMM surveys in the Beaufort Sea from 2008-2011 noted feeding groups of bowhead whales in September most of those years (Clarke et al. 2011b, c, 2012). Additionally, hunters from Kaktovik traditionally conduct hunts in the nearshore waters from the community in the fall. Hunts typically begin in late August/early September and continue until mid- to late September, depending on upon migration patterns, weather and ice conditions, etc. Although subsistence seal hunts could occur yearround, they are most commonly conducted in this area from October-June. Closing the area to oil and gas activities during this time period would reduce adverse impacts, particularly those associated with noise disturbance (e.g. displacement and avoidance), on bowhead whales feeding, resting, or migrating through this area. Reducing impacts on concentrations of bowhead whales in an important feeding area could be energetically beneficial to the whales. Prohibiting activities in this area during the period of highest use by bowheads could result in a decreased intensity of effects during the closure period. Reduced adverse impacts on bowhead whales would, however, be limited to the closure area. Noise effects of activities occurring outside of this closure area could continue to impact bowhead whales in the vicinity that are either outside the closure zone or within the zone, but at a distance from the sound source within which behavioral reactions are still possible. However, the implementation of buffer zones around the closure area would help to reduce further impacts from occurring within this important location.

Barrow Canyon and Western Beaufort Sea: Due to sub-sea topography and the ocean currents, Barrow Canyon is one of the two primary concentration areas for bowhead whales in the Beaufort Sea, particularly as a staging/feeding area during the fall migration of bowheads out of the Beaufort Sea. Physical and oceanographic features of Barrow Canyon promote a bowhead whale feeding “hotspot” here during late-summer and fall. Bowhead whales congregate in the area to exploit dense prey concentrations (Ashjian et al. 2010, Moore et al. 2010, Okkonen et al. 2011). Barrow Canyon is also an important feeding area for beluga whales (Clarke et al. 2011b, 2011c, Moore et al. 2000). Time/Area closures for this area are to mitigate effects on bowhead whales (late August to early October), belugas (mid-July to late August), and the fall bowhead whale subsistence hunt out of Barrow (September 15 to close of the hunt). Barrow Canyon may also serve as feeding habitat for ringed, bearded, and ribbon seals. Subsistence seal hunts typically occur in this area from November-January and then again in the spring. Closing the area to oil and gas activities during these time periods would reduce adverse impacts, particularly those associated with noise disturbance (e.g. displacement and avoidance), on bowhead whales feeding, resting, or migrating through this area, as well as for belugas. Reducing impacts on concentrations of whales in an important feeding area could be energetically beneficial to the whales. Prohibiting activities in this area during the period of highest use by bowheads and belugas could result in a decreased intensity of effects during the closure period. Reduced adverse impacts on whales would, however, be limited to the closure area. Noise effects of activities occurring outside of this closure area could continue to impact whales in the vicinity that are either outside the closure zone or within the zone, but at a distance from the sound source within which behavioral reactions are still possible. However, the implementation of the buffer zones around the closure area would help to reduce further impacts from occurring within these biologically important areas.

Beaufort Sea Shelf: The shelf break of the Beaufort Sea is an important feeding habitat for beluga whales. Active leases in the Beaufort Sea are generally on the shelf, inshore of the shelf break; drilling activities would, therefore, not be impacted through this closure. Seismic activities and associated vessel traffic would be affected, thereby reducing potential adverse impacts on beluga whales, particularly those associated with noise disturbance. The time and location of reduced adverse impacts would be limited to the area defined by the shelf break. Implementing buffer zones around the closure area could further reduce impacts of noise on the closure area generated by activities occurring in areas adjacent to the closure.

Hanna Shoal: Hanna Shoal is an important feeding area for Pacific walrus (USGS 2011) and was historically important as a feeding area for gray whales (Moore et al. 2000, Nelson et al. 1994). Additionally, the area is used as part of the bowhead whale fall migratory corridor. Hanna Shoal is also known as an important feeding area for ice seals, especially bearded seals, since polynya systems typically develop there during winter months. These polynya systems then support higher numbers of ringed and bearded seals. Closure of Hanna Shoal is primarily to mitigate potential impacts on subsistence hunters during the fall bowhead whale hunt (September 15 to close of the hunt). Barrow and Wainwright conduct fall subsistence hunts for bowhead whales in the northeast Chukchi Sea where they could be impacted by vessels transiting between the coast and Hanna Shoal. Harvested whales are generally taken well inshore of Hanna Shoal (Ashjian et al. 2010). Closure of the area to all oil and gas exploration activities during September and October could reduce adverse effects of these activities, especially those associated with noise disturbance, such as displacement, on marine mammals migrating across the area. There are no leases within Hanna Shoal, therefore, there would be no impacts to drilling operations. However, the requirement to maintain a buffer zone around the area could reduce impacts from seismic surveys.

Kasegaluk Lagoon and Ledyard Bay: Kasegaluk Lagoon provides important habitat for beluga whales and spotted seals. Belugas of the eastern Chukchi Sea stock congregate in Kasegaluk Lagoon in June and July (Frost et al.1993, Huntington et al. 1999). Omalik Lagoon, south of Kasegaluk Lagoon, is also an important gathering area for belugas in June, except in years when there is heavy ice along the shore (Huntington et al. 1999). Kasegaluk Lagoon hosts the largest concentrations of spotted seals north of Point Hope, and, consequently, Ledyard Bay can be expected to be an important feeding area for spotted seals by virtue of its proximity to Kasegaluk Lagoon and its nearshore habitat. Subsistence seal hunts can occur in this area yearround but are most common from October to June. This closure area does not contain any lease areas, and leases in the Chukchi Sea occur dozens of miles away; therefore, actual on-lease seismic or drilling operations would not be affected by the closure. Off-lease seismic surveys and associated vessel and aircraft traffic would, except in emergency situations, be required to divert around the closure area. This could decrease disturbance effects of vessel activity within these important habitats and closure areas, while shifting vessel activity further offshore. The buffer zone would require all components of the activities to occur at least some distance from these locations.

History of Implementation: NMFS has consistently required a shutdown of activities in the Beaufort Sea in the vicinity of Kaktovik on August 25 until the close of the fall bowhead whale hunt by the community (as well as for the community of Nuiqsut conducting its fall bowhead hunt from Cross Island) in IHAs. Temporary cessation of activities near the other locations noted in this mitigation measure has not been required in the last few years and has never been included in IHAs for all of these areas. Shutdowns near Barrow have also been required in IHAs in the past to accommodate the fall bowhead whale hunt. Although never required in NMFS IHAs, BOEM and USFWS require cessation of oil and gas exploration activities from July 1 to November 15 in the LBCHU in G&G permits and LOAs, respectively.

Practicability: Avoidance of these time/area closure locations may be costly to industry, as many of the proposed closure periods occur at the same time as proposed industry operations. Moreover, federal lease sales within some of these proposed closure areas have already occurred, and companies have purchased leases in these areas. The Hanna Shoal time/area closure overlaps with ten lease blocks (four of which are completely inside the proposed time/area closure location and six of which are partially inside the proposed time/area closure location). However, some of these areas would be easier to avoid, such as Kasegaluk Lagoon and the LBCHU, since there are no active leases in that area.

Recommendation: At this time, it is difficult to weigh the costs and benefits of requiring this mitigation measure without more specific information, such as the proximity of the proposed activities to these proposed time/area closure locations. NMFS would aim to limit oil and gas exploration activities in these locations through the use of these time/area closures during times when marine mammals may be present to perform specific biologic life functions or during times when subsistence hunts occur when making decisions on individual MMPA ITA requests. However, we would need to weigh the practicability for implementation against the reduction of adverse impacts to marine mammals and subsistence uses of marine mammals on a case-by-case basis.

***Walrus* –** Additional Mitigation Measures B1 and B2 apply to all exploration activities that occur during open-water season. The important areas designated in this mitigation measure are primarily meant to protect whale habitat and to avoid conflicts with subsistence whaling. The reduction of exploration activity at the designated sites in the Beaufort Sea would have little mitigative value for walrus since they infrequently occur in those areas. However, Hanna Shoal is an important habitat for feeding walrus and any reduction in exploration activity in this area would reduce the potential for disturbance of walrus. This mitigation measure is not intended to reduce overall exploration activities so any reduction in impacts in one location and time could be displaced to another location and time and the total number of animals affected by exploration activities may not change with the implementation of this mitigation measure.

***Polar Bears* –** The important areas designated in this mitigation measure are primarily meant to protect whale habitat during open-water season and to avoid conflicts with subsistence whaling. This measure would theoretically reduce disturbance impacts on polar bears by reducing seismic activities but there would likely be very few bears affected to any extent by open-water seismic surveys even without these additional restrictions. The time/area closures could be important to polar bears when pack ice is present but not during the open-water season. It is therefore unlikely that this measure would appreciably reduce the potential effects of seismic surveys on polar bears.

Additional Mitigation Measure B2. 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). Require industry to organize a way to interact with one another to identify when and if duplicative surveys are likely to occur (survey type to gather same type of data within five years) and outline efforts to avoid or describe justification.

Applicable Activities: 2D/3D seismic surveys

Purpose: This measure is intended to reduce disturbance of marine mammals through the reduction in the total amount of sound energy put in the water by alleviating duplicative seismic operations that would collect data already collected by another source.

Science, Support for Reduction of Effects, Likely Effectiveness: There is no specific science to support this mitigation measure. Rather, it is reasonable to expect that preventing or minimizing repeated perturbations in specific areas could reduce avoidance behavior, potential hearing injuries, and other sensitivities resulting from multiple exposures to disturbances. By lessening or removing chronic effects in the environment, fish and marine mammal species would not be subjected to harassment in the same area on multiple occasions. It is not clear how much this measure would reduce overall effort, if at all, but would appear to only affect area-wide surveys on non-lease sale areas. There is the potential for this measure to reduce repeated disturbance to bowhead whales in a particular area. However, Alternative 2 (and the other action alternatives) has a specified level of exploration activity that could be authorized, even with restrictions. Both BOEM and industry representatives have suggested that it is unlikely that much duplication of effort is occurring, as it would not likely be a profitable endeavor.

History of Implementation: Neither NMFS nor BOEM have ever restricted activities in this manner. However, it is also unclear what degree of duplication (if any) is currently occurring.

Practicability: In order to implement this measure, it would be necessary to closely track existing and proposed surveys and the willingness of industry to share what may be considered proprietary information, which could potentially create business advantages for other companies. Legal issues would also likely prohibit implementation of this measure by BOEM or NMFS. NMFS is mandated to issue or not issue an ITA based on findings pursuant to the specific proposed action. Section 101(a)(5) of the MMPA does not allow NMFS to deny an ITA for a particular action prior to the case-specific analysis. BOEM does not have the authority under OCS Lands Act to impose such a restriction either.

Recommendation: Due to the lack of evidence that duplicative surveys are occurring, the logistical effort that would be needed by industry and the Federal Agencies to implement such a measure, and the fact that neither MMPA nor OCS Lands Act seem to allow for this type of restriction through thte sections contemplated in this EIS, this measure should not be considered further.

***Walrus* –** The effects of this additional mitigation measure on walrus would be the same as described for ice seals in Section 4.5.2.4.12. Additional Mitigation Measures B2 and B3 would impose further spatial restrictions on seismic surveys during open-water season. These measures would theoretically reduce disturbance impacts on walrus by reducing seismic activities but there would likely be few walrus affected to any extent by open-water seismic surveys even without these additional restrictions. The temporal/spatial restrictions on exploration activities in the Chukchi could appreciably reduce the potential effects of exploration on walrus at Hanna Shoal.

***Polar Bears* –** The effects of this additional mitigation measure on polar bears would be the same as described for ice seals in Section 4.5.2.4.12.

Additional Mitigation Measure B3. Separate seismic surveys are prohibited from operating within 145 km (90 mi) of one another.

Applicable Activities: 2D/3D seismic surveys, including in-ice surveys

Purpose: The intended purpose of this measure, as put forth by the public in comment letters, is to avoid creating a large ensonified area between two surveys through which marine mammals are reluctant to pass (potentially barring them from areas they need to get to, or imposing additional energetic costs) and/or impacts are intensified. The 145 km (90 mi) separation appears to be loosely based on avoiding the overlap of the 120-dB isopleths of two seismic arrays.

Science, Support for Reduction of Impacts, and Likelihood of Effectiveness: Currently, standard operational requirements for seismic arrays include a separation distance of 24 km (15 mi). There is no evidence to support the idea that widening this gap to 145 km (90 mi) will result in a reduction of impacts to marine mammals, either in number or severity. Although the body of literature is growing, there are limited field data clearly illustrating how marine mammals respond to single sound sources, far less information indicating how marine mammals would likely respond when exposed to multiple sound sources simultaneously, and none that we are aware of comparing responses to different configurations of multiple concurrent sound sources. Separating seismic surveys by farther distances decreases the overlap of ensonified space, increasing the total ensonified area, and potentially the likely effects.

History of Implementation: This measure has not previously been required by NMFS or BOEM.

Practicability: In the Arctic, the Beaufort lease areas cover an area that is about 240 km (149 mi) from east to west and about out to 80 km (50 mi) off shore. The Chucki leases cover an area that is about 240 km (149 mi) east to west and 80 km (50 mi) north to south. Due to available open water and subsistence limitations, almost all seismic surveys conducted in the Arctic will overlap in time to some degree. Separating two concurrent surveys within either the Beaufort or the Chukchi creates serious logistical issues. Separating more than two surveys in this manner would be nearly impossible.

Recommendation: Due to the lack of any evidence supporting that this measure will result in a reduction of adverse impacts, this measure should be removed from future consideration.

***Walrus* –** The effects of this additional mitigation measure on walrus would be the same as described for ice seals in Section 4.5.2.4.12.

Polar Bears – The effects of this additional mitigation measure on polar bears would be the same as described for ice seals in Section 4.5.2.4.12.

Additional Mitigation Measure C1. Vessel and aircraft avoidance (by 0.8 km [0.5 miles]) of concentrations of groups of ice seals.

Applicable Activities: All activities that occur during the open-water season (i.e. 2D/3D seismic surveys including in-ice seismic, CSEM surveys, site clearance and high resolution shallow hazards surveys, and exploratory drilling activities)

Purpose: To increase the distance between oil and gas related vessel and aircraft operations and marine mammals therefore decreasing the likelihood of causing disturbance or energetic stress to the marine mammals; to decrease the potential for collisions with marine mammals; and to decrease the likelihood of separating marine mammals that are resting or traveling in close proximity.

Science, Support for Reduction of Impacts, and Likelihood of Effectiveness: Numerous studies have indicated an inverse relationship between distance to a vessel/ aircraft and the likelihood that ice seals, walrus or polar bears will be stressed or disturbed by the vessel/ aircraft (see Brueggeman et al. 1989, 1990, 1991, Salter 1972, Anderson and Aars 2008, Amstrup 1993 and others). Additional studies have indicated that reducing speed, avoiding separating conspecifics and giving a wide berth to marine mammals decreases the potential for collisions (see Silber et al. 2010, Thompson et al. 2010, Weinrich et al. 2010, and others).

This measure would require all vessels to slow down, steer around if possible, and not approach ice seals within 0.8 km (0.5 mi). It is not clear how much practical effect this would have on ice seals even if it is assumed that similar requirements would apply as they do for walrus groups in USFWS LOAs. Ice seals are difficult to see at 0.8 km (0.5 mi) under many weather/sea conditions and they can swim much faster than most exploration vessels so there may be very few cases when a vessel might detect and then successfully maintain a 0.8 km (0.5 mi) safety buffer approaching groups of ice seals. In addition, the great majority of seals observed during aerial surveys in the Chukchi Sea have been single animals rather than recognizable groups (Thomas et al. 2010). This measure may marginally reduce disturbance for ice seals but would probably only be effective for faster vessels if they had PSOs on board.

History of Implementation: This measure has been included pursuant to USFWS LOAs but not previously by NMFS.

Practicability: Not likely difficult to implement. These measures have been required through the USFWS LOA process for a number of years, and operators appear to be following them.

Recommendation: Based on likely reduction in adverse impacts and apparent ease of implementation, this measure should become standard.

Walrus – Additional Mitigation Measure C1 is intended to provide extra protection for groups of ice seals. All of the elements relating to walrus are identical to what would be required under a USFWS LOA so this measure would make no practical difference to walrus.

Polar Bears – Additional Mitigation Measure C1 is intended to provide extra protection for groups of ice seals. All of the elements relating to polar bears are identical to what would be required under a USFWS LOA so this measure would make no practical difference to polar bears.

Additional Mitigation Measure C2. Specified shipping or transit routes to avoid important habitat in areas where marine mammals may occur in high densities.

Applicable Activities: All involving vessel use

Purpose: To minimize the potential for disturbance impacts from repeated overflights or vessel trips when multiple back and forth trips are required to complete operations.

Science, Support for Reduction of Impacts, and Likelihood of Effectiveness: Slowing vessel speeds and using standard shipping lanes and flight paths is a long established method used to decrease the spatial footprint of activities, in this case, to avoid impacting marine mammal concentration areas such as established pinniped haul outs; see Salter 1972, Gales et al 2003, Laist et al 2001, Marine Mammal Commission Report to Congress 2007, Kruse 1997, Lawler 2005, Maier 1998 and others. These designated shipping routes would likely focus on avoiding some of the areas identified above as important for bowheads, belugas, and subsistence hunting. Of note, five Alaska Native Organizations recently came together to form the Arctic Marine Mammal Coalition, which concluded that, unless effectively managed, increasing ship traffic in Arctic waters has the potential to have adverse impacts on marine mammals and their subsistence uses.

This measure would require exploration vessels to use unspecified designated shipping lanes while in transit to avoid concentrations of marine mammals. A designated route could result in decreased disturbance to animals in those important habitats. However, as seismic activities often cover wide regions, particularly for the 2D non-lease sale areas, designated transit routes may be difficult to establish. As long as routes are the same year to year, it would potentially be easier for vessels to avoid these areas, although it may result in increased transit time for some.

Practicability: This mitigation measure is likely feasible; it has been successfully implemented for similar operations (for example, Northstar resupply trips). However, clear proposed routes have not been identified and additionally, less routine activities, such as new seasonal drilling or seismic operations will require further explanation as to how standard routes would be implemented.

Recommendation: This sort of mitigation measure is well-supported by current scientific literature, and specific transit routes have been successfully implemented without apparent conflicts with safe operations in the past. However, because these areas have not been clearly delineated, it will be important to evaluate them on a case by case basis before requiring.

***Walrus* –** This additional mitigation measure requires shipping routes to avoid high densities of marine mammals, including walrus. This measure is also identical to what would be required under a USFWS LOA to protect groups of walrus.

***Polar Bears* –** Additional Mitigation Measure C2 requires shipping routes to avoid high densities of marine mammals. Because polar bears typically do not occur in "concentrations" in open water, it is not apparent that this measure would have any practicable effect on polar bears.

Additional Mitigation Measure C3. 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.

Applicable Activities: Exploratory drilling activities

Purpose: To decrease potential impacts to marine mammals, and marine mammal prey species through habitat degradation. For example, benthic prey species in the immediate vicinity of a drill site could be smothered or crushed by cuttings, affected by increased suspended sediments, salinity or temperature. The spatial scale and duration of effects would depend upon the depth of the well, amount of discharges and dispersion rates (Section 4.5.1.5.1 and 4.5.2.1) but would likely be small, for example, the extent of the depositional footprint from a previous drill site in the Beaufort Sea was on the order of 30 m (98 ft).

This mitigation measure would also mitigate adverse impacts to subsistence uses and hunts of marine mammals, as discharges raise concerns by Native hunters of food tainting and a reduced willingness to eat animals that have been exposed to oil and gas exploration activity discharges.

Science, Support for Reduction of Impacts, and Likely Effectiveness: See analysis in Section 4.5.1.5.1 and 4.5.2.1 of the EIS. BOEM studies to date in the Chukchi Sea and Beaufort Sea of past exploration wells indicate some increases in contaminants from cuttings in some cases, impacts to benthic invertebrates, fish larvae, fish eggs and possibly other lower trophic organisms in the immediate well site vicinity are likely in the short term. To date, this loss of prey and prey habitat has been limited to relatively small areas and has not been linked to decreases in benthic feeding mammals, such as walrus, bearded seals, or gray whales. Additionally, it is unclear whether moving the cuttings to another area may create a problem there.

History of Implementation: Shell voluntarily included this measure in their proposed action in the Beaufort Sea in 2012; however, neither NMFS nor BOEM have otherwise required this measure previously.

Practicability: This measure is expensive to implement. However, in the Beaufort Sea, Shell voluntarily included this measure during the 2012 season, indicating that it may be practicable in some instances.

Recommendation: Recommend further study and evaluation before large scale implementation. Since two exploration drilling operations were conducted in 2012, only one of which removed cuttings, this presents a good opportunity to conduct follow up studies at both sites. No exploratory drilling programs are proposed for the 2013 open water season.

***Walrus* –** This additional mitigation measure reduces discharge of potentially harmful substances. This measure would require reduced discharges of various waste streams from exploration vessels, drilling rigs, and facilities. No reduction levels are specified but, to the extent that any substances with potentially adverse effects on walrus or their prey could be kept out of the marine environment, this measure could reduce adverse effects on walrus by reducing the risk of injury/mortality and habitat changes.

***Polar Bears* –**

This additional mitigation measure reduces discharge of potentially harmful substances. This measure would require reduced discharges of various waste streams from exploration vessels, drilling rigs, and facilities. No reduction levels are specified but, to the extent that any substances with potentially adverse effects on polar bears or their prey could be kept out of the marine environment, this measure could reduce adverse effects on polar bears by reducing the risk of injury/mortality and habitat changes.

Additional Mitigation Measure C4. Operators are required to recycle drilling muds.

Applicable Activities: Exploratory drilling

Purpose: Reduce contaminant waste streams into the environment and potential impacts to habitat and benthic prey

Science, Support for Reduction of Impacts, and Likely Effectiveness*:* See analysis in Section 4.5.1.5.1 and 4.5.2.1 of the EIS, and Boesch and Rabelais 1987, Neff 2002, Neff 2008, Cranford et al 1999, and others. Although water based drilling muds currently used are less toxic than earlier industry standards, scientific research continues to evaluate the long term effects at drill sites of muds, cuttings and other discharges. These measures would be expected to result in potentially reduced impacts on food sources and habitat of bowhead whales on a localized scale where the discharge activity may occur. The level at which these additional mitigation measures would reduce impacts to bowhead whales is, however, unknown (extent would be dependent on volume of discharge). Also of note, this measure removes one source of potential impacts from the waste stream; however, particulate matter from cuttings may have a higher impact (disruption of feeding, respiration or burial), see Hyland et al. (2003).

History of Implementation: This measure has not previously been required by BOEM or NMFS.

Practicability: Operators could incur additional costs with implementation of this measure; however, companies typically already attempt to re-use drilling muds to the degree possible.

Recommendation: This measure is already mostly standard for industry operators, but could be reinforced through inclusion in MMPA authorizations.

***Walrus* –** This additional mitigation measure requires recycling of drilling muds and other waste reduction measures and is very similar to Additional C3. To the extent that any substances with potentially adverse effects on walrus or their prey could be kept out of the marine environment, this measure could reduce adverse effects on walrus by reducing the risk of injury/mortality and habitat changes.

***Polar Bears* –** Additional Mitigation Measure C4 requires recycling of drilling muds and other waste reduction measures. This mitigation measure is very similar to Additional Mitigation Measure C3. To the extent that any substances with potentially adverse effects on polar bears or their prey could be kept out of the marine environment, this measure could reduce adverse effects.

Additional Mitigation Measure C5. Use trained seal-lair sniffing dogs for areas with water deeper than 3 m (9.8 ft) depth contour to locate seal structures under snow in the work area and camp site before initiation of activities. Seal lairs are to be avoided by a distance of 152 m (500 ft).

Applicable Activities: On-ice seismic surveys

Purpose: The purpose of this measure is to avoid disturbance or injury of ice seals.

Science, Support for Reduction of Impacts, and Likely Effectiveness*:* Use of trained dogs greatly improves the ability to detect ice seals under the snow and ice. It is not clear how many seals may be affected but this measure would definitely reduce the risk of disturbing/injuring ice seals in their lairs from close distances. If proposed on-ice surveys were in known ice seal concentration areas, this measure could reduce disturbance impacts for substantial numbers of seals.

Practicability: The logistics of securing the services of trained dogs and their handlers should be fairly straightforward as this technique has been in use for decades. However, there are a limited number of dogs that are trained specifically for these purposes. Therefore, it might be difficult to implement if there are no dogs available that are well enough trained to be used.

History of Implementation: NMFS has required this measure in past IHAs issued for on-ice seismic surveys in the Beaufort Sea.

Recommendation: This measure should likely be included as a standard measure in IHAs.

Additional Mitigation Measure C6. Use trained seal-lair sniffing dogs to survey the ice road and establish a route where no seal structures are present.

Applicable Activities: On-ice seismic surveys

Purpose: The purpose of this measure is to avoid disturbance or injury of ice seals.

Science, Support for Reduction of Impacts, and Likely Effectiveness*:* Use of trained dogs greatly improves the ability to detect ice seals under the snow and ice. It is not clear how many seals may be affected but this measure would definitely reduce the risk of disturbing/injuring ice seals in their lairs from close distances. If proposed on-ice surveys were in known ice seal concentration areas, this measure could reduce disturbance impacts for substantial numbers of seals.

Practicability: The logistics of securing the services of trained dogs and their handlers should be fairly straightforward as this technique has been in use for decades. However, there are a limited number of dogs that are trained specifically for these purposes. Therefore, it might be difficult to implement if there are no dogs available that are well enough trained to be used.

History of Implementation: NMFS has required this measure in past IHAs issued for on-ice seismic surveys in the Beaufort Sea.

Recommendation: This measure should likely be included as a standard measure in IHAs.

4.5.2.4.16.1 Additional Mitigation Measures Summary for Marine Mammals

Additional mitigation measures that may possibly be incorporated into future authorizations and that could mitigate potential adverse impacts on marine mammals are discussed above. Efficacy and practicability of these measures are discussed to the extent possible, given the varying degrees of current availability and use. The information and analyses provided here will serve as tools in NMFS' and BOEM's future MMPA and OCS Lands Act decision-making regarding whether to require these measures pursuant to specific projects.

A few of the measures, such as sound source verification, have been implemented in recent years. Others, such as acoustic and imaging technologies to enhance detectability of marine mammals during poor visibility conditions have been used with limited success for mitigation and monitoring but still need improvement. Augmenting visual observations by PSOs with acoustic detection could improve detectability of marine mammals at sufficient distances to avoid disturbance and auditory injury at a higher rate than is possible with visual observations alone—once the technology is available and effective for use in Arctic waters. Measures to mitigate impacts to subsistence harvests through time/area closures or to reduce or eliminate discharges would reduce adverse effects to bowhead whales and their habitat, respectively.

Most of the additional mitigation measures considered in this section would have very limited potential to reduce adverse effects on polar bears and ice seals except for Additional Measures C5 and C6. These measures could improve detection of seal lairs on ice and therefore reduce the risk of injury or mortality from on-ice surveys. The temporal/spatial restrictions on exploration activities in the Hanna Shoal area could reduce adverse impacts to Pacific walrus, especially at times when the ice pack was nearby. However, given the mitigation measures that would be required by USFWS LOAs and the standard and additional mitigation measures required by NMFS, the effects on Pacific walrus would still likely be low in magnitude, distributed over a wide geographic area, and temporary in duration.

4.5.2.5 Terrestrial Mammals

There are approximately 30 species of terrestrial mammals within the vicinity of the EIS project area (Table 3.2-5). Based on the proposed action for this EIS, only caribou are expected to be potentially affected during critical periods of their life cycle; therefore, this analysis will focus only on caribou. Four caribou herds utilize habitats along Alaska's Arctic coast: the Western Arctic; the Porcupine; the Central Arctic; and the Teshekpuk herds (ADFG 2010a). Please refer to Section 3.2.5.1 for information regarding caribou distribution, abundance, reproduction, and life history.

The oil and gas exploration activities proposed in Alternative 2 that could affect caribou is one exploratory drilling program in the Beaufort Sea and one exploratory drilling program in the Chukchi Sea per year, as they require aircraft support for crew changes. Aircraft fly overs in support of exploration activities could result in disturbance to caribou while occupying preferred habitats or following preferred migration routes. The other possible effects that may occur as a result of oil and gas exploration would be disturbances caused by additional human activities (air or ground) in the EIS project area, due to the overall increase in human population due to support crews living in the North Slope area.

4.5.2.5.1 Direct and Indirect Effects

Behavioral Disturbance

Aircraft used for crew changes can either be helicopters or fixed wing aircraft. Caribou respond to flyovers and nearby landings in a variety of ways depending on the degree of their habituation, weather conditions, sex and age composition of the herd, and the aircraft itself (Calef et al. 1976, Horejsi 1981). The type of aircraft, altitude, airspeed and frequency of flyovers all play a role on the caribou's reaction. Disturbance of caribou is an important consideration because it can cause immediate physical injury or death by animals fleeing the disturbance, can result in increased expenditures of energy, or changes in the physiological condition of the animals, which reduces their rates of survival and reproduction, and can result in long-term changes in behavior, especially the traditional us of calving areas and insect relief areas (Calef et al. 1976). There is a higher likelihood of a behavioral disturbance along the Beaufort Sea coast where the Central and Teshekpuk herds use the area for calving and insect relief. There are no habitats along the Chukchi Sea that are recognized as caribou calving habitat; however, the Western Arctic Herd uses coastal areas and alpine ridges in the Brooks Range for insect relief.

Injury and Mortality

Another anticipated effect of oil and gas exploration is an increase in vehicle traffic from support crews. Vehicle strikes could also cause injury to caribou or even mortality.

There is the potential for terrestrial mammals to be exposed to small, accidental fuel spills of less than 50 bbl (see Section 4.2.7). Small fuel spills, discharges, and any air/water quality effects would be extremely small, if detectable at all, along the Alaskan coast, and vessel traffic will be far offshore, preventing any noise or other activities from having effects on terrestrial mammal resources. Therefore, negligible effects are anticipated for terrestrial mammals from small fuel spills.

Habitat Alterations

It is possible that road construction, as well as pipeline construction, will not only destroy vegetation within the footprint of the road but could also result in a reduction of habitat use within the adjacent areas. Cameron et al. (1992) found that calving caribou were displaced outward after construction of the Milne Point road system, resulting in underutilization of habitats adjacent to roads and overutilization elsewhere effectively diminishing the capacity of the area to support caribou.

4.5.2.5.2 Conclusion

The direct and indirect effect of oil and gas exploration activities on caribou resulting from implementation of Alternative 2 would be medium intensity, temporary to long term duration, local extent, and the context would be common. Therefore, the summary impact level of Alternative 2 on caribou would be considered minor.

4.5.2.6 Time/Area Closure Locations

The analysis of the direct and indirect effects associated with time/area closures can be found in Sections 4.5.2.4 (Marine Mammals), 4.5.2.3 (Marine and Coastal Birds) and 4.5.3.2 (Subsistence).

4.5.2.7 Mitigation Measures for the Biological Environment—Non-Marine Mammal Resources

Standard Mitigation Measures are outlined in Section 2.4.10 and Additional Mitigation Measures are outlined in Section 2.4.11, and both are described in detail in Appendix A. Requirements for implementation depend on type, time, and location of activities and co-occurrence of multiple activities. A combination of mitigation measures could be required for any one ITA. While the ultimate goal of the mitigation measures is to reduce impacts to marine mammals or subsistence hunts of marine mammals, there is the potential for some reduction of impacts to other biological resources. These standard and additional mitigation measures are evaluated within the context of those more targeted resources (i.e. marine mammals and subsistence uses) and are not repeated here.

4.5.3 Social Environment

4.5.3.1 Socioeconomics

The following discussion of direct and indirect effects of Alternative 2 evaluates effects on public revenues and expenditures, employment and personal income, demographic characteristics, and demand on social organizations and institutions.

The level of impacts on socioeconomics will be based on levels of intensity, duration, geographic extent, and context, identified in Table 4.4-1 (Alternative 1).

4.5.3.1.1 Direct and Indirect Effects

Public Revenue and Expenditures

Under Alternative 2, the following are categories of revenue generation (under the current tax system):

> **Federal Revenue**: None. Federal lease payments were already made in advance of the proposed activities. The likelihood of exploration resulting in production cannot be predicted, but the potential for generating future revenue would not be foregone under this alternative.
>
> **State Revenue**: None. Lease payments were already generated in advance of the proposed activities; there are no facilities proposed that would generate property tax; and no production activity that would generate production revenue or corporate income tax. The likelihood of exploration resulting in production cannot be predicted, but the potential for generating future revenue would not be foregone under this alternative.
>
> **Local Revenue**: Sales or Special Taxes would be generated from the purchase of goods and services in the communities where crew and support services are stationed. No new property taxes would be generated other than potential rental fees. A general economic contribution related to the purchase of goods and services, aside from taxes and employment, would occur in all communities that serve some staging purpose.

A detailed list of communities that could receive local revenue from the proposed action alternatives can be found in Table 4.5-22. Table 3.3-1 lists costal communities’ tax regimes. Only cities with sales or special (bed, tobacco, alcohol, or gaming) taxes would generate local revenue from the stationing of crew, support, logistics, or supplies for survey/exploration vessels. This includes Barrow, Nome, and Unalaska/Dutch Harbor.

Table 4.5-22 Potential Revenue Sources Under Alternative 2

Alternative 2 (Activity Level 1)	Support/Crew Changes[1]	Owner	New Public Revenue from Services[2]
Up to four 2D/3D seismic surveys in the Beaufort Sea per year including One in-ice towed-streamer 2D (using icebreaker)	West Dock or Oliktok Dock near Prudhoe. Air support out of Prudhoe or Barrow.	Up to 3 in federal waters; one survey in state waters (nearshore)	Prudhoe Bay & **Barrow**
Up to three 2D/3D seismic surveys in the Chukchi Sea per year including One in-ice towed-streamer 2D (using icebreaker)	Nome or possibly Barrow & Wainwright	Federal waters, not associated with leases	**Nome** or **Barrow** & Wainwright
Up to three site clearance and high resolution shallow hazards survey programs in the Beaufort	West Dock or Oliktok only once per year	Federal & state active leases	Prudhoe Bay
Up to three site clearance and high resolution shallow hazards survey programs in the Chukchi per year	Wainwright or Nome only once per year	Federal active leases	Wainwright or **Nome**
One exploratory drilling program in the Beaufort per year	Unalaska/Dutch Harbor then Prudhoe Bay. Helicopter resupply and marine monitoring from Barrow	Federal active leases; drilling in state leases from land	**Unalaska/Dutch Harbor**, Prudhoe Bay & **Barrow**
One exploratory drilling program in the Chukchi per year	Unalaska/Dutch Harbor then Wainwright. Helicopter resupply and marine monitoring from Wainwright or Barrow	Federal active leases	**Unalaska/Dutch Harbor**, Wainwright & **Barrow**

Notes:

1) Search & Rescue is coordinated by the Coast Guard and the nearest vessels are deployed. Typically, resources are available out of Barrow and Deadhorse. Coast Guard does not typically reimburse for the cost of these efforts (Majors 2011).
2) Communities that implement sales or special taxes are in **bold**; these communities could capture revenue associated with goods and services.

The establishment of Communications Centers (Com Centers) could generate a small amount of property tax revenue for the City or Borough if it resulted in construction of new facilities. The Com Centers are associated with Standard Mitigation D2:

- D2 – Establishment and utilization of Communication Centers in subsistence communities to address potential interference with marine mammal hunts on a real-time basis throughout the season.

Employment & Personal Income

Under Alternative 2, there would be a limited number of (direct) new local hire employment opportunities associated with the standard mitigation measure D2, associated with jobs:

- A3 – Protected Species Observers (PSOs) required on all seismic source vessels, ice breakers, and support (chase) vessels when required.
- A6 – PSOs required on all drill ships and ice management vessels.

The standard mitigation measures could create a limited number of (direct) new local hire employment opportunities associated with the PSO program, Subsistence Advisor (SA) program, Com Centers program, and Oil Spill Response (see Section 2.3.4 for more details). Employment activities associated with crew positions on vessels and the administration of the seismic, drilling, and survey activities are very specialized and would likely draw from a pool of workers statewide or the Lower 48. All new employment opportunities would draw regionally or nationally for qualified individuals. Table 4.5-23 outlines communities that may see larger numbers of local hire opportunities.

Table 4.5-23 Employment Opportunities Associated with the Standard Mitigation Measures

Required Standard Mitigation	Details	Communities Likely to Experience Higher Employment and New Revenue from Support Services
Protected Species Observers	Details on maximum seasonal part-time employment in Table 4.5-24	Prudhoe Bay, Barrow, Kaktovik, Nuiqsut, Wainwright
Oil Spill Response	Use of Village Response Team members trained in Hazwoper	Seasonal employment opportunities in all coastal villages
Subsistence Advisors	Not available	Prudhoe Bay, Barrow, Kaktovik, Nuiqsut, Wainwright
Communications Center	Staff hired to man radio transmissions from survey vessels, aircraft, and whaling crews in subsistence communities. Unclear whether collaboration between Plan holders would occur.	Seasonal employment opportunities in all coastal villages

Notes: Details about the required standard mitigation measures can be found in Chapter 2.

IHAs require biologically-trained, on-site individuals to be onboard vessels approved in advance by NMFS. Table 4.5-24 demonstrates a hypothetical quantity of PSOs hired under Alternative 2. The total workforce in the NSB, NAB and City of Nome is 12,461. Therefore, the maximum number of new seasonal, part-time positions (200) would represent less than two percent of new employment opportunities. Approximately half of the observers employed seasonally in the Arctic today are local hire, so it is more likely that around 100 new seasonal, part-time positions would be created.

Table 4.5-24 Maximum PSO Positions Under Alternative 2[1]

	Alternative 2 (Annual Activity Level 1)	Vessels Deployed (PSOs required)[2]	Aerial Observers	PSOs/survey	Total PSOs
Beaufort Sea	**Four 2D/3D seismic surveys**	Source (5) 2 chase/monitoring and/or icebreaker (3 each)	4	15	60
	Three site clearance and high resolution shallow hazards survey programs	Source (5)	4	9	27
	One exploratory drilling program	Drilling rig (5) 2 ice management (3 each) 3 other various (2 each)	4	21	21
Chukchi Sea	**Three 2D/3D seismic**	See Beaufort examples	4	15	45
	Three site clearance and high resolution shallow hazards survey programs		4	9	27
	One exploratory drilling		4	21	21
			TOTAL per year	**88**	**201**

	Alternative 2 (Annual Activity Level 1)	Vessels Deployed (PSOs required)[2]	Aerial Observers	PSOs/survey	Total PSOs

Notes:

1) Assumes all positions are unique; one PSO would not be hired for multiple surveys.
2) Numbers based on (Funk 2011) and (NMFS 2009 IHA permit)

Aside from the positions described in the mitigation measures, it is unclear whether direct full-time employment benefits would materialize locally from the Action Alternatives. Companies like Shell and BPXA have committed to hiring local residents. Historically, few village residents have been employed despite industries' efforts of training programs and recruitment (MMS 2002). The NSB is actively advocating for the employment of Iñupiat people, but still sees room for improvement by the industry to train unskilled laborers (MMS 2002).

In general, employment and associated personal income increases would be at a relatively low level in exploration; they usually peak during development activities (MMS 2007a). The indirect employment opportunities associated with Alternative 2 are shore-based, including: transport of equipment, room and board of survey/seismic crews, and administration of permits to conduct the surveys. Native Corporations and private entities may capitalize on these opportunities.

Demographic Characteristics

Alternative 2 would not have a direct or indirect contribution to demographics in the EIS project area communities. The seismic, site clearance, on-ice, and exploratory drilling activities are seasonal and short-term in nature. If workers associated with the surveys and programs do not already live in the EIS project area, they would not relocate permanently.

Social Organizations & Institutions

The implementation of Alternative 2 would result in relatively small revenues to Municipal Governments, primarily in sales and special taxes, and employment and service contracts with Regional and Village Corporations. In the communities where crew changes occur or vessels are based, there could be short-term, seasonal demand on institutions and social services for Barrow, Wainwright, Nome and Unalaska/Dutch Harbor.

If a deflection or disturbance of subsistence resources occurs as a result of Alternative 2 (see Section 4.4.3.2), the activities of non-profit organizations (see Table 3.3-6 in Section 3) could be impacted in order to coordinate adaptive strategies regarding potential economic and social implications of reduced harvest of subsistence resources. The Conflict Avoidance Agreement (CAA), Communication Centers, and Plans of Cooperation (POC) are mechanisms currently used for communication, cooperation, and conflict avoidance between industry and local groups like the AEWC. These are described more in Section 2.3.4 and evaluated in Chapter 5.

4.5.3.1.2 Conclusion

Based on the criteria identified in Table 4.4-1 (under Alternative 1), the magnitude of the socioeconomic impact is positive, but low, because total personal income and local employment rates are not increased by more than five percent. Revenues to the NSB would also not exceed five percent of their annual operating budgets. Standard mitigation measures could reduce interference between industry and subsistence activities and associated social impacts.

The duration of the socioeconomic impacts is temporary because it is not year-round. However, the activity is scheduled to occur over a fixed number of years. The positive economic impacts of the activity are statewide and even national. The context of the socioeconomic impacts is unique because the people that would experience the flow of workers and research vessels are predominantly Iñupiat. The summary impact level for Socioeconomics under Alternative 2 is minor.

4.5.3.2 Subsistence

4.5.3.2.1 Direct and Indirect Effects

The level of impacts on subsistence resources will be based on levels of intensity, duration, geographic extent, and context, as shown in Table 4.5-25.

Table 4.5-25 Impact Levels for Effects on Subsistence

Impact Component	Effects Summary		
Magnitude or Intensity	**Low**: No noticeable impact to subsistence use patterns	**Medium**: Minimal spatiotemporal overlap of activities with subsistence hunts; effects able to be mitigated	**High**: Large-scale overlap of activities with subsistence hunts; adverse effects on success of hunts
Duration	**Temporary**: Effects last only a few days; hunters able to obtain species within a few days after impact	**Interim**: Effects last a few weeks to a month; hunters have to wait 1-2 weeks before can attempt hunts again	**Long-term**: Effects last at least an entire hunting season; hunters may not be successful that season for a given species
Geographic Extent	**Local**: Effects realized by a single community	**Regional**: Effects realized by two or more communities	**State-wide**: Effects realized throughout the EIS project area and may extend beyond the EIS project area
Context	**Common**: Affects only locally abundant subsistence resources or little changes in harvest and sharing practices	**Important**: Affects subsistence resources/ access/ or harvest and sharing practices within the region	**Unique**: Affects subsistence resources/ access/ or harvest and sharing practices beyond the region

As a result of activities under Alternative 2, disturbance and displacement of subsistence resources could occur and would be considered a direct impact from the activities. The following sources of disturbance may result in displacement of resources or changes in behavior such that the subsistence resources move away from coastal waters and become less readily available to subsistence hunters:

- Offshore noise from seismic and high resolution shallow hazard surveys and exploratory drilling;
- Offshore and nearshore noise from helicopter and fixed wing aircraft overflights;
- Increased levels of vessel traffic (including their noise contribution) associated with activities offshore and while transiting through nearshore areas;
- Ice management and icebreaking activities;
- Noise and vehicle movement from on-ice seismic surveys; and
- Permitted discharges.

These sources of disturbance have distinct characteristics in their effects on marine mammal and other important subsistence resource species. In the next six sections, the literature on each of these types of disturbance is reviewed in relation to the distinctive impacts on particular species. Traditional knowledge observations from subsistence users and communities are offered alongside the summary from the scientific literature. This review forms the foundation for analysis in later sections of the intensity, duration, extent, and context for estimated impacts to subsistence uses of the major species.

Table 4.5-26 describes the different subsistence hunts that occur within the EIS project area by resource, where these subsistence hunts occur, the seasons of occurrence and the potential for overlapping with proposed activities of Alternatives 2 through 6. Detailed information regarding the seasonal cycles of subsistence resources and harvest patterns is described in Section 3.3.2.

Table 4.5-26 Description of Subsistence Hunts by Resource

Community	Bowhead whales	Beluga Whales	Seals	Walrus	Polar Bear	Fish	Marine and Coastal Birds	Caribou	Potential to overlap with proposed activities (Alternatives 2 through 6)
Kaktovik	Fall – August to October about 20 miles off the coastline.	August to November - (opportunistically harvested with bowhead whaling and sealing in the fall) about 20 miles off the coastline.	Year round – peaks during whaling season. Occurs along coastline Kaktovik to Prudhoe Bay area. Northeastern Camden Bay and Point Griffin in the summer months.	June and July if present nearshore waters.	Year round along coastline - though not as common June, July and August.	Freshwater fish harvested January to mid-June and August through December at Hula Hula River, Kongakut River and into the Brooks Range. Marine fish July to November along the coast. Point Griffin, Kaktovik Lagoon, Camden Bay to Jago Spit in summer and the Canning Delta. Canning and Kuparuk rivers in the fall.	Harvested year round. Waterfowl arrive with open water in late spring and early summer months at Camden Bay and on barrier islands.	January to May and late summer/early fall months (September) if present. Inland fall and winter hunting occurs at the Hula Hula River and into the Brooks Range. Along the coast during summer hunting occurs when caribou are present at Point Griffin, Canning River, and Konganevik Point in the summer months.	Under Standard Mitigation Measure D1 proposed activities could not occur from Aug 25 until after bowhead harvest/quota is reached. Standard Mitigation Measure D2 establishes communication centers. Summer and early fall marine mammal harvests (seals, walrus, polar bears), marine and coastal bird, and caribou hunting could be impacted by aircraft overflights. Flight paths could originate from the Prudhoe Bay area to where offshore seismic survey activities and drilling operations are located but would be limited by altitude restrictions of Standard Mitigation Measure D3. Nearshore summer and late fall seal, walrus, marine and coastal bird hunting could be impacted by nearshore vessel traffic. One on-ice survey could occur at the same time that seals and polar bear are harvested during the winter.
Nuiqsut	Base for fall whaling is at Cross Island which is 90 – 100 miles from the community. Whaling occurs August to October. Most intense periods of whaling begin in mid-September and occur along the coast as far east as the Canning River.	Opportunistically harvested during bowhead whaling activity and sealing in the fall) from August to October.	Hunts occur at Cross Island, Thetis Island and the barrier islands. Seals are taken on the sea ice during March through May. During summer, ringed and spotted seals are hunted near the Colville River to Ocean Point. During the fall (August to October) hunts occur near the Colville Delta and along the coast from Cape Halkett to Foggy Island.	Hunted in June and July if present nearshore waters.	Occasionally taken during bowhead whaling hunt. And occasionally taken on coast late October through March.	Fishing occurs from Nuiqsut 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. In June whitefish are taken in the Colville River. Summer fishing occurs farther up the Colville River and on Fish Creek. Summer coastal fishing occurs for whitefish and cisco. Fall and summer fish camps are on the Colville River and at Fish Creek.	Harvest is year round. Hunting occurs from Nuiqsut 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. Ducks in fall are taken while whaling offshore.	Caribou harvest is year round. Hunting occurs from Nuiqsut 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. Caribou hunting is the primary activity in late summer. Some hunting in the area of Fish Creek during the winter.	Under Standard Mitigation Measure D1 proposed activities could not occur from Aug 25 until after bowhead harvest/quota is reached. Standard Mitigation Measure D2 establishes communication centers. Summer and early fall marine mammal harvests (seals, walrus, polar bears), marine and coastal bird, and caribou hunting could be impacted by aircraft overflights. Flight paths could originate from the Prudhoe Bay area to where offshore seismic survey activities and drilling operations are located but would be limited by altitude restrictions of Standard Mitigation Measure D3. Nearshore summer and late fall marine mammal harvests (seals, walrus, polar bears), marine and coastal bird hunting could be impacted by nearshore vessel traffic. One on-ice survey could occur at the same time that seals and polar bear are harvested during the winter.
Barrow	Spring whaling April through June is based from camps on the ice shelf northwest of the community and occurs west and east of Point Barrow. Hunting area is 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. Fall whaling occurs east or northeast of Cape Simpson on Smith Bay from August to October in an area that extends 16 km (10 mi) west of	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.	Seal hunting areas range from Peard Bay to Pitt Point in spring and summer months and winter. In the spring bearded seals may become available offshore west and north of Point Barrow in April. In June hunting camps are set up along the coast southwest to Peard Bay. Bearded seal hunts in the summer are conducted west of Barrow or from Pigniq. Ringed seals are hunted along the coast in the fall.	Walrus hunt areas range from west of Barrow and southwestward to Peard Bay. In April walrus may be hunted offshore west and north of Point Barrow. During summer to early fall, (June to September) hunts occur from west of Barrow southwestward to Peard Bay.	Hunts occur October to June if present at areas ranging west of Barrow southwestward to Peard Bay.	Fishing occurs April through early November. Fish are harvested in local rivers and lakes and in Elson Lagoon and west of Point Barrow during spring and summer. Historic site of Pulayaaq on the Meade River is used for summer fishing. During fall fishing occurs inland at such historic places as Iviksuk on the Inaru River and Nauyalik on the Meade River.	Hunting occurs primarily in the spring and fall. Historic site of Pulayaaq on the Meade River for taking waterfowl in the spring, Pulayatchiaq is also noted as a current and historical area for and spring waterfowl. By June, duck hunting camps are set up along the coast southwest to Peard Bay including the historic site of Pigniq, north of Barrow. In the fall duck hunting can continue into September at Pigniq.	Caribou hunting occurs year round. Historic site of Pulayaaq on the Meade River is used for trapping in late winter. Pulayatchiaq is also noted as a current and historical area for trapping. Majority of caribou hunting occurs by boat during the summer and fall months along the nearshore coast and inland along rivers.	Standard Mitigation Measure D2 establishes communication centers. Summer and early fall marine mammal harvests (seals, walrus, polar bears), marine and coastal bird, and caribou hunting could be impacted by aircraft overflights. Flight paths could originate from the Prudhoe Bay area and Barrow to where offshore seismic survey activities and drilling operations are located but would be limited by altitude restrictions of Standard Mitigation Measure D3.

Community	Bowhead whales	Beluga Whales	Seals	Walrus	Polar Bear	Fish	Marine and Coastal Birds	Caribou	Potential to overlap with proposed activities (Alternatives 2 through 6)
	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, the hunt extends east as far as Smith Bay and Cape Halkett or Harrison Bay. October is preferred month to hunt.								Nearshore summer and late fall harvests for seals, walrus, marine and coastal bird hunting could be impacted by nearshore vessel traffic. One on-ice survey could occur at the same time that seals and polar bear are harvested during the winter.
Wainwright	Spring – In April, these whales are taken in open leads in the offshore ice as they pass close to shore near Point Belcher and Icy Cape. Whalers travel up the coast as far as Peard Bay to hunt bowheads in the spring. Whaling camps are sometimes located 10 to 15 mi (16 to 24 km) from shore. Whales are taken from April through to August. Fall whaling recently resumed in 2010.	The beluga whale hunt takes place in the spring lead system from April to June in 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.	Bearded and harbor seals are harvested from spring through fall. Ringed seals, however, are hunted during the spring in open leads. Bearded seals are hunted in early summer southwest of the community. Spotted seals harvested in the late summer early fall.	Walrus may be taken in spring but most are taken in the summer (July and August) from drifting ice floes near Wainwright and along the coast to Peard Bay. From August to September at local haul-outs, with the main area being from Milliktagvik north to Point Franklin. Icy Cape is a known walrus haulout location.	Polar bear subsistence hunts occur in the fall and winter (October through February) around Icy Cape, at the headland from Point Belcher to Point Franklin, and at Seahorse Island.	Kuk River and Kuk River estuary is an area where fishing occurs. Smelt fishing is done in January through March in the Kuk Lagoon. In general fishing occurs year round. During midsummer, nets are set up in front of the community for salmon, trout, and whitefish. Fall fishing along the Kuk, Ivisaruk, and Avalik rivers.	Migratory waterfowl harvest occurs along the coast and along rivers beginning in late April and early May. Waterfowl are harvested in early summer until nesting and some egg collecting occurs along Kasegaluk Lagoon or Seahorse Island. Fall harvests are at Icy Cape and Point Belcher.	Caribou are harvested year round. Caribou migrate to the coast during summer and are harvested from Icy Cape to Peard Bay and along major rivers beginning in late August and into the fall.	Proposed offshore activities would not overlap with bowhead whale and beluga whale harvests. Standard Mitigation Measure D2 establishes communication centers. Air traffic originating from a Wainwright shorebase, could traverse routes reported as beluga subsistence use areas by hunters from Wainwright, Point Lay, and Point Hope. These communities harvest belugas primarily in the spring, and the majority of harvest would have occurred prior to the commencement of seismic and high resolution shallow hazard surveys and exploratory drilling operations. Summer and early fall marine mammal harvests (seals, walrus, polar bears), marine and coastal bird, and caribou hunting could be impacted by aircraft overflights. Flight paths could originate from Barrow and Wainwright to where offshore seismic survey activities and drilling operations are located but would be limited by altitude restrictions of Standard Mitigation Measure D3. Nearshore summer and late fall marine mammal harvests (seals, walrus, polar bears), marine and coastal bird hunting could be impacted by nearshore vessel traffic.
Point Lay	Spring bowhead hunting resumed in 2009 in open leads.	Hunts occur from late June through mid-July herding them from the south to the shallows inside Kasegaluk Lagoon. Hunters are most familiar with beluga whale harvest in the area between Omalik Lagoon and Point Lay, although hunts can be as far north as Icy Cape. Summer harvest is from the middle of June to the middle of July. The summer hunting area is concentrated in Naokak and Kukpowruk Passes south of Point Lay. If the July beluga hunt is unsuccessful, Point Lay hunters y travel as far north as Utukok Pass and as far south as Cape Beaufort in search of beluga whales.	Ringed and bearded seals are available year-round. Ringed and bearded seals are hunted 20 miles (32 km) and 30 miles (48 km) north of Point Lay, respectively, with bearded seals concentrated in the Solivik Island area and up to three miles north off the island. Bearded seals are also hunted from south of Point Lay to the southern end of Kasegaluk Lagoon. Spotted seals are hunted mostly in the fall.	Summer walrus hunt occurs near Icy Cape. In June, the walrus migrate north past Point Lay, and the community conducts their annual hunt. Walrus are hunted from late May to late August along the entire length of Kasegaluk Lagoon, south of Icy Cape, and as far as 20 mi (32 km) offshore.	Polar bears hunted from September to April along the coast with the hunting area rarely extending more than two miles offshore.	May through October. Summer months fishing 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.	Icy Cape area used for hunting waterfowl. Migratory waterfowl and eggs are harvested during May and June at coastal sites and along inland rivers. Eggs are harvested at the islands in Kasegaluk Lagoon and along the barrier islands. Fall hunting near icy Cape.	Hunted year round. Caribou hunting areas in the western Brooks Range in the southeast corner of the NPR-A are used by Point Lay and Wainwright hunters. In the summer hunted near as they move toward the coast or in the Amatusuk and Kiklupiklak hills. Also taken along the coast and around Icy Cape. Fall hunting from late August to October at inland locations.	Proposed offshore activities would not overlap with bowhead whale and beluga whale harvests. Standard Mitigation Measure D2 establishes communication centers. Air traffic originating from a Wainwright shorebase, could traverse routes reported as beluga subsistence use areas by hunters from Wainwright, Point Lay, and Point Hope. These communities harvest belugas primarily in the spring, and the majority of harvest would have occurred prior to the commencement of seismic and high resolution shallow hazard surveys and exploratory drilling operations. Summer and early fall seals, walrus, marine and coastal bird, and caribou hunting could be impacted by aircraft overflights. Flight paths could originate from Wainwright to where offshore seismic survey activities and drilling operations are located but would be limited by altitude restrictions of Standard Mitigation Measure D3.

Community	Bowhead whales	Beluga Whales	Seals	Walrus	Polar Bear	Fish	Marine and Coastal Birds	Caribou	Potential to overlap with proposed activities (Alternatives 2 through 6)
									Vessels would not be expected to be present in seal subsistence harvest areas during the summer and fall months. Polar bears are unlikely to be present at times when vessels would be transiting through their habitat during the open water season.
Point Hope	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 when pack-ice lead is rarely more than 10-11 km (6-7 mi) offshore.	Spring - belugas are usually taken from late March through June in offshore leads. In summer whaling also occurs again in July, and some may be taken with nets from the beach areas. The second beluga hunt occurs later in the summer from July to August. During this second hunt, 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.	Hunted year round. Main sealing season begins along the south shores of the peninsula after whaling has concluded in the late spring.	Spring – hunts are in south shore leads from May to July along the southern shore from Point Hope to Akoviknak Lagoon.	Hunting takes place from January to April and occasionally from October to January. Hunting occurs in the area south of Point Hope as far out as 16 km (10 mi) from shore.	Summer marine fishing for char and salmon is conducted with beach seines and nets along the north and south shores, and lagoons. Summer salmon and grayling are caught at the mouth of the Kukpuk River and at other fishing areas along the river. About three fourths of the total fish harvest is obtained in the fall at the Kukpuk River. Fishing is combined with caribou and moose hunting up to the mouth of the Ipewik River. Cod are harvested in the fall on the beaches.	Spring - 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 are used. Summer - Bird nesting sites at Cape Thompson and Cape Lisburne are visited by boat to collect eggs and harvest birds. Fall - harvests are along the south shore inland to an area beyond the Kukpuk River and part of the north coast.	Hunted year round. Summer - Caribou are harvested at several places inland along the coast, including the Kukpuk River area or towards the Pitmegea River. Fall - Caribou are hunted along the Kukpuk River and at coastal and inland areas around Cape Thompson.	Proposed offshore activities would not overlap with spring bowhead whale and beluga whale harvests. Standard Mitigation Measure D2 establishes communication centers. Air traffic originating from a Wainwright shorebase, could traverse routes reported as beluga subsistence use areas by hunters from Wainwright, Point Lay, and Point Hope. However, the majority of harvest would have occurred prior to the commencement of seismic and high resolution shallow hazard surveys and exploratory drilling operations. Summer and early fall marine mammal harvests (seals, walrus, polar bears), marine and coastal bird, and caribou hunting could be impacted by aircraft overflights. Flight paths could originate from Wainwright to where offshore seismic survey activities and drilling operations are located but would be limited by altitude restrictions of Standard Mitigation Measure D3. Vessels would not be expected to be present in seal subsistence harvest areas during the summer and fall months. Polar bears are unlikely to be present at times when vessels would be transiting through their habitat during the open water season.
Kivalina	Spring – Whalers participate on Point Hope crews.	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. North Kivalina coastline is used for beluga whales during spring and summer.	Winter, ringed seals and bearded seals are harvested on open leads. 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. North Kivalina coastline is used for hunting ringed, bearded, and spotted seal during the spring. Summer – spotted seals along barrier island beaches and north Kivalina coast.	Spring – hunting occurs along the north Kivalina coast.	Polar bears are hunted in the spring along the north Kivalina coast.	Year round. 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. Summer - The Upper Kivalina River and its tributary streams are used for fishing.	The north Kivalina coast is an important resource use area where waterfowl hunting occurs during the spring and later in the fall. Fall - Cape Krusenstern area is used by waterfowl during fall migration.	Year round. Winter - Caribou winter use areas harvest occurs are along the north Kivalina coast and the Upper Kivalina River and its tributary streams. Summer - The Upper Kivalina River and its tributary streams are used for hunting.	Proposed offshore activities would not overlap with spring bowhead whale and beluga whale harvests. Standard Mitigation Measure D2 establishes communication centers. Summer and early fall marine mammal harvest (seals,) marine and coastal bird, and caribou hunting could be impacted by aircraft overflights. Flight paths would be limited by altitude restrictions of Standard Mitigation Measure D3. Vessels would not be expected to be present in seal subsistence harvest areas during the summer and fall months. Polar bears and walrus are unlikely to be present at times when vessels would be transiting through their habitat during the open water season.

Community	Bowhead whales	Beluga Whales	Seals	Walrus	Polar Bear	Fish	Marine and Coastal Birds	Caribou	Potential to overlap with proposed activities (Alternatives 2 through 6)
Kotzebue	Spring – Whalers participate on Point Hope crews.	Spring – beluga harvest near Sisoalik Spit. Summer (June and July) at Eschscholtz Bay and the Elephant Point/Choris Peninsula area.	Spring – ringed seals near Sisoalik Spit. Summer – spotted seal hunting at Eschscholtz Bay and the Elephant Point/Choris Peninsula area.	Rarely harvested.	Rarely harvested.	Kobuk/Selawik Lakes are used year round for subsistence activities by residents of several communities mainly for sheefish hooking. Spring –harvest near Sisoalik Spit. The Kobuk River Delta is another important year-round subsistence use area.	Spring - Waterfowl hunting occurs in Paul's Slough and throughout the delta area. The Sisoalik Spit area is heavily used from June to freezeup (mid-September). Year round - The Kobuk River Delta. Summer – egg gathering at Eschscholtz Bay and the Elephant Point/Choris Peninsula area. Fall - hunting occurs in fall in the Kobuk River Delta and near the Omar River.	Winter - The lower North Fork River and all of the Omar River drainage receives heavy some years use by wintering caribou. The valleys of the Omar and North Forks Rivers provide north/south migration corridors for caribou moving to calving and summering areas in the spring and returning to winter range in the fall.	Proposed offshore activities would not occur offshore of Kotzebue. Flight paths and vessel traffic would not occur from Kotzebue to areas where offshore seismic survey activities and drilling operations are located.

Effects of Seismic and High Resolution Shallow Hazard Surveys and Exploratory Drilling Disturbance to Subsistence Resources

Bowhead Whales

The potential effects of noise from seismic and high resolution shallow hazard surveys and exploratory drilling on bowhead whales, which may result in changes in migration patterns or adverse effects on the bowhead population health and productivity is of great concern to the Iñupiat people due to possible effects on their culture. During seismic and high resolution shallow hazard surveys and exploratory drilling, noise is transmitted through the water and air from acoustic sound sources, helicopter and fixed-winged aircraft traffic, support-vessel traffic, and ice management activities. Section 4.5.2.4 (Marine Mammals) describes the mechanisms by which activities associated with oil and gas exploration in the Beaufort and Chukchi seas could directly or indirectly affect marine mammals are primarily those associated with noise exposure, possibly ship strikes and habitat degradation.

As discussed previously in this EIS (Section 4.5.2.4.9), noise from oil and gas exploration activities has been shown in certain instances to displace bowhead whales from certain habitat areas in the EIS proposed project area. Should displacement occur and cause bowhead whales to migrate in areas too far offshore to be readily available to subsistence users, this may be considered an adverse direct impact to the bowhead subsistence hunt. Whaling crews would be required to travel greater distances from shore, which would mean spending more money on gas, additional travel time, and potentially putting crews at greater risk for adverse weather in order to intercept eastward and westward migrating whales (depending upon the time of year of the activity). Hunting at greater distances from shore also means longer distances to tow a whale to shore, following a successful harvest, during which time the meat can spoil. Braund and Moorehead (1995) report that whaling crews rarely pursue whales beyond 80 km (50 mi) from shore.

Another effect as described by hunters is that whales behave differently in the presence of sound in a manner that in turn makes them more difficult to harpoon. Traditional knowledge indicates that bowhead whales become increasingly "skittish" or "spooked" in the presence of seismic noise. Whales are more wary around the hunters and tend to expose a much smaller portion of their back when surfacing (which makes harvesting more difficult). Additionally, Alaska Natives report that bowheads exhibit angry behaviors in the presence of seismic, such as tail-slapping, which translate to danger for nearby subsistence harvesters (NMFS 2006). As described by Tom Albert, former Iñupiat Senior Scientist for the NSB, who related that: *"When a captain came in to talk to me, I knew he was going to say that the whales are displaced [by noise] farther than you scientists think they are. But some of them would also talk about 'spookiness'; when the whales were displaced out there and when the whaler would get near them, they were harder to approach and harder to catch"* (MMS, 1997).

Edward Nukapigak at the Nuiqsut Public Scoping meeting for this EIS on March 11, 2010 remarked that vessel presence also effects bowhead whales: *"with all the interference, with all these vessels we have, it's difficult for us to harvest our quota because all those whales are being spooked, skittish, and hard to approach because they have been harassed from the east by these vessels that are traveling from east to west going to West Dock, maybe possibly further west."*

Iñupiat hunters have for many years stated that bowhead and beluga whales can detect sounds at greater distances than can be measured by scientific instrumentation and methodology. Of great concern to residents of the EIS project area is that the increased levels of noise as a result of seismic and high resolution shallow hazard surveys and exploratory drilling could disrupt the normal migration routes of subsistence resources – in particular the bowhead whale, beluga whale, bearded seal, and walrus. At the Arctic Seismic Synthesis and Mitigating Measures Workshop held in March 1997 by MMS in Barrow, Alaska, with subsistence whalers from the communities of Barrow, Nuiqsut, and Kaktovik, whalers agreed on the following statement concerning the "zone of influence" from seismic-survey noise: *"Factual experience of subsistence whalers testify that pods of migrating bowhead whales will begin to* *divert from their migratory path at distances of 35 miles from an active seismic operation and are displaced from their normal migratory path by as much as 30 miles* (MMS 1997)*."*

The AEWC has commented extensively on the issue of noise impacts to bowhead whales, beluga whales, and other marine mammals: *"As has been documented time and time again, bowhead whales, beluga whales and other marine mammals react to very low levels of underwater noise. Studies conducted by Richardson and others, as have been discuss[ed] in the 2008 Arctic Regional Biological Opinion, document bowhead whale deflection when received sound levels are at or perhaps lower than 120 dB. More recently, we understand that monitoring activities from Shell's seismic activity in the Beaufort during 2007 and 2008 demonstrate that call detection rates drop significantly during airgun operation. Disruption of communication and migration patterns certainly meets the definition of "harassment" under the MMPA and therefore must be regulated by NMFS"* – Harry Brower, representing the AEWC, in written comments on this EIS dated April 9, 2010.

"Our observations, proven correct time and again by scientific research, are that bowhead whales change their behavior when industrial activity is taking place in their usual habitat. Because of these changes in behavior, the whales become less available or completely unavailable to our hunters during the time the activity is occurring, due both to noise disturbance and to pollution in the water. We also are very concerned that some habitats might be abandoned altogether if industrial activity increases or if it is undertaken in a way that creates ongoing disturbance" - Harry Brower, representing the AEWC, in written comments on this EIS dated April 9, 2010.

"If you put a drill ship there at Sivulliq Prospect, the whales are going to start migrating further north. I guarantee you that. They're not going to come in inside the islands. They're going to go up north and go around the drill ship. Then we have to travel 30-plus miles out to try and scout and harvest a whale. Just like one of our elders, one of our whaling elders mentioned earlier, that due to interference, they had travel 30-plus miles out. By the time the whale was harvested, the wind has already picked up. You have no ice out there to protect the swells" – Edward Nukapigak at the Nuiqsut Public Scoping meeting for this EIS on March 11, 2010.

"Barrow whalers and Nuiqsut whalers have encountered "unacceptable levels" of disturbance from industrial activities in these waters, where whales were harvested far from ideal locations. The result was putting the Iñupiat hunters in a greater danger by deflecting the whales as far as 30 miles off course; some boat[s] have succumbed to storms and greater wave actions and sunk; in some cases, individuals lost their lives. The harvest of the whale, therefore, was spoiled, after a 12-hour tow or more; the whale gasifies its internal organs and contaminates the meat, and the whale at this point cannot be eaten. This is a direct impact to feeding the indigenous Iñupiat people of the Arctic. In Barrow alone, it takes a minimum of 10 whales to feed the community for a day, for the season's events. Our culture is surrounded by the whale" - Gordon Brower, as stated in the Arctic Multiple-Sale EIS (MMS 2008) on November 1, 2008.

These direct impacts could result in whalers having to travel further offshore to hunt and an increase in the number of days it takes for whalers to be successful. As subsistence activities and wage economics are highly interdependent, the cost of expenditures for whaling activities could rise in terms of fuel costs and potential for loss of wages (time taken away from regular jobs) if increased time was spent away from work while engaged in subsistence resources harvest activities. Direct effects could also result in a limited sharing of resources and in turn affects the quality of life, which can be summarized as:

"[talking about environmental justice] 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" - Bill Tracey at Point Lay Public Scoping Meeting for this EIS February 22, 2010.

"Even if the impact on the whales from noise during construction is low as expected, the sociocultural impact of the community is likely to be high. They are -- they are the single most important animal in the North Slope sociocultural system. Iñupiat whaling is a proud tradition that involves ceremonies, dancing, singing, visiting, and cooperation between communities in sharing of food" - Thomas Napageak at the April 19, 1990 public hearing in Nuiqsut on the Beaufort Sea Planning Area Oil and Gas Lease Sale 124.

For the spring bowhead hunt in the Chukchi Sea, the impacts of disturbance could be limited by mitigation measures. Seismic and high resolution shallow hazard surveys and exploratory drilling operations may not occur until the spring bowhead whale hunts of Wainwright, Point Lay, and Point Hope are completed in the Chukchi Sea. In addition, shutdown of exploration activities in the Chukchi Sea for Wainwright, Point Lay, and Point Hope bowhead whale hunts would be based on real-time reporting of whale presence and hunting activity rather than a fixed date. Subsistence hunters in the Chukchi Sea have a limited hunting range. These whalers prefer to take whales close to shore to avoid hauling a harvested whale over long distances during which time the whale can spoil. Subsistence hunters in the Chukchi Sea during the fall will pursue bowhead whales as far as 80 km (50 mi) from the coast in small, fiberglass boats (Comstock 2011). Subsistence whaling is unlikely to occur in areas far offshore in the Chukchi Sea where it is assumed that seismic and high resolution shallow hazard surveys and exploratory drilling operations would occur in the Chukchi Sea during the late summer and fall months where these communities are not actively whaling. However, Wainwright whalers have expressed concerns that offshore oil and gas activities have disrupted previous spring migrations (Quakenbush and Huntington 2010). Wainwright whalers are concerned that increases in the levels of oil and gas activities in the Beaufort Sea could push southward migrating whales away from the eastern coast of the Chukchi Sea where they become inaccessible to hunters during the fall (Quakenbush and Huntington 2010).

In regard to the fall bowhead hunt (largely in the Beaufort Sea), mitigation measures require that seismic surveys and drilling operations would be limited in time and space during the fall bowhead whale migration. Mitigation is intended to reduce negative impacts occurring to subsistence hunting. Limitations of when activity can occur in the Beaufort Sea would continue at least until strike quotas have been filled by the coastal communities. Bowhead whaling at Barrow could continue into October. Standard and additional mitigation measures analyzed in this EIS could require shutdown of exploration activities in the Beaufort Sea for the Nuiqsut (Cross Island), Kaktovik, and Barrow bowhead whale hunts based on real-time reporting of whale presence and hunting activity rather than a fixed date. Short- and long-term effects on the Beaufort Sea subsistence hunts are expected to range from no impact to negligible impacts if the mitigation is applied.

Any impacts of seismic and high resolution shallow hazard surveys and exploratory drilling noise that do affect bowhead whales are expected to result in some temporary deviation in migratory path in the vicinity of the disturbance. However, the level of the response may depend on whether the whales are feeding, aggregated, or spread out and responses could range from apparent tolerance to interrupted communication, minor displacement or avoidance of an area (Section 4.5.2.4.9) Depending on where the disturbance activity occurred relative to the geography of the area the whales could move closer to the coastline or move offshore. Noises in shallow waters are more amplified and could result in bowhead whales moving further offshore. Local knowledge and comments by whaling captains indicate that subsistence whalers perceive deflection of bowhead whales as likely, resulting in the need to travel further for successful hunts. Disturbance effects are not expected to rise to the level of impacts on a population, such that the bowhead resource declines with long term impacts to subsistence harvest. The impact of disturbance to subsistence hunters is estimated to be of low intensity and temporary duration, i.e. for the duration of the seismic surveys and exploratory drilling activities offshore. These effects involve a resource that is unique in context, due to its importance as a key subsistence resource. Direct impacts that do occur would be considered of low intensity, limited in extent to a local area, temporary in duration but unique in context. Bowhead whales are an essential subsistence resource for Iñupiat of the Arctic coast and Yupiit Eskimo of the Bering Strait southward, which places them in the context of being a unique resource. The summary impact to subsistence harvest from disturbance of bowhead whales could be minor.

No effects from on-ice surveys are expected on bowhead subsistence hunts as those activities generally occur outside of the time frame of bowhead hunting. There is the potential for some late season on-ice surveys to occur during part of the spring bowhead whale hunt. However, the on-ice surveys would only occur in the Beaufort Sea, east of Point Barrow. Nuiqsut and Kaktovik do not conduct spring bowhead whale hunts. In the Beaufort Sea, Barrow is the only community to conduct such a hunt. Therefore, impacts from on-ice seismic surveys in the Beaufort Sea are anticipated to have either no effect or negligible impacts on bowhead subsistence harvests.

Beluga Whales

Section 4.5.2.4.10 (Beluga Whales) describes the mechanisms by which activities associated with oil and gas exploration in the Beaufort and Chukchi seas could directly or indirectly affect beluga whales. Beluga whales are reported by the Northwestern Alaska communities, including Point Lay, Point Hope, and Kivalina, to be especially sensitive to noise and motors. Huntington et al. (1999) reported that beluga whales avoid anthropogenic noise, although a certain degree of habituation occurs, mostly for noises that are constant.

As noted by the Alaska Beluga Whale Committee (in comments by Willie Goodwin at the public scoping meeting for this EIS on February 18, 2010): *"Now, in the belugas that we tag or the research that we've done, we know that the belugas are sensitive to noise, any noise. And I am concerned about that, because until we know exactly when they had their young, any kind of noise would cause stress in the female beluga and may abort their young beluga, or the mother may just not want to nurse it. So there's some involvement that noise affects the belugas, and we are concerned about that."*

In the Chukchi Sea, beluga whales could be displaced from or could avoid the vicinity of seismic and high resolution shallow hazard surveys and exploratory drilling operations in July through October during their spring and fall migrations. This would have the potential to impact and disrupt some communal beluga subsistence hunts (mostly Point Lay which heavily depends on this resource) by disturbing and altering the course of these migrating whales. Some of the early season industry activities could overlap in time with the Point Lay beluga hunt. This could make belugas more difficult to herd into the lagoons for the harvest (as is the practice in Point Lay). The impacts would be minimized or avoided given the mitigation measures considered and analyzed in this EIS. As mitigated, the effects of disturbance would be considered to be of low intensity and temporary duration, occurring for the duration of the activities offshore, and affecting a resource that is important in context. These impacts would not be expected to rise to the level of impacts on a population level that would have long term impacts to subsistence harvest. Beluga whales are an essential subsistence resource for some Iñupiat and Yupik Eskimo communities of the Arctic coast. The summary impact to subsistence harvest from disturbance of belugas could be minor.

Seals

Bearded, ringed, and spotted seals comprise a large portion of subsistence harvest and could be affected by seismic and high resolution shallow hazard surveys, including on-ice seismic surveys and exploratory drilling activities. Section 4.5.2.4.12 (Ice Seals) describes the mechanisms by which activities associated with oil and gas exploration in the Beaufort and Chukchi seas could directly or indirectly affect these seals.

Observations by subsistence hunters have contradicted conclusions that seals are not disturbed: *"Point Hope is having hard time catching seals. There was a little seismic operation that went on in the Arctic a* *few years back, and our seals haven't come back yet"* – Earl Kingik, Point Hope: at the 2011 Open Water Meeting in Anchorage, AK, March 7, 2011.

As a result of the short duration of the proposed activities and in consideration of the observed effects of offshore drilling on seals, measureable population level changes are not expected to seals. The short-term exposures of seals to airgun sounds are not expected to result in any long-term negative consequences for the individuals or their populations. In a study of subsistence hunting in Barrow, Nuiqsut, and Katktovik, Braund and Associates (2010) found that while ringed and bearded seals can be hunted year-round, there tends to be a peak in July. Additionally, while most of the identified hunting areas in the study were closer to shore, some hunters travelled between 32.2 and 40.3 km (20 and 25 mi) offshore to hunt seals, with the mouth of the Colville River and Thetis Island shown as popular seal hunting grounds (Braund and Associates 2010). While there is some potential for temporal overlap at the beginning of the open water season with seismic surveys and exploratory drilling activities, interactions are expected to be limited in duration. Activities within the lease areas far offshore that are likely to be explored would have no impact on subsistence hunting for seals. Therefore, the summary impact of these activities on seal subsistence harvests is expected to be negligible, taking into account the standard mitigation measures.

Pacific Walrus

Effects to walrus could occur during the summer months if seismic and high resolution shallow hazard surveys and exploratory drilling operations were conducted when walrus are present. Section 4.5.2.4.13 (Pacific Walrus) describes the mechanisms by which activities associated with oil and gas exploration in the Beaufort and Chukchi seas could directly or indirectly affect walrus. Should walrus leave or abandon areas where they could be harvested by subsistence hunters, then subsistence harvest patterns would be affected.

Impacts of disturbance to walrus are expected to be limited as far as the resource becoming unavailable for subsistence harvest. As a result, the intensity of the impact is low, temporary in duration, local in extent, and affecting a resource that is common in context. The summary impacts of disturbance to subsistence harvest of walrus are negligible.

Polar Bears

Section 4.5.2.4.14 (Polar bears) describes the mechanisms by which activities associated with oil and gas exploration in the Beaufort and Chukchi seas could directly or indirectly affect polar bears. Seismic and high resolution shallow hazard surveys and exploratory drilling activities are likely to occur in areas offshore and in open water areas where polar bears are not expected to be present, and subsistence harvest is not likely to be affected. For 2D/3D seismic surveys, high resolution shallow hazard surveys and exploratory drilling activities the summary rating regarding the subsistence harvest of polar bears is no impact.

Fish

Disturbance from sound generated by seismic and high resolution shallow hazard surveys and exploratory drilling activities could result in the temporary avoidance of the vicinity of these sound sources by fish. Mortality of fish or other population level effects are not anticipated. Subsistence fishing tends to occur in harvest areas located closer to shore and not in areas where seismic and high resolution shallow hazard surveys and exploratory drilling would affect subsistence activities. As a result there are no anticipated effects of disturbance to subsistence fishing.

Subsistence fishing has not been observed to occur in the areas likely to be subject to seismic and high resolution shallow hazard surveys and exploratory drilling activities. The sounds generated by seismic and high resolution shallow hazard surveys and exploratory drilling activities and their associated support vessels could result in temporary avoidance of the vicinity of these sound sources by fish but would not result in adult fish mortality or other population effects.

Fishing by residents of the Beaufort Sea communities occurs at inland fish camps and in nearshore areas along the beaches and would be unaffected by seismic and high resolution shallow hazard surveys and exploratory drilling activities. Fishing by residents of the Chukchi Sea communities occurs in the lagoons and inland along rivers in areas that are not expected to be affected by seismic and high resolution shallow hazard surveys and exploratory drilling activities. Offshore areas anticipated to be explored would be in locations that are not used in subsistence fishing harvest. No impact is expected.

Marine and Coastal Birds

No effects from seismic and high resolution shallow hazard surveys and exploratory drilling are expected to occur to the subsistence harvest of birds because of the distance of such activities from the coastlines of both seas. Subsistence harvest of birds and egg gathering occurs throughout the spring, summer, and fall, at inland areas and near coastal waters. The spring bird harvest is often at the same time as marine mammals hunts when seismic and high resolution shallow hazard surveys and exploratory drilling activities would not be occurring. The Nuiqsut eider hunt occurs in the OCS in association with seal hunting, peaking in July (Braund and Associates 2010). There is the potential for some overlap between oil and gas exploration activities and this hunt.

Subsistence bird harvest and egg gathering has not been observed to occur in the areas likely to be subject to seismic and high resolution shallow hazard surveys and exploratory drilling activities. The sounds that would be generated by these activities and their associated support vessels could result in temporary avoidance of the vicinity of these sound sources by birds. However, direct mortality or other population-level effects are not expected to result.

Bird harvest and egg gathering by residents of the Beaufort and Chukchi sea communities occurs in the lagoons and along the coast line, as well as some minimal hunts in the OCS, and could be expected to be unaffected by seismic and high resolution shallow hazard surveys and exploratory drilling activities. Most offshore areas, especially in the Chukchi Sea, anticipated to be explored would be in locations that are not used in subsistence bird harvest and egg gathering harvest. Therefore only negligible impacts would be anticipated.

Caribou

No effects from 2D/3D seismic and high resolution shallow hazard surveys and exploratory drilling activities are expected on caribou. Caribou are an important source (by percent of harvest) of meat for village residents. Offshore seismic and high resolution shallow hazard surveys and exploratory drilling activities are not likely to have any effect on land mammals, including caribou, in consideration of the distance of such activities from the coastlines of both seas.

Offshore 2D/3D seismic and high resolution shallow hazard surveys and exploratory drilling activities are not likely to have any impact from disturbance in consideration of the distance of such activities from the coastlines of both seas.

Effects of Aircraft Overflights to Subsistence Resources

Bowhead Whales

Bowhead whales have been observed to be less responsive to aircraft in comparison to vessel traffic. Information on the impacts of aircraft sounds associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Section 4.5.1.4 and Section 4.5.2.4.9 (Bowhead Whales) of this EIS.

The sound emitted by aircraft overflights potentially could cause some disruption to bowhead whale harvest, but aircraft overflights as mitigated are not expected to make bowhead whales unavailable to (or more difficult to harvest by) subsistence hunters. Whales could be expected to temporarily deflect from overflights, but mitigation measures analyzed in and contemplated by this EIS would limit the probability and consequence of this impact. It is expected that helicopters servicing offshore seismic and high resolution shallow hazard surveys and exploratory drilling operations could traverse areas utilized by subsistence whalers during fall whaling in the Beaufort Sea and limited areas of the Chukchi Sea. Flight paths could originate from the Prudhoe Bay area, Barrow and Wainwright shorebases to areas where offshore seismic activity and exploratory drilling operations are located. Flight path and altitude restrictions are expected to reduce to a low level any such potential impacts.

If bowhead whales were affected by aircraft overflights, it is unlikely that large numbers or a large whaling area would be affected, so the impact would be considered low in intensity and temporary in duration. Effects of the impact would be local, affecting a resource that is important in context. The summary impact is considered minor.

Beluga Whales

Beluga whales are reported to be sensitive and to exhibit short-term behavioral responses to the presence of helicopter and fixed wing overflights. Information on the impacts of aircraft sounds associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Section 4.5.2.4.10 (Beluga Whales) of this EIS.

Aircraft traffic transiting the Beaufort and Chukchi seas out to support vessels, and traffic between the shorebase and offshore drilling locations as part of activities under Alternative 2, would have the potential to disturb and alter the course of these migrating whales. In turn, this could make belugas more difficult to herd into the lagoons and harvest as belugas have previously been observed to react to helicopter overflights. The effects of this disturbance would be considered to be of low intensity though temporary in duration and occur for the duration of the overflights but would not be expected to have effects on a population level. The impacts would be minimized or avoided under the standard mitigation measures, such as mandatory flight elevations and offset distances in Mitigation Measure D1. Additional Mitigation Measure B1 would impose further area specific limitations on the areas where aircraft disturbance could potentially occur.

It is unlikely that helicopter traffic from Barrow to offshore areas would traverse routes where belugas are commonly harvested. For helicopter flights originating from a Wainwright shorebase, the routes could traverse reported beluga subsistence use areas by hunters from Wainwright, Point Lay, and Point Hope. These communities harvest belugas primarily in the spring, and the majority of harvest would have occurred prior to the commencement of seismic and high resolution shallow hazard surveys and exploratory drilling operations. The spring/early summer beluga hunts in Wainwright, Point Lay, Point Hope and Kivalina and Kotzebue would occur in the months prior to the start of offshore exploration activities in the Chukchi Sea. Some summer beluga hunting could be impacted by aircraft overflights, though mitigation measures are expected to lessen the extent of disturbance, which would be considered low in intensity, temporary in duration, and localized to a very specific area along the helicopter flight path affecting a locally important resource. Mitigation measures are expected to minimize or altogether avoid impacts to beluga whales and their subsistence harvest. The summary impact to subsistence harvest from aircraft disturbance of belugas could be minor.

Seals

Information on the impacts of aircraft sounds to seals associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Section 4.5.2.4.12 (Ice Seals) of this EIS.

The sound emitted by aircraft overflights could cause disruption to subsistence seal harvest, but aircraft overflights as mitigated are not expected to make seals unavailable to subsistence hunters. The assumed aircraft overflights associated with seismic survey activities and exploratory drilling would occur during the open-water season after seals have pupped and molted, fast ice has melted away, and flowing ice has retreated north. The standard mitigation measures of this EIS, including D1 on mandatory elevations and offset distances, would minimize or avoid impacts to seal subsistence harvests. At present, air traffic currently exists along the coastal areas of the Beaufort and Chukchi sea communities (Section 3.3.7). An increase in the levels of helicopter traffic between the expected support shorebases (Barrow, Deadhorse and potentially Wainwright) and the offshore drilling locations would be limited due to the small number of flights and the altitude at which flights occur. The spring/early summer seal hunts in Nuiqsut, Barrow, Wainwright, Point Lay, Point Hope, Kivalina and Kotzebue would occur in the months prior to the start of offshore exploration activities in the Beaufort and Chukchi seas. However, there is some potential for overlap with the hunts in July and August.

Aircraft overflights are unlikely to have an adverse effect on seal availability for subsistence harvest. Impacts that did occur would be considered low in intensity and temporary in duration. Effects of the impact would be local and affecting resources that are common in context. The summary impact is considered negligible.

Pacific Walrus

Walrus could react to aircraft overflights by stampeding into the water when they become disturbed while ashore at haul out sites. During a stampede the calves would be the most vulnerable to trampling mortality. Brueggeman (et al. 1990) observed reactions of walrus to aircraft at an altitude of 305 m (1,000 ft) over the pack ice and at 152 m (500 ft) over land and reported that walrus hauled out on land or ice were more sensitive to overflights (Brueggeman et al. 1990). The implications to subsistence hunters could be that repeated overflights cause disturbance at haul outs sites and limit the availability of this resources for harvest. Information on the impacts of aircraft sounds to Pacific Walrus associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Section 4.5.2.4.13 (Pacific Walrus) of this EIS.

Limited numbers of walrus are likely to be present in the central and eastern Beaufort Sea. In the Chukchi Sea walrus would not be expected to haul out in large concentrations during the open water period when seismic and high resolution shallow hazard surveys and exploratory drilling would occur. Instances where walrus occur near these presumed activities would be infrequent.

The mitigation measures analyzed in and contemplated by this EIS, including restricting aircraft to above 457 m (1,500 ft), unless the aircraft is engaged in marine mammal monitoring, approaching, landing or taking off and conducting regular aerial and vessel monitoring surveys, would minimize or avoid impacts to walrus and subsistence harvests of this species. At present, air traffic transits the coastal areas of the Beaufort and Chukchi seas between the communities. An increase in the levels of helicopter traffic between the expected support shorebases (Barrow, Deadhorse and potentially Wainwright) and the offshore drilling locations would be have limited impacts due to the small number of flights and the altitude at which flights occur. This is unlikely to affect the walrus hunting in the Chukchi communities, which occurs primarily in the spring and summer.

Aircraft overflights are unlikely to have an adverse effect on walrus availability for subsistence harvest. Impacts that would occur would be considered low intensity and temporary in duration. The impact would be local in extent, affecting resources that are common in context. The summary impact is considered negligible.

Polar Bears

The responses of polar bears exposed to aircraft overflights are likely to be that a bear initially moves away but then resume their natural habits. Polar bears have not been observed to remain in open water areas over which aircraft overflights occur. Polar bears would be most affected by helicopter and fixed wing aircraft overflights during the months when they are nearest to the shore or unable to access the offshore ice pack. Information on the impacts of aircraft sounds to polar bears associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Section 4.5.2.4.14 (Polar bears) of this EIS.

In response to seismic and high resolution shallow hazard surveys and exploratory drilling, polar bears may display avoidance behavior resulting in short-term and localized effects, which could reduce the availability of this resource for subsistence harvest. These behavioral responses to disturbance from aircraft would be expected to be brief and not expected to rise to the level of long-term impacts to individuals or adverse impacts at the population level. Mitigation measure D1 on mandatory flight elevations and offset distances, would be anticipated to reduce the likelihood of impacts to polar bears. Aircraft overflights and helicopter routes could be planned to avoid areas of known polar bear dens.

After mitigation is taken into account, aircraft overflights are unlikely to have an adverse effect on polar bear availability for subsistence harvest. Any unintended impact that did occur would be infrequent and would be considered of low intensity and temporary in duration. Effects of the impact would be local, affecting a resource that is important in context. The summary impact is considered minor.

Fish

No direct or indirect impacts to fish from aircraft overflights are expected. Aircraft traffic would have no impact on the availability of subsistence fish resources. However subsistence hunters may view increased aircraft traffic from seismic and high resolution shallow hazard surveys and exploratory drilling activities as disruptive within harvest areas. The mitigation measures would reduce the likelihood of this perceived disturbance. It would be expected that regular helicopter overflights to support offshore operations would occur through a limited area that overlaps with known fishing areas of Wainwright and Barrow subsistence users. However, no impacts are expected to subsistence fish resources or to subsistence fishing activities because of the required flight altitudes over these areas. Limited aircraft traffic is expected over the Point Hope, Kivalina, or Kotzebue subsistence fish harvest areas. However these areas would be further away from the normal air traffic routes for flights related to exploration activities offshore in the Chukchi Sea and no impacts are expected to subsistence fish resources or to subsistence fishing activities in those areas. Nuiqsut fish hunts are conducted in rivers and at the mouths of the rivers with hunts for Arctic Cisco and burbot peaking in months when open water activities do not occur (Braund and Associates 2010). Although Nuiqsut and Kaktovik fish for several species in July and August, Nuiqsut hunts occur in the rivers, and fishing by Kaktovik hunters is conducted both inland and along the coast. Increased air traffic in the coastal areas could occur during the life of various oil and gas activities but is not anticipated to impact the availability of subsistence fish resources to subsistence users in these communities.

Marine and Coastal Birds

Repeated disturbance from aircraft overflights could prevent staging birds from acquiring or maintaining sufficient nutrients for later migration. Colonies of nesting birds in coastal waters would be the most susceptible to disturbance from repeated aircraft overflights. In the Chukchi Sea, the areas where potential disturbances of marine birds could occur in large numbers include Kasegaluk Lagoon, Peard Bay, and Ledyard Bay all of which are heavily used for molting or staging. Repeated disturbances could result in displacement of small numbers of birds from preferred habitat and induce stress to birds that would then result in birds becoming unavailable for subsistence harvest and egg gathering activities. Information on the impacts to marine and coastal birds from of aircraft sounds associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Section 4.5.2.3 (Marine and Coastal Birds) of this EIS.

Helicopter traffic between the shorebase and offshore drilling locations and fixed wing aircraft traffic between the shorebase and regional hub airports could potentially disturb birds and therefore subsistence hunts for birds during the summer and fall. The mitigation measures analyzed in and contemplated by this EIS would reduce the likelihood of impacts to marine and coastal birds by restricting aircraft to above 457 m (1,500 ft). Aircraft overflights and helicopter routes could be planned to avoid areas of known bird subsistence harvest areas.

Birds are considered an important food source available during a limited seasonal window and there could be a perception that repeated disturbances could threaten subsistence harvests. The probability of disturbance and displacement of birds occurring within subsistence harvest areas is considered low.

Impacts that did occur to subsistence hunting and egg collecting would be of low intensity and temporary duration. Impacts would be local and affect resources that are common and /or important in context. The summary impact is considered to be minor.

Caribou

Effects to caribou could range from no response or running away from the noise of aircraft overhead. Caribou are present along the nearshore coasts in the summer and have been observed at beach habitats where they congregate to minimize harassment by insects. Subsistence hunting for caribou is conducted along the coastal areas in summer time, using boats for access, and this practice could be affected if long term disruption of caribou habitat causes displacement from a normal harvest area.

Subsistence hunters may view increased aircraft traffic as disruptive and as intruding on their traditional subsistence areas. Hunters have noted that caribou may avoid areas in which they can see and hear aircraft traffic: *"The amount of noise from the activities from these seismic -- from seismic work and by travel that they'll be doing by sea and by air will have a negative impact on our community, because I believe it will scare the caribou away"* – Carla Sims Kayotuk at the Public Scoping Meeting for this EIS on March 3, 2010.

In the Arctic Multiple-Sale EIS (MMS 2008), Nuiqsut residents noted that aircraft have diverted subsistence resources away from areas where hunters were actively pursuing them, directly interfering with harvests or causing harvests to fail. Nuiqsut subsistence hunters report that on-shore seismic activity displaces game, especially caribou, wolves and wolverine from the area being surveyed.

At present, air traffic exists along the coastal areas of the Beaufort and Chukchi sea communities. An increase in the levels of helicopter traffic between the expected support shorebases (Barrow, Deadhorse and potentially Wainwright) and the offshore drilling locations would be limited due to the small number of flights and the altitude at which flights occur. It is likely that there would be a limited disturbance to caribou or to caribou subsistence hunting from helicopter traffic on the coast as the helicopters travel offshore from the shorebases. Thus only small proportions of available subsistence hunting areas would be affected.

The impacts to subsistence hunters would be considered of low intensity and temporary in duration. Effects of the impact would be local and affecting a resource that is common in context. Subsistence hunters could perceive increased levels of aircraft traffic as disruptive and intrusive in subsistence areas, resulting in hunters avoiding affected areas.

Aircraft overflights are unlikely to have an adverse effect on caribou availability for subsistence harvest. Impacts that did occur would be considered of low intensity and temporary duration. The impact would be local in extent, affecting a resource that is common in context. The summary impact is considered negligible.

Effects of Vessel Traffic to Subsistence Resources

Bowhead Whales

Information on the impacts of vessel sounds associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Section 4.5.2.4.1 (Bowhead Whales) of this EIS. Bowhead whales have been observed to avoid approaching marine vessels. Reactions have been noted to be less severe when marine vessels are slow moving and do not approach these whales in a direct path (NMFS 2008). Bowhead whales have been reported to respond by swimming rapidly away from approaching vessels with avoidance responses beginning when a vessel rapidly approaches from 1 to 4 km (0.62 to 2.5 mi) away. When vessels approach bowheads, their behavior changes, and they may alter surface time and dive patterns. It has been noted that vessel disturbance can disrupt activities and social groups (Richardson and Malme 1993). Bowhead whales have been reported to avoid marine vessels, altering their behavior during migration to avoid the area(s) within a few miles of vessel activity.

Changes in behavior, such as swimming speed and orientation, respiration rate, and surface-dive cycles, could be temporary and last only minutes or hours. As a result of vessel disturbance, whales could scatter and become less readily available for subsistence whaling activities for a limited period of time.

These types of observations have been reported by whalers. As voiced by Thomas Brower, Sr. on October 1, 2008 in the Arctic Multiple Sale document (MMS 2008): *"The whales are very sensitive to noise and water pollution. In the spring whale hunt, the whaling crews are very careful about noise. In my crew, and in other crews I observe, the actual spring whaling is done by rowing small boats, usually made from bearded sealskins. We keep our snow machines well away from the edge of the ice so that the machine sound will not scare the whales. In the fall, we have to go as much as 65 miles out to sea to look for whales. I have adapted my boat's motor to have the absolute minimum amount of noise, but I still observe that whales are panicked by the sound when I am as much as 3 miles away from them. I observe that in the fall migration, the bowheads travel in pods of 60 to 120 whales. When they hear the sound of the motor, the whales scatter in groups of 8 to 10, and they scatter in every direction)."*

"We were impacted, us whalers were impacted out there, but in -- within the last 10 years, I observed, I was impacted along with all our whalers here, impacted by vessels that were out there. And it costs us to not harvest our whale" – Carl Brower at the Nuiqsut Public Scoping Meeting for this EIS on March 11, 2010.

In addition vessel traffic (barge traffic) presently occurring in subsistence harvest areas, but unassociated with seismic and high resolution shallow hazard surveys and exploratory drilling, has been observed to affect subsistence hunting: *"Because I know when you go to Nuiqsut, you'll hear a lot of this other, you know, entities that's disturbing the hunt…. And then Crowley [a barge company delivering fuel] was the one that disturbed Nuiqsut's hunt"* - Thomas Nukapigak at the Point Lay Public Scoping Meeting for this EIS on February 22, 2010.

Vessels for seismic and high resolution shallow hazard surveys and exploratory drilling and their associated support vessels typically do not enter the Chukchi Sea until after July 1 when most of the spring bowhead migration is complete. Moreover an additional mitigation measure considers vessels not entering the Chukchi Sea until July 15. During the fall migration, vessel activity in the Beaufort Sea associated with seismic and high resolution shallow hazard surveys and exploratory drilling and their associated support vessels would not be present in the areas near Cross Island and Kaktovik from August 25 until after fall whaling is completed by Kaktovik and Nuiqsut subsistence whalers.

The mitigation measures would also protect subsistence harvest of bowhead whales by requiring vessels to reduce speed within 274 m (900 ft) and avoid separating members from a group of whales from one another. Additionally, vessels would be required to avoid multiple course changes when within 274 m (900 ft) of bowhead whales and other marine mammals. During periods of poor weather, vessels would be required to reduce their speed to 10 knots while underway in order to avoid strikes or collisions with bowhead whales and other marine mammals.

A limited number of late migrating spring and fall bowhead whales could encounter seismic and high resolution shallow hazard surveys and exploratory drilling activities. However the mitigation measures would limit impacts from vessel traffic to late migrating bowhead whales and subsistence hunting. Impacts to subsistence hunting are likely to be of low intensity, temporary to interim in duration, local in extent, and affecting a resource that is important in context. The summary impact could be considered minor.

Beluga Whales

Information on the impacts of vessel sounds to beluga whales associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Section 4.5.2.4.10 (Beluga Whales) of this EIS. Vessel traffic that causes whales to avoid subsistence harvest areas could result in them being unavailable for harvest – particularly for the Chukchi Sea communities, such as Point Lay, which harvest beluga whale intensively.

A limited number of late migrating spring beluga whales could encounter vessels during seismic and high resolution shallow hazard surveys and exploratory drilling activities and operations. The impact of disruption to beluga whales from vessel traffic could result in temporary deflection of beluga whales from subsistence harvest areas and impact the success of these hunts. Vessels typically do not begin transiting through the Bering Straits into the Beaufort and Chukchi seas for seismic and high resolution shallow hazard surveys and exploratory drilling until July 1 after the majority of the spring beluga hunting is completed in the Chukchi Sea villages. However, some villages, such Point Lay and Kotzebue, may continue hunting belugas into mid-July. An additional mitigation measure contemplates no vessel transit into the Chukchi Sea before July 15. The impact to late migrating beluga whales that do encounter vessels would be of low intensity, temporary to interim duration, local extent, and affecting a resource that is locally important in terms of the context. The summary impact could be considered minor.

Seals

Information on the impacts of vessel sounds to seals associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Section 4.5.2.4.12 (Ice Seals) of this EIS. Upon exposure to vessel noise, seals may show avoidance of vessels transiting through an area. Avoidance of vessels transiting through areas of subsistence hunting could make seals less available for subsistence harvest. Seals could be displaced or may avoid areas where vessels are transiting as part of seismic and high resolution shallow hazard surveys and exploratory drilling activities. However as a result of the mitigation measures for vessels transiting into the Beaufort and Chukchi seas for seismic and high resolution shallow hazard surveys and exploratory drilling and their associated support vessels, no unmitigable adverse impacts to seals and subsistence hunting activities are expected. Subsistence hunts for seals occur in nearshore coastal areas away from areas likely to be transited by vessels. Although there is the potential for some spatial and temporal overlap, the impact to subsistence seal harvest would be of low intensity, temporary duration, local extent, and affecting resources that are common in context. The summary impact could be considered negligible to minor.

Pacific Walrus

Information on the impacts of vessel sounds to Pacific Walrus associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Section 4.5.2.4.13 (Pacific Walrus) of this EIS. Effects to walrus from approaching vessel traffic may cause them to flee haulout locations and to avoid moving vessels that pass within less than a mile (or less than 1.6 km) (Richardson et al. 1995). However, walrus may also exit the water or approach vessels out of curiosity. Walrus that avoid vessel traffic may affect subsistence harvest by becoming less readily available for subsistence harvest.

Walrus could be displaced or avoid areas where vessels are transiting as part of seismic and high resolution shallow hazard surveys and exploratory drilling activities, By applying mitigation measures to vessels transiting into the Beaufort and Chukchi seas for these activities and their associated support vessels, no unmitigable adverse impacts to walrus and subsistence hunting activities would be expected. Subsistence walrus hunts would occur in nearshore coastal areas away from areas likely to be transited by vessels. In areas where walrus subsistence hunting occurs in the summer, as in Wainwright, vessels associated with these activities could be present in offshore subsistence harvest areas. The impact to subsistence walrus harvests would be of low intensity, temporary duration, local extent, and affecting a resource that is important in terms of the context. The summary impact could be considered negligible to minor.

Polar Bears

Reactions and responses to vessel traffic could range from walking, running, or swimming away to no response at all (Richardson et al. 1995). Polar bears are unlikely to be present at times when vessels would be transiting through their habitat during the open water season.

It would be unlikely that polar bears would be present in open-water areas where seismic and high resolution shallow hazard surveys and exploratory drilling activities would occur, as polar bears would most likely be in active ice zones during the late summer and early fall. Subsistence hunting for polar bears in nearshore areas during the spring and winter months would not be occurring when these proposed activities are being conducted. Under the mitigation measures for vessels transiting into the Beaufort and Chukchi seas for these activities, no unmitigable adverse impacts to polar bears or subsistence hunting practices would be expected. The impact to subsistence harvest of polar bears is considered of low intensity, temporary duration, local extent, and affecting a resource that is unique in context, due to listing under the ESA. The summary impact could be considered negligible, and in some areas, no effect is anticipated.

Fish

Vessel traffic is not expected to affect subsistence fishing harvests. While fish may avoid a vessel transiting through an area, the disturbance would be expected to affect a very small portion of populations. Effects to subsistence fishing are likely below measurable thresholds.

Few impacts to subsistence fishing are anticipated as a result of vessel traffic associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities. Vessels would likely be transiting areas that are offshore and removed from subsistence harvest areas. Crew and supply vessels transiting to or from a coastal community may pass through local subsistence fishing areas. Any impact that did result would be expected to occur for only the length of time the vessel is potentially transiting through a nearshore area where subsistence fishing is occurring. The impact to subsistence harvest of fish is considered of low intensity, temporary duration, local extent, and affecting resources that are common in context. The impact could be considered negligible in terms of the levels of subsistence fishing and sharing of the resource that would be affected.

Marine and Coastal Birds

In response to the presence of vessels, birds may flush from marine and coastal areas where they are foraging or resting. Birds in coastal areas that are engaged in breeding, brood rearing, or foraging in preferred habitat areas in the lagoons are less likely to be affected and displaced by vessels transiting farther offshore. The presence of vessels may also affect some species more than others. The risk for collision and strikes increases as more vessels transit through the nearshore waters where birds are expected to be present in higher numbers. Some species could be attracted to the presence of vessels. If birds were continually displaced from subsistence harvest areas, the levels of harvest could be affected. The effects of vessel traffic to marine and coastal birds are described in Section 4.5.2.3.

Vessel traffic would be expected to potentially cause temporary disruption and displacement of some foraging and resting birds. However, this displacement and disturbance would be limited to the flushing of birds away from vessels transiting through the areas in which the birds were present. Vessel passage closer to nearshore waters would likely cause higher levels of impacts and disturbance to subsistence hunters if birds were flushed and lower productivity results in reduced availability of the resource. However, the disturbance potentially caused from offshore vessel traffic should be short term, occurring only as long as the activity takes place, and affecting only localized areas. The impact from disturbance from vessel traffic is not anticipated to result in bird mortality, so this activity would not be expected to affect birds on a population scale. Only minimal overlap with bird hunting in the region is expected, as few communities hunt birds further offshore. Nuiqsut does conduct some bird hunting in the Beaufort Sea OCS. The impacts to subsistence hunting and egg gathering are likely to be of low intensity, temporary duration, local extent, and affecting resources that are common in terms of context. The summary impact could be considered negligible.

Caribou

No anticipated effects of vessel traffic to caribou and other land mammals that are harvested for subsistence purposes are expected. Vessel traffic would occur offshore, and vessels coming into nearshore areas would be expected to arrive at ports or docks that are already established and not located in subsistence harvest areas. Therefore, no measurable effects to subsistence hunting of caribou are anticipated from vessel traffic.

Given the distance offshore that vessels will transit relative to subsistence harvest areas, it is unlikely that adverse impacts would occur to caribou and other land mammals or would make them unavailable for harvest. Vessels would only come to established dock and port facilities for lightering or offloading supplies and personnel. Disturbances at onshore areas from vessel traffic noise associated with approaching vessels could cause caribou to avoid these areas. However vessels would be approaching established areas where caribou and land mammals would not be expected to be present in large enough numbers to impact subsistence harvests. The impacts to subsistence hunting are likely to be of low intensity, temporary duration, local extent, and affecting a resource that is common in context. The summary impact could be considered negligible.

Effects of Disturbance from Icebreaking and Ice Management

Section 4.5.2.4 describes the effects of icebreaking and ice management on marine mammals. Disturbance from icebreaking activities to marine mammal subsistence resources would depend upon the time of year that the activity occurs. Active icebreaking involved with seismic survey plans could occur from October to December when bowhead whales, beluga whales and seal harvests are not as concentrated. Icebreaking could be associated with seismic survey plans that extend into the late open water season late fall to early winter (October to December) when daylight is very limited to nonexistent and visibility is reduced.

Ice management activities would introduce less noise into the marine environment than full on icebreaking (Section 4.5.2.4). Ice management would be associated with exploratory drilling operations in the summer and open water season and involve the use of smaller support vessels around the drill rig/ship to ensure the safety of the operation. Towards the end of the drilling season (i.e. late October), there is a greater chance of ice occurring in the drilling area. Icebreaking would only occur if the floe posed a risk to the drilling unit and needs to occur to safely cease operations and remove the equipment. Icebreaking would not be conducted for the express purpose to continue operations late in the season. The ice management vessels typically consist of an icebreaker and an anchor handler, as well as an auxiliary ice management vessel.

Bowhead Whales

As discussed in Section 4.5.2.4.9 the additional sound from icebreaking that accompanies seismic activity could cause temporary avoidance of bowhead whales from areas where the vessels are operating and potentially cause temporary deflection of the migration corridor (NMFS 2010c). Some operators have recently proposed to conduct seismic surveys during the in-ice or shoulder season (i.e. October through December). These surveys would require the use of an icebreaker to go ahead of the seismic survey vessel. The mitigation measures limit the time frame in which these activities occur. Surveys utilizing icebreakers could cause avoidance and displacement over a larger radius with the additional noise input from the icebreaking activities, and limited daylight and poor visibility would make it harder for onboard observers to visually observe whales and other marine mammals. The majority of these types of in-ice surveys requiring icebreaking would occur after the completion of fall bowhead harvests in the Beaufort and Chukchi seas.

Bowhead whales would be expected to avoid areas where icebreaking is occurring as a response to the noise generated by this activity. This could affect subsistence harvest by making the whales divert from normal migratory paths and thus become less readily available for harvest. The avoidance by the whales of icebreaking activity may be only temporary but could still have an effect on availability for harvest. It may make it necessary for whaling crews to travel further offshore to be successful or result in a hunt being unsuccessful and/or whales spoiling before being processed. However, many (but not all) of the icebreaking activities are anticipated to occur during times when there is no bowhead hunting. The likelihood of interaction diminishes by late October as most bowhead whales will have migrated out of the Beaufort Sea. The period of time over which icebreaking for seismic surveys could overlap with bowhead whales being present and subsistence whaling in the Beaufort Sea is short and seismic surveys and exploratory drilling could not occur until after fall whaling is complete for Nuiqsut and Kaktovik. In the event that icebreaking does cause bowhead whales to avoid an area, the impact to subsistence resources is expected to be low in intensity, short term in duration, local in extent, and affecting a resource that is unique in context. This would be considered a minor summary impact.

The majority of seismic and high resolution shallow hazard surveys and exploratory drilling activities would be expected to occur during the open water season (i.e. July through November) when seismic and high resolution shallow hazard surveys and exploratory drilling vessels would not encounter large amounts of sea ice. However ice management may be necessary during late fall or early winter when industry may still be engaged in seismic and high resolution shallow hazard surveys and exploratory drilling activities in order to protect equipment, vessels, and infrastructure. The mitigation measures limit the time frame in which these activities that may require ice management could occur. The majority of these types of surveys and exploratory drilling operations would occur after the completion of fall bowhead harvests in the Beaufort and Chukchi seas. As a result, the likelihood of impacts to subsistence harvest as a result of ice management activities is reduced and unlikely to adversely affect subsistence harvest of bowhead whales. In the event that ice management does cause bowhead whales to avoid an area, the impact to subsistence resources is expected to be low in intensity, temporary to interim in duration, local in extent, and affecting a resource that is important in context. This would be considered a minor summary impact.

Beluga Whales

Beluga whales are reported to be extremely sensitive to icebreaking (Section 4.5.2.4.10). Effects of icebreaking and ice management may cause belugas to avoid the vicinity of the activity. Therefore, if such activities were to occur in nearshore areas, the availability of this resource to subsistence hunters could be reduced.

Subsistence hunters have expressed concerns that belugas will "remember" the impacts of icebreaking and avoid specific areas where the impact occurred in subsequent years:

"…evidence of beluga being affected by noise. I have evidence but it is anecdotal. In 1989, Red Dog became operational. Before the port was built, every summer a beluga was harvested in July. Since 1989, Kivalina has never gotten whales in July since then" - Inoke Adams Jr., Kivalina Open Water Meeting in Anchorage on March 7, 2011.

Mitigation measures are expected to minimize and potentially avoid impacts on beluga whales so that no unmitigable adverse impacts occur to the subsistence harvest of beluga whales (i.e. subsistence users are able to conduct hunts that meet subsistence needs). There is a low probability that impacts could occur to subsistence users from late season activities. Some operators have recently proposed to conduct seismic surveys requiring icebreaking during the in-ice or shoulder season (i.e. October through December). These surveys would require the use of an icebreaker to go ahead of the seismic survey vessel. The mitigation measures limit the time frame in which these activities occur. Surveys utilizing icebreakers could cause avoidance and displacement over a larger radius with the additional noise input from the icebreaking activities, and limited daylight and poor visibility would make it harder for onboard observers to visually whales and other marine mammals. The majority of these types of in-ice surveys requiring icebreaking would occur after the completion of harvests in the Beaufort and Chukchi seas. Therefore, no effect is anticipated.

Ice management activities could be necessary as part of seismic and high resolution shallow hazard surveys and exploratory drilling activities when ice is encountered in the late fall early winter months of exploration drilling operations. Ice management would be limited to areas where industry is actively drilling. Ice management activities would be conducted far removed from areas typically used as hunting grounds in the Chukchi Sea. No impacts are anticipated for beluga subsistence hunts in the Beaufort Sea, as beluga hunting is conducted opportunistically during the fall bowhead hunt. Mitigation measures would prohibit seismic and high resolution shallow hazard surveys and exploratory drilling activities (and associated ice management) from occurring during this time.

Seals

Icebreaking could be associated with seismic survey plans that extend into the late open water season late fall to early winter (October to December) when daylight is very limited or absent and visibility is reduced making seals more difficult to spot. At this time of year sealing efforts for subsistence are not a concentrated or intensive activity. Icebreakers could potentially collide with seals hauled out on the ice (Section 4.5.2.4.12). The probability of icebreakers colliding with seals and having lethal effects on populations of seal is low. Seals are more likely to avoid areas where icebreaking is occurring. If large numbers were to be killed by collisions with icebreakers or to avoid areas important for subsistence hunting, then levels of seal harvest could be affected. In the event that icebreaking causes seals to avoid an area, the impact to subsistence harvest is expected to be low in intensity, short term in duration, and local in extent, and affecting resources that are common to important in context. This would be considered a negligible summary impact.

Ice management activities could be necessary as part of seismic and high resolution shallow hazard surveys and exploratory drilling activities and would occur in the offshore waters during the open water season after sea ice has retreated and melted. Activities under Alternative 2 would occur after pupping and molting seasons for all ice seals end, so there would be few seals expected in the area where the proposed activities would be occurring. Subsistence harvest of seals would not be expected to occur in areas of active ice management offshore. The mitigation measures are expected to avoid and minimize impacts on seals and in turn on subsistence harvesting so that no unmitigable adverse impacts occur. In the event that ice management causes seals to avoid an area, the impact to subsistence resources and subsistence users is expected to be low in intensity, temporary in duration, and local in extent, and affecting resources that are common in context. This would be considered a negligible summary impact.

Pacific Walrus

Icebreaking activities could cause walrus to avoid the areas where these activities would be occurring (Section 4.5.2.4.13). Walrus that are hauled out or feeding when icebreaking is occurring could be affected by avoiding the area. In areas where subsistence hunting occurs for walrus, avoidance of the area could lead to reduced availability of this resource to hunters and reduced harvests. Given the dispersed distribution of walrus on the ice and the short time period and limited geographic extent of icebreaking activities authorized under Alternative 2, it is unlikely that many walrus would be affected in the Chukchi Sea and unlikely that any would be affected in the Beaufort Sea. Such disturbance would be temporary as the icebreaker moved through an area and the ice reformed relatively quickly. In the event that icebreaking does cause walrus to avoid a subsistence use area and reduces the success of harvest, the impact to subsistence resources is expected to be low in intensity, short term in duration, local in extent, and affecting a resource that is important in context. This would be considered a negligible summary impact to subsistence harvest of walrus.

Ice management activities, and associated vessel traffic, would not likely be conducted in offshore waters that are subsistence use areas for this species. Mitigation measures are expected to avoid and minimize impacts on walrus subsistence harvest so that no unmitigable adverse impacts occur. There is a low probability that impacts could occur to subsistence users. In the event that ice management activities cause walrus to avoid a subsistence use area and reduce the success of the harvest, the impact to subsistence is expected to be low in intensity, short term in duration, local in extent, and affecting a resource that is important in context. This would be considered a negligible summary impact to subsistence harvest of walrus.

Polar Bears

In response to the presence of icebreakers and icebreaking activities, polar bears may flee from the noise at the sight of icebreakers or be drawn to them. Icebreaking and ice management would likely occur when polar bears are on pack ice. In areas of polar bear subsistence hunting, avoidance of the area could lead to a reduced availability of this resource to hunters and reduced harvest.

Icebreaking could be necessary as part of late season survey activities. Given the dispersed distribution of bears on the ice and the short time period and limited geographic extent of icebreaking activities, it is unlikely that more than a few bears would be affected in either sea and such disturbance would be temporary to both the bears and their ice seal prey (Section 4.5.2.4.14). There is a low probability that impacts could occur to subsistence users, if late season icebreaking causes polar bears to avoid a subsistence use area and reduces the success of harvest. However, the impact to subsistence resources is expected to be low in intensity, short term in duration, local in extent, and affecting a resource that is unique in context, due to listing under the ESA. This would be considered a minor summary impact.

Polar bears are unlikely to be present in the areas where seismic and high resolution shallow hazard surveys and exploratory drilling activities would occur during the open water season. Ice management activities would be conducted in offshore waters that are not subsistence use areas for polar bear harvest. The mitigation measures are expected to minimize and potentially avoid impacts on polar bear harvest so that no unmitigable adverse impacts occur. While there is a low probability that impacts could occur to subsistence users, if ice management does cause polar bears to avoid a subsistence use area and reduces the success of harvest the impact to subsistence resources is expected to be low in intensity, short term in duration, local in extent, and affecting a resource that is unique in context, due to listing under the ESA. This would be considered a minor summary impact based on the unique context of this species under this analysis.

Fishing

Icebreaking and ice management are not expected to affect subsistence fishing. Any effects to fish from icebreaking and ice management would be limited to avoidance in the area near the active ice management vessels during ice management activities. Avoidance would be expected to last only minutes, and no impacts to subsistence fishing would be likely.

Ice breaking and ice management activities would likely occur in areas that are offshore and removed from subsistence fish harvest areas. The impacts to the subsistence harvest of fish would be considered to have no effect.

Marine and coastal birds

Effects of icebreaking and ice management could have similar effects to marine and coastal birds as the vessel traffic and cause birds present to flush or avoid the area where the activity is occurring. Birds could avoid or be attracted to the activity. Avoidance of the area could lead to a lesser availability of birds for subsistence hunters and lower rates of harvest.

Icebreaking and ice management would not be expected to occur in areas of critical bird habitat and other areas of high bird concentrations. Icebreaking and ice management activities are not anticipated to impact the availability or distribution of birds and bird eggs for subsistence harvest. These activities would likely occur in areas that are offshore and removed from subsistence bird harvest areas. The impacts to subsistence harvests of bird and egg gathering are considered of low intensity, temporary duration, local extent, and affecting resources that are common in context. The summary impact could be considered negligible.

Caribou

Icebreaking and ice management activities would occur offshore and would not be expected to affect caribou, a terrestrial mammal. Therefore, no measurable effects to subsistence hunting of caribou are anticipated from icebreaking or ice management activity.

No impacts are anticipated to occur to caribou or caribou subsistence harvests from icebreaking and ice management for offshore seismic and high resolution shallow hazard surveys and exploratory drilling. Due to the distance of such activities from the coastlines of both seas, no impacts on the terrestrial habitat of caribou or on the availability of caribou for subsistence harvests would be expected.

Effects of noise and vehicle movement from on-ice seismic surveys

Bowhead Whales

The on-ice seismic survey that could occur in the Beaufort Sea would take place at a time of the year when bowhead whales are not present. Therefore, no impacts to bowhead whale subsistence harvest from on-ice seismic surveys are expected to occur.

Beluga Whales

The on-ice seismic survey that could occur in the Beaufort Sea would take place at a time of the year when beluga whales are not present. Therefore, no impacts to beluga whale subsistence harvest from on-ice seismic surveys are expected to occur.

Seals

Section 4.5.2.4.12 (Ice Seals) describes the mechanisms by which activities associated with oil and gas exploration in the Beaufort and Chukchi seas could directly or indirectly affect seals. One on-ice seismic survey could be permitted in the Beaufort Sea under Alternative 2, but mitigation measures to limit adverse effects to seals and subsistence harvests could be applied. Subsistence harvest areas for ringed and bearded seals by Nuiqsut and Barrow hunters extend through the area east of Point Barrow where one on-ice survey could occur at the same time that seals are in their lairs during the winter. As a result of on-ice seismic survey activities seals could become displaced from their lairs and would then be unavailable for harvest or could become more difficult to harvest for the duration of the industry on-ice activity. Any impacts to seal subsistence harvests would be characterized as a low intensity, limited to a local area, temporary in duration, and affecting a resource that is common in context. The summary impact is considered negligible.

Pacific Walrus

The on-ice seismic survey that could occur in the Beaufort Sea would take place at a time of the year when walrus are not present. Therefore, no impacts to walrus subsistence harvest from on-ice seismic surveys are expected to occur.

Polar bears

Section 4.5.2.4.14 (Polar bears) describes the mechanisms by which activities associated with oil and gas exploration in the Beaufort and Chukchi seas could directly or indirectly affect polar bears. There is the potential for one on-ice seismic survey to occur in the Beaufort Sea, east of Point Barrow during January through May. Impacts to polar bear subsistence hunts in the Beaufort Sea communities could be affected as polar bears could become displaced from the on-ice survey area or disturbed while denning. Direct impacts that do occur would be considered of low intensity, limited in extent to a local area, temporary in duration but unique in context. Therefore, impacts from on-ice seismic surveys in the Beaufort Sea are anticipated to have minor impacts on polar bear subsistence harvests.

Fishing

Noise and vehicle movement from on-ice seismic surveys are not expected to affect subsistence fishing. Any effects to fish from noise and vehicle movement during on-ice seismic surveys would be limited to avoidance in the area near the activities. Avoidance would be expected to last only minutes, and no impacts to subsistence fishing would be likely. On –ice seismic activity would occur in a marine area that is removed from subsistence fish harvest areas during the winter and early spring when marine subsistence fishing is not occurring in the Beaufort Sea communities. No impacts to marine subsistence fishing are anticipated.

Marine and Coastal Birds

The on-ice seismic survey that could occur in the Beaufort Sea would take place at a time of the year when marine and coastal birds are not present in large numbers on the coast. The likelihood of disturbance to marine and coastal birds resulting in lost opportunity for subsistence harvest would be of low intensity, temporary, local in extent and common in context. Therefore the impact is considered negligible.

Caribou

The on-ice seismic survey that could occur in the Beaufort Sea would take place at a time of the year when caribou are not present in large numbers on the coast. The likelihood of disturbance to caribou resulting in lost opportunity for subsistence harvest would be of low intensity, temporary, local in extent and common in context. Therefore the impact is considered negligible.

Effects from Permitted Discharges

The effects of permitted discharges (including bilge and ballast water, non-contact cooling water, desalination wastes, domestic and sanitary wastes, excess cement slurry, and deck drainage) to marine waters could affect marine mammals and fish. These species may respond by avoiding the areas in the vicinities of the discharge. Drill cuttings and mud discharges may displace marine mammals and fish from a short distance from each drilling location. Fish eggs and larvae could be destroyed, but it is unlikely that population-level effects would occur or that the discharges would limit the availability of these resources to subsistence hunters. These measurable effects on benthic communities have the potential to impact fish resource, particularly benthic feeders. However, scientific evidence suggests that drilling discharges and cuttings have minor effects on adult fish health (Hurley and Ellis 2004) (See Section 4.5.2.2.).

Concerns of contaminants occurring in Arctic subsistence resources – in particular bowhead whales - as a result of industrial pollution, long distance vectors for transport and deposition in Arctic environments, and high rates of persistence were summarized by NMFS (2008). NMFS noted: *"Bowhead whale subsistence foods have been analyzed for their levels of contaminants, including PCBs, DDTs, OCs, and chlordanes and heavy metals. These contaminant levels varied with gender, length/age, and season, but were generally relatively low compared to other marine mammals. Reports by the Arctic Monitoring and Assessment Programme (AMAP) identified levels of contamination meriting closer public health attention in some parts of the Arctic, through generally not in Alaska (AMAP, 2002, 2003). At the same time, public health officials recognize that the loss of subsistence foods would have far-reaching consequences throughout the sociocultural system of small, predominantly indigenous communities."* NMFS (2008) concluded that *"the documented contaminant levels in bowhead whales in Alaska do not represent a threat to the health of subsistence users at current levels. Given the low levels of risk, public health officials conclude that the nutritional decline from loss of subsistence foods, like bowhead whale meat and blubber, would be far more adverse."* There is an important perception among subsistence hunters that contamination of these subsistence resources could result from the action alternatives. Hunters may harvest "perceived" affected resources in lesser amounts and in turn harvest other terrestrial mammal species or freshwater fish at higher levels. Section 4.5.3.3 describes the direct impacts of environmental contaminants to subsistence resources and implications and perceptions of these effects to public health.

Permitted discharges would be required to be conducted under the conditions and limitations of the required NPDES General Permits. The impacts of a major oil spill are discussed in Section 4.10.6.15 and 4.10.7.15. Permitted discharge could be mitigated by Additional Mitigation Measures C3 and C4, which would place requirements and limitations on the levels of discharge and discharge streams that could affect marine mammal habitat, marine mammals, and eventually the diets of subsistence users.

These mitigation measures may not alleviate the perception that a small oil spill or regulated wastewater discharge might contaminate subsistence resources. There is a perception the foods could become contaminated by discharges and/or small fuels spills, resulting in impacts to human health from consumption of the resources.

"Our whaling captains have always observed that the whales will shy away from human smells. In the spring, we have to be very careful with our cooking when we're camping on the ice during the spring. The whales can pick up the smells of our cooking or even making coffee. It's the same for discharges into the water. We are taught from a young age never to dump anything into the water during whaling. If we do, we won't see the whales. We also worry about the health effects of trying to eat marine mammals that have migrated through areas of waste discharge. We eat our marine mammals right out of the ocean and we can't be feeding our people waste from drilling operations" – Harry Brower, pers. comm., March 12, 2013.

"Near Cross Island, we have observed the whales deflecting around discharges into the water. During the 1980s, we saw this at times when we could also see cuttings floating on the water. At these times, the whales were diverted over 30 miles north from shore. That is why, under our Conflict Avoidance Agreement, we now ask the companies not to discharge any drilling muds or cuttings or other waste into the waters of the near-shore Beaufort Sea, where the whales migrate in the fall time. The whales will deflect away from the areas where waste is being dumped and it makes it harder for our hunters to find them. Shell has agreed to zero discharge under the CAA because of this" - Isaac Nukapigak, pers. comm., March 12, 2013.

The likelihood of subsistence resources occurring in the vicinity of the likely areas where drilling and/or any associated discharge or minor spills could occur is low as these activities would occur at a time when subsistence hunts are not occurring in areas that are offshore and removed from known hunting areas. In addition, fuel transfers are not expected during transit between the Beaufort and Chukchi seas. The direct impact of drill cuttings and mud discharges may displace marine mammals and fish a short distance from each drilling location. The impacts to subsistence users would be of low intensity, temporary to interim duration, local to regional extent, and affecting resources that are common to important in context.

4.5.3.2.2 Conclusion

Impacts of Disturbance from Seismic and High Resolution Shallow Hazard Surveys and Exploratory Drilling Activities to Subsistence Resources

The noise produced by the proposed seismic surveys, high resolution shallow hazards surveys, and exploratory drilling with standard mitigation measures that could be applied in order to minimize or avoid any adverse effects on all marine mammals and other subsistence resources, and other additional mitigation measures will be evaluated here and potentially required in MMPA ITAs. In consideration of the standard and additional mitigation measures, seismic surveys, site clearance and high resolution shallow hazards surveys, and exploratory drilling are not expected to disturb or disrupt subsistence activities at a level that would make resources unavailable for harvest or significantly alter the existing levels of harvest.

There may be rare instances where subsistence activities are interrupted. Only then would there be a direct impact from disturbance/disruption of or to the resource being harvested. Subsistence harvest patterns tend to be adaptive, and in the case of bowhead whaling, crews are likely to travel farther on longer trips to achieve harvest goals. Bowhead whales are such a highly productive food resource that in the communities highly reliant on this species, a major decline in bowhead harvest could not be replaced by other subsistence species but could potentially be replaced by sharing with other communities that were able to conduct successful bowhead whale hunts. Apart from the special case of bowhead whale harvests, subsistence harvest composition shows inter-annual variation, and shortfalls in some species are replaced by increased harvests of others, so that overall annual production meets harvest targets. (For a recent quantitative demonstration of variation in subsistence fish harvests in the neighboring Northwest Arctic, see Magdanz et al. 2011).

By implementing mitigation measures, the impacts from disruption of subsistence harvest would be low in intensity and temporary in duration. Impacts would be local to regional in extent and would affect resources that range from common to important in context. For instance, the loss of opportunity for a community to successfully harvest its full quota of bowhead whales for one season if the whales were deflected and hunters had a harder time reaching the whales as a result of seismic and high resolution shallow hazard surveys and exploratory drilling activities this would be a direct impact of the activity. Additional effort to harvest bowhead whales or reduced harvests would be considered an impact that is medium in intensity, interim to long-term in duration, local to regional in extent (in view of sharing practices), and affecting a resource that is important in context. As a result, this summary impact would be considered moderate. Mitigation measures evaluated in relation to this alternative are considered effective in reducing impacts on subsistence resources to the lower levels noted above. The summary impact of Alternative 2 in regard to disturbance to other subsistence resources is considered negligible to minor, depending on the species. The summary impact to belugas is considered minor. The summary impact to seal and walrus harvest are considered negligible. No impacts of disturbance are anticipated to subsistence harvests of polar bear, fish, marine and coastal birds, and caribou.

Impacts of Disturbance from Aircraft Overflights to Subsistence Resources

Increased aircraft traffic associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities could cause subsistence resources some temporary behavioral disturbance and possibly deflection away from the sound source by terrestrial or marine mammals. The level of the disturbance would depend on the size of the aircraft and repeated exposure or displacement. However mitigation measures regarding minimum altitudes and offset distances would reduce these effects.

Aircraft overflights are unlikely to have an adverse effect on subsistence harvests. Impacts that did occur would be considered low in intensity but temporary in duration. Effects of the impact would be local and affecting resources that are common to important in context. The summary impact of Alternative 2 in regard to impacts of air traffic to subsistence resources is considered negligible to minor depending on the species. The summary impact to bowhead whales is considered minor. The summary impact to belugas is considered minor. The summary impact to seal and walrus harvest are considered negligible. The summary impacts to polar bears, marine and coastal birds and caribou are considered minor. No impacts of disturbance are anticipated to subsistence harvests of fish.

Impact of Vessel Traffic to Subsistence Resources

The summary impact of vessel traffic on subsistence harvest of bowhead and beluga whales is expected to be minor to moderate. The summary impact to subsistence harvest from vessel traffic on seals and walrus is considered negligible to minor. The summary impact to subsistence harvest of polar bears is considered minor. Negligible summary impacts to subsistence harvest of fish, bird hunting and egg gathering, and caribou hunting are expected as a result of vessel traffic.

Impacts of Icebreaking and Ice Management on Subsistence Resources

Summary impacts to bowhead whales, beluga whales, and polar bears from icebreaking and ice-management activities are expected to be minor. Summary impacts to seals, walrus, fish, and bird hunting and egg gathering from icebreaking are expected to be negligible. No impacts to caribou or caribou hunting are expected.

Impact of On-ice Seismic Surveys to Subsistence Resources

No impacts are anticipated subsistence harvests of bowhead whales, beluga whales, Pacific walrus, and fishing as a result of the on ice seismic survey. Summary impacts to seals, marine and coastal birds and caribou are expected to be would be negligible. The summary impacts to polar bears could be minor.

Indirect Impact to Subsistence Resources from Permitted Discharges

The impacts to subsistence users would be of low intensity, short term duration, local extent, and affecting resources that are common to unique in context. Therefore the summary impact to subsistence resources, activities, and subsistence users would be minor, though the perception of the impact could be moderate.

Using the impact criteria identified in Table 4.5-25, the direct and indirect effect of all oil and gas exploration activities on subsistence resources resulting from implementation of Alternative 2 would be of low intensity, temporary to interim in duration, local to regional in extent, and the context would be common to important. Therefore the summary impact level of Alternative 2 on subsistence resources and harvests would be considered to range from negligible to minor depending upon the specific subsistence resource affected and source of disturbance.

4.5.3.2.3 Standard Mitigation Measures for Subsistence

In order to analyze likely impacts to subsistence uses arising from the seismic survey and high resolution shallow hazard surveys and exploratory drilling activities under Alternative 2, it is also necessary to identify those mitigation measures that offset potential impacts. The sections that follow examine standard mitigation measures that were designed to mitigate impacts to subsistence hunting and would be required pursuant to all applicable activities under this alternative. Of note, the Marine Mammal section contains more standard mitigation measures that are intended to reduce impacts to multiple species (e.g., bowheads, belugas, and ice seals), and those measures would indirectly reduce impacts to subsistence uses.

D1. Shutdown of exploration 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.

Applicable Activities: 2D/3D seismic, including in-ice, surveys, CSEM surveys, site clearance and high resolution shallow hazards surveys, exploratory drilling activities, and all associated support vessels

Purpose: This mitigation measure applies to the communities of Kaktovik and Nuiqsut to ensure no unmitigable adverse impacts occur to the subsistence harvest of bowhead whales for these two communities.

Science, Support of Reduction of Impacts, and Likely Effectiveness: This mitigation measure would require seasonal restrictions (shutdown) on activities occurring in specific areas of the Beaufort Sea corresponding to the start and conclusion of the fall bowhead whale hunts conducted at Cross Island by Nuiqsut whalers and by Kaktovik whalers. Operators would shut down their activities on August 25 and would not resume until the fall bowhead hunts were concluded for both of these communities.

As a result of the restrictions incorporated into this mitigation measure, industry activity would not occur until after the fall bowhead hunt is considered closed (i.e. when the village Whaling Captains'

Association declares the hunt ended or the village quota has been exhausted, as announced by the village Whaling Captains' Association or the AEWC). During the fall migration, only those whales that have not yet migrated westward of Kaktovik and Nuiqsut would be affected by noise disturbance and possible deflection from proposed activities. As vessels associated with activities transit the area beginning August 10 to August 25, industry participants will communicate and collaborate with AEWC on any planned vessel movement in and around Kaktovik and Cross Island to avoid impacts to the whale hunt. Whalers have reported that spooked/skittish whales become less available during the whaling season, and this mitigation measure would limit the potential for disturbance to occur. This mitigation measure may be reduce impacts to subsistence whalers at Barrow as it would limit the potential for disruption of whales as they pass Kaktovik and Nuiqsut, and, therefore, whales would be assumed to be following their normal migratory paths towards Barrow. This measure has been successfully implemented by industry operators for several years in the Beaufort Sea.

However as indicated by residents of these communities, conflicts can still exist with impacts on the success of the bowhead hunt: *"When there was a rig on the east side of Barrow, Point Barrow, in the fall, and I was there, and as a whaler for the community of Barrow. And when the rig was there, there was no whales within that area, so we had to go further out because the whales had been diverted to further out. The same thing is going to happen within our waters in the Chukchi Sea because they are experiencing that before here. They have to go further out"* Jimmy Oyagak at Nuiqsut Public Scoping meeting for this EIS on March 11, 2010.

Fenton Rexford, then President of Kaktovik Iñupiat Corporation (KIC), in a community meeting on August 14, 1996 stated that during exploratory drilling in Canadian offshore waters: *"We were not successful or had a very hard time in catching our whale when there was activity with the single steel drilling caisson, the drilling rig off Canada. And it diverted [bowhead whales] way offshore; made it very difficult for our whalers to get our quota."*

Carl Brower noted at the Nuiqsut Public Scoping meeting for this EIS on March 11, 2010: *"We were harassed by how many vessels and let us catch half our quota. And last year was a -- we barely saw whales. Most of the whales were up north, and we -- the whales we saw that were close to the island, we saw one, two a day, where we usually see, in one day, each boat chasing their own whale. So that's my question, what do you have to [do to] mitigate [disturbance to] a whale?"*

Innupiat hunters report that this measure is critical for reducing adverse impacts of industry activity on their subsistence hunts.

History of Implementation: Limitation of activities in these areas and times has been consistently required for years during exploration activities in the Beaufort Sea.

Practicability: Although cessation of exploration activities around the particular subsistence hunting activities does incur some cost to industry and increases risk when requiring drilling operations to shut down and move off site into the middle of drilling a well, industry has worked with the various communities along the Beaufort and Chukchi seas to establish communication centers during the open water season to avoid conflicts and have also include design measures in programs to move activities from one area to another to avoid conflicts.

Recommendation: Based on the importance of implementing this measure to ensure no unmitigable adverse impact to subsistence uses, it makes sense to continue requiring this measure of industry operators.

D2. Establishment and utilization of Communication Centers in subsistence communities to address potential interference with marine mammal hunts on a real-time basis throughout the season.

Applicable Activities: 2D/3D seismic, including in-ice, surveys, CSEM surveys, site clearance and high resolution shallow hazards surveys, exploratory drilling activities, and all associated support vessels

Purpose: Mitigation Measure D2 requires the establishment and utilization of Communication Centers in subsistence communities to address potential interference with marine mammal hunts on a real-time basis throughout the season. This measure also would allow for the potential implementation of other proposed mitigation measures that require real-time communication between hunters and industry operations.

Science, Support of Reduction of Impacts, and Likely Effectiveness: In order to be effective, it is necessary that industry and the affected communities both participate and implement the steps that would be taken to cooperate with one another. The Plan of Cooperation (POC) required by this mitigation measure would identify and document potential conflicts and associated mitigation measures that would be taken to minimize any adverse effects on the availability of marine mammals for subsistence use. To be effective, the POC must be a dynamic document which will be updated to incorporate new requirements for effective communications and consultation with the communities. The effectiveness of Mitigation Measure D2 is a subject of debate among some of the affected communities. Concerns have been expressed that the communication centers are not working as effectively in avoiding interference with subsistence hunters as had been expected.

As reported by one commenter: *"And for years now we've had a lot of impacts. We've run into a lot of vessels sometimes. Our boats are small, we're in the ice pack, and we have an ice breaker coming at us, we've had those incidents where we -- you know, we couldn't get to them on the radio…We have Badami right there that they have fuel runs, barge runs that are hauling fuel or hauling material when its barging season is open. And I've seen a lot of deflection, you know, because I'm tracking with GPS, their GPS when they're giving me coordinates. And I keep -- I get coordinates every six hours from industry, and sometimes we say, no, don't go, we have activity there. But still they go because it's their time and money that they're talking about when they have to have these resupply runs to their vessels out there. That causes impact, and it's recorded"* – Dora Leavitt at the Nuiqsut Public Scoping March 11, 2010 for this EIS.

Willie Goodwin, representing the Alaska Beluga Whale Committee made comments at the Kotzebue Public Scoping Meeting for this EIS on February 18, 2010: *"I think you should require that any seismic work or any other work that's going to be done by the oil industry, you should require them to have MMOs, marine mammal observers. At the very least, to be able to not harm the marine mammals or their migration."*

Dora Leavitt remarked at Nuiqsut Public Scoping meeting for this EIS on March 11, 2010: *"I know that they [industry] - and they now use marine mammal observers, but they don't have them in each vessel. They have them in the -- maybe the main supply or whatever vessel. And then you have all these runners, the resupply runners that go on their own with no observers. So, you know, they [industry] need more marine mammal observers."*

Innupiat hunters report that this measure is critical for reducing adverse impacts of industry activity on their subsistence hunts.

History of Implementation: Industry operators have been required to set up and run communication centers for many years.

Practicability: Past success indicates that this measure is practicable.

Recommendation: Based on the importance of implementing this measure to ensure no unmitigable adverse impact to subsistence uses, it makes sense to continue requiring this measure of industry operators.

D3. Required flight altitudes and paths for all support aircraft in areas where subsistence occurs, except during take-off, landing, and emergency situations.

Applicable Activities: 2D/3D seismic, including in-ice, surveys, CSEM surveys, site clearance and high resolution shallow hazards surveys, exploratory drilling activities, and all associated support vessels

Purpose: This mitigation measure is intended to ensure no unmitigable adverse impacts occur to subsistence users from the anticipated increases in levels of aircraft overflights during seismic and high resolution shallow hazard surveys and exploratory drilling operations.

Science, Support of Reduction of Impacts, and Likely Effectiveness: This mitigation measure applies to the communities of Kaktovik, Nuiqsut, Barrow, Wainwright, Point Lay, Point Hope, and Kivalina to ensure no unmitigable adverse impact to subsistence uses occur to the subsistence harvest of whales and seals for these seven communities. Mitigation Measure D3 sets forth the flight altitudes and paths (offset distances) for all support aircraft in areas where subsistence occurs, except during take-off, landing, and emergency situations.

Implementation of this mitigation measure requires that vessels and aircraft avoid concentrations or groups of whales. Operators shall, at all times, conduct their activities at a maximum distance from such concentrations of whales.

Subsistence users have commented on the importance of aircraft altitude restrictions: *"Require aircraft to maintain a 1,000 ft minimum altitude when flying over marine mammals observed on or near the surface"* - Alex Whiting and Linda Joule - Written comments representing Native Village of Kotzebue February 26, 2010.

Inclement weather may occasionally cause brief instances when aircraft are operated at altitudes below 305 m (1,000 ft) and short term impacts to subsistence resources and users would then occur.

The complete removal of potential sources of aircraft disturbance to marine mammals during any subsistence uses (with exceptions noted above), is expected to reduce potential adverse impacts on subsistence uses from industry activities. Innupiat hunters report that this measure is critical for reducing adverse impacts of industry activity on their subsistence hunts.

History of Implementation: Limitation of aircraft activity in the vicinity of the hunts has been consistently required for years during exploration activities in the Beaufort Sea.

Practicability: Although limitation of air activity around the particular subsistence hunting activities does incur some cost to industry, industry has worked with the various communities along the Beaufort and Chukchi seas to establish communication centers during the open water season to avoid conflicts and have also include design measures in programs to move activities from one area to another to avoid conflicts.

Recommendation: Based on the importance of implementing this measure to ensure no unmitigable adverse impact to subsistence uses, it makes sense to continue requiring this measure of industry operators.

Walrus – This mitigation measure applies to all open-water exploration activities and is intended to ensure no unmitigable adverse impacts to the availability of marine mammals (particularly bowhead whales) for subsistence uses. This mitigation measure is similar to B1, but, as it specifically concerns the reduction of potential conflicts with subsistence hunting of bowhead whales, it is more limited in time and areas of implementation and would not likely be an effective mitigation measures for walrus.

***Polar Bears* –** This mitigation measure applies to all open-water exploration activities and is intended to ensure no unmitigable adverse impacts to the availability of marine mammals (particularly bowhead whales) for subsistence uses. This mitigation measure is similar to B1, but, as it specifically concerns the reduction of potential conflicts with subsistence hunting of whales, it is more limited in time and areas of implementation and would not likely be an effective mitigation measures for polar bears.

4.5.3.2.4 Standard Mitigation Measures Summary for Subsistence

In general, the Standard Mitigation Measures discussed above would avoid or reduce the disturbance of marine mammals and other resource harvests for subsistence purposes, or would avoid or reduce interference with subsistence activities. Using the impact criteria identified in Table 4.5-25, the direct and indirect effect of oil and gas exploration activities on subsistence resources resulting from implementation of Alternative 2 would be of low intensity, temporary in duration, local to regional in extent, and the context would be common to important. Therefore the summary impact level of Alternative 2 on subsistence resources and harvests would be considered to range from negligible to minor depending upon the specific subsistence resource affected and source of disturbance.

4.5.3.2.5 Additional Mitigation Measures for Subsistence

Additional mitigation measures are outlined in Section 2.4.11 and described in detail in Appendix A. These measures may, or may not, be incorporated in future permits and authorizations, depending on the specific activity and the analysis conducted pursuant to the MMPA and the OCS Lands Act. See Sections 2.4.2 and 4.3 for an explanation of how specific measures would be chosen for inclusion in any future permits or authorizations. The following are applicable to mitigating effects of oil and gas exploration activities on marine mammals.

Of note, the Marine Mammal section contains more additional mitigation measures that are intended to reduce impacts to multiple species (e.g., bowheads, belugas, and ice seals), and those measures, if required and implemented, would indirectly reduce impacts to subsistence uses.

Additional Mitigation Measure B1. Temporal/spatial limitations to minimize impacts in particular important habitats, including Kaktovik, Barrow Canyon, Hanna Shoal, the shelf break of the Beaufort Sea, and Kasegaluk Lagoon, and Ledyard Bay Critical Habitat Unit.

Section 4.5.2.4.16 contains the full analysis for this mitigation measure. As noted in that section, this additional mitigation measure would also help to reduce impacts to the following hunts: the fall bowhead whale hunt by the community of Kaktovik; the fall bowhead whale hunt by the communities of Barrow and Wainwright; and the late spring/early summer beluga hunt by the community of Point Lay. Additionally, adverse impacts to some subsistence sealing would also potentially be reduced.

Additional Mitigation Measure D1. No transit of exploration vessels into the Chukchi Sea prior to July 15 or until the beluga hunt is completed at Point Lay. Any vessel transiting through the Chukchi Sea for the purpose of conducting geophysical work in the Chukchi Sea should remain at least 8 km (5 mi) offshore during transit except for emergencies or human/navigation safety. Actual geophysical operations shall not be conducted within 96.5 km (60 mi) of any point on the Chukchi Sea coast. Oil and gas exploration operators would need to communicate with local hunters to ascertain the hunting end date.

Applicable Activities: 2D/3D seismic surveys, including in-ice seismic, CSEM surveys, site clearance and high resolution shallow hazards surveys, and exploratory drilling activities, and associated support vessels

Purpose: The purpose of the mitigation measure is to minimize conflict with the beluga whale hunt at Point Lay and Wainwright. It would also reduce disturbance from vessels on bowhead whales migrating east in that time frame, although most bowhead whales have already migrated past these areas by July.

Science, Support for Reduction of Impacts, and Likely Effectiveness*:* The science behind the mitigation measure is contained in Section 4.5.2.4.10, Beluga Whales, of the EIS. Deflection due to noise and vessel presence could cause whales to avoid subsistence harvest areas, which could make the whales less available for harvest.

The potential effectiveness of the mitigation measure is not well known. The discussion in Section 4.5.3.2 , Subsistence, indicates that most of the beluga hunt occurs from late June to mid-July inside Kasegaluk Lagoon or other inshore locations inside the barrier islands. As such, the prohibition against conducting geophysical activity within 96.5 km (60 mi) of the Chukchi Sea coast seems somewhat excessive in order to prevent interference with the subsistence hunt at Point Lay, which occurs at nearshore locations. However, there is some concern amongst subsistence hunters that belugas that may be disturbed by operations offshore may not enter into the nearshore areas, thus reducing the number of animals available for the hunt.

BOEM lease stipulation 7 and the standard requirement placed in G&G permits based on the FWS BO prohibits transit of exploration vessels and seismic activity in the LBCHU, which will keep those vessels outside of the harvest area. However, the concern still remains about affecting belugas farther offshore.

History of Implementation: NMFS required a similar measure in IHAs until 2008. However, this measure has not been required in recent years.

Practicability: Limiting entrance into the Chukchi Sea until after July 15 could shorten exploration periods during the open water period in both the Beaufort and Chukchi seas by preventing activity and staging prior to this time. Operators often begin entering the Chukchi Sea around July 1 (or as soon thereafter as ice conditions allow) so as to be at the activity location a few days or one week later (depending on site location).

Recommendation: This measure should be revised to require operators to ensure all vessel traffic remains at least 8 km (5 mi) offshore when transiting through the Chukchi Sea prior to July 15.

Additional Mitigation Measure D2. Vessels transiting east of Bullen Point to the Canadian border should remain at least 8 km (5 mi) offshore during transit along the coast, except for emergencies or human/navigation safety.

Applicable Activities: All exploration activities

Purpose: The purpose for which the mitigation measure is intended is to avoid conflict with the subsistence hunt in the nearshore region, but would also reduce the potential for vessel disturbance to marine mammal subsistence resources hunted near Nuiqsut and Kaktovik.

Science, Support for Reduction of Impacts, and Likely Effectiveness*:* Subsistence mapping of Nuiqsut, Kaktovik, and Barrow (MMS OCS Study 2009-003) and described in the Draft EIS indicates most intense use in in the nearshore area of the coast, although not all the area described in the mitigation measure is intensely used. The measure would likely be effective in preventing use conflicts.

History of Implementation: NMFS has not required this measure in the past.

Practicability: Operators could incur costs and lost survey time associated with altering transit routes farther offshore. However, operators have shown that routes can be altered in the Chukchi Sea to remain farther offshore.

Recommendation: This sort of mitigation measure is supported by current scientific literature, and specific transit routes have been successfully implemented without apparent conflicts with safe operations in the past. However, because specific transit routes in this particular area have not been required previously, it will be important to evaluate this measure on a case by case basis before requiring.

Additional Mitigation Measure D3. 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.

Applicable Activities: All exploration activities

Purpose: The purpose for the mitigation measure is to avoid conflict with the subsistence hunt and give both the hunters and operators flexibility in when they stop activities in the vicinity of Nuiqsut and Kaktovik. As the hunters commence whaling activities, the exploration activity would move out of the area. Therefore, there would be fewer disturbances to bowhead whales from exploration activities, but whaling activities also result in disturbance to the animals.

Science, Support for Reduction of Impacts, and Likely Effectiveness: Subsistence mapping of Kaktovik and Nuiqsut bowhead use areas (MMS OCS Study 2009-003, Map 64 and 65 and 113 and 144, respectively) indicates overall and most intense use areas. As the hunters commenced whaling activities, they would communicate with industry vessels via the designated communication protocols and the exploration activity would move out of the area. Therefore, there would be less chance that the industry activities would either disturb bowhead whales or otherwise interfere with the bowhead hunt. As noted earlier in this EIS, cessation of activities at the time of a whale hunt reduces the potential for conflicts between hunters and operators and also reduces impacts to the animals.

History of Implementation: NMFS has not required this measure in the past.

Practicability: Although industry could incur costs associated with shutting down operations, basing closures on real time reporting could lead to shorter closure periods and reduced survey down time. Specific protocols for real-time communication would need to be determined in order for this measure to be practicable.

Recommendation: If measures for real-time communication to shutdown activities can be determined, this measure could replace Standard Mitigation Measure D1.

Additional Mitigation Measure D4. Shutdown of exploration activities in the Beaufort Sea for the Barrow bowhead whale hunts from Pitt Point on the east side of Smith Bay to a location about half way between Barrow and Peard Bay from September 15 to the close of the fall bowhead whale hunt in Barrow.

Applicable Activities: All exploration activities

Purpose: The purpose for the mitigation measure is to avoid conflict with the subsistence hunt and give both the hunters and companies certainty regarding when they stop activities in the vicinity of Barrow. On the date indicated, the exploration activity would move out of the area. Therefore, there would be less disturbance to bowhead whales from exploration activities.

Science, Support for Reduction of Impacts, and Likely Effectiveness: As noted in other parts of this document, cessation of activities has the potential to reduce impacts on marine mammals and therefore to reduce the potential for interference with subsistence hunts of marine mammals. However, the geographic area in this measure does not correspond to the historic overall use area or the most important high use area for fall bowhead whale hunting by crews in Barrow. Data indicate that the hunting grounds do not extend to the west side of Smith Bay or to Peard Bay. The measure has the potential to be effective, as it replicates agreed to conditions for exploration activities by some oil and gas operators. However, the overall areal extent of the measure is not supported by available information on subsistence use areas.

History of Implementation: NMFS required a similar measure in past IHAs. However, this measure has not been required in recent years.

Practicability: Although industry could incur costs associated with shutting down operations, shutdowns for subsistence activities in the Beaufort Sea have proven practicable in the past.

Recommendation: NMFS recommends that if this measure is to be included in future ITAs, the geographic extent should be re-defined to more closely match with current fall whaling areas. Additionally, this measure may benefit from real-time communication instead of a fixed date, allowing for flexibility in the shutdown date. This measure would be assessed on a case-by-case basis, with spatiotemporal overalap of the activity playing a key role in whether or not it would be included in an authorization.

Additional Mitigation Measure D5. 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.

Applicable Activities: All exploration activities

Purpose: The purpose for the mitigation measure is to avoid conflict with the subsistence hunt and give both the hunters and companies flexibility in when they stop activities in the vicinity of Barrow. As the hunters commence whaling activities, the exploration activity would move out of the area. Therefore, there would be fewer disturbances to bowhead whales from exploration activities, but whaling activities also result in disturbance to the animals. The purpose for the mitigation measure is to avoid conflict with the subsistence hunt and give both the hunters and companies flexibility in when they stop activities in the vicinity of Barrow. As the hunters commence whaling activities, the exploration activity would move out of the area. Therefore, there would be fewer disturbances to bowhead whales from exploration activities, but whaling activities also result in disturbance to the animals.

Science, Support for Reduction of Impacts, and Likely Effectiveness*:* The potential effectiveness of the mitigation measure is low, as it does not correspond to areas where most intense bowhead whaling takes place. However, any reduction in activity has the potential to reduce overall impacts.

History of Implementation: NMFS has not required this measure in the past.

Practicability: Although industry could incur costs associated with shutting down operations, shutdowns for subsistence activities in the Beaufort Sea have proven practicable in the past.

Recommendation: This measure should be removed and changed to reflect current fall whaling areas by the communities of Barrow and Wainwright in the Chukchi Sea.

Additional Mitigation Measure D6. Shutdown of exploration activities in the Chukchi Sea for the Point Hope and Point Lay bowhead whale hunts based on real-time reporting of whale presence and hunting activity rather than a fixed date.

Applicable Activities: All exploration activities

Purpose: The purpose for the mitigation measure is to avoid conflict with the subsistence hunt and give both the hunters and companies certainty in when they stop activities in the vicinity of Point Hope and Point Lay.

Science, Support for Reduction of Impacts, and Likely Effectiveness: The science behind the measure is not clear. Exploration generally cannot begin in the Chukchi Sea until the ice has retreated, which is well after the completion of the spring whale hunts in the communities. Successful fall whaling in these communities is not historically undertaken from these communities. Hunters from Point Lay and Point Hope typically travel to Barrow or other communities that conduct fall bowhead whale hunts. Distance of the coastal buffer does not appear to correspond to reported use areas. Point Lay subsistence activities are currently "buffered" by BOEM Lease Stipulation 7, and requirements for exclusion of vessel traffic related to BOEM permitted and authorized activities in the FWS BO effectively curtails exploration activities from occurring within the LBCHU. It is not clear how effective the measure will be.

History of Implementation: NMFS has not required this measure in the past.

Practicability: Although industry could incur costs associated with shutting down operations, shutdowns for subsistence activities have proven practicable in other parts of the U.S. Arctic in the past.

Recommendation: This measure is not recommended for inclusion.

Additional Mitigation Measure D7. 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.

Applicable Activities: All exploration activities

Purpose: The purpose for the mitigation measure is to avoid conflict with the subsistence hunts in Barrow and the Chukchi Sea communities.

Science, Support for Reduction of Impacts, and Likely Effectiveness*:* The science behind the mitigation measure is contained in Section 4.5.3.2, Subsistence, of the Draft EIS. Deflection due to noise and vessel presence could cause whales to avoid subsistence harvest areas, which would make the whales unavailable for harvest. Discussion indicates that not all marine mammals have pronounced avoidance behaviors or are hunted during the period in which transits would take place.

The potential effectiveness of the mitigation measure is marginal. As the discussion in Section 4.5.3.2 , Subsistence, indicates, most of the beluga hunt occurs from late June to mid-July inside Kasegaluk Lagoon or other inshore locations inside the barrier islands. The terminology "travel under certain conditions" is vague as it defines neither the type of travel nor the conditions. The distance of 32 km (20 mi) appears to be arbitrary, with no definitive basis identified in the analysis.

History of Implementation: NMFS has not required this measure in the past.

Practicability: While oil and gas operators have shown that they are able to abide by transit distances from shore in the past, the reason for this measure is unclear.

Recommendation: This measure is not recommended for inclusion.

Additional Mitigation Measure D8. For exploratory drilling operations in the Beaufort Sea west of Cross Island, no drilling equipment or related vessels used for at-sea oil and gas operations shall be

moved onsite at any location outside the barrier islands west of Cross Island until the close of the bowhead whale hunt in Barrow.

Applicable Activities: Exploratory drilling activities

Purpose: The purpose for the mitigation measure is to avoid conflict with the Barrow subsistence hunt.

Science, Support for Reduction of Impacts, and Likely Effectiveness: As noted earlier in this EIS, ceasing activities prior to and during a subsistence hunt reduces impacts to the individual animals and also elimates the possibility of interference between the hunters and the operators. The measure would likely be effective at reducing or eliminating the potential for interference with the hunt. Equipment would need to be moved to a location agreed upon with the affected subsistence users to ensure that the "stand-by" location does not create impacts to the hunters.

History of Implementation: NMFS has not required this measure in the past.

Practicability: While the oil and gas operators have shown that they are able to conduct temporary shutdowns for subsistence hunts, there are extra costs that are incurred. Additionally, this measure does not specify if activities could occur up until a specific time prior to the hunt.

Recommendation: This measure needs to be better defined before it is considered for inclusion.

Collectively, Additional Mitigation Measures D1 through D8 could be required for issuance in ITAs (as described in Sections 2.4.2 and 4.3) and are intended to reduce impacts to marine mammal subsistence users in the various communities. The efficacy of previous similar mitigation measures is described by subsistence hunters who have reported the following observations:

> *On the Chukchi we have a big wide buffer, a 25-mile wide buffer zone that goes way down -- all the way down near Point Hope. That's there for us. That's -- we're the ones that's taking the impact. I mean all these years we've been asking, ever since the lease sales start occurring, to protect our subsistence whales. And so far up today that we haven't received a buffer [near Cross Island]* - Thomas Napageak Jr. Nuiqsut Public Scoping Meeting on March 11, 2010.

4.5.3.2.6 Additional Mitigation Measures Conclusion for Subsistence

The additional mitigation measures considered in this section would have the potential to further reduce the potential of adverse effects on subsistence resources. Given the standard and additional mitigation measures the effects on subsistence resources would likely be considered low intensity, temporary in duration, local to regional in extent, and the context would be common to important. Therefore the summary impact level of Alternative 2 on subsistence resources and harvests with additional mitigation measures applied would be considered to range from negligible to minor depending upon the specific subsistence resource affected and source of disturbance.

4.5.3.3 Public Health

The level of impacts on public health and safety will be based on levels of intensity, duration, geographic extent, and context, as shown in Table 4.5-27.

Table 4.5-27 Impact Levels for Effects on Public Health and Safety

Impact Component	Effects Summary		
Magnitude or Intensity	**Low**: Affects one health indicator in a single community	**Medium**: Affects multiple communities or multiple health indicators in a single community	**High**: Affects multiple health indicators in multiple communities throughout the region
Duration	**Temporary**: Changes in health indicators last for less than one year	**Long-term**: Changes in health indicators extend up to several years	**Permanent**: Changes in health indicators persist after actions that caused the impacts cease
Geographic Extent	**Local**: Affects individuals in a single community	**Regional**: Affects two or more communities in the EIS project area	**State-wide**: Affects communities throughout the EIS project area
Context	**Common**: Affects communities that are not minority or low-income	**Important**: Not Applicable	**Unique**: Affects minority or low-income communities

4.5.3.3.1 Direct and Indirect Effects

This section describes the direct and indirect effects of Alternative 2 on six important pathways that may affect the health and well-being of the people who live in the study area:

- Diet and nutrition;
- Contamination;
- Safety;
- Acculturative stress;
- Economic impacts; and
- Health care services.

Figure 4.5-2 summarizes the complex relationships between the environmental and social factors that could be impacted by the action alternatives and the factors that comprise health and well-being in the affected communities.

Diet and Nutrition

Changes in diet and nutrition are common potential effects of oil and gas exploration activities where there are populations that rely on subsistence resources. These changes can lead to a number of important public health outcomes.

For indigenous populations, a traditional diet has been shown to be strongly protective against chronic diseases. The traditional diet in Alaska is associated with reduced risk of chronic diseases such as diabetes, high blood pressure, high cholesterol, heart disease, stroke, depression and arthritis (Chan et al. 2006, Dewailly et al. 2001, Dewailly et al. 2002, Din et al. 2004, ADHSS 2005, Murphy et al. 1995, Ebbesson et al. 2007, Reynolds et al. 2006, Murphy et al. 1995, Adler et al. 1994, Adler et al. 1996, Ebbesson et al. 1999).

Decreasing intake from subsistence diets is usually associated with an increased reliance on store-bought foods. Some studies have shown that the nutritional value of store-food available in rural Alaskan villages tends to be low (high in saturated fat, sugar and salt), and that the cost of buying nutrition-dense food (such as fruits, vegetables and whole grains) is often prohibitively expensive (Bersamin and Luick 2006). The result is that when subsistence resources become unavailable and people rely more heavily on store-bought foods to replace traditional sources, the nutritional value of the diet decreases, and the risk of developing problems such as diabetes increases (Murphy et al. 1997, Young et al. 1992, Bjerregaard et al. 2004). Therefore, any change away from a subsistence diet is likely to cause an increase in metabolic disorders such as obesity, heart disease, and diabetes.

Food insecurity is another potential outcome associated with a shift away from subsistence diets. Food insecurity refers to an inability to secure sufficient healthy food for a family. Studies of food insecurity and health have found a variety of detrimental health impacts including overweight/obesity, poor psychological functioning among children, poor cardiovascular health outcomes, and lower physical and mental health ratings (Olson 1999, Stuff et al. 2004, Seligman et al. 2010). The high cost of store-bought food, the costs associated with harvesting of subsistence resources, and the year-to-year variation in subsistence resource availability is all implicated in high rates of food insecurity in many northern indigenous populations.

As described in Section 3.3.3.5, the reliance on subsistence foods is very high in the NSB. In the 2010 NSB census, between 44 and 67 percent of households indicated that they get at least half of their meals from subsistence sources, and virtually all Iñupiat households reported relying on subsistence resources to some extent (Circumpolar Research Associates 2010). As described in Section 4.5.3.2 (Subsistence), in Kotzebue and Kivalina an estimated 78 to 95 percent of households actually harvest subsistence foods and 100 percent of households use subsistence foods. As described in Chapter 3, rates of obesity, diabetes and heart disease–all outcomes associated with dietary changes towards less-healthy foods—have been rising rapidly in the study area over the last several decades. This combination of a high reliance on subsistence foods and metabolic changes in the population means that changes to the availability or quality of subsistence resources could have severe detrimental impacts on nutritional health outcomes and food insecurity for the local population. A compensating factor is that the wide variety of traditional food sources has provided most communities with the ability to adapt to transient changes in availability of single species. This has historically helped temper the dietary and nutritional impact of year-to-year variability in the success of the hunt.

Summary

Activity levels pursuant to Alternative 2 are not expected to have a significant impact on the numbers of marine mammals harvested in any community in the study area, as discussed in Section 4.5.3.2. Although dispersion of some animals may result in greater travel time and cost, the overall availability and subsequent consumption levels of traditional foods is not expected to change. Therefore, changes in diet and health outcomes resulting from decreased subsistence availability are not anticipated.

The potential for diet and nutrition to be affected via increased income to hunters is discussed below under *Economic Impacts*. The potential for diet and nutrition to be affected via perceived safety of subsistence foods is discussed below under *Contamination*.

Contamination

Offshore oil and gas activity has the potential to produce a number of environmental contaminants that may be harmful to human health. These include polycyclic aromatic hydrocarbons (PAHs) such as benzene, toluene, ethylbenzene, and xylene, and heavy metals such as arsenic, lead, cadmium and mercury. Chronic exposure to these substances can increase the risk of cancer and may have other effects on the respiratory, pulmonary, gastrointestinal, renal, or dermatologic systems (ATSDR 2009).

Whether any health effects manifest from exposure to environmental contaminants depends on several factors, including the nature of the contaminant, the amount and duration of exposure, and the sensitivity of the person who comes in contact with the contaminant. In the case of the NSB and NAB communities, exposure could occur through the consumption of contaminated subsistence food sources.

A number of studies have examined the current contaminant load in marine mammal species used for subsistence purposes in the North Slope communities, including bowhead whales, beluga whales, seals, walrus and polar bear. The range of contaminants examined has included polychlorinated biphenyls (PCBs); dichlorodiphenyltrichloroethane (DDT); heavy metals; organochlorines, including chlordanes; and PAHs.

Elevated levels of contaminants were found in several of these species (Becker 2000). However, the levels found in subsistence foods in the North Slope area appear at present to be generally low compared with other Arctic areas (NSB 2006). Bowhead whales in particular appear to have contaminant levels lower than those found in other whale species (USDC 2008). The current levels of contaminants in subsistence foods in the North Slope area are lower than what would trigger public health concern (NSB 2006) and "do not represent a threat to the health of subsistence users at current levels" (USDC 2008, Wetzel et al. 2008).

Aside from actual exposure to environmental contamination, the *perception* of exposure to contamination is also linked with known health consequences. Perception of contamination causes stress and anxiety about the safety of subsistence foods and avoidance of subsistence food sources (CEAA 2010, Loring et al. 2010), which may result in changes in nutrition-related diseases. 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 toxicological effects in humans; the effects are linked to the perception of contamination, rather than to measured levels.

However, many Iñupiat residents of the NSB have reported that they are concerned that current and/or future oil and gas activities could increase contaminant loads of subsistence foods to a level that would threaten human health (Poppel et al. 2007). Concerns center around accidental oil spills, persistent leaks, and poor waste management practices. In a recent survey, 44 percent of Iñupiat village residents outside of Barrow reported concern that fish and animals may be unsafe to eat (Poppel et al. 2007). Residents have also indicated that they believe that established contaminant thresholds developed by regulatory bodies do not take into consideration the large amounts of fish or game consumed by the Iñupiat but rather were developed based on the consumption levels of the general population (BLM 2005).

Summary

Current levels of contamination in subsistence food sources are low. As described in Section 4.5.3.2, the permitted discharges associated with Alternative 2 are likely to result in only a minor change in the availability of subsistence resources, although the predicted contaminant load of marine mammals, fish, and seabirds is not discussed. Except in the event of a very large oil spill (discussed in Section 4.10), there are likely to be only negligible to minor health effects from contamination of food sources as a result of the activities associated with Alternative 2.

However, even at the current low levels of contaminants, perception of contamination is widespread in the EIS project area. The level and nature of the activity specified under Alternative 2 may add to this perception. Although any anticipated change in risk perception will likely be below the threshold required to see measurable changes in health outcomes, ongoing oil and gas exploration activity has the potential to reduce confidence in subsistence resources and subsequent consumption. The potential for these impacts is addressed in the cumulative impact assessment in Section 4.10.

Acculturative Stress

Acculturation is a commonly used concept to describe the psychological and cultural impacts of rapid modernization and loss of tradition. Studies have found rapid cultural change to be linked to a wide variety of health outcomes, ranging from impaired mental health and social pathology (such as substance abuse, violence and suicide) to cardiovascular disease and diabetes (Curtis et al. 2005, Bjerregaard 2001, Shephard and Rode 1996). While acculturation can affect any population experiencing rapid change, it is a particularly common problem in indigenous populations, including the Iñupiat, other Arctic populations such as the Inuit, and aboriginal populations in Australia (Inuit Tapirisat of Canada 2000, Smylie 2009).

The specific health impacts of acculturation in the Iñupiat are well documented; for example, the shift away from a nutrient-rich traditional diet and towards store bought and western foods is associated with cardiovascular risk and obesity (Curtis et al. 2005). Similarly, the transition from a traditional to a wage economy and lifestyle may play a role in cardiovascular disease and diabetes in part due to the associated decrease in physical activity (Murphy et al. 1992, Ebbesson et al. 1998, Jørgensen et al. 2002). However, equally if not more important is the loss of the sociocultural value of subsistence: traditional foods are highly valued among circumpolar populations, as they are considered to be “healthy and provide strength, warmth and energy in ways that store-bought food do not” (Arctic Climate Impact Assessment 2004). Subsistence foods contribute to cultural identity, tradition, and social cohesion. The enjoyment of traditional foods is seen to be of equal cultural value to speaking the native language (Kleivan 1996, Searles 2002).

Identity and involvement in cultural activities provide numerous benefits to Alaska Natives: improved self-esteem (Zimmerman et al. 1996); enhanced resiliency in harsh life circumstances (Belcourt-Dittloff 2006, Walters and Simoni 2002); and diminished feelings of historical loss (Whitbeck et al. 2004). Participation in American Indian traditional activities has been found to be protective against substance use problems and risk (Herman-Stahl et al. 2002, Lysne 2002, Winterowd et al. 2005) and suicide attempts (Garroutte et al. 2003, Lester 1999). Evidence suggests that focusing on culture to promote health and prevent disease in Arctic communities may provide value (Curtis et al. 2005); indeed, health promotion professionals often promote traditional culture as a population health intervention.

The importance of Iñupiat participation in subsistence activities and consumption of subsistence foods extends beyond their nutritional and dietary importance: the hunt and consumption of subsistence foods involve cultural, traditional, and spiritual activities that involve the entire community. Of particular importance among subsistence activities is the bowhead whale hunt. The Iñupiat have hunted the bowhead whale for over 2,000 years (Stoker and Krupnik 1993), and the whale hunt continues as a cornerstone of diet, social organization, and cultural survival (Brower et al. 1998, Michie 1979).

Oil and gas exploration in the Arctic, and the rapid modernization associated with the development of this resource, has led to many of these symptoms being observed in the NSB and similar communities (Ahtuangaruak 2003, BLM 2004). In *Gift of the Whale*, Bill Hess highlights an unsuccessful bowhead hunt in 1982 (Hess 1999). The news that no whales had been caught for the season was “greeted with frustration and anger”, whereas during years with a good hunt, social problems were described to virtually disappear. These sentiments, and the resulting social pathologies, are shared by this public testimony:

> *We had seismic activity in Camden Bay that caused us to lose two whaling boats. We did not harvest whale two seasons in a row. We went without whale those winters. Those were the deepest, darkest winters I faced as a community health aide. We saw an increase to the social ills, we saw domestic violence, we saw drug and alcohol abuse, we saw all the bad things that come when we are not able to maintain our traditional life activities.* (BLM 2004)

In the NSB, whaling is seen as a “physical, emotional, and spiritual experience” which provides self-confidence and unites the communities (Brower et al. 1998). A report analyzing potential restrictions on the bowhead hunt described that the bowhead hunt held particular importance to this culture and found that where societal changes had weakened cultural ties, particularly in younger Iñupiat, whaling had "revitalized interest in traditional culture" among this age group (Hankins 1990). Traditional skills are passed on to younger generations, and traditional social structure and the Iñupiat cultural identity are reinforced (Worl 1979, Braund and Associates 1997). The whale hunt is "one of the greatest concentrations of community-wide effort and time" (USDC 2008). Most of the village is involved in some part of the whale hunt, and the proceeds are shared and enjoyed in feasts and celebrations. Where in many aspects of Iñupiat life cultural changes have taken place at the expense of tradition, the whale hunt remains "key to the survival of [Iñupiat] culture" (Brower et al. 1998).

Although acculturative stress is a concern among the Iñupiat, the strength of traditional culture and local institutions, and in particular the value and stability of the bowhead hunt, provide a strongly protective effect against the health impacts of acculturation.

Summary

The communities that will be most impacted by industrial activity (crew changes and staging for offshore exploration) are Deadhorse and Barrow. Deadhorse is an enclave development specifically built for industrial use. Consequently, increased activity in Deadhorse associated with Alternative 2 will have no impact on health as a result of acculturative stress. Similarly, Barrow is accustomed to a transient and non-indigenous workforce and a wage economy. The small increase in activity level associated with Alternative 2 is unlikely to result in a significant change in acculturative stress in Barrow and will not cause measurable changes in health in the community.

The use of Wainwright as a staging site for activity within the Chukchi Sea is likely to result in some acculturative stress, given the community's smaller size and more traditional nature. It is unlikely, however, that this stress will be great enough to cause measurable health impacts.

The greatest risk to the Iñupiat with regard to the health impacts of acculturative stress would arise from a major and persistent decline in the success of the bowhead hunt in any single community. This is not an anticipated result of the activity levels associated with Alternative 2, and, thus, the anticipated health impacts remain negligible.

Safety

In indigenous populations in Alaska and across North America the rate of accidents and trauma is very high (ANTHC 2008; Day et al. 2006). This is particularly true in the Arctic populations of Alaska and Canada and is reflected in the statistics for hospitalizations and deaths from injuries (McAninch 2010). A large part of this burden is a result of the risks inherent to subsistence activities in an often hostile environment. Not surprisingly, the indigenous people of the Arctic have a strong concern for safety.

For the Iñupiat, harvesting of marine mammals requires travel in small open boats in the Beaufort and Chukchi seas, camping at the edge of shorefast ice, and travel by snow machines and sleds across sea ice. Local history provides numerous examples of both fatal accidents and near misses, the details of which are recounted and dissected to provide warnings and lessons for other hunters. Weather and ice conditions are constant topics of discussion. Traditional knowledge provides the base for interpretation of current conditions and risks and allows for adaptation and responses to help mitigate or avoid the dangers associated with subsistence activities.

Some hunters are concerned that safety has already been compromised by climate change and offshore exploration activity. Shorefast ice is less predictable in recent years (George C. 2011) and may be associated with an increased risk of break-offs (USDC 2008). Anecdotal reports suggest that hunters believe that offshore seismic activity has already caused deflection of whales from their migratory paths, requiring them to travel further to successfully complete an open water hunt. This could lead to a greater risk of hazardous open water incidents. For example, unfavorable weather conditions could suddenly arise while a crew is far offshore.

Icebreaking activity could result in the isolation of hunting groups or weakening of ice for those traveling over the sea ice to hunting areas (Brubaker et al. 2011). *Changes in ice quality secondary to icebreaker travel would most likely impact communities during the early winter hunts for seals and polar bears. Icebreaking activity close to shore or to and from staging areas is of particular concern as it has the highest likelihood to intersect travel routes of local hunters.*

Injury and trauma will continue to be a significant public health concern, tempered primarily by the strong local search and rescue capacity, traditional knowledge and communication between hunters.

Summary

The main contributor to public safety impacts arising from Alternative 2 is the potential for water and ice safety issues during hunts. Water safety will be compromised should the dispersion of marine mammals occur, which will result in longer and riskier travel for subsistence activities.

Open water hunts for bowhead in the fall (occurring in Barrow, Kaktovik, Nuiqsut, and Wainwright) are likely to carry the greatest risk, along with greater travel for hunters in Point Lay if beluga are significantly dispersed from the lagoons.

The primary concern with regard to ice safety is if icebreaking activities were to result in disruption of sea access for winter hunting. Early winter hunting for seals and polar bears in areas of icebreaking could cause some increased risk, particularly during travel to and from hunting grounds. The limited amount of icebreaking activity and the separation of icebreaking from traditional hunting will minimize this risk, and the overall risk can be classified as minor. Additionally, the use of Com Centers will reduce this risk.

Economic Impacts

Industrial development often impacts population health through changes to the economic environment. Income and employment are fundamental determinants of health (Cox et al. 2004). Increased income directly or indirectly resulting from oil and gas activity has the potential to reduce impacts to health in affected communities by raising the standard of living, reducing stress, and providing opportunities for personal growth and social relationships (ACPH 1999). Income and employment may also strengthen community and cultural ties by providing money to fund subsistence activities, the health effects of which are described above. Conversely, low income increases risk of low birth weight babies, injuries, violence, most cancers, and chronic conditions (Yen and Syme 1999), and unemployment is associated with increased stress, depression, and anxiety, which are known contributors to cardiovascular disease (Doyle et al. 2005).

However, income and employment can also result in increased prevalence of social pathologies in some populations, including substance abuse, assault, domestic violence, as well as unintentional and intentional injuries. Fraternization of high-wage migratory workers with the local communities also has a tendency to increase rates of sexually transmitted infections in small communities (Goldenberg et al. 2008).

At present, most industrial activity in the study area has followed a model of enclave development with transient workers housed in camps in Deadhorse. Barrow provides most government and service jobs and has a mixed economy with a combination of wage employment and subsistence activities. Outside of Barrow, most communities have a fairly traditional economy; although some communities have expressed a desire to see an increase in investment and jobs.

Although the rate of sexually transmitted infections in the NSB is high, the current focus on enclave development and isolation of most communities from transient workers is likely protective against exacerbation of these rates. Additionally, some Alaskan data support the argument that with strong social and political systems, income can be channeled to provide positive influences for a community, such as increased access to health care and educational opportunities (Haley 2004).

Summary

The economic benefits resulting from Alternative 2 are not great enough to anticipate measurable changes in health status at either the individual or community level and should be classified as negligible. Similarly, the adverse impacts of increased cash in a community (typically manifesting as the social pathologies described in Chapter 3) are not anticipated to result from the activity levels of Alternative 2.

The presence of transient workers in Wainwright may result in some increase in alcohol and drug use or sexually transmitted infections if transit times through the community are prolonged and fraternization with locals is allowed.

Health Care Services

Resource development projects around the world have demonstrated the potential for increased demand on local health and social services when workers migrate to an area or when the local burden of disease changes (Utzinger et al. 2004, Calain 2008, Barron et al. 2010). An influx of resource development workers into an area can strain local health resources for trauma, injuries, and illness. Resource development projects may also directly or indirectly cause the increase of certain conditions, including alcohol/drug-related issues, social pathology and increased rates of infectious disease (Utzinger et al. 2004, Goldenberg et al. 2008, Barron et al. 2010). If this increased demand exceeds the capacity of local services, then community health may be affected by reduced access to, and quality of, available health and social services (Calain 2008, Barron et al. 2010). However, resource development projects in some instances can improve local service provision in remote communities by providing additional tax revenue to local government (Calain 2008, Barron et al. 2010).

Outside of Barrow, healthcare provision in NSB communities is limited and has little capacity to deal with increased demand. Daily care and emergency services are provided by Health Care Aides, and patients must either travel to see a physician or wait for a regularly scheduled physician visit. Acute injuries and trauma require local stabilization and air transfer to Barrow. These villages have little to no capacity to respond to increased demand or medical incidents. Barrow, which acts as the referral center for the NSB communities, has more adaptability and ability to respond should increase demand or an emergency occur (ASNA 2010). Search and rescue capacity, based out of Barrow, is strong.

Summary

Tax revenues from increased exploration activity in Alternative 2 may bolster the provision of health care services in the NSB; however, the impact would be negligible and would not be expected to result in any measurable change in population health outcomes. Acute care and search and rescue capacity in Barrow will be able to absorb any increase in demand that could be expected to result from illness and injury related to activity levels in Alternative 2.

Staging of crews in Wainwright could stress the limited resources of the local clinic, particularly if transit times through the community are prolonged, thereby potentially allowing for the spread of infectious disease. However, the most common way in which oil and gas crews interact with local health care facilities is as a result of injury, and the centralization of search and rescue operations in Barrow will minimize the impact on Wainwright's health care facilities.

4.5.3.3.2 Conclusion

The following table summarizes the public health and safety effects of Alternative 2. The definitions and rationale for each of the five criteria used can be found in Section 4.1.3 of this document.

Table 4.5-28 Summary of Effects on Public Health and Safety from Alternative 2

Impact Criterion	Effects Summary
Magnitude or intensity	Low: above background conditions, but within normal variation of human health conditions
Duration	Permanent: changes in health indicators persist after actions that caused the impacts cease
Geographic Extent	Regional: affects two or more communities in the EIS project area
Context	Unique: affects minority or low-income communities

Both potential beneficial and adverse impacts are anticipated as a result of Alternative 2. Possible changes could occur to health outcomes such as chronic disease and trauma and many of the pathways relate to traditional practices and subsistence activities. However, there is a very low likelihood of these health outcomes arising, and effects are unlikely to be large enough cause a measurable change in health outcomes. The magnitude or intensity of effects is estimated to be low: above background conditions, but small and within both the natural variation and adaptive ability of the local population. If health changes do occur, the duration of changes may be permanent, and multiple communities could be affected.

4.5.3.4 Cultural Resources

This section describes potential impacts to cultural resources from each of the alternatives described in Chapter 2. The information presented below has been derived from a review of records on file with the Alaska Office of History and Archeology, which document previously recorded archaeological sites and the results of previous archaeological inventory efforts conducted within the vicinity of the EIS project area. These records largely concern on-shore resources. An appropriate level of investigation, including intensive on-shore and offshore surveys; evaluations of all resources potentially eligible for listing on the National Register of Historic Places; assessments of adverse effects; and applicable mitigation of identified impacts, would be completed before any potentially destructive activities could begin.

Activities associated with lease operations (exploratory drilling and site clearance high resolution seismic surveys) will only occur on active leases, along potential pipeline corridors, and on leases acquired in future lease sales (both federal and state). Seismic surveys not specifically associated with a lease (i.e. 2D and 3D surveys) would occur over large areas within the EIS project area, and could occur either on- or off-lease. Active State of Alaska leases occur in the Beaufort Sea from the coastline out to three nautical miles, except in the areas of Harrison Bay and Smith Bay, which are considered historical bays thus extending the area beyond three nautical miles from the coastline. Most of the State's active leases are concentrated between Harrison Bay and Bullen Point. There are currently no State of Alaska leases in the Chukchi Sea. As of May 2011, the State has 360,435 acres on 189 leases in the Beaufort Sea. Exploratory activities (drilling and seismic surveys) could occur in any of these active state leases. The State of Alaska plans to conduct area-wide lease sales in the Beaufort Sea annually through 2017 (ADNR 2013), potentially adding new areas where exploratory activities could occur. Industry activities on State of Alaska Beaufort Sea leases in the recent past have largely been concentrated offshore between Harrison Bay and Bullen Point.

Exploratory activities will include 2D and 3D seismic surveys, site clearance and high resolution shallow hazards survey, on-ice seismic surveys in the Beaufort Sea, exploratory drilling located in offshore portions of the Beaufort Sea, and exploratory drilling in the Chukchi Sea.

Seismic surveys and clearance and hazards surveys are conducted using towed arrays, in-ice arrays, and ocean-bottom cable (OBC) or ocean bottom node (OBN) seismic surveys. OBC and OBN surveys are used 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. An OBC operation begins by laying cables off the back of a layout boat, using cable lengths of 4 to 6 km (2.5 to 3.7 mi) but occasionally up to 12 km (7.5 mi). 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, 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. Laying an array of cables on the seabed could potentially adversely affect surface cultural resources, if any exist in that location.

Towed arrays or in-ice arrays demonstrate little or no potential to damage offshore archaeological resources. OBC and OBN seismic surveys could potentially impact both prehistoric and historic archaeological resources, because the cables or receivers are placed on the seafloor instead of towed behind a survey vessel.

Three principal forms of exploratory drilling platforms are currently used in offshore exploration: artificial or natural islands; bottom-founded structures; and floating vessels. Exploratory wells are generally drilled vertically to simplify well design and maximize benefits from subsurface data collection (i.e. well logs, cores). Directional wells (any well that is not vertical) may be drilled if a suitable surface location cannot be used or if there is a subsurface anomaly that should be avoided. Like seafloor seismic surveys, exploratory drilling potentially could impact both prehistoric and historic archaeological resources.

The level of impacts on cultural resources will be based on levels of intensity, duration, geographic extent, and context, as shown in Table 4.5-29.

Table 4.5-29 Impact Levels for Effects on Cultural Resources

Impact Component	Effects Summary		
Magnitude or Intensity	**Low**: Disturbances in cultural resources may not be measurable or noticeable	**Medium**: Noticeable disturbances in cultural resources	**High**: Acute or obvious disturbance in cultural resources
Duration	**Temporary**: Disturbances in cultural resources last less than one year	**Long-term**: Disturbances in cultural resources extend up to several years	**Permanent**: Disturbances in cultural resources persist after actions that caused the impacts cease
Geographic Extent	**Local**: Affects cultural resources only locally	**Regional**: Affects cultural resources on a regional scale	**State-wide**: Affects cultural resources beyond a regional scale
Context	**Common**: Affects usual or ordinary resources; not depleted or protected by legislation	**Important**: Affects depleted resources within the locality or region or resources protected by legislation	**Unique**: Affects unique resources or resources protected by legislation

4.5.3.4.1 Direct and Indirect Effects

Nearly all potential direct physical impacts to cultural resources would occur during the exploratory and construction phases of project activities. Cables for towing seismic arrays on the seafloor would disturb cultural resources on the surface of the seafloor, and any coring could affect buried archaeological sites (including geomorphological features) and palaentological resources. There could also be impacts resulting from ground-disturbing activities that encounter additional cultural materials that, based on previous archaeological studies, were either thought to occur only at the surface (on-shore resources) or were previously undetected because they were completely buried (onshore and offshore resources). Improved access to remote on-shore areas could also increase the likelihood of looting or other damage to archaeological properties during the construction and operation phases of the project. Another impact that could occur from construction of on-shore project facilities would be visual intrusion effects to potential traditional cultural properties.

Direct effects to archaeological resources include those activities that physically impact the condition or integrity of the resource. Sea-floor based seismic activities and exploratory drilling could directly affect submerged prehistoric sites or historic vessels on the seafloor.

Indirect effects to offshore resources are unlikely, given that impacts would likely result during the exploratory phase of the project. Previously undiscovered resources, however, could be inadvertently damaged during this phase of the project. On-shore resources are more susceptible to indirect effects and can include inadvertent damage, looting caused by the introduction of increased access and local activity; and visual impacts to historic or traditional cultural properties.

4.5.3.4.2 Conclusion

Compliance with existing federal, state, and local archaeological regulations and policies and the application of 30 CFR 550.194 regarding the protection of archaeological resources and 30 CFR 551.6 (a)(5) regarding G&G Explorations of the Outer Continental Shelf and the provision to avoid disturbing archaeological resources, will reduce or eliminate most impacts to archaeological resources. Therefore, no impacts or only negligible impacts to archaeological resources are anticipated. To ensure compliance, prior to exploratory drilling of a well, lessees may be required to conduct surveys to detect archaeological resources. Lessees may also be required to conduct analyses and/or provide reports if proposed activities are of the type that have the potential to cause effects on historic properties. These surveys may be collected over portions of individual lease blocks or several contiguous lease blocks depending on the likelihood that historic or prehistoric resources may be present. These surveys would typically need to be completed at least one season in advance of a drilling operation. Alternatively, since it is difficult to assess effects in the absence of information, federal agencies may request archaeological reports of contiguous seismic areas or post-seismic archaeological reports rather than completion of a survey in advance of a drilling operation. Companies may also use high resolution geophysical equipment to survey off-lease areas for possible subsea pipeline routes. As a result of these studies, many submerged archaeological resources can be identified prior to seafloor disturbing activities and resources can be avoided.

Direct and indirect impacts to cultural resources resulting from the implementation of Alternative 2 would be low-intensity and long-term in duration, but in a very localized area and affecting resources that are common in context. Therefore, the summary impact level of Alternative 2 on cultural resources would be considered negligible.

4.5.3.5 Land and Water Ownership, Use, and Management

The level of impacts on land and water ownership, use, and management will be based on levels of intensity, duration, geographic extent, and context, identified in Table 4.4-2 (Alternative 1).

4.5.3.5.1 Direct and Indirect Effects Land and Water Ownership

Federal Ownership

Because federal processes involved in seismic exploration and exploratory drilling (see Section 2.3.1) utilize leases and do not result in any change in existing leasing rights or the sale or transfer of any federal land or waters, no direct or indirect change in underlying land or water ownership is anticipated. This includes federal waters (from 3 to 200 nm), the Arctic National Wildlife Refuge (ANWR), the National Petroleum Reserve-Alaska (NPR-A), Alaska Maritime National Wildlife Refuge, and Cape Krusenstern National Monument. Additional conditions may be attached to federal exploration activity authorizations and permits to avoid or mitigate adverse effects.

State Ownership

Because state processes involved in seismic exploration and exploratory drilling (see Section 2.3.1) utilize leases and do not result in any change in existing leasing rights, or the sale or transfer of any state land or waters, no direct or indirect change in underlying land or water ownership is anticipated. This includes state waters (shore to the 3 nm limit), state lands, and state selected lands. State land selections have already been established, and their conveyance is not influenced by the implementation of this project alternative.

Private Ownership

Because the project does not involve any ANCSA corporation lands or Alaska Native allotments, no direct change in land ownership is expected. Support activities are anticipated to use existing facilities or new facilities built on private lands; however, no foreseeable indirect effects on land ownership will result. This private ownership includes Native corporation lands (village and regional [with some selections still under the ownership of the federal government]), and Native allotments. Alaska Native Corporation land selections have already been established, and their conveyance is not influenced by the implementation of this project alternative.

Borough and other Municipal Lands

Because the project does not involve or facilitate the sale or transfer of borough or municipal lands, no direct change in underlying municipal land or water ownership is expected. Likewise, since support activities are anticipated to use existing facilities or new facilities constructed on private lands, no foreseeable indirect effects on land ownership will result. This includes lands owned by the NSB and the NAB. No change in ownership is anticipated for any other municipal lands. Municipal land selections have already been established, and their conveyance is not influenced by the implementation of this project.

4.5.3.5.2 Conclusion

Based on Table 4.4-2, and the analysis provided above, the impacts on land and water ownership under Alternative 2 are described as follows. The magnitude of ownership impacts would be low because no changes in land or water ownership will result from this action. The duration of impact would be temporary because no changes in ownership or development rights will occur. The extent of impacts would be local, occurring only in the activity area and involving no ownership change. The context of impact would be common because the federal waters affected have no special, rare, or unique ownership characteristics. In total, the direct and indirect impacts on land ownership are considered to be negligible;

they would be low intensity, temporary, localized, and result in no change of ownership or development rights.

4.5.3.5.3 Direct and Indirect Effects of Land and Water Use

Recreation

Recreation occurs at generally low levels of use in the EIS project area. Key recreational activities include wildlife viewing and sightseeing from the air. Because seismic exploration is already occurring in the EIS project area, use conflicts would be low, given the low level of recreation activity and existing exploration activities. Direct and indirect impacts on recreation are discussed in detail in Section 4.7.3.7.

Subsistence

Subsistence, which refers to harvest activities involving hunting, fishing, trapping, and gathering as a way of life, is a wide-spread land use throughout the EIS project area. Some seismic activities are already occurring in the EIS project area, utilizing standard mitigations described in Appendix A. Utilization of standard and additional mitigation would reduce the potential land conflicts with subsistence use, and would be considered low. Direct and indirect impacts on subsistence are discussed in detail in Section 4.7.3.2.

Industrial

Under Alternative 2, there is the potential for an increase in crew change and survey preparation activity in some areas as a result of increased ship traffic. If activity under this alternative requires the construction of new facilities such as a dock, warehouse, airstrip or other industrial facilities, zoning may change to accommodate the change in land use, and this is a direct impact. If a smaller community, such as Wainwright where no infrastructure yet exists, requires such construction, impacts would be considered more intense than in an area where such infrastructure is already found, such as Deadhorse, and depending on perspective, beneficial or adverse. Potential impacts would be low to medium, depending on the location. If activities under this alternative do not require new facilities or infrastructure or if only existing facilities are used, no direct impact is expected.

Residential

There is the potential for an increase in the number of crew members and support staff in some areas as a result of the increase in ship traffic. Despite this, residential land use would not be affected because the activities under Alternative 2 are temporary and would not result in any new permanent residents needing housing.

Mining

This alternative would increase offshore exploratory and seismic activity; however the levels or extent of mining operations is not influenced by seismic exploration and would not result in any road construction or other infrastructure that would open new areas to mining. For this reason no direct or indirect impacts are expected to affect mining in the EIS project area.

Protected Natural Lands

An increase in seismic exploration activity under Alternative 2 would have no expected direct or indirect impacts on critical habitat, wilderness areas, or other land used for ecological reasons; the land use is removed from areas of offshore seismic activity and exploratory drilling. The primary potential for land use conflict would be associated with marine vessel and air traffic associated with crew changes and other support activities. Any seismic and exploration activities as part of this alternative would be compatible with current protected land uses and compliant with the way they are currently managed.

Transportation

Under Alternative 2, an increase in aircraft and vessel traffic along the North Slope is expected to and from the North Slope to transport people and supplies to support the survey vessels. If new docks and airstrips are needed to accommodate this increase, rezonings to industrial uses may result, as mentioned above. This increase in air and transportation use would occur primarily in areas that are currently being used for support activities such as Barrow, Deadhorse, Nome, and Dutch Harbor, and would constitute a minor increase in existing use. However, increase in transportation activity in Wainwright could constitute a moderate increase. No new roads or railroad lines are expected to be built under this alternative; therefore no changes are expected in land use to accommodate expanded land transportation systems.

Commercial

Under Alternative 2, an increase in seismic exploration would increase commercial activity associated with support activities. However, potential impacts to commercial land use are expected to be low because it will be temporary in nature, and no new facilities are likely to be built as a result of the project, with the possible exception of Wainwright. See Socioeconomic Section 4.5.3.1 for further discussion on employment opportunities under this alternative.

4.5.3.5.4 Conclusion

Based on Table 4.4-2 and the analysis provided above, the impacts of land and water use caused by Alternative 2 are described as follows. The magnitude of impact would be high where activity occurs in areas of little to no previous activity (such as Wainwright), and the magnitude of impact would be low where activity occurs in areas where previous activity is common (Prudhoe Bay, Barrow, Nome, Dutch Harbor). The duration of impact would be temporary because an increase in aircraft and shipping traffic would last only for that survey season, although the impact could be permanent if construction of a new facility or infrastructure to accommodate shipping traffic were built in Wainwright. The extent of impacts would be local because any changes in land use as a result of this alternative would be limited geographically to the communities that would support the survey vessels. The context of impact would be common because the areas of land and water use affected are extensively available and have no special, rare, or unique characteristics identified. In summary, the direct and indirect effects of Alternative 2 on land and water use would be moderate because of the possibility for high intensity impact and long term structures in smaller communities.

4.5.3.5.5 Direct and Indirect Effects of Land and Water Management

Federal Lands and Water Management

BOEM has awarded leases in the Beaufort and Chukchi seas for the purpose of exploring for and developing petroleum resources in the federal OCS. The level of exploration activity in federal water under this alternative is consistent with management of the OCS. Currently, the U.S. Fish and Wildlife Service is updating the Comprehensive Conservation Plan for the Arctic National Wildlife Refuge, with a final revised plan expected to be released during the summer of 2012 (USFWS 2011b), and the Bureau of Land Management is updating the Integrated Activity Plan/Environmental Impact Analysis for the National Petroleum Reserve-Alaska, with the first draft scheduled for early 2012 (BLM 2011). Because seismic surveys, exploratory drilling and leasing activities have been ongoing in the Beaufort and Chukchi seas for over 30 years, their occurrence is already well established and not newly introduced by this project. Consequently, they are already part of the existing regulatory environment known in the area. However, both documents are in draft form, and there is a chance that the information generated in this EIS could result in additional mitigation measures affecting the management of exploratory drilling activities in the Records of Decision of those documents. Based on this, no inconsistencies or changes in federal land or water management are anticipated to result from this alternative, including federal waters (from 3 to 200 nm), Alaska Maritime National Wildlife Refuge, National Petroleum Reserve-Alaska, and Cape Krusenstern National Monument.

State Lands and Waters Management

The state prepares Best Interest Findings before allowing seismic exploration activities on state lands and waters, and each proposed activity must demonstrate individual consistency with state management policies before permits are issued on state lands or waters. Permitted exploration activities are consistent with the management of state waters. Therefore, no inconsistencies or changes in state land or waters management is anticipated as a result of this alternative. This includes state waters (shore to the 3 nautical mile limit), Area Plans, and lands subject to oil and gas lease sales.

Borough and other Municipal Lands

While the level of exploration activity may increase under this alternative, no change in underlying land or water management is anticipated as a result of this project. This includes community planning, and the NSB and NAB comprehensive plans. The NSB Zoning ordinance (Title 19.70), in particular, includes policies related to offshore development and coastal management. However, compliance with local land management regulations within state and federal waters is undertaken on a voluntary basis. As indicated in Section 3.3.6 Coastal Management, the Alaska Coastal Management Program was not reauthorized by the State legislature and is no longer in effect. The NSB and NAB may recommend mitigation measures and permit/authorization conditions in response to new land based projects proposed within its jurisdiction.

4.5.3.5.6 Conclusion

Based on Table 4.4-2 and the analysis provided above, the impacts on land and water management caused by Alternative 2 are described as follows. The magnitude of impact would be low because the action is consistent with existing management plans, subject to conditions of approval. The duration of impact would be temporary because project activities are short term in duration and would not result in long-term conflicts with management plans. The extent of impacts would be local because proposed activities would not involve management plans beyond the localized areas of exploration and support activities. The context of impact would be common because the areas of land and water affected are extensively available and have no special, rare or unique characteristics identified in an adopted management plan. In total, the direct and indirect impacts of Alternative 2 on land and water management would be negligible because they are low intensity, would be temporary in nature, local, and common.

4.5.3.6 Transportation

The direct and indirect impacts for transportation are described by mode. Activity levels under Alternative 2 for seismic exploration and exploratory drilling in the EIS project area would increase, thereby influencing air, surface, and marine traffic.

The level of impacts on transportation will be based on levels of intensity, duration, geographic extent, and context, as shown in Table 4.5-30.

Table 4.5-30 Impact Levels for Effects on Transportation

Impact Component	Effects Summary		
Magnitude or Intensity	**Low**: change in transportation volume may not be measurable or noticeable	**Medium**: Noticeable change in transportation volume	**High**: Acute or obvious change in transportation volume
Duration	**Temporary**: Changes in transportation volume last less than one year	**Long-term**: Changes in transportation volume extend up to several years	**Permanent**: Changes in transportation volume persist after actions that caused the impacts cease
Geographic Extent	**Local**: Affects transportation volume only locally	**Regional**: Affects transportation volume on a regional scale	**State-wide**: Affects transportation volume beyond a regional scale
Context	**Common**: Affects usual or ordinary transportation opportunities and constraints	**Important**: Affects transportation opportunities and constraints within the locality or region protected by legislation	**Unique**: Affects unique transportation opportunities and constraints

4.5.3.6.1 Direct and Indirect Effects

Air Transportation

The levels of commercial and private aircraft transportation that currently exist within the coastal communities of the project area and the Prudhoe Bay area (including Deadhorse) are likely to continue at existing levels, as described in Section 3.3.7. Air traffic would increase, as associated with the programs listed in Table 2.4 in Chapter 2. The level and pattern of increase would be affected by the number of source and support vessels, the types of sound sources used, time periods when the activity could occur, number of days of active operations, and size of the program activity area. Increased levels of air traffic activity could require construction of new airstrips or hangars/warehouses or modifications to existing facilities.

Exploratory drilling located in offshore portions of the Beaufort Sea would likely occur initially in areas offshore of Camden Bay in the eastern portion of the Beaufort Sea during the initial year of this EIS's analysis window. For Beaufort Sea operations, it is expected that support flights would originate in Barrow, Deadhorse, or Prudhoe Bay. Helicopters stationed at Barrow would provide emergency or search and rescue support (SAR), as needed. Exploratory drilling in the Beaufort Sea is assumed to include the use of helicopters (4 to 12 air operations per week) to provide support for crew changes, provision resupply, and SAR operations for each drilling program. Fixed winged aircraft operating daily out of Barrow or Deadhorse would support marine mammal monitoring and scientific investigations.

Exploratory drilling in the Chukchi Sea would likely occur initially in areas on federal leases for which exploration plans have recently been submitted or expected to be submitted during the timeframe of this EIS, and where there have been recent requests to authorize ancillary activities. For surveys in the Chukchi Sea, air support operations would occur primarily out of Nome but could also occur out of Wainwright and/or Barrow. Exploratory drilling in the Chukchi Sea is assumed to require up to 24 air operations per week, for transit from Wainwright or Barrow to each of the drilling sites. For emergencies, SAR helicopters would operate out of Barrow.

The increased levels of air traffic that result from activities under Alternative 2 are considered to be a direct impact to existing local and regional transportation. Air travel that is necessary to support seismic surveys and exploration drilling programs would be required to comply with the required mitigation measures in order to conduct aerial monitoring for marine mammals and provide flights in support of crew changes, expansion of shore based infrastructure, and for littering supplies to offshore support vessels.

Aircraft overflights associated with oil and gas seismic surveys and exploratory activities would occur in the nearshore areas of the Beaufort and Chukchi seas. Aircraft traffic associated with seismic surveys and exploratory drilling would likely be limited to an area where infrastructure for air traffic/commercial travel already exists (i.e. Prudhoe Bay, Barrow and potentially Wainwright). The levels of aircraft using Prudhoe Bay, Barrow, and Wainwright shore based infrastructure may increase for short durations while offshore seismic survey and exploratory drilling operations are occurring. A limited fleet of industry support aircraft would use existing airport infrastructure and is unlikely to interrupt the patterns of existing air traffic or strain the capacity of existing carriers within the region. It is possible but unlikely that increased aircraft use would require construction of new infrastructure.

Subsistence users have noted that aircraft overflights can disturb subsistence resources making it more difficult for hunters to obtain these resources. Aircraft disturbance in caribou migratory pathways from industry operations and recreational hunters (tourism) near the coast has been observed:

> *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 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.* - Carla Sims Kayotuk at the Kaktovik Public Scoping Meeting for this EIS, March 12, 2010.

> *These are our only times during the summer [on calm days] that we have access to hunting caribou that go down to the coast. If activity, support activity, such as aircraft or helicopters or other support activities are near the coast -- and we have many people that can make oral statements that during the summer when they're getting close to caribou, either a small plane or helicopter show up and drive the caribou further inland.* - Fenton Rexford, representing Native Village of Kaktovik at the Kaktovik Public Scoping Meeting for this EIS, March 12, 2010.

Surface Transportation

Increased use of airstrips and docks by aircraft and vessels under Alternative 2 would require ground support to transfer passengers and supplies, refuel aircraft and vessels, or provide other support that would increase vehicle traffic on local roadways. Additionally, increased use of aviation and vessel fuel could result in overland shipments of fuel via trucks on ice roads or by Rolligons.

The on-ice seismic survey that would be permitted under this alternative would likely require the construction of ice roads for surface transportation. Transportation of supplies and crews would occur via winter ice roads and are expected to originate from the Prudhoe Bay area. Therefore, there would be no direct or indirect impact from aircraft overflights in the winter. Construction of ice roads and equipment traveling the roads could disturb marine mammals during January to May exploration activities.

Marine Transportation

The levels of local marine vessel traffic are expected to continue at their present rate, as described in Section 3.3.7. This includes localized small vessel, tug, and barge traffic between the communities located near the Beaufort and Chukchi seas. Vessel traffic in nearshore coastal waterways encompasses sealift and tug/barge traffic to and from the Prudhoe Bay area, and through the eastern Beaufort Sea towards Canada. Activities proposed under Alternative 2 would result in an increase in the present levels of vessel traffic in the nearshore waters and in the offshore areas of the Beaufort and Chukchi seas.

It is assumed that marine-based support for 2D/3D seismic surveys, shallow hazard surveys, and support vessel traffic would increase, and Beaufort Sea operations would originate from the West Dock area, or Oliktok Dock near Prudhoe Bay. For 2D/3D seismic surveys in the Chukchi Sea, vessel-support operations, including crew changes, would occur primarily out of Nome, and possibly Barrow or Wainwright as well. Increased vessel activity could result in the need for new or improved docks and other marine related infrastructure along the coast.

Chase/monitoring vessels would provide transport for crew changes and resupply, as well as for acoustic study and marine mammal monitoring support. They would also assist in ice management operations if required. These vessels would not introduce sounds into the water beyond those associated with standard vessel operations. These activities could occur several times during a season, involving transit to onshore support areas.

Vessel traffic associated with exploratory drilling in offshore portions of the Beaufort Sea would likely occur initially in areas offshore of Camden Bay in the eastern portion of the Beaufort Sea during the initial year of this EIS' analysis window. Table 2.4 (Chapter 2) outlines specifics associated with these activities. Assumptions of increased vessel traffic related to exploratory drilling in the Beaufort Sea are as follows:

- For each exploratory drilling program, a drillship or conical drilling unit (CDS) with up to 11 support vessels would be deployed that would be used for ice management, anchor handling, oil spill response, refueling, resupply, and servicing the drilling operations. The ice management vessels will consist of an icebreaker and anchor handler.
- At the start of the program, the drillship or CDS and support vessels would transit the Bering Strait into the Chukchi Sea, and then transit further on to the Beaufort Sea drill site(s). Vessels could transit from marine bases in the Canadian Beaufort Sea (e.g. Tuktoyaktuk) or Russian Arctic.
- Timing of operations would commence on or after approximately July 1 and typically end by early November.
- Drilling could occur on multiple drill sites per drilling program per year with the analysis assumption being up to three wells drilled per program per year.
- Resupply vessels would operate from both Dutch Harbor (using ocean going vessels) and West Dock at Prudhoe Bay using a coastwise qualified vessel. Ten resupply trips per drilling program are estimated.
- At the end of the drilling season, the drillship or CDS (under tow) and associated support vessels will exit the area by traveling west into and through the Chukchi Sea. As an alternative, the CDS, if used, could be towed to the Canadian Beaufort for the winter.

Under Alternative 2 the exploratory drilling programs in the Chukchi Sea would likely occur initially in areas on federal leases for which exploration plans have recently been submitted and where there have been recent requests to approve ancillary activities. Table 2.4 (Chapter 2) outlines specifics associated with these activities. Assumptions for vessels associated with the exploratory drilling in the Chukchi Sea would include:

- For each exploratory drilling program, a drillship or jackup rig with six to eight support vessels would be deployed. Support vessels would be used for ice management, anchor handling, oil spill response, refueling, resupply, and servicing the drilling operations. The ice management vessels would consist of an icebreaker and anchor handler. Oil spill response vessels would be staged near the drillship or jackup rig. The icebreaker and anchor handler would be staged away from the drill site when not in use but would move closer to perform duties when needed.

- Drillship and support vessels would be deployed on or about July 1, traveling from Dutch Harbor, Alaska, through the Bering Sea, or from the east through the Beaufort Sea from marine bases in the Canadian Beaufort Sea (e.g. Tuktoyaktuk), arriving on location in the Chukchi Sea in early July.
- Timing of drilling operations would commence soon after arriving at the drill site in early July and typically end by early November.
- Drilling could occur on multiple drill sites with up to four wells drilled per drilling program per year.
- Marine resupply vessels would operate between the drill sites and Dutch Harbor or Wainwright. Ten resupply trips per drilling program are estimated.
- At the end of the drilling season, the drillship or jackup rig, and associated support vessels will transit south out of the Chukchi Sea.

Marine vessel traffic has been noted by residents to impact subsistence bowhead hunters as a result of whales being deflected from the area, thereby limiting potential strike opportunities for subsistence harvest. Subsistence bowhead hunters voiced concern during the scoping process for this EIS that impacts of increased vessel traffic, and regulating vessel traffic, be a part of mitigation. This is so that interference from vessel traffic does not disturb hunting activities. A North Slope resident noted that past and existing levels of barge traffic have led to disturbance:

> *I've seen barge activity that's over the past 15 years diverted bowhead whales. As a whaler, I've seen it all my life.* As commented by Thomas Napageak, Jr. at the Nuiqsut Public Scoping Meeting for this EIS, March 11, 2010.

Shipping routes through the Bering Straits and into the Beaufort and Chukchi seas are similar to the routes of migratory marine mammals. There is a remote possibility that vessel collisions that result in the death or serious injury of marine mammals could occur as a result of increased vessel traffic in the project area. At present there are relatively few known incidents of Arctic or ice-adapted marine mammal species being involved in ship strikes (Arctic Council 2009). The relatively infrequent occurrence is likely a result of low vessel traffic in high latitudes as compared to major trading routes and human population centers in lower latitudes (Arctic Council 2009). However, an increase in the number of ships transiting the Bering Straits (considered a bottleneck for Arctic shipping routes) could be expected to increase the likelihood of ship strikes.

4.5.3.6.2 Conclusion

Under Alternative 2 there would be an increase in the levels of air traffic in the regional air transportation system. However, the increase in the levels of air traffic to regional transportation would be of low intensity, and the duration would be temporary (length of survey or exploratory drilling activities each year). The impacts would be local in extent and affect resources that are considered common in context. As a result, the impact of increased aircraft traffic by implementing Alternative 2 would be considered negligible.

Only one on-ice seismic survey would be permitted in the Beaufort Sea under this alternative. While surface travel via snowmachine is a method of transportation during the winter months, it is unlikely that there would be a direct impact to surface transportation routes between coastal communities as the on-ice survey would occur in a very local area. Impacts to surface transportation via ice roads would be characterized as a low intensity, limited in spatial extent, temporary effect on a resource that is common in context. Increased vehicle traffic on local roadways would also be characterized as temporary, and affecting a resource that is common in context. The impact is considered negligible.

The increase in vessel traffic as a result of seismic and exploratory drilling operations as a result of implementation of Alternative 2 would be a direct impact to the existing levels of vessel traffic in the Beaufort and Chukchi seas. Considering the required and additional mitigation measures, direct impacts from increased vessel traffic in these seas would be temporary and occur regionally. The intensity of increased marine vessel traffic is considered low, as it would be temporary in duration, local in extent, and common in context. Industry vessel traffic associated with Alternative 2 would occur in areas that are largely offshore, within a specific region and are considered common in context. The implementation of Alternative 2 would be unlikely to adversely affect existing nearshore transportation or displace current levels of marine transportation. Direct and indirect impacts on regional vessel transportation would be of low intensity, temporary duration, and affecting resources that are common in context. Direct impacts from the anticipated increases in vessel traffic are considered minor.

4.5.3.7 Recreation and Tourism

Recreation and tourism occur at generally low levels of use in the EIS project area and are more common onshore (hiking, river float trips) than offshore (small cruise ships, kayaking). It is important to distinguish between recreation and subsistence uses. The vast majority of fishing, hunting, and boating that occurs in the project area are *subsistence*-based, managed completely apart from *recreation*-based activities, with separate rights and privileges (see Section 4.5.3.2, Subsistence for further discussion). This section discusses only recreation-based activities, a small portion of the human uses in the area.

The direct and indirect impacts for recreation and tourism will be described by setting and activities. Activity levels for seismic exploration and exploratory drilling in the EIS project area would increase; however, recreation in the area is generally low and is not expected to be considerably impacted.

The level of impacts on recreation and tourism will be based on levels of intensity, duration, geographic extent, and context, as shown in Table 4.5-31.

Table 4.5-31 Impact Levels for Effects on Recreation and Tourism

Impact Component	Effects Summary		
Magnitude or Intensity	**Low**: Changes in recreation setting or activities may not be measurable or noticeable	**Medium**: Noticeable changes in recreation setting or activities	**High**: Acute or obvious changes in recreation setting or activities
Duration	**Temporary**: Changes in recreation setting or activities last less than one year	**Long-term**: Changes in recreation setting or activities extend up to several years	**Permanent**: Changes in recreation setting or activities persist after actions that caused the impacts cease
Geographic Extent	**Local**: Affects recreation setting or activities only locally	**Regional**: Affects recreation setting or activities on a regional scale	**State-wide**: Affects recreation setting or activities beyond a regional scale
Context	**Common**: Affects usual or ordinary recreation opportunities and constraints	**Important**: Affects recreation opportunities and constraints within the locality or region protected by legislation	**Unique**: Affects unique recreation opportunities and constraints

4.5.3.7.1 Direct and Indirect Effects

Setting

The setting for recreation and tourism could potentially be impacted by Alternative 2. The primary direct impact would be on the recreation setting and the visitor experience of that setting. If a visitor was expecting a fairly isolated and undeveloped recreation setting, the presence of industrial vessels or drilling rigs could alter the experience of the setting or the sense of place (Williams & Stewart 1998), as expectations of the setting would not be met. The expectation for an isolated and undeveloped setting could be held by people traversing the project area in personal pleasure boats or yachts. Visual impacts are discussed in further detail in Section 4.4.3.8.

Implementation of Alternative 2 could have a potential indirect impact on the recreation setting including impacts on existence and bequest values (Schuster et al. 2005). Existence value refers to the knowledge that a particular resource exists and an emotional attachment to the resource is held, even if the place is never visited in person (Cordell et al. 2003, Rolston 1985) and bequest value refers to a desire to bequeath a natural resource to future generations (Cordell et al. 2003, Rolston 1985). A person who does not physically recreate in the EIS project area could hold existence or bequest values related to the Arctic Ocean environment. An increase in oil and gas exploration in the area would alter the recreation setting from a primitive or undeveloped setting to a developed setting with industrial activity. The experience of the recreation setting would also likely be altered, including the experience of recreationists that hold existence and bequest values related to the Arctic Ocean environment.

Activities

Under Alternative 2 little direct or indirect impact is expected on recreation activities. Offshore wildlife viewing may be impacted by an increase in survey vessels or drilling rigs if wildlife avoids these vessels or industrial sites. Nearshore activities are generally engaged in by residents of local communities, and levels of activity are low; little impact is expected on levels or types of recreation use. Recreation activities could also be displaced; recreationists may avoid seismic survey and exploratory drilling programs, choosing instead to recreate someplace else to avoid project activities.

Under Alternative 2, one on-ice seismic survey per year is expected in the Beaufort Sea; recreation use is more probable in the vicinity of the existing leases in the Beaufort Sea. Recreation uses would not likely occur near the lease sales in the Chukchi Sea, as they are much farther offshore. The on ice survey would not likely impact recreation activities in the project area as it would not occur during the visitor season.

4.5.3.7.2 Conclusion

Based on the criteria given in Section 4.1.3, the intensity of direct and indirect effects on recreation and tourism are expected to be low; the alternative would not noticeably alter recreation in the EIS project area. Direct impacts to the recreation setting would be temporary as they would last only for the duration of the survey season or exploratory drilling program. Indirect impacts to existence and bequest values would be temporary; the survey activity or exploratory drilling would affect the setting for the length of the seismic or drilling program. The direct impacts to visitor setting would be local, and limited to the area where the project activity is taking place. Indirect impacts to existence and bequest values would be considered state-wide (and potentially nationally or internationally) based on the criteria because recreationists beyond the EIS project area could hold existence and bequest values for the area. Recreation opportunities are not scarce in the project area and are not protected by legislation. Therefore recreation and tourism would be considered common in context.

The direct impacts would be low intensity, temporary duration, local extent, and common in context. Indirect impacts would be the same levels as direct impacts, except that the geographic area would be broader, extending beyond the region to a state-wide level and potentially beyond. In summary, the impact of Alternative 2 on recreation and tourism would be minor.

4.5.3.8 Visual Resources

This section discusses potential impacts on visual resources that could result from implementing Alternative 2 of the proposed project.

The level of impacts on visual resources will be based on levels of intensity, duration, geographic extent, and context, as shown in Table 4.5-32.

Table 4.5-32 Impact Levels for Effects on Visual Resources

Impact Component	Effects Summary		
Magnitude or Intensity	**High**: Acute or obvious disturbance in visual resources	**Medium**: Noticeable disturbances in visual resources	**Low**: Disturbances in visual resources may not be measurable or noticeable
Duration	**Permanent**: Disturbances in visual resources persist after actions that caused the impacts cease	**Long-term**: Disturbances in visual resources extend up to several years	**Temporary**: Disturbances in visual resources last less than one year
Geographic Extent	**State-wide**: Affects visual resources beyond a regional scale	**Regional**: Affects visual resources on a regional scale	**Local**: Affects cultural visual only locally
Context	**Unique**: Affects unique visual resources or resources protected by legislation	**Important**: Affects visual resources within the locality or region or resources protected by legislation	**Common**: Affects usual or ordinary visual resources; not protected by legislation

4.5.3.8.1 Impact Assessment Methodology

The analysis area for visual resources includes onshore and offshore areas. Onshore areas include Alaska Native communities located along the shoreline between Kotzebue, on the western side of the Arctic Coastal Plain (ACP), across the northern 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 Borrow and the U.S.-Canadian border, and the Chukchi Sea, located between Point Borrow and Kotzebue. Both the Beaufort and the Chukchi seas are located in the Arctic Ocean. The geographic extent of the offshore portion of the analysis area was defined by the EIS project area.

Indicators used to measure potential impacts to visual resources that may result from the proposed project included:

- Impacts to visual resources, measured by the estimated level of visual contrast created by the project; and
- Expected temporary change in the distribution of scenic resources, as measured by temporary change in scenic quality class.

Additional qualitative indicators included the expected level of change to the existing landscape aesthetic, such as movement, activity (measured in terms of change in vehicular traffic and amount of people), noise, or naturalness.

Methods for determining the anticipated level of contrast were developed based on the BLM's Contrast Rating procedure (BLM 1986). This method assumes that the extent to which the project results in adverse effects to visual resources is a function of the visual contrast between the project and the existing landscape character. Impact determinations are typically based on the level of contrast identified using visual simulations and <u>are not</u> a measure of the overall attractiveness of the project. Because no visual simulations were prepared for the proposed project, the level of contrast has been estimated based on analysis factors, including: distance from the project; predominant angle of observation; dominant use (i.e. recreation, subsistence, industry); and duration of typical views.

At each Scenic Quality Rating Unit (SQRU), existing landforms, vegetation, and structures were evaluated using the basic components of form, line, color, and texture. The levels of contrast are defined as follows:

- *None*: The element contrast is not visible or perceived.
- *Weak*: The element contrast can be seen but does not attract attention.
- *Moderate*: The element contrast begins to attract attention and begins to dominate the characteristic landscape.
- *Strong*: The element contrast demands attention, will not be overlooked, and is dominant in the landscape.

Temporary change in Scenic Quality Class was measured by estimating the Scenic Quality Score for each action alternative and comparing that value to the baseline Scenic Quality Score established in Section 3.3.9 (Table 3.3-46).

An overall impact determination was made based on the anticipated contrast, change in Scenic Quality Rating, the duration and geographic extent of affected views, and context of the proposed action.

Effect determinations were based on the parameters listed below:

NO EFFECT would occur if the facilities would be isolated, not noticed in the view, most often seen from background distance zones, temporary, or where no visually sensitive resources would be affected.

Effect would be considered **MINOR** where project components would result in weak contrast against the existing landscape; where deviations in the landscape character are not expected to result in a reduction of Scenic Quality Class; where project design is consistent with existing planning goals, temporary, and/or where sensitive viewers located in the background (5 to 15 miles) distance zone would be affected.

Effect would be considered **MODERATE** where project components would result in moderate contrast against the existing landscape; where deviations in the landscape character are expected to result in a reduction of Scenic Quality Class; where project design is not consistent with existing planning goals, temporary or long-term, and where sensitive viewers located in the foreground/middle ground distance zones (5 to 8 km [3 to 5 mi]) would be affected.

Effect would be considered **MAJOR** where project components would result in strong contrast against the existing landscape; where deviations in the landscape character are expected to result in a reduction of Scenic Quality Class; where project design is not consistent with existing planning goals, long-term, and where sensitive viewers located in the immediate foreground (<5 km [3 mi]) and foreground/middle ground distance zones (5 to 8 km [3 to 5 mi]) would be affected.

The following assumptions were used when analyzing effects of the project on visual resources:

All the potential operations-related impacts to visual resources that were examined as part of each Action Alternative analysis are considered short term and will not extend beyond the life of the EIS (5 years).

- The assessment of short-term construction-related impacts was limited to actions associated with exploratory drilling. Because open water / on-ice seismic surveys and hazard surveys do not require construction of facilities (i.e. artificial islands, jackup rigs), short-term construction-related impacts do not pertain to these actions and are not considered in this analysis.
- The assessment of short-term impacts that may result from decommissioning of the proposed project was limited to structures associated with exploratory drilling. Because open water / on-ice seismic surveys and hazard surveys are not reliant on any facility or related infrastructure (i.e. artificial islands, jackup rigs), it is assumed that potential impacts related to decommissioning of the project do not pertain to these actions and are not considered in this analysis.
- For the purposes of this analysis and for comparison of alternatives, indirect effects are not considered in this analysis. It is assumed that all vessels and project-related infrastructure (i.e. drill sites) would be removed at the end of the permit cycle.
- It is assumed that existing roads would be used to transport material used to construct ice-islands if obtained from on-land quarries. It is further assumed that no new quarries would be constructed to support this action.
- Because changes to landform, vegetation, water, color, adjacent scenery, and scarcity are not expected to be altered as a result of any action alternative, the discussion of potential changes to the ranking of scenic quality for key factors used to determine Scenic Quality Class is limited to "Cultural Modification."
- The effect determination was based on the highest impact identified across all portions of the analysis area.

4.5.3.8.2 Direct and Indirect Effects

Alternative 2 would include vessel-based surveys implemented in the Beaufort and Chukchi seas, and a single exploratory drilling program in both the Beaufort and Chukchi seas. Project-related actions would primarily be seen from population centers located east of Barrow, extending to the Canadian border (including the ANWR). Due to the distances offshore, views of the proposed project in the Chukchi Sea would be restricted to those of industrial workers or commercial marine traffic occurring in offshore locations in the Chukchi Sea and would not be detected by any sensitive viewer groups located in on-land or near-shore locations (see Section 3.3.9.7 for a description of viewer groups). The degree of project-related visual contrast and subsequent degree of cultural modification will depend on site-specific factors, including: viewer distance; viewer's angle of observation; duration of their view; and atmospheric conditions. It is assumed for the purposes of this analysis that the landscape/seascape type is describe as a large-scale panoramic. Viewer sensitivity to the potential impacts to views will depend on existing land use and perceived cultural value. Landscape analysis factors for each of the viewshed areas are summarized in Table 4.5-33.

Table 4.5-33 Description of Analysis Factors by Scenic Quality Rating Unit

	Scenic Quality Rating Unit			
	West Beaufort Sea	**East Beaufort Sea**	**North Chukchi Sea**	**South Chukchi Sea**
Distance from Project	Up to approximately 50 miles	Up to approximately 50 miles	>50 miles	>50 miles
Predominant Angle of Observation	Variable within a 180º arc	Variable within a 180º arc	Variable within a 180º arc	Variable within a 180º arc
Dominant Land Use	On land and near shore Industrial	Near shore Industrial; On-land ANWR	Predominantly Undeveloped, but including the NPRA[1] on shore	Predominantly Undeveloped
Duration of View	Prolonged, but short-term	Prolonged, but short-term	Prolonged, but short-term	Prolonged, but short-term

Notes:

1) NPRA = National Petroleum Reserve Alaska

Because predominant viewer distance of sensitive viewers in the North and South Chukchi SQRUs is greater than 80 km (50 mi), it is assumed that the project would not be detected when viewed from this vantage point. Viewers situated in onland and nearshore areas of these SQRUs (i.e. Cape Krusenstern National Monument, or the Alaska Native communities of Wainwright, Point Lay, Point Hope, Kivalina, or Kotzebue) may experience views of survey vessels and/or support vessels transiting to/from the proposed EIS project area via the Bering Straits or within the Chukchi Sea for resupply trips. Operations-related vessel traffic occurring in the Chukchi Sea is expected to be seen only by industrial workers stationed offshore. In both cases, viewing of transiting and operations-related vessels would be temporary and localized and therefore is not considered further in this analysis.

The operation of survey and support vessels would not entail construction or decommissioning phases, as vessels are deployed for surveys and CSEM and would not return to the surveyed area once work is completed. Operations-related vessel traffic would be transient, restricted to short time periods, and occur in localized areas. For these reasons, the operation of survey and support vessels is expected to result in an overall weak visual contrast where actions occur at close proximity (within Foreground-Middleground [FM] zone) to on-land and near-shore locations state waters of the Beaufort Sea. Visual contrast is expected to attenuate beyond 8 km (5 mi) due to the scale of the vessels relative to the landscape and the transient nature of the proposed action.

The exploratory drilling program included in this alternative would include construction, operation, and decommissioning phases. Construction-related impacts to visual resources and scenic quality would vary based on the type of infrastructure used to support the well. For example, drillships and jack-up rigs can be erected on site with no sea bottom preparation; however structures such as artificial islands or caisson-retained islands would require dredging and transport to the drill site to establish the foundation for the drilling unit. Exploratory drilling in federal waters of the Beaufort and Chukchi seas would be implemented using a drillship, CDS, or a jackup rig, and consequently no construction-related impacts to visual resources are expected.

Construction-related impacts may occur as part of exploratory drilling programs situated in state waters (located within 5 km [3 mi]) of the Beaufort Sea. It is assumed that an artificial island would be used to support exploratory drilling and that this facility would be constructed between Harrison Bay and Bullen Point. This geographic area includes the Alaska Native community of Nuiqsut and the industrial centers of Deadhorse and Prudhoe Bay. Construction-related actions would result in a temporary increase in marine barge, vehicle, and potentially air traffic around localized drill site(s). Such actions would contribute color, angular lines, and movement to the landscape; however, because oil and gas activity is underway in this area, change in visual resources and scenic quality as a result of construction of drill site(s) is not expected to create visual contrast or attract attention of the casual observer. It is assumed that actions associated with decommissioning of the ice island would be similar to those incurred during construction.

During the operational phase, the moderate to strong visual contrast may result from operation of drill sites, particularly where situated within five miles of viewers. Each drill site would require up to eleven support vessels, resulting in a noticeable increase in industrial marine traffic from this distance. The greatest contrast is expected to occur during summer daylight conditions, or during winter months when periods of low-light may result in a bold silhouette of the facility due to back-lighting. During periods of darkness, facility lighting could be detected up to and beyond the background distance zone (24 km [15 mi]). Like vessel traffic, visual contrast of drilling facilities (i.e. ice islands) and lighting would be maximized where viewed from proximate locations and would attenuate with distance from the viewer. Project-related actions in the nearshore Beaufort Sea would be viewed by both highly sensitive viewers from the Alaska Native community of Nuiqsut and viewers located in the industrial centers of Deadhorse and Prudhoe Bay characterized as having low visual sensitivity.

Project-related actions are not expected to change the Scenic Quality Class of any SQRU analyzed. Project actions and effects to visual resources expected to result from implementation of Alternative 2 are summarized in Table 4.5-34, below. An explanation of factors used to determine scenic quality scores is provided in Section 3.3.9.9.

Table 4.5-34 Potential Temporary Changes to Scenic Quality Rating under Alternative 2

	Key Factor	Scenic Quality Rating (Summer/Winter)			
		East Beaufort Sea Unit	West Beaufort Sea Unit	North Chukchi Sea Unit	South Chukchi Sea Unit
Existing Conditions	Cultural Modification	0/0	-4/-3	0/0	0/0
	Total Score	24/15	20/12	25/16	25/16
	Scenic Quality Class[1]	A/B	A/B	A/B	A/B
Alternative 2	Cultural Modification	-2/-2	-4/-3	0/0	0/0
	Total Score	22/13	20/12	25/16	25/16
	Scenic Quality Class[1]	A/B	A/B	A/B	A/B

Notes:

1) Class A = Score of 19+
2) Class B = Score of 12-18
3) Class C = Score of 11 or less

4.5.3.8.3 Conclusion

In conclusion, implementation of Alternative 2 is expected to result in *short-term moderate effects* to scenic quality and visual resources. Potential impacts could be of low to medium intensity depending on specific location of drill sites. The geographic extent of potential impacts would be localized; however they would occur in an important ecosystem.

4.5.3.9 Environmental Justice

The coastal communities of Kaktovik, Nuiqsut, Barrow, Wainwright, Point Lay, Point Hope, Kivalina, and Kotzebue are predominantly Alaska Native communities. Nome also has a substantial Alaska Native population. In the analysis of environmental effects (including human health, economic and social effects), there is the requirement under Executive Order 12898 to identify and address "disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations." Therefore, the purpose of this section is to analyze potential impacts to these communities and their sociocultural systems resulting from the implementation of the alternatives.

Scoping comments (Appendix C) regarding environmental justice included:

- Ensure the requirements of Executive Order 12898 (Federal Actions to Address Environmental Justice in Minority and Low-Income Populations) are being met;
- Evaluation of any disproportionate impacts placed upon the Iñupiat people should take into account the unique interests of local Iñupiat communities; and
- Particular attention must be given to consideration of the dependence of local communities on local and regional subsistence resources, access to those resources, and perception of the quality of those resources.

The discharges associated with Alternative 2 that could impact human health and subsistence resources are detailed in Chapter 2. These may include wastes from exploration drilling, deck drainage, platform discharges, air emissions, human discharges from vessels, and/or non-permitted releases and minor oil spills. Displacement of subsistence resources or disruption of subsistence activities associated with noise and vessel traffic are described in Chapter 2, Marine Mammals Section 4.5.2.4 and Subsistence 4.5.3.2.

4.5.3.9.1 Direct and Indirect Effects

Impacts to Subsistence Foods and Human Health

As described in the Subsistence Section 4.5.3.2, the activity levels associated with Alternative 2 are expected to have a negligible to minor impact to the numbers of marine mammals harvested for subsistence use in the EIS project area. As described in the Public Health Section 4.5.3.3, increased contamination levels in subsistence food sources are likely to be negligible. Alternative 2 may have an indirect effect of adding to the perception that subsistence foods are contaminated and alter confidence in their consumption.

4.5.3.9.2 Conclusion

Activities related to implementation of Alternative 2 would have a low intensity impact on subsistence resources and human health, a temporary duration, and a regional extent. Subsistence foods and human health are unique resources, and they are protected under the MMPA and EO 12898. Thus, Alternative 2 is expected to have a minor impact to subsistence resources. Alternative 2 with Standard Mitigation Measures would also create some local employment and economic support activities, and would reduce adverse effects. There would be minor disproportionate adverse and beneficial impacts to Alaska Native communities under Alternative 2.

4.5.3.10 Standard Mitigation Measures for the Social Environment

Standard and Additional Mitigation Measures are outlined in Sections 2.4.10 and 2.4.11, respectively, and described in detail in Appendix A. Requirements for implementation depend on type, time, and location of activities and co-occurrence of multiple activities. A combination of these measures could be required for any one ITA. While the ultimate goal of the mitigation measures is to reduce adverse impacts to marine mammals and subsistence hunts of marine mammals, some of the mitigation measures have the potential to impact resources within the social environment. For example, the requirement to hire PSOs and establish Com Centers will create jobs on the North Slope. Sections 4.5.2.4.15 and 4.5.2.4.16 provide discussion and analysis of the standard and additional mitigation measures aimed at reducing impacts to marine mammals, and Sections 4.5.3.2.3 and 4.5.3.2.5 provide discussion and analysis of the standard and additional mitigation measures aimed at reducing impacts to subsistence hunts. Those analyses include a discussion of potential economic impacts as well, and those discussions are not repeated here.

4.6 Direct and Indirect Effects for Alternative 3 – Authorization for Level 2 Exploration Activity

4.6.1 Physical Environment

4.6.1.1 Physical Oceanography

4.6.1.1.1 Direct and Indirect Effects

Water Depth and General Circulation

Under Alternative 3, changes in water depth resulting from exploratory drilling programs would be the same in nature as those described for Alternative 2. Alternative 3 would allow additional drilling programs in the EIS project area, and as a result of the additional drilling programs, the intensity as well as the spatial extent of the impact would effectively be doubled. Relative to Alternative 2, water depth would be affected over a larger area. The effects of Alternative 3 on water depth would be low-intensity, permanent, and would affect a common resource. Changes in water depth from discharged material would have only minor effects on the physical resource character of the proposed action area. Although common resources would be affected across increased spatial scales relative to Alternative 2, the overall effects of Alternative 3 on water depth would be minor.

Currents, Upwellings, and Eddies

Seismic surveys, site clearance and shallow hazards surveys, and on-ice seismic surveys would have only negligible effects on currents, upwellings, and eddies within the EIS project area under Alternative 3. Construction of artificial islands, which could occur in nearshore state waters of the Beaufort Sea at a rate of two islands per year under Alternative 3, would result in medium-intensity, permanent/temporary (permanent if gravel, temporary if ice), localized effects on nearshore currents in the waters adjacent to the artificial islands. Over the life of this EIS, those effects would be minor and would occur only if artificial islands are constructed to support exploratory drilling activities. Exploratory drilling activities in the Chukchi Sea are anticipated to occur from temporary structures, as opposed to artificial islands that could be built in the Beaufort Sea. Therefore, exploratory drilling activities in the Chukchi Sea would have only negligible effects on currents, upwellings, and eddies within the proposed action area.

Tides and Water Levels

The activities described under Alternative 3 would not affect tides or water levels within the EIS project area.

Stream and River Discharge

The activities described under Alternative 3 would not affect stream and river discharge within the EIS project area. Exploratory drilling in state waters on grounded ice could occur from manmade reinforced ice “islands” but would have negligible effects on stream and river discharge within the EIS project area.

Sea Ice

Under Alternative 3, impacts to sea ice resulting from the proposed activities would be the same in nature as those described for Alternative 2. Alternative 3 would allow additional drilling programs and additional artificial islands in the proposed action area, and, as a result of the additional drilling programs, the intensity as well as the spatial extent of the impact would effectively be doubled. Relative to Alternative 2, sea ice would be affected over a larger area due to more extensive icebreaking activity and thermal inputs associated with exploratory drilling activities.

Although Alternative 3 would allow additional seismic surveys in both the Beaufort and Chukchi seas relative to Alternative 2, each action alternative would authorize only one survey per year in each of the seas to involve icebreaking activity. Likewise, only one on-ice seismic survey per year would be authorized under each of the action alternatives. Therefore, the level of activity contemplated for these specific types of exploration activities under Alternative 3 is the same as what is contemplated under Alternative 2.

The effects of these activities on sea ice would be medium intensity, local, temporary, and would affect a resource that is common in the EIS project area. The presence of sea ice in lease and non-lease areas targeted for open water seismic exploration and exploratory drilling could result in changes to the schedule, location, and duration of exploratory activities. The presence of ice also represents a potential hazard to vessels and exploratory drilling platforms. Industry operators in offshore areas have developed procedures for managing sea ice, including changes to schedule, vessels dedicated to ice management, and procedures for taking drill platforms off location until potential hazards subside.

Within ice and on ice exploration activities could experience similar and additional hazards from sea ice, including the potential for ice override events. In-ice exploration activities would use ice breakers and other vessels for the purpose of ice management and/or ice breaking, and protocols would be established for response to potential ice hazards. Drilling on grounded ice from artificial ice islands would not be subject to potential hazards from moving ices, but could experience potential effects from storm surge and ice override events. Within the Beaufort Sea, where drilling on constructed artificial ice islands could occur in state waters, much of the area is protected from ice override by barrier islands. Individual drilling operations would need to assess the potential for ice related hazards and develop appropriate design and operation protocols.

Although common resources would be affected across increased spatial and temporal scales relative to Alternative 2, the overall effects of Alternative 3 on sea ice would be minor.

4.6.1.1.2 Conclusion

The overall effects of the proposed actions on physical ocean resources would be of medium intensity (due to the increase in impacts to sea ice), temporary, local, and would affect common resources as defined in the impact criteria in Section 4.1 of this EIS. The overall effects of the proposed activity described in Alternative 3 on physical ocean resources in the proposed action area would be minor.

4.6.1.2 Climate

Under this alternative, emissions would be higher when compared to Alternative 2 because the alternative proposes additional surveys and exploration plans described as Level 2 Exploration Activity on the Arctic OCS. In the U.S. Chukchi Sea OCS Planning Area, two additional seismic surveys are planned along with two additional site clearance surveys, and an additional EP is included. In the U.S. Beaufort Sea OCS Planning Area, two additional seismic surveys are considered along with two additional site clearance surveys, and an additional EP. The majority of additional emissions are from the additional EP proposed for Level 2 Exploration Activity.

Refer to Section 3.1.4.4 (*Climate Change in the Arctic*) for a thorough discussion of climate systems and the effects of GHG emissions.

4.6.1.2.1 Direct and Indirect Effects

Direct Effects

Direct effects under this alternative are the same as those described under Alternative 2.

Indirect Effects

Indirect Effects under this alternative are the same as those described under Alternative 2.

Regulatory Reporting and Permitting

Regulatory reporting and permitting under this alternative would be the same as those described under Alternative 2.

CO_2e Emissions Inventory

The specific description and number of each of these programs and activities proposed for the Arctic OCS, on an annual basis, were summarized earlier in Table 2.4 (*Activity Definitions*), and Section 2.4.5 (*Alternative 2 – Authorization for Level 1 Exploration Activity*). The estimated potential annual emissions of CO_2e for each type of activity and program proposed under this alternative are provided in Table 4.6-1. The data in this table assumes no controls to reduce emissions.

Effects of this Alternative on Climate Change

Reporting emissions of CO_2e under this alternative would be the same as described under Alternative 2.

Effects of Climate Change on Resources under this Alternative

Effects of climate change on resources under this alternative would be the same as described under Alternative 2.

Table 4.6-1. Estimated CO_2e Emissions by Activity and Program Type for the Arctic OCS

Activity/Program Types	**U.S. Chukchi Sea OCS Annual CO_2e Emissions** (metric tons per year)
2D/3D Seismic Survey (including one survey using an ice breaker vessel)	72,048
Site Clearance and High Resolution Shallow Hazards Survey Program	12,392
Exploration Plan	186,013
Total	**270,454**
Activity/Program Types	**U.S. Beaufort Sea OCS Annual CO_2e Emissions** (metric tons per year)
2D/3D Seismic Survey (including one survey using an ice breaker vessel)	85,692
Site Clearance and High Resolution Shallow Hazards Survey Program	12,392
On-Ice Seismic Survey	25
Exploration Plan	186,013

Total	284,123

Sources: EPA. October 1996. Compilation of Air Pollutant Emission Factors (AP-42) 5th ed., Volume I, Chapter 3, Table 3.3-1 and Table 3.4-1.
EPA. July 2010. Median Life, Annual Activity and Load Factor Values for Nonroad Engine Emissions Modeling (EPa-420-R-10-016, NR-005d).
BOEM. 2012. ION Seismic Survey.
EPA. 2012. EPA and NHTSA Set Standards to Reduce GHG and Improve Fuel Economy for Model Years 2017-2025 Cars and Light Trucks. Table 1. http://www.epa.gov/oms/climate/documents/420f12051.pdf

4.6.1.2.2 Conclusion

Direct and indirect impacts associated with climate are associated mainly with potential emissions of CO_2e that could, decades from now, contribute to changes in the environmental conditions already occurring in the Arctic and throughout the world. As such, the impacts to climate change cannot be measured on a project-level basis and instead are global in scope. However, total emissions of CO_2e emissions should be disclosed in the NEPA review.

4.6.1.3 Air Quality

Under this alternative, emissions would be higher when compared to Alternative 2 because the alternative proposes additional surveys and exploration plans described as Level 2 Exploration Activity on the Arctic OCS. In the U.S. Chukchi Sea OCS Planning Area, two additional seismic surveys are planned along with two additional site clearance surveys, and an additional EP is included. In the U.S. Beaufort Sea OCS Planning Area, two additional seismic surveys are considered along with two additional site clearance surveys, and an additional EP. The majority of additional emissions are from the additional EP proposed for Level 2 Exploration Activity.

4.6.1.3.1 Direct and Indirect Effects

Direct and indirect effects under this alternative would be from the same sources of emissions as described under Alternative 2 in Section 4.5.1.3.

Exploration Plan Emission Inventory

The emission rates likely to reflect Level 2 Exploration Activity in each sea are presented in Table 4.6-2 **Estimated Annual Emission Inventory of an Exploration Plan**. The inventory assumes no application of BACT or the use of ultra-low-sulfur diesel (ULSD) fuel. The emission inventory presented in Table 4.6-3 assumes the same method of calculation and EP operational characteristics as described for Alternative 2.

Survey Emission Inventory

The emission rates likely to reflect the increased level of seismic and other surveys under this alternative as compared to Alternative 2 are presented in **Table 4.6-3** and **Table 4.6-4**.

The survey inventories assume no application of BACT or the use of ultra-low-sulfur diesel (ULSD) fuel. The emission inventory presented in Table 4.6-4 assumes the same method of calculation and survey vessel operational characteristics as described for Alternative 2.

Table 4.6-2. Estimated Annual Emission Inventory of Level 2 Exploratory drilling for each Sea

Pollutant Sources	Two (2) Exploratory Drilling Programs Annual Emissions (tons per year)					
	PM	**NO_X**	**SO_2**	**CO**	**VOC**	**CO_2e***
Drill Rig	125.46	4,312.40	2.16	940.80	129.38	36,369
Ice Breakers (2 vessels each EP)	96.40	3,318.80	1.68	724.00	99.56	72737
Anchor Handler	22.40	312.20	0.12	67.60	25.00	909
Oil Spill response Barge	48.20	1,659.40	0.84	362.00	49.78	36,369
Oil spill Response Tug	22.40	312.20	0.12	67.60	25.00	909
Tank Vessel for Spill Storage	48.20	1,659.40	0.84	362.00	49.78	36,369
Support Vessels (3 vessels each EP)	67.20	936.60	0.36	202.80	75.00	2,351
Aircraft	0.00	0.10	0.42	16.12	6.56	
Total	**430.26**	**12,511.10**	**6.54**	**2,742.92**	**460.06**	**186,013**

Notes: SO_x (sulfur oxides) includes emissions of sulfur dioxide (SO_2).
NO_x (nitrogen oxides) includes emissions of nitrogen dioxide (NO_2).
PM (particulate matter) includes emissions of coarse and fine particulate matter (PM_{10} and $PM_{2.5}$).
VOC is volatile organic compounds.
CO is carbon monoxide.
CO_2e (carbon dioxide equivalent) is a combination of emissions of the six most common greenhouse gases expressed as a rate in relation to the global warming potential of CO_2.
*CO_2e is expressed in metric tons; all other data are given in units of short tons.
** No information on CO_2e emissions is available from EPA for aircraft.
Sources: BOEM, Alaska OCS Region. 2012.

Table 4.6-3. Estimated Annual Emission Inventory of Multiple Surveys on the Chukchi Sea OCS

Vessels	U.S. Chukchi Sea OCS Five (5) - 2D/3D Seismic Surveys Annual Emissions (tons per year)					
	PM	**NO_X**	**SO_2**	**CO**	**VOC**	**CO_2e***
Seismic Vessel	28.60	795.10	117.55	177.95	30.15	33,448
Receiver Vessel	14.05	481.40	81.10	110.35	14.35	21,110
Monitoring Vessel	9.09	311.54	52.50	71.39	9.28	13,660
Ice Breaker Vessel (for 1 of 5 Surveys)	2.81	96.28	16.22	22.07	2.87	3,830
Total	**54.55**	**1,684.32**	**267.37**	**381.76**	**56.65**	**72,048**
Vessels	**U.S. Chukchi Sea OCS Five (5) - Site Clearance and High Resolution Shallow Hazards Surveys Annual Emissions** (tons per year)					

	PM	NO_X	SO_2	CO	VOC	CO_2e*
Monitoring Vessel	9.09	311.54	52.50	71.39	9.28	12,392

Notes: SO_x (sulfur oxides) includes emissions of sulfur dioxide (SO_2).
NO_x (nitrogen oxides) includes emissions of nitrogen dioxide (NO_2).
PM (particulate matter) includes emissions of coarse and fine particulate matter (PM_{10} and $PM_{2.5}$).
VOC is volatile organic compounds.
CO is carbon monoxide.
CO_2e (carbon dioxide equivalent) is a combination of emissions of the six most common greenhouse gases expressed as a rate in relation to the global warming potential of CO_2.
*CO_2e is expressed in metric tons; all other data are given in units of short tons.
Sources: BOEM, Alaska OCS Region. 2012.
BOEM. 2012. ION Seismic Survey.

Table 4.6-4. Estimated Annual Emission Inventory of Multiple Surveys on the Beaufort Sea OCS

Vessels	**U.S. Beaufort Sea OCS Six (6) - 2D/3D Seismic Surveys Annual Emissions** (tons per year)					
	PM	**NO_X**	**SO_2**	**CO**	**VOC**	**CO_2e***
Seismic Vessel	34.32	954.12	141.06	213.54	36.18	40,137
Receiver Vessel	16.86	577.68	97.32	132.42	17.22	25,332
Monitoring Vessel	10.90	373.84	63.00	85.67	11.14	16,392
Ice Breaker Vessel (for 1 of 6 Surveys)	2.81	96.28	16.22	22.07	2.87	3,830
Total	**64.89**	**2,001.92**	**317.60**	**453.70**	**67.41**	**85,692**
Vessels	**U.S. Beaufort Sea OCS Five (5) - Site Clearance and High Resolution Shallow Hazards Surveys Annual Emissions** (tons per year)					
	PM	**NO_X**	**SO_2**	**CO**	**VOC**	**CO_2e***
Monitoring Vessel	9.09	311.54	52.50	71.39	9.28	12,392
Equipment	**U.S. Beaufort Sea OCS One (1) – On-Ice Seismic Survey Annual Emissions** (tons per year)					
	PM	**NO_X**	**SO_2**	**CO**	**VOC**	**CO_2e***
Trucks (2 vehicles)	0.001	0.04	0.0002	0.24	0.02	2
Bulldozer	0.26	6.05	1.76	4.59	2.59	23
Total	**0.27**	**6.09**	**1.76**	**4.83**	**2.62**	**25**

Notes: SO_x (sulfur oxides) includes emissions of sulfur dioxide (SO_2).
NO_x (nitrogen oxides) includes emissions of nitrogen dioxide (NO_2).
PM (particulate matter) includes emissions of coarse and fine particulate matter (PM_{10} and $PM_{2.5}$).
VOC is volatile organic compounds.
CO is carbon monoxide.

CO_2e (carbon dioxide equivalent) is a combination of emissions of the six most common greenhouse gases expressed as a rate in relation to the global warming potential of CO_2.
*CO_2e is expressed in metric tons; all other data are given in units of short tons.
Sources: BOEM, Alaska OCS Region. 2012.
BOEM. 2012. ION Seismic Survey.

4.6.1.3.2 Air Quality Impact Analysis

The air quality impact analysis would be conducted as described under Alternative 2.

4.6.1.3.3 Level of Effect

The annual rate of air emissions and onshore pollutant concentrations are the two basic measurements for assessing a proposal's level of effect on air quality. The emission inventory provided in this section discloses the rate of emissions likely to reflect a proposal under this alternative (Alternative 3), expressed in short tpy. When necessary, an emission inventory is translated into pollutant concentrations expressed in micrograms per cubic meter ($\mu g/m^3$), a value that can be measured against the NAAQS allowing the level of effect to be categorized relative to the conditions summarized under Alternative 2 in Table 4.5-7 *Impact Levels for Effects on Air Quality*. Further information regarding level of effect under this alternative would be the same as discussed under Alternative 2.

4.6.1.3.4 Conclusion

Emissions from exploratory drilling activities proposed under this alternative would be higher than emissions estimated for Alternative 2. Without emission reduction controls on the drillship engines, there is a greater potential for one or more of the EPA SILs to be exceeded onshore. The Level 2 Exploration Activity would almost certainly require additional modeling to demonstrate the effect of pollutant concentrations on the nearest onshore area. A moderate level of effect on air quality is expected, which may be mitigated by emission control strategies to result in a minor level of effect. Cumulatively, the total estimated emissions for each Arctic OCS planning area, when considering all plans and activities described under this alternative, are summarized in Table 4.6-5.

Control of oil and gas emission sources on the OCS, and levels of effect, are considered on a project-by-project basis, as each individual operator would have the responsibility to engage any engine emission controls required by BOEM AOCSR. Emission reduction strategies have the potential to reduce at least some emissions of all pollutant types, including CO_2e. Therefore, the data provided in Table 4.6-5 would represent a worst-case scenario for each Arctic OCS planning area.

Table 4.6-5. Estimated Annual Emission Inventory for Arctic OCS – Level 2 Activity

Plan/Activity	U.S. Chukchi Sea OCS Annual Emissions (tons per year)					
	PM	NO_X	SO_2	CO	VOC	CO_2e*
2D/3D Seismic Surveys (1 of 5 Surveys with an Ice Breaker Vessel) - Five (5)	54.55	1,684.32	267.37	381.76	56.65	72,048
Site Clearance and High Resolution Shallow Hazards Survey Programs - Five (5)	9.09	311.54	52.50	71.39	9.28	12,392
Exploration Plans - Two (2)	430.26	12,511.10	6.54	2,742.92	460.06	186,013
Total	**493.89**	**14,506.95**	**326.40**	**3,196.08**	**525.99**	**270,454**
Plan/Activity	**U.S. Beaufort Sea OCS**					

	Annual Emissions (tons per year)					
	PM	**NO_X**	**SO_2**	**CO**	**VOC**	**CO_2e***
2D/3D Seismic Surveys (1 of 6 Surveys with an Ice Breaker Vessel) - Six (6)	64.89	2,001.92	317.60	453.70	67.41	85,692
Site Clearance and High Resolution Shallow Hazards Survey Programs - Five (5)	9.09	311.54	52.50	71.39	9.28	12,392
On-Ice Seismic Surveys – One (1)	0.27	6.09	1.76	4.83	2.62	25
Exploration Plans - Two (2)	430.26	12,511.10	6.54	2,742.92	460.06	186,013
Total	**504.51**	**14,830.65**	**378.40**	**3,272.85**	**539.37**	**284,123**

4.6.1.4 Acoustics

Under Alternative 3, the number of seismic survey programs envisioned is increased from Alternative 2 by two exploration surveys and two site clearance or high resolution shallow hazards surveys in each of the Chukchi Sea and Beaufort Sea (Tables 4.2-1 and 4.2-2), using the same types of noise-generating sources. This represents an increase in seismic survey activities of approximately 65 percent in the Chukchi Sea and 50 percent in the Beaufort Sea. The amount of drilling activity has also doubled in each sea between Alternatives 2 and 3. A detailed discussion of the acoustic properties of the noise sources is given in Section 4.5.1.4; that discussion is relevant also to Alternative 3 operations.

4.6.1.4.1 Direct and Indirect Effects

Estimates of Total Surface Areas of Ensonification at Threshold Levels

Table 4.6-6 contains estimates of surface areas ensonified above given threshold levels under Alternative 3. For the purpose of computing these notional areas, the seismic survey activities listed in Table 4.2-2 for Activity Level 2 are distributed among the three environments considered in this EIS. The five exploration surveys and five site clearance or high resolution shallow hazard surveys in the Chukchi Sea are all assumed to be in the mid-depth shelf region; the six exploration surveys and five site clearance or high resolution shallow hazard surveys in the Beaufort Sea are divided between the mid-depth shelf and the shallow-depth coastal regions in the proportions of 4:2 and 3:2 respectively (giving greater representation to the shelf region makes the estimates more precautionary). The source array sizes in the three zones reflect the prevailing configurations for seismic surveys conducted in each region. The percentages are based on nominal surface areas of 263,500 km^2 for the Chukchi portion of the EIS project area and 255,350 km^2 for the Beaufort portion. The surface areas presented in Table 4.6-6 indicate the total area of each sea that would be ensonified if the maximum number of surveys allowed under this alternative were to be performed concurrently. Of note, the total surface areas do not subtract out either overlap with other isopleths of concurrent source operation, or land area where activities are closer to shore, for that reason, the area ensonified over 120 dB is likely a significant overestimate (see figures 4.3-1 through 4.5-3 illustrating conceptual examples to get a sense of this).

Table 4.6-6 Total Surface Areas Ensonified Above Sound Level Thresholds Under Alternative 3, From Averages Listed in Table 4.5-12.

		Total Surface Areas (km^2) to sound level (90% rms SPL (dB re 1 µPa rms))			
		190	**180**	**160**	**120**
Chukchi Sea Shelf 40 to 52 m depth					
	5x ~3200 in^3	4.41	48.7	1,798	141,764
	5x 40 in^3	0.03	0.29	25.3	10,619
	2x drill/support *			1044	1,044
	% Chukchi	**0.00%**	**0.02%**	**1.09%**	**58%**
Beaufort Sea Shelf, 15 to 40 m depth					
	4x ~3200 in^3	9.96	82.9	1,633	45,238
	3x 20 in^3	0.003	0.03	5.59	2,535
	2x drill/support *			1044	1,044
Beaufort Coastal, inside and outside barrier islands to 10 m depth					
	2x 880 in^3	0.46	2.02	46.9	2,206
	2x 20 in^3	0.02	0.12	4.35	268
	% Beaufort	**0.00%**	**0.03%**	**1.07%**	**20%**
Entire Region					
		15	**134**	**5601**	**204,718**
	% EIS area	**0.00%**	**0.03%**	**1.08%**	**39%**

*drill/support indicates area within 13-km radius around drill rig, notionally encompassing support

vessels. Indicated area is within 120-dB radius, included in 160-dB column for assessment.

4.6.1.4.2 Conclusion

The intensity rating of this alternative is high, as additional exploration activities will introduce sources with source sound levels that exceed 200 dB re 1 µPa. Because the exploration activities could continue for several years, the duration is considered as long term. The spatial extent of these activities is regional, since the distribution of exploration activities over the project areas will lead to 39 percent of the EIS area being exposed to sound levels in excess of 120 dB re 1 µPa . Therefore, the overall impact rating for direct and indirect effects to the acoustic environment would be moderate.

4.6.1.5 Water Quality

Impacts to water quality from Alternative 3 are expected to be very similar to those described above for Alternative 2. The only difference between the two alternatives is the level of activity. Any differences in impacts between the two alternatives are noted below.

4.6.1.5.1 Direct and Indirect Effects

Temperature and Salinity

Seismic Surveys

Similar to the impacts under Alternative 2, seismic surveys under Alternative 3 would not expected to have any measureable impact on temperature or salinity in the EIS project area.

Site Clearance and Shallow Hazards Surveys

Similar to the impacts under Alternative 2, site clearance and shallow hazards surveys under Alternative 3 would not be expected to have any measureable impact on temperature or salinity in the EIS project area.

On-ice Seismic Surveys

Similar to the impacts under Alternative 2, on-ice seismic surveys under Alternative 3 would not be expected to have any measureable impact on temperature or salinity in the EIS project area.

Exploratory Drilling Programs

Under Alternative 3, changes in water quality related to temperature and salinity resulting from exploratory drilling programs would be the same in nature as those described for Alternative 2. Alternative 3 would allow additional drilling programs in the EIS project area, and as a result of the additional drilling programs, the intensity as well as the spatial extent of the impact may effectively be doubled. Relative to Alternative 2, salinity and temperature may be affected over a larger area. However, the effects of Alternative 3 on water quality resulting from changes in temperature and salinity would be low intensity, temporary, and local. Although common resources may be affected across increased spatial scales relative to Alternative 2, the overall effects of Alternative 3 on water quality related to temperature and salinity resulting from exploratory drilling programs would be minor.

Turbidity and Total Suspended Solids

Seismic Surveys

Effects on water quality resulting from increases in turbidity and total suspended solids from seismic surveys under Alternative 3, if any, would be low-intensity, temporary, local, and would affect a common resource. The nature of those effects would be similar to those described under Alternative 2.

Site Clearance and Shallow Hazards Surveys

Effects on water quality resulting from potential increases in turbidity and total suspended solids from site clearance and shallow hazard surveys under Alternative 3, if any, would be low-intensity, temporary, local, and would affect a common resource. The nature of those effects would be similar to those described under Alternative 2.

On-ice Seismic Surveys

On-ice seismic surveys would not affect turbidity or concentrations of suspended solids in the proposed action area. As they occur on the ice and not in the open-water environment, no contact is made with the seafloor during these types of surveys.

Exploratory Drilling Programs

Effects on water quality resulting from increases in turbidity and total suspended solids from exploratory drilling programs are described in detail under Alternative 2. Alternative 3 would allow additional drilling programs in the EIS project area, and, as a result of the additional drilling programs, the intensity as well as the spatial extent of the impact may be effectively doubled. Relative to Alternative 2, turbidity and concentrations of suspended solids may be affected over a larger area. However, the effects of Alternative 3 on water quality resulting from changes in turbidity and concentrations of suspended solids would be low intensity, temporary, and local. Although common resources would be affected across increased spatial and temporal scales relative to Alternative 2, the overall effects of Alternative 3 on water quality related to turbidity and concentrations of suspended solids resulting from exploratory drilling programs are expected to be minor.

Metals

Seismic Surveys

Similar to the impacts under Alternative 2, seismic surveys are not expected to have any measureable impact on dissolved metal concentrations in the EIS project area.

Site Clearance and Shallow Hazards Surveys

Similar to the impacts under Alternative 2, site clearance and shallow hazards surveys are not expected to affect dissolved metal concentrations in the proposed action area.

On-ice Seismic Surveys

Similar to the impacts under Alternative 2, on-ice seismic surveys would not affect dissolved metal concentrations in the EIS project area.

Exploratory Drilling Programs

Direct and indirect effects on water quality resulting from increases in concentrations of metals from exploratory drilling programs are described in detail under Alternative 2. Alternative 3 would allow additional drilling programs in the EIS project area, and, as a result of the additional drilling programs, the intensity as well as the spatial extent of the impact may effectively be doubled. Relative to Alternative 2, metal concentrations may be affected over a larger area. However, the effects of Alternative 3 on water quality resulting from changes in metal concentrations would be low intensity, temporary, and local. Although common resources would be affected across increased spatial and temporal scales relative to Alternative 2, the overall effects of Alternative 3 on water quality related to metal concentrations resulting from exploratory drilling programs would be minor.

Hydrocarbons and Organic Contaminants

Seismic Surveys

Similar to the impacts under Alternative 2, while the level of activity would double, seismic surveys are expected to have negligible impacts on concentrations of hydrocarbons and organic contaminants in the waters of the EIS project area.

Site Clearance and Shallow Hazards Surveys

Similar to the impacts under Alternative 2, while the level of activity would double, site clearance and shallow hazards surveys are expected to have negligible impacts on concentrations of hydrocarbons and organic contaminants in the waters of the EIS project area.

On-ice Seismic Surveys

Similar to the impacts under Alternative 2, on-ice seismic surveys are expected to have minor impacts on concentrations of hydrocarbons and organic contaminants in the waters of the EIS project area under Alternative 3. Alternative 3 contemplates the same level of on-ice seismic activity as Alternative 2; therefore, the level of impacts is anticipated to be the same. Contaminants from fluids entrained in the ice roads would be discharged every spring during breakup. Any entrained hydrocarbons and other organic contaminants from vehicle exhaust, oil, grease, and other vehicle-related fluids not recovered would pass into the Beaufort and/or Chukchi Sea system at each breakup as a result of on-ice seismic surveys. The effects of these discharges on water quality would be temporary and local in nature, and overall impacts to water quality from on-ice seismic surveys under Alternative 3 are expected to be minor.

Exploratory Drilling Programs

Direct and indirect effects on water quality resulting from increases in concentrations of hydrocarbons and other organic contaminants from exploratory drilling programs are described in detail under Alternative 2. Relative to Alternative 2, Alternative 3 would allow additional drilling programs in the EIS project area, and, as a result of the additional drilling programs, the intensity as well as the spatial extent of the impact may effectively be doubled. Relative to Alternative 2, concentrations of hydrocarbons and other organic contaminants would be affected over a larger area. Impacts to water quality resulting from hydrocarbons and other organic contaminants would be temporary and would dissipate soon after the discharge is stopped. Such impacts would be local in nature due to rapid dilution of discharged compounds into the ocean. It seems probable that inputs of hydrocarbons and other organic contaminants from exploratory drilling programs under Alternative 3 would have minor to moderate effects on water quality outside of the discharge plume area. However, due to lack of applicable water quality criteria for some organic compounds in drilling fluids (EPA 2006b), it is problematic to determine whether or not inputs of hydrocarbons and other organic compounds from the proposed activity would exceed water quality regulatory limits.

Although unlikely, it is plausible that accidental or emergency events may occur within the proposed action area. Due to the rarity of such unforeseen events, and the potential magnitude and extent of their impacts relative to the effects of normal operation and maintenance activities, such accidental or emergency events are not addressed in this section and are covered in Section 4.10 of this EIS. Standard mitigation measures requiring operators to have plans in place to minimize the likelihood of a spill would reduce the potential for adverse impacts to water quality.

4.6.1.5.2 Conclusion

After mitigation, the effects of the proposed actions on water quality are expected to be low-intensity, temporary, local, and would affect a common resource. The overall effects of the proposed activity described in Alternative 3 on water quality in the EIS project area are expected to be negligible.

4.6.1.6 Environmental Contaminants and Ecosystem Functions

4.6.1.6.1 Direct and Indirect Effects

Contaminants of Concern

Contaminants of concern introduced to the EIS project area as a result of the activities proposed in Alternative 3 would be the same as those described for Alternative 2. Because Alternative 3 would authorize a greater level of activity relative to Alternative 2, the amounts of contaminants introduced to the EIS project area would potentially be greater under Alternative 3.

Proposed mitigation measures intended to reduce/ lessen non-acoustic impacts on marine mammals have the potential to reduce adverse impacts resulting from contaminants of concern.

Exposure of Habitat and Biological Resources

Pathways for exposure of habitat and biological resources to contaminants of concern as a result of the activities proposed in Alternative 3 would be the same as those described for Alternative 2.

Effects on Ecosystem Functions

In response to comments and suggestions received as part of the scoping process for this EIS, effects of (contaminants of concern from) the proposed activities on ecosystem functions are assessed in the following section. Effects of the activities proposed under Alternative 3 on the four categories of ecosystem functions (defined in Section 4.4.1.6) are assessed below.

Regulation Functions

The nature of the effects of the activities proposed under Alternative 3 on regulation functions would be the same as described under Alternative 2. The effects of greatest concern would be associated with exploratory drilling programs. Alternative 3 would authorize up to two exploratory drilling programs per year in the Beaufort Sea and up to two exploratory drilling programs per year in the Chukchi Sea, whereas Alternative 2 would authorize only one exploratory drilling program per year in each sea. Thus, the magnitude of the effects on regulation functions would be greater under Alternative 3 compared to Alternative 2. The magnitude and extent of effects of Alternative 3 on regulation functions would depend upon interrelationships between impacts to biological and physical resources, which are addressed in other sections of this EIS.

Habitat Functions

The nature of the effects of the activities proposed under Alternative 3 on habitat functions would be the same as described under Alternative 2. Effects of Alternative 3 on habitat functions would include impacts to refugium functions and nursery functions (provision of suitable reproduction habitat) associated with benthic habitats resulting from discharges from exploratory drilling. Overall effects to benthic habitat functions would be temporary, local, and low-intensity. Effects would also occur to functions associated with pelagic and epontic habitats. Functions associated with terrestrial habitats would be affected to a lesser degree. Overall, effects of Alternative 3 on habitat functions would be medium-intensity, temporary, and local. The functions affected could be common, important, or unique depending on the spatial location of the impact.

Proposed mitigation measures intended to reduce/ lessen non-acoustic impacts on marine mammals have the potential to reduce adverse impacts to habitat functions.

Production Functions

The nature of the effects of the activities proposed under Alternative 3 on production functions would be the same as described under Alternative 2. Impacts to production functions related to provision of raw materials and food (i.e. subsistence) could be affected by the activities proposed under Alternative 3. These impacts are described in the subsistence section of this EIS. In addition to introducing contaminants to secondary and tertiary consumers via trophic transfer processes, contaminants of concern could interrupt trophic transfer processes resulting in shorter food chains (less complex food webs), and reduced throughput of energy and nutrients at higher trophic levels. Oil and gas are ecosystem goods, and the flows of energy that they represent are ecosystem services. These ecosystem goods and services could potentially be derived from historical production functions in the EIS project area under Alternative 3.

Information Functions

Information functions contribute to the maintenance of human health by providing opportunities for spiritual enrichment, cognitive development, recreation, and aesthetic experience (DeGroot et al. 2002). The effects of Alternative 3 on information functions in the EIS project area would depend upon interrelationships between impacts to cultural resources, social resources and aesthetic resources, which are addressed in other sections of this EIS.

4.6.1.6.2 Conclusion

Direct and indirect impacts to ecosystem functions resulting from the implementation of Alternative 3 would be medium-intensity, temporary, localized, and would affect common resources. The functional properties of ecosystems described in this section, such as nutrient cycling and habitat functions, are more robust (i.e. resistant to stressors) than are species composition and other structural properties. Because Alternative 3 would authorize a greater level of activity than Alternative 2 there is potential for increased volume of contaminants introduced to the project area. However, the overall effects of Alternative 3 on ecosystem functions would be considered minor.

4.6.1.7 Standard and Additional Mitigation Measures

Standard and additional mitigation measures that could reduce impacts to the physical environment are discussed under Alternative 2 (Section 4.5.1.7).

4.6.2 Biological Environment

4.6.2.1 Lower Trophic Levels

4.6.2.1.1 Direct and Indirect Effects

The direct and indirect impacts discussed in Section 4.5.3.7 for Alternative 2 are also applicable for this alternative. The increased levels of activity associated with Alternative 3 would not generate different types of impacts to lower trophic levels. The conclusions for Alternative 2 are applicable to Alternative 3; therefore, the overall impact to lower trophic levels would be moderate.

4.6.2.1.2 Conclusion

Given the implementation of the standard mitigation measures considered in this EIS, the direct and indirect effects on lower trophic levels associated with Alternative 3 would likely be low in intensity, temporary to long-term in duration, of local extent and could affect common resources; resulting in a summary impact level of negligible. The only exception to these levels of impacts would be the introduction of an invasive species due to increased vessel traffic, which could be of medium intensity, long-term or permanent duration, of regional geographic extent, and affect common or important resources, which could cause a summary impact of moderate.

4.6.2.2 Fish and Essential Fish Habitat

4.6.2.2.1 Direct and Indirect Effects

Under Alternative 3, the types of oil and gas exploration activities undertaken in the EIS project area would be the same as those in Alternative 2, but the level of activity would be higher. An increase from Level 1 to Level 2 would result in an overall increase in activity of approximately 40 percent, distributed unevenly among the different activities. It would double some activity levels while leaving others unchanged. There would be no increase in icebreaking or on-ice seismic surveys, an increase of 50 percent in seismic surveys and site clearance and high resolution shallow hazard surveys, and a doubling of exploratory drilling programs. This uneven nature of the increase would also apply to the impacts on different fish resource groups.

The types and mechanisms of effects would remain the same in Alternative 3 as in Alternative 2. For a complete discussion of the types and mechanisms of effects on fish resources, please see Section 4.5.2.2, Fish and Essential Fish Habitat.

Marine Fish

The direct and indirect effects on marine fish resulting from Alternative 3 would be very similar to those described under Alternative 2. Due to the uneven nature of the increases in activity levels by activity type, the increase in impacts to different fish assemblages would vary. The cryopelagic assemblage would have essentially no additional impacts, as the level for activities likely to affect that group (icebreaking and on-ice seismic surveys) would not change from Alternative 2. Demersal assemblages, on the other hand, would feel the additional effects from the increase in seismic survey levels and exploratory drilling, both in terms of habitat loss and the effects from noise. Pelagic assemblages would be impacted by the increase in surveys but less so by the increased drilling programs. However, in spite of the potential for different resource groups to experience uneven increases in level of effect, the overall impact would remain the same given the limited area affected compared to the distribution of fish populations. The impacts to marine fish would be considered minor.

For a complete discussion of the effects on Marine Fish, please see Section 4.5.2.2.

Migratory Fish

The direct and indirect effects on migratory fish resulting from Alternative 3 would be very similar to those described under Alternative 2. Because anadromous fish are more likely to be impacted by the activity types than amphidromous fish, as discussed under Alternative 2, they are likely to experience a disproportionate increase in adverse impacts when the two groups are compared. However, as described in Alternative 2, those anadromous species known to inhabit the area where project activities would occur are not very abundant, and they are unlikely to be impacted. Therefore, the overall impact to the resource group would remain the same. The impacts to migratory fish would be considered negligible.

For a complete discussion of the effects on Migratory Fish, please see Section 4.5.2.2.

Essential Fish Habitat

The direct and indirect effects on essential fish habitat resulting from Alternative 3 would be very similar to those described under Alternative 2, with an increase in effects due to the increase in oil and gas exploration activities. In particular, the increase in exploratory drilling programs would result in increased habitat loss and alteration, potentially to EFH for saffron cod and salmon. Since there would be no increase in icebreaking activities, EFH for Arctic cod would be impacted the least. The opportunity for habitat loss or alteration resulting from Alternative 3 is very small and only incrementally larger than for Alternative 2. Most impacts would be of such low intensity and of such small geographic extent that the effects would be considered minor.

For a complete discussion of the effects on Essential Fish Habitat, please see Section 4.5.2.2.

4.6.2.2.2 Conclusion

The overall impact of Alternative 3 on Fish Resources and EFH is minor. Despite a substantial increase in level of activity over Alternative 2, there would be no corresponding increase in the overall impact level. Due to the very small scale of any potential effects relative to overall population levels and available habitat, and the temporary nature of the majority of the activities associated with Alternative 3, there would be no measurable effect on the resource.

4.6.2.3 Marine and Coastal Birds

4.6.2.3.1 Direct and Indirect Effects

Alternative 3 includes all of the same type of exploration activities as in Alternative 2 so the discussion of potential direct and indirect effects on marine and coastal birds under Alternative 3 involves all the same mechanisms and types of effects as discussed for Alternative 2 in Section 4.5.2.3. The difference between alternatives concerning marine and coastal birds is a matter of degree. Alternative 3 includes a larger number of some authorized exploration activities than Alternative 2. These activities take place in the same areas and timeframes and also involve the same standard mitigation measures. This EIS includes a number of standard and additional mitigation measures as part of each alternative that are intended to reduce adverse effects on marine mammals but may also reduce adverse effects on birds. In addition to the mitigation measures imposed by NMFS, the USFWS requires certain mitigation measures specific to ESA-listed species under its jurisdiction, including spectacled and Steller's eiders (USFWS 2009c). Section 4.5.2.3 summarizes the mitigation measures typically required by the USFWS and other agencies for oil and gas exploration activities in the Beaufort and Chukchi seas to minimize impacts on birds and these measures are incorporated into the analysis of potential effects under Alternative 3.

The direct and indirect effects of oil and gas exploration activities on marine and coastal birds would be very similar under Alternative 3 as those described under Alternative 2. Marine birds would be subject to increased disturbance from vessels and seismic sources due to the increase in seismic surveys that could be authorized under Alternative 3 in both Arctic seas. However, disturbance effects would be temporary even if they occurred over a wider area and birds could fly or swim away from acute disturbance.

With more exploration activities authorized under Alternative 3, the potential for adjacent activities to magnify effects on birds could be increased. However, the requirement to maintain a minimum distance of 24 km (15 mi) between two seismic surveys conducted concurrently would effectively limit the intensity of seismic survey effects on birds no matter where the activities take place during the open water season. The Ledyard Bay closure period would be the same under Alternative 3 as under Alternative 2 so this area would be unaffected by increases in exploration elsewhere.

The risk of birds colliding with vessels would increase incrementally. A full complement of vessels for a full season as considered under this alternative may result in a greater number of strikes than occurred during the 2012 drilling season. Based on the existing preliminary bird strike reports from 2012, four simultaneous future drilling operations could result in as many as 356 bird strikes per open-water season—this could include an estimated 197 passerines, 45 shearwaters/storm petrels/auklets, 17 shorebirds, and 96 seaducks. Of the seaducks, 47 could be king eiders, 32 could be long-tailed ducks, and 16 could be common eiders. This potential mortality for each species is small by comparison with the post-breeding population; thus, no species would experience a population-level effect. However, small flocks of eiders can strike a vessel, suggesting that the authorized incidental take of listed eiders could be exceeded in one strike event.

4.6.2.3.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to marine and coastal birds are discussed under Alternative 2 (Section 4.5.2.3). These include aircraft flight paths and altitude restrictions to reduce the chance of disturbing marine and coastal birds, and development of an oil response plan and procedures for exploratory drilling to minimize the risk of spills occurring and to expedite clean-up responses.

4.6.2.3.3 Conclusion

Most marine and coastal birds are legally protected under the Migratory Bird Treaty Act and several are protected under the ESA. Birds fulfill important ecological roles in the Arctic and many are important subsistence resources. Depending on the species, they are considered to be important or unique resources in a NEPA perspective. The effects of disturbance, injury/mortality, and changes in habitat for marine and coastal birds would likely be temporary or short-term, localized, and not likely to have population-level effects for any species. The overall effects of oil and gas exploration activities authorized under Alternative 3 on marine and coastal birds would therefore be considered negligible to minor according to the impact criteria in Table 4.2-1.

4.6.2.3.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to marine and coastal birds are discussed under Alternative 2 (Section 4.5.2.3).

4.6.2.3.5 Additional Mitigation Measures Conclusion

Most of the additional mitigation measures considered in this EIS would not appreciably reduce potentially adverse effects on birds except for Additional C3 and C4. These two measures would reduce the risk of contamination from discharges and drilling muds, although the reduction in adverse effects relative to the standard mitigation measures would be limited to small numbers of birds and small areas of benthic habitat. Given the implementation of standard and additional mitigation measures considered by NMFS in this EIS, and assuming no large oil spill occurred during exploration activities, the effects on birds would likely be low in intensity, temporary to long-term in duration, of local extent, and would affect important or unique resources. The effects of Alternative 3 with additional mitigation measures would therefore be considered negligible to minor for birds.

4.6.2.4 Marine Mammals

4.6.2.4.1 Bowhead Whales

4.6.2.4.1.1 Direct and Indirect Effects

The types of oil and gas exploration activities undertaken in the EIS project area under Alternative 3 would be the same as those discussed under Alternative 2, with an increased level of activity for all but icebreaking or on-ice seismic (vibroseis) surveys (Table 4.2-2). The types and mechanisms of direct and indirect effects on bowhead whales would, therefore, be the same under Alternative 3 as discussed for Alternative 2 in Section 4.5.2.4.9. The difference between alternatives is a matter of degree. An increase from Level 1 to Level 2 would result in an overall increase in activity of approximately 40 percent, distributed unevenly among the different activities. It would double some activity levels while leaving others unchanged. There would be no increase in icebreaking or on-ice seismic surveys, an increase of 50 percent in seismic surveys and site clearance and shallow water hazard surveys, and a doubling of exploratory drilling programs. These activities take place in the same areas and timeframes and also consider the same standard and additional mitigation measures under both alternatives.

Behavioral Disturbance

Each of the exploration activities that would be authorized under Alternative 3 includes several mechanisms for potential disturbance to bowhead whales. Most result from noise generated by oil and gas exploration equipment and associated vessels and aircraft. The mechanisms for disturbance and the suite of potential reactions by bowheads to disturbance under Alternative 3 are as described in detail for Alternative 2 in Section 4.5.2.4.9.

There could be a significant increase in the amount of open-water activities under Alternative 3 compared to Alternative 2. Exploration activity and associated effects may increase in time and space under Alternative 3, but the resulting direct and indirect effects on bowhead whales would be similar in nature to those described under Alternative 2. Potential effects of in-ice seismic surveys with icebreaker support and on-ice vibroseis surveys would be identical to Alternative 2, since activity level would remain the same under Alternative 3.

Disturbance effects of seismic activity on bowhead whales under Alternative 3 would be of medium to high intensity. Some whales may be displaced but would not leave the EIS project area entirely. The duration is expected to be interim. Long term effects are unknown. The extent of the impact would depend on the number of seismic activities and associated support vessels in an area. Individual sound source vessels may produce localized impacts, especially if one considers potential harassment of some percentage of bowhead whales exposed to sound levels below 120 dB, as discussed in Section 4.2.6. Historical take estimates from seismic studies do not suggest that these surveys alone would warrant a "high" intensity rating, however, our draft revisions of the acoustic criteria suggest that takes resulting from these surveys might be somewhat more extensive than previously calculated. Multiple seismic activities in one area or in several areas across the migratory corridor could lead to more widespread, regional impact. Bowhead whales are considered a unique resource, due to their endangered species status.

Anticipated impacts of an additional OBC survey in the Beaufort Sea, in terms of magnitude (medium), duration (interim), extent (local), and context (unique), may be similar to those described for one OBC survey under Alternative 2. Since disturbance effects may extend 20 to 30 km (12 to 19 mi) from the sound source, the zone of impact could be expected to expand spatially in the presence of multiple OBC surveys. This could result in the geographic extent of impact broadening from localized to regional.

Direct and indirect effects of site clearance and high resolution shallow hazards surveys under Alternative 3 would be similar to those described for Alternative 2. Magnitude of effects would be medium, and duration would be temporary or interim. Given the increase in the number of surveys in each sea under this alternative, the extent could increase from local, as it was under Alternative 2, to more regional, depending on the spatial and temporal distribution of activities.

For bowhead whales, historical take estimates suggest that exploratory drilling results in more take of bowhead whales than other categories of activities (Tables 4.2-5 and 4.2-6 in Section 4.2.6). Alternative 3 doubles the level of potential drilling, which results in a substantial increase in intensity. Anticipated impacts of two exploratory drilling programs under Alternative 3 would be similar to that for Alternative 2 in terms of magnitude (medium), duration (interim), extent (local), and context (unique) but will ultimately contribute to an increase in intensity when the combined effects of all activities are considered. The extent of impact resulting from the addition of a second drilling program in each sea would depend on the spatial and temporal distribution of the activities within the open water season. Extent could potentially increase from local to regional.

Disturbance effects resulting from vessel and aircraft activity under Alternative 3 would be similar to Alternative 2. Disturbance effects of vessel and aircraft activity would likely be of medium intensity, and the duration of disturbance is expected to be interim (long term effects are unknown). The extent of impact would depend on the number of support vessels in an area. Impacts are expected to be localized for individual activities; multiple activities in one area or in several areas across the migratory corridor could result in a broader, regional impact.

Please refer to Section 4.5.2.4.9 for a complete discussion of the disturbance effects, by activity type, on bowhead whales.

Hearing Impairment, Injury, and Mortality

The primary mechanisms of potential injury or mortality due to oil and gas exploration activities are permanent hearing loss or damage (auditory injury) and collisions with vessels. These are discussed in detail in Section 4.5.2.4.9. As noted under Alternative 2, it is not currently possible to assess whether or not auditory impairment (TTS or PTS) is occurring in bowhead whales. The potential effects of ship strikes under Alternative 3 are similar to that discussed under Alternative 2. The intensity of impact could be considered medium, given past low-level occurrence and potential increased occurrence with additional vessel traffic associated with oil and gas exploration activities. The impact would be temporary, although the results (injury or mortality) would be permanent for the impacted whale. The extent of impact would be local, given the relative infrequency of occurrence and the non-random distribution of both bowhead whales and exploration activity in the EIS project area.

Please refer to Section 4.5.2.4.9 for a complete discussion of potential injury or mortality effects on bowhead whales. Although it seems difficult to rule out the potential for TTS or PTS completely, the majority of the standard mitigation measures are geared towards minimizing the likelihood of injury, and are expected to be relatively successful.

Habitat Alterations

The potential effects on bowhead whale habitat in the EIS project area under Alternative 3 would likely be similar to those summarized under Alternative 2, with the exception of acoustic habitat. Additional exploratory drilling could, however, increase the number of localized sites experiencing possible habitat effects of drilling activities.

As noted in Section 4.6.1.4, with the addition of more 2D/3D surveys and exploratory drilling, the area ensonified above the levels that bowheads are expected to respond behaviorally, but also above the levels at which masking might be expected to potentially occur for some types of signals, increases significantly. When the larger 120-dB zones around all of the potential sound sources are considered (not suggesting that all individuals exposed to this would be taken, but suggesting that they would all have to deal with a sound that is audible and potentially in the range where it would mask another important sound (including inter-species communication), the area of effect is quite large and, depending on the location of the individual activities, could (for months) span a large portion of the north-south extent of the area through which migrating bowheads, with their calves, must traverse.

Please refer to Section 4.5.2.4.9 for a complete discussion of the potential effects on bowhead whale habitat.

4.6.2.4.1.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to bowhead whales are discussed under Alternative 2 (Section 4.5.2.4.15).

4.6.2.4.1.3 Conclusion

For Alternative 3, when all of the potential categories of activities combined are considered, and the maximum level of each is considered, the increase in potential impacts on bowheads, through a combination of behavioral harassment and loss of acoustic habitat, is potentially substantial (intensity going from medium to high). If the example take estimates from Tables 1 and 2 in Section 4.2.6 are used, the difference in maximum activity levels results in almost a two-fold increase in takes. Bowhead whales are listed as endangered, and the Beaufort and Chukchi seas are important areas for them, through which the entire population migrates with calves, occasionally stopping to feed, which places them in the context of being a unique resource. The intensity and duration of the various effects and activities considered are mostly high and interim. Potential long-term effects from repeated disturbance are, however, unknown. Although the various individual activities may affect bowhead whales on a local level, the area and extent over which the combined effects occur would likely increase with multiple activities occurring simultaneously or consecutively throughout much of the summer-fall range of this population. Considering these factors, along with potential reduced adverse impacts through the imposition of required standard mitigation measures, the overall impact of Alternative 3 on bowhead whales would be considered moderate.

Type of effect	Impact Component	Effects Summary	
Behavioral disturbance	Magnitude or Intensity	Low	
		Medium	
		High	Take of bowheads exceeds 30% of population
	Duration	Temporary	
		Interim	All activity types last more than month, but combination < 6 months
		Long-term	
	Geographic Extent	Local	
		Regional	Impacts should be considered regional, especially when consider area ensonified over 120 dB (>10% EIS area)
		State-wide	
	Context	Common	
		Important	
		Unique	ESA-listed species, impacts across migratory corridor through which mother/calve pairs traverse, potential disruption of feeding

Type of effect	Impact Component	Effects Summary	
Injury and mortality	Magnitude or Intensity	**Low**	Injury or death unlikley
		Medium	Though unlikely, cannot rule out PTS
		High	
	Duration	**Temporary**	
		Interim	Type of potential injury (though unlikely) would likely have moderate effects
		Long-term	
	Geographic Extent	**Local**	Since unlikely, any few impacts would be considered local
		Regional	
		State-wide	
	Context	**Common**	
		Important	ESA listed species, but population is increasing
		Unique	
Habitat alterations	Magnitude or Intensity	**Low**	
		Medium	Combination of potential habitat impacts, including acoustic habitat, are medium
		High	
	Duration	**Temporary**	
		Interim	Although other alterations shorter, acoustic habitat is altered for duration of activities
		Long-term	
	Geographic Extent	**Local**	
		Regional	Impacts considered regional, especially when consider area over which sound exceeds 120 dB, and the communication distances of baleen whales.
		State-wide	
	Context	**Common**	
		Important	ESA listed species, but population is increasing
		Unique	

4.6.2.4.1.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to bowhead whales are discussed under Alternative 2 (Section 4.5.2.4.16).

4.6.2.4.1.5 Additional Mitigation Measures Conclusion

Conclusions regarding the potential for these additional measures to reduce adverse impacts of oil and gas activities on bowhead whales allowed under Alternative 3 are the same as under Alternative 2. Refer to Section 4.5.2.4.16 for details.

4.6.2.4.2 Beluga Whales

4.6.2.4.2.1 Direct and Indirect Effects

This section discusses the potential direct and indirect effects of Alternative 3 on beluga whales. Alternative 3 includes the same types of exploration activities as in Alternative 2, so the discussion of potential direct and indirect effects on beluga whales under Alternative 3 is the same as those discussed in Section 4.5.2.4.10. The exploration activities discussed in Alternatives 2 and 3 take place in the same geographic areas and timeframes and also consider the same standard and additional mitigation measures. The difference between the alternatives is simply a matter of degree; Alternative 3 includes a larger number of authorized exploration activities than Alternative 2.

The following discussion will focus on the differences between alternatives rather than repeating the same information presented in Section 4.5.2.4.10.

Behavioral Disturbance

The same number of 2D (icebreaker) and vibroseis surveys would be authorized under Alternative 3 as for Alternative 2. The level of disturbance from these types of surveys would therefore be the same for Alternative 3 as is discussed for Alternative 2, which was considered to have temporary and low magnitude effects on beluga whales.

There would be a substantial increase in the amount of open-water activities under Alternative 3 compared to Alternative 2 (meaning especially 2D/3D seismic surveys and drilling operations with their associated support vessels). These activities could affect beluga whales over a large area, and the disturbance effects would be interim in duration and medium in magnitude, characterized by avoidance of vessels. The addition of one or more seismic surveys to either the Beaufort or Chukchi seas would increase the likelihood that two or more different surveys could be operating in the same general area at the same time and the effect of the disturbances could be synergistic – with the net impact being greater than the sum of the individual impacts, or, it could be that an animal exposed to one source in a given time would not be further impacted by the vicinity of another.

Based on the historical take estimates used for beluga whales, in-ice seismic surveys are responsible for the vast majority of behavioral disturbance of beluga whales (see Tables 4.2-5 through 4.2-7 in Section 4.2.6). Since the number of in-ice seismic surveys (1 each in Beaufort and Chukchi) did not increase above Alternative 2, if one considers the combined impacts of all activity types, the overall increase in anticipated behavioral takes was only about 15%.

Hearing Impairment, Injury, and Mortality

As discussed under Alternative 2, the primary mechanism of potential injury or mortality to beluga whales due to oil and gas exploration activities are permanent hearing loss or damage (auditory injury) and collisions with vessels. The duration of an impact from an auditory impairment would be temporary for TTS, but permanent if PTS were to occur. The extent of such impacts would be local and the context unique, since beluga whales are an integral part of the Iñupiat subsistence lifestyle. It is not known whether there have been any ship strikes involving beluga whales and exploration vessels in the Arctic, but the intensity of the impact should be considered medium due to the belugas cultural significance. The impact would be temporary, although the results (injury or mortality) would be permanent for the impacted whale.

Habitat Loss/Alteration

Potential impacts on beluga whale habitat in the EIS project area under Alternative 3 would likely be similar to those described under Alternative 2, with the exception of acoustic habitat. As noted in the Section 4.6.1.4 with the addition of more 2D/3D surveys and exploratory drilling, the area ensonified above the levels that bowheads are expected to respond behaviorally has, increased significantly. Additionally, although the lower frequencies of these sources are not in the area of highest sensitivity for belugas or at frequencies likely to mask interspecies communication, these sounds, which are covering large areas for months, are audible and potentially in frequency ranges that could mask other important sounds.

4.6.2.4.2.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to beluga whales are discussed under Alternative 2 (Section 4.5.2.4.15).

4.6.2.4.2.3 Conclusion

The overall impact to beluga whales is likely to be moderate. Beluga whales in the Arctic are not listed under the ESA, but there are a couple of areas in the action area that are of specific importance to this population for feeding (Barrow Canyon and Beaufort Sea Shelf Break). The intensity and duration of the various effects and activities considered are mostly medium and interim, respectively. However, potential long-term effects from repeated disturbance are unknown. Although, individually, the various activities may elicit local effects on beluga whales, the area of extent over which effects occur will likely increase with multiple activities occurring simultaneously or consecutively throughout much of the spring-fall range of this population and would be considered regional.

For Alternative 3, when all of the potential categories of activities combined are considered, and the maximum level of each is considered, the increase in potential impacts on belugas, through a combination of behavioral harassment and loss of acoustic habitat, is potentially moderate. If the example take estimates from Tables 1, 2, and 2a in Section 4.2.6 are used, the difference in maximum activity levels results in about a 15% increase in takes. Beluga whales are not ESA listed in the EIS project area, and, although, there is not enough information to indicate a trend, Chukchi data suggest that that population is not decreasing (Allen and Angliss 2011). The intensity and duration of the various effects and activities considered are mostly medium and interim.

Type of effect	Impact Component	Effects Summary	
Behavioral disturbance	**Magnitude or Intensity**	**Low**	
		Medium	Behavioral harassment occurring, but likely < 30% of population disturbed
		High	
	Duration	**Temporary**	
		Interim	All activity types last more than month, but combination < 6 months
		Long-term	
	Geographic Extent	**Local**	
		Regional	Combined activities considered regional
		State-wide	
	Context	**Common**	
		Important	Non-ESA listed, population status not well known, but thought not to be declining in Chukchi, important feeding and calving areas
		Unique	
Injury and mortality	**Magnitude or Intensity**	**Low**	Injury or death unlikley
		Medium	Though unlikely, cannot rule out PTS
		High	
	Duration	**Temporary**	
		Interim	Type of potential injury (though unlikely) would likely have moderate effects
		Long-term	
	Geographic Extent	**Local**	Since unlikely, any few impacts would be considered local
		Regional	
		State-wide	
	Context	**Common**	Not ESA listed, populations not thought to be decreasing
		Important	
		Unique	

Type of effect	Impact Component	Effects Summary	
Habitat alterations	Magnitude or Intensity	Low	
		Medium	Combination of potential habitat impacts, including acoustic habitat, are medium
		High	
	Duration	Temporary	
		Interim	Although other alterations shorter, acoustic habitat is altered for duration of activities
		Long-term	
	Geographic Extent	Local	
		Regional	When acoustic habitat is considered, impacts considered regional
		State-wide	
	Context	Common	Not ESA listed, populations not thought to be decreasing
		Important	
		Unique	

4.6.2.4.2.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to beluga whales are discussed under Alternative 2 (Section 4.5.2.4.16).

4.6.2.4.3 Other Cetaceans

Under Alternative 3, the types of oil and gas exploration activities undertaken in the EIS project area would be the same as those in Alternative 2, but the level of activity would be considerably higher.

The types and mechanisms of effects would remain the same in Alternative 3 as in Alternative 2. The activities involved with Level 2 exploration activity take place in the same areas and timeframes and also consider the same standard and additional mitigation measures as Level 1 activity presented in Alternative 2. Therefore, the difference between the two alternatives is a matter of scale, with an increased activity level leading to a corresponding, incremental increase in effects. For a complete discussion of the types and mechanisms of effects on other cetaceans, please see Section 4.5.2.4.11.

4.6.2.4.3.1 Direct and Indirect Effects

Behavioral Disturbance

Under Alternative 3, disturbance effects of oil and gas exploration activity on other cetaceans would be of low (for those species that were not encountered or exposed) to medium intensity, based on determinations for Alternative 2. The substantial increase in level of activity over Alternative 2 would likely result in a notable increase in impact level. Some cetaceans may be displaced a short distance, but they would not be anticipated to leave the EIS project area entirely. The duration is expected to be interim. Long term effects are unknown. The extent of the impacts would depend on the number of seismic activities and associated support vessels in an area. Individual sound source vessels may produce localized impacts. Multiple activities in one area or in several areas across migratory corridors could lead to more widespread, regional impacts.

Based on the historical take estimates used for these other cetacean species, if one considers the combined impacts of all activity types at max levels, the overall increase in anticipated behavioral takes between Alternative 2 and 3 ranges from 75-100% (see Tables 4.2-5 through 4.2-7 in Section 4.2.6). However, since these species are rare or have low densities in these areas, the numbers are still relatively low.

Please refer to Section 4.5.2.4.11 for a complete discussion of disturbance effects on Other Cetaceans.

Hearing Impairment, Injury, and Mortality

The primary mechanisms of potential injury or mortality due to oil and gas exploration activities are permanent hearing loss or damage (auditory injury) and collisions with vessels. These are discussed in detail in Section 4.5.2.4.11. As noted under Alternative 2, it is not currently possible to assess whether or not auditory impairment (TTS or PTS) is occurring in other cetaceans. The potential effects of ship strikes under Alternative 3 are similar to that discussed under Alternative 2. The intensity of impact could be considered medium, given past low-level occurrence and potential increased occurrence with additional vessel traffic associated with oil and gas exploration activities. The impact would be temporary, although the results (injury or mortality) would be permanent for the impacted whale. The extent of impact will be local, given the relative infrequency of occurrence and the non-random distribution of other cetacean species and exploration activity in the EIS project area.

Please refer to Section 4.5.2.4.11 for a complete discussion of potential injury or mortality effects on Other Cetaceans.

Habitat Alterations

The potential effects on cetacean habitat in the EIS project area under Alternative 3 would likely be similar to that described under Alternative 2, with the exception of acoustic habitat. As noted in Section 4.6.1.4, with the addition of more 2D/3D surveys and exploratory drilling, the area ensonified above the levels that other cetaceans (and especially mysticetes) are expected to respond behaviorally, but also above the levels at which masking might be expected to potentially occur for some types of signals and species (especially mysticetes), increases significantly. When the larger 120-dB zones around all of the potential sound sources are considered (not suggesting that all individuals exposed to this would be taken, but suggesting that they would all have to deal with a sound that is audible and potentially in the range where it would mask another important sound (including inter-species communication), the area of effect is quite large. However, this area is not densely populated by these other species, and represents the edge of several of their ranges, so the impacts are not expected to be great.

Please refer to Section 4.5.2.4.11 for a complete discussion of the potential effects on Other Cetacean habitat.

4.6.2.4.3.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to other cetaceans are discussed under Alternative 2 (Section 4.5.2.4.15).

4.6.2.4.3.3 Conclusion

Evaluated collectively, the overall impact of Alternative 3 on Other Cetaceans is minor to moderate. Despite a substantial increase in level of activity over Alternative 2, resulting in a notbable increase in potential behavioral and acoustic habitat impacts, the overall anticipated impacts are still relatively low because of the compairtively low density of these species in this area and their large ranges. For Alternative 3, impacts on the resource would be low to medium in intensity, of temporary to interim duration, and of local to regional extent. Long term impacts are unknown, but anticipated to be minor.

4.6.2.4.3.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to other cetaceans are discussed under Alternative 2 (Section 4.5.2.4.16).

Type of effect	Impact Component	Effects Summary	
Behavioral disturbance	Magnitude or Intensity	**Low**	Possible that some other species may not come into contact with activities or be impacted
		Medium	If behavioral harassment occurs, would be < 30% of population disturbed
		High	
	Duration	**Temporary**	
		Interim	All activity types last more than month, but combination < 6 months
		Long-term	
	Geographic Extent	**Local**	Effects primarily considered local
		Regional	Impacts from max levels of activity might be considered regional for gray whales when consider area ensonified over 120 dB (>10% EIS area) and fact that gray whales are more likely to be encountered than other species.
		State-wide	
	Context	**Common**	
		Important	Although not ESA listed, important areas exist for gray whales.
		Unique	
Injury and mortality	Magnitude or Intensity	**Low**	Injury or death unlikley
		Medium	Though unlikely, cannot rule out PTS
		High	
	Duration	**Temporary**	
		Interim	Type of potential injury (though unlikely) would likely have moderate effects
		Long-term	
	Geographic Extent	**Local**	Since unlikely, any few impacts would be considered local
		Regional	
		State-wide	
	Context	**Common**	Not ESA listed species, but trends of some species not known
		Important	Not ESA listed species, but trends of some species not known
		Unique	
Habitat alterations	Magnitude or Intensity	**Low**	
		Medium	Combination of potential habitat impacts, including acoustic habitat, are medium
		High	
	Duration	**Temporary**	
		Interim	Although other alterations shorter, acoustic habitat is altered for duration of activities
		Long-term	
	Geographic Extent	**Local**	Lower to mid-level of ativities considered regional
		Regional	
		State-wide	
	Context	**Common**	
		Important	Not ESA listed species, but trends of some species not known
		Unique	ESA listed species, trends of some species not known

4.6.2.4.4 Ice Seals

4.6.2.4.4.1 Direct and Indirect Effects

Alternative 3 includes all of the same type of exploration activities as in Alternative 2, so the discussion of potential direct and indirect effects on ice seals under Alternative 3 involves all the same mechanisms and types of effects as discussed for Alternative 2 in Section 4.5.2.4.12. The difference between alternatives concerning ice seals is a matter of degree. Alternative 3 includes a larger number of some authorized exploration activities than Alternative 2 (Table 4.2-2). These activities take place in the same areas and timeframes and also consider the same standard and additional mitigation measures.

The following discussion will focus on the differences between alternatives rather than repeating the same information presented in Section 4.5.2.4.12.

Behavioral Disturbance

Each of the different types of exploration activities that would be authorized under Alternative 3 include several mechanisms for potential disturbance to ice seals in the water and on the ice, primarily involving the noise generated by and the physical presence of vessels and associated exploration equipment. The two types of surveys which take place on or in sea ice, the preferred habitat of ice seals and where they are most likely to be concentrated, are the in-ice 2D surveys with icebreakers and the on-ice vibroseis surveys. For both of these types of surveys, the same number of surveys would be authorized under Alternative 3 as for Alternative 2. The level of disturbance from these types of surveys would therefore be the same for Alternative 3 as is discussed for Alternative 2, which was considered to have temporary and low magnitude effects on ice seals.

There would be a moderate increase in the amount of open-water activities under Alternative 3 compared to Alternative 2. These activities could affect ice seals over a large area, especially for the 2D/3D seismic streamer surveys, but the disturbance effects would be of interim duration and of medium intensity, characterized by avoidance of vessels but with mild or unnoticeable behavioral reactions of ice seals.

Alternative 3 could authorize up to two exploratory drilling programs in both Arctic seas. The level of disturbance to seals is likely more intense in terms of the physical presence of the ships than any types of exploratory surveys, but the geographic area involved is much smaller. The noise generated from drilling is produced on an almost continual basis, making it essentially a chronic sound source in one location and seals could become habituated to it. Given the mild reaction of seals to marine vessels and the close distances to which they often approach vessels, it is unlikely that having two drilling programs operating in the same general area at the same time will result in any additive disturbance effects on particular seals, although more seals could be affected than would occur with only one drilling program. Any disturbance and displacement of seals would cover a very small area and be considered short-term.

Based on the historical take estimates used for ice seals (see Tables 4.2-5 through 4.2-7 in Section 4.2.6), in-ice seismic surveys are responsible for the vast majority of behavioral disturbance of ringed seals, with open water 2D/3D seismic surveys contributing to the majority of the behavioral disturbance takes for other species. Although no additional in-ice surveys were added in this alternative, the number of open water surveys did increase, and total take numbers between Alternative 2 and 3 increased from anywhere from 20 to 80%. For bearded, spotted, and ribbon seals, the total takes represent a relatively small portion of the population; however, for ringed seals magnitude is medium.

Hearing Impairment, Injury, and Mortality

As discussed under Alternative 2, there is very little risk of any ice seals being injured as a result of high noise levels or ship strikes because they can easily detect and avoid vessels as they approach in the water or on/through the ice. There is a lack of data on the physiological thresholds for acoustic injury in ice seals but that information could only be obtained through captive studies involving potential injury to the animals and, given the behavioral avoidance of wild animals to loud seismic sources, this lack of data is not crucial for this analysis.

There is the potential for seals to be exposed to small accidental spills of oils, lubricants, and other compounds used by vessels, vehicles, and equipment during exploration activities. Spills in the offshore or onshore environments could occur during normal operations (e.g. transfer of fuel, handling of lubricants and liquid products, and general maintenance of equipment). Exposure of seals to oil products could lead to irritation of eyes, mouth, lungs, and anal and urogenital surfaces (St. Aubin 1990). Ice seals are commonly observed near exploratory activities during the open-water season and could be exposed to spills in the water or on ice. A small phocid such as a 50 kg ringed or harbor seal would have to ingest several hundred milliliters of crude oil to be at risk. It is “unrealistic to assume that pinnipeds would consume such large volumes of oil during the course of normal feeding" (St. Aubin 1988, 1990). Likewise grooming would not present much of a risk for ingesting oil because it is a relatively uncommon activity among pinnipeds (McLaren 1988, 1990). McLaren (1990) concluded pinnipeds, with the exception of benthic feeders and species that prey upon birds or other seals, are unlikely to consume significant quantities of hydrocarbons since their prey species are unlikely to accumulate residues. Smith and Geraci (1975) concluded that ringed seals in their study had a very low likelihood of ingesting large amounts of oil accidentally or through oiled food items. Geraci and Smith (1976a) found that up to 75 ml of ingested crude oil is not irreversibly harmful to seals, finding only transient liver enzyme release and negligible liver damage. Geraci and Smith (1977) noted "Reports which suggest that oil might affect seals by acute intoxication through ingestion should be viewed cautiously. Our experience has shown that immersed seals ingest very small quantities. Seals are not known to be carrion feeders, and any oil which they might consume from live prey would be negligible". If a small spill did occur, cleanup efforts would begin immediately and those activities would likely include the presence of PSOs to monitor for ice seals and other marine mammals and deter them from entering the spill area if possible. Alternative 3 could authorize a greater level of exploration activity than Alternative 2 and the resulting risk of small accidental spills occurring would be proportionally greater. However, given the mitigation measures in place to prevent and clean up spills, the risk of ice seals being exposed to small spills during exploration activities authorized under Alternative 3 is considered to be minor. The potential effects of a very large oil spill caused by a well blowout are much more serious and are discussed in Sections 4.10.6.11 and 4.10.7.11. Please refer to Section 4.5.2.4.12 for a complete discussion of potential injury or mortality effects on pinnipeds.

Habitat Alterations

The two types of activities that involve potential changes to ice habitat, icebreaking and vibroseis, would be at the same level as discussed under Alternative 2, and they were considered to have temporary effects that are similar in scope as those occurring due to natural forces in the dynamic sea ice environment. The increase from one exploratory drilling program in each Arctic sea under Alternative 2 to two drilling programs in each sea under Alternative 3 would increase the amount of intentional and unintentional discharges of drilling muds and other wastes. There is a lack of information about how any of these discharges could interact directly with ice seals or be carried through the environment to affect the food supply of ice seals (primarily fish and crustaceans). Given this lack of ecological information on the effects of these discharges on ice seal habitat, it is not possible to say whether two drilling programs constitute a substantially larger risk to habitat quality for ice seals than one drilling program. Unfortunately, the types of ecological monitoring studies required to address these issues are very difficult to conduct in the Arctic and even more difficult to interpret given the vast number of complicating factors. With the addition of more 2D/3D surveys and exploratory drilling, the area ensonified above the levels that ice seals are expected to be behaviorally disturbed, as well as the areas ensonified to to levels that might be expected to mask sounds that are important to ice seals, has increased (see Section 4.6.1.4).

4.6.2.4.4.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to pinnipeds are discussed under Alternative 2 (Section 4.5.2.4.15).

4.6.2.4.4.3 Conclusion

The four species of ice seals would likely not be affected to the same extent by exploration activities in the Beaufort and Chukchi seas based on their respective abundance and distribution. Ringed seals and bearded seals have been the most commonly encountered species of any marine mammals in past exploration activities and their reactions have been recorded by PSOs on board source vessels and monitoring vessels. These data indicate that seals do tend to avoid on-coming vessels and active seismic arrays but their behavioral responses are often neutral rather than swimming away and they do not appear to react strongly even as ships pass fairly close with active arrays. They also primarily appear to react to icebreaking or on-ice surveys by keeping their distance or moving away at some point to an alternate breathing hole or haulout. None of the behavioral reactions observed to date indicate that any of the ice seal species would be displaced from key areas or resources for more than a few minutes or hours and would therefore be unlikely to experience any measurable effects on their reproductive success or survival. Ice seals are legally protected (ringed and bearded seals are also listed as threatened under the ESA), and are therefore considered to be important resources. Given the standard and additional mitigation measures considered in this EIS, the effects of exploration activities that could be authorized under Alternative 3 on ice seals would likely be medium to high in magnitude (the latter for ringed seals), distributed over a local to regional geographic area, and interim in duration. The effects of Alternative 3 would therefore be considered minor to moderate (the latter for ringed seals) for ice seal species according to the criteria established in Section 4.1.3.

Type of effect	Impact Component	Effects Summary	
Behavioral disturbance	**Magnitude or Intensity**	**Low**	
		Medium	Behavioral harassment occurring, but likely < 30% of population disturbed for all species but ringed seals
		High	When maximum activities considered, more than 30% ringed seals may be taken
	Duration	**Temporary**	
		Interim	All activity types last more than month, but combination < 6 months
		Long-term	
	Geographic Extent	**Local**	Effects of activities considered local
		Regional	Max levels potentially regional
		State-wide	
	Context	**Common**	
		Important	ESA-listed species, but impacts not occurring in areas specifically important for feeding/pupping, etc.
		Unique	
Injury and mortality	**Magnitude or Intensity**	**Low**	Injury or death unlikley
		Medium	Though unlikely, cannot rule out PTS
		High	
	Duration	**Temporary**	
		Interim	Type of potential injury (though unlikely) would likely have moderate effects
		Long-term	
	Geographic Extent	**Local**	Since unlikely, any few impacts would be considered local
		Regional	
		State-wide	
	Context	**Common**	
		Important	ESA listed species, no reliable data available to assess population trends
		Unique	
Habitat alterations	**Magnitude or Intensity**	**Low**	
		Medium	Combination of potential habitat impacts are medium
		High	
	Duration	**Temporary**	
		Interim	Although other alterations shorter, acoustic habitat is altered for duration of activities
		Long-term	
	Geographic Extent	**Local**	Lower to mid-level of ativities considered local
		Regional	Max levels potentially regional
		State-wide	
	Context	**Common**	
		Important	ESA listed species, population status unknown, no reliable data on trends
		Unique	

4.6.2.4.4.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to pinnipeds are discussed under Alternative 2 (Section 4.5.2.4.16).

4.6.2.4.5 Walrus

4.6.2.4.5.1 Direct and Indirect Effects

This section discusses the potential direct and indirect effects of Alternative 3 on Pacific walrus. This species is dependent on pack ice and coastal shores for haul outs. Alternative 3 includes all of the same types of exploration activities as in Alternative 2 so the discussion of potential direct and indirect effects on Pacific walrus under Alternative 3 involves all the same mechanisms and types of effects as discussed for Alternative 2 in Section 4.5.2.4.13. The difference between alternatives concerning Pacific walrus is a matter of degree. Alternative 3 includes a larger number of some authorized exploration activities than Alternative 2. These activities take place in the same areas and timeframes and also consider the same standard and additional mitigation measures. Walrus are distributed widely across the Chukchi Sea but are uncommon in the deeper offshore waters of the Beaufort Sea. Therefore activities that occur in the Beaufort Sea are not anticipated to impact Pacific walrus. The following discussion focuses on the differences between alternatives rather than repeating the same information presented in Section 4.5.2.4.13.

Behavioral Disturbance

Each of the different types of exploration activities that would be authorized under Alternative 3 include several mechanisms for potential disturbance to walrus in the water and on the ice, primarily involving the noise generated by and the physical presence of vessels and associated exploration equipment. The one type of survey that takes place on or in sea ice (the preferred habitat for walrus and where they are most likely to be concentrated) is the in-ice 2D survey with icebreakers. On-ice vibroseis surveys would only occur in the Beaufort Sea at times when walrus would not be present. Only one such in-ice survey could be authorized for each Arctic sea under any of the action alternatives. The level of disturbance from these types of surveys would therefore be the same for Alternative 3 as is discussed for Alternative 2, which was considered to have temporary and low magnitude effects on walrus.

There would be a moderate increase in the amount of open-water activities under Alternative 3 compared to Alternative 2. These activities could affect walrus over a large area, especially for the 2D/3D seismic streamer surveys, but the disturbance effects would be temporary and low in magnitude, characterized by avoidance of vessels but with mild or unnoticeable behavioral reactions of walrus. Under standard operating procedures, seismic surveys would need to be separated by at least 24 km (15 mi). At this distance, concurrent and adjacent surveys are unlikely to disturb the same walrus at the same time, although some animals could be exposed to more than one survey vessel over time as it travels through an area. The addition of one or more seismic surveys to either the Beaufort or Chukchi seas would increase the likelihood that two or more different surveys could be operating in the same general area at the same time but the minimum distance requirement would still apply and therefore effectively minimize the concern for increased disturbance to any one group of walrus.

Alternative 3 could authorize up to two exploratory drilling programs in each sea. The level of disturbance to walrus is likely more intense from the multiple support ships associated with a drilling rig than any types of exploratory surveys, but the geographic area involved is much smaller. The noise generated from drilling is produced on an almost continual basis, making it essentially a chronic sound source in one location and walrus could become habituated to it. Given the mild reaction of walrus to marine vessels it is unlikely that having two drilling programs operating in the same general area at the same time will result in any additive disturbance effects on particular walrus, although more walrus could be temporarily affected than would occur with only one drilling program. Any disturbance and displacement of walrus would cover a very small area and be considered of interim duration.

Hearing Impairment, Injury, and Mortality

As discussed under Alternative 2, there is very little risk of any walrus being injured or killed as a result of high noise levels or ship strikes because they can easily detect and avoid vessels as they approach in the water or on/through the ice. It is also very unlikely that any walrus would be exposed to very loud sounds from seismic operations to the point where they might be injured.

There is a potentially dangerous situation with walrus on land-based haulouts primarily on the Chukchi coast from Point Lay to Barrow. Disturbance by low-flying aircraft or nearby vessels could cause stampedes and crushing deaths. USFWS LOA mitigation measures for exploration aircraft and vessels are intended to monitor and avoid such haulouts to avoid causing such deadly disturbance.

As discussed in Section 4.5.2.4.13 exposure to small accidental spills of oils, lubricants, and other compounds used by vessels, vehicles, and equipment during exploration activities could have substantial health effects on walrus and could spread among animals in a close herd. Alternative 3 could authorize a greater level of exploration activity than Alternative 2 and the resulting risk of small accidental spills occurring would be proportionally greater. However, given the mitigation measures in place to prevent and clean up spills and the occurrence of walrus primarily on or near the pack ice rather than swimming in open water where most exploration activities take place, the risk of walrus being exposed to small spills during exploration activities is considered to be minor. The potential effects of a very large oil spill are much more serious and are discussed in Sections 4.10.6.11 and 4.10.7.11.

Please refer to Section 4.5.2.4.13 for a complete discussion of potential injury or mortality effects on walrus.

Habitat Alterations

Benthic prey of walrus may experience disturbance/mortality from bottom-contact equipment used in exploration activities such as ocean bottom cable surveys in the Beaufort Sea, vessel anchors, and exploratory drilling. All of these activities could displace benthic mollusks and crustaceans temporarily and may cause small amounts of mortality. Alternative 3 could authorize higher levels of exploration activities that involve benthic disturbance than Alternative 2. However, given the very small areas of benthic surface that could be impacted by all of these activities and the wide distribution of prey fields for walrus, these activities would be unlikely to affect the availability of prey to walrus.

Icebreaking ships intentionally disrupt pack ice in order to conduct seismic surveys or to help manage ice floes around exploratory drilling equipment. The amount of icebreaking activity and potential impacts to under Alternative 3 would be similar to Alternative 2.

Alternative 3 could authorize a greater level of exploration activity than Alternative 2, including double the amount of exploratory drilling, and the resulting risk of small accidental spills and discharges occurring would be proportionally greater. The potential effects on the quality of walrus habitat would depend primarily on the amount of sub-surface benthic habitat disturbed during drilling operations and the richness of the invertebrate fauna at that location. Please refer to Section 4.5.2.4.13 for further discussion of potential effects on walrus habitat.

4.6.2.4.5.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to Pacific walrus are discussed under Alternative 2 (Section 4.5.2.4.15).

4.6.2.4.5.3 Conclusion

Walrus have been regularly encountered during vessel-based exploration activities in the past, primarily in late summer as the pack ice recedes, as recorded by PSOs on board seismic source vessels and monitoring vessels. This data indicates that walrus do not react strongly to vessels and active seismic arrays and their behavioral responses are often neutral rather than swimming away. They tend to dive into the water as icebreaking ships approach from some distance and are therefore not exposed to the loudest of sounds generated by the ships. Mitigation measures required for walrus by USFWS LOAs since the early 1990s have reduced the risk of close encounters with seismic and other exploration vessels and have reduced the risk of accidental spills that may affect walrus or their prey. None of the data collected to date on walrus reactions to exploration activities indicate that they would be displaced from key areas or resources for more than a few minutes or hours. Careful avoidance of vessel and aircraft traffic around walrus haulouts on land would be important to minimize the risk of mortality from stampedes.

Walrus are legally protected, fulfill an important ecological role in the Arctic, and are important subsistence resources and are therefore considered to be a unique resource for purposes of this analysis. Given the level and type of exploration activities that would be authorized under Alternative 3, and considering the mitigation measures that would be required by USFWS LOAs and NMFS in this EIS, the effects on walrus would likely be medium in magnitude, distributed over a wide geographic area, and interim in duration. The effects of Alternative 3 would therefore be considered minor for Pacific walrus according to the criteria established in Section 4.1.3.

4.6.2.4.5.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to Pacific walrus are discussed under Alternative 2 (Section 4.5.2.4.16).

4.6.2.4.6 Polar Bears

4.6.2.4.6.1 Direct and Indirect Effects

This section discusses the potential direct and indirect effects of Alternative 3 on polar bears. This species is dependent on pack ice for much of their denning habitat and for hunting seals. Alternative 3 includes all of the same type of exploration activities as in Alternative 2 so the discussion of potential direct and indirect effects on polar bears under Alternative 3 involves all the same mechanisms and types of effects as discussed for Alternative 2 in Section 4.5.2.4.14. The difference between alternatives concerning polar bears is a matter of degree. Alternative 3 includes a larger number of some authorized exploration activities than Alternative 2. These activities take place in the same areas and timeframes and also consider the same standard and additional mitigation measures as Alternative 2. The following discussion focuses on the differences between alternatives rather than repeating the same information presented in Section 4.5.2.4.14.

Behavioral Disturbance

Each of the different types of exploration activities that would be authorized under Alternative 3 include several mechanisms for potential disturbance to polar bears along leads in the ice and in broken ice, primarily involving the noise generated by and the physical presence of vessels and associated exploration equipment including the potential for direct bear-human encounters. The two types of surveys which take place on or in sea ice, the hunting and denning habitats for polar bears, are the in-ice 2D surveys with icebreakers and the on-ice vibroseis surveys. For both of these types of surveys, the same number of surveys would be authorized under Alternative 3 as for Alternative 2. The level of disturbance from these types of surveys would therefore be the same for Alternative 3 as is discussed for Alternative 2, which was considered to have temporary and low magnitude effects on polar bears.

There would be a moderate increase in the amount of open-water activities under Alternative 3 compared to Alternative 2. These activities could affect polar bears over a larger area, especially for the 2D/3D seismic airgun arrays; however, few polar bears are encountered in open water, so the disturbance effects would be temporary and low in magnitude, characterized by neutral or ambiguous behavioral reactions of polar bears. Some polar bears could be exposed to more than one survey vessel over time as it travels through an area, but most encounters with exploration vessels typically occur while polar bears are on ice or land. The addition of one or more seismic surveys to either the Beaufort or Chukchi seas would increase the likelihood that two or more different surveys could be operating in the same general area at the same time but the minimum distance requirement (24 km [15 mi]) would still apply and therefore effectively minimize the concern for increased disturbance to any polar bear.

Alternative 3 could authorize up to two exploratory drilling programs in each sea. The level of disturbance to polar bears is likely more intense from the multiple support ships associated with a drilling rig than any types of exploratory surveys, but the geographic area involved is much smaller. The noise generated from drilling is produced on an almost continual basis, making it essentially a chronic sound source in one location and polar bears could become habituated to it. Given the mild reaction of polar bears to marine vessels it is unlikely that having two drilling programs operating in the same general area at the same time will result in any additive disturbance effects on particular bears, although more bears could be temporarily affected than would occur with only one drilling program. Any disturbance and displacement of polar bears would cover a very small area and be considered short-term.

Hearing Impairment, Injury, and Mortality

As discussed under Alternative 2, there is very little risk of any polar bears being injured or killed as a result of noise levels or ship strikes used in oil and gas exploration activities because of the infrequency of polar bears being observed in the open-water areas where most exploration is conducted, and their ability to detect and avoid vessels as they approach in the water or on/through the ice. It is also very unlikely that any polar bears would be exposed to very loud sounds from seismic operations to the point where they might be injured. Exposure to accidental spills of fuel, oils, and other compounds from exploration vessels and equipment could kill a polar bear (USFWS 2008b), but given the small volume of typical spills and clean-up requirements that would include MMOs to deter polar bears if necessary, the risk of polar bears being exposed to oil spills is considered negligible. Polar bears are curious, so there is always the potential for bear-human interactions during oil and gas exploration in the Arctic, even if the activities are temporary, but continuation of diligent polar bear monitoring and safety management will decrease the risk of injury or death for humans and bears. The potential effects of a very large oil spill caused by a well blowout are much more serious and are discussed in Sections 4.10.6.11 and 4.10.7.11.

Habitat Alterations

The two types of activities that involve potential changes to polar bear habitat, ice breaking and vibroseis, would be at the same level under Alternative 3 as discussed under Alternative 2. These activities would have only temporary effects on the physical characteristics of the ice and are not likely to displace polar bear prey species (ice seals) for more than a few hours. Seal distribution and abundance would continue to be determined by ice conditions and other natural factors rather than the presence of exploration activities. Polar bear habitat quality would therefore not be affected by exploration activities. The increase from one exploratory drilling program in each sea under Alternative 2 to two drilling programs in each sea under Alternative 3 would increase the amount of intentional and unintentional discharges of drilling cuttings and other wastes. The amount of increase would depend upon the depth of the wells and other factors. However, polar bears are unlikely to be affected by discharges to the seafloor.

4.6.2.4.6.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to polar bears are discussed under Alternative 2 (Section 4.5.2.4.15).

4.6.2.4.6.3 Conclusion

Polar bears have been infrequently encountered during vessel-based exploration activities in the past, as recorded by PSOs on board source vessels and monitoring vessels. These sparse data indicate that polar bears do not react strongly to vessels and active seismic arrays and their behavioral responses are often neutral rather than running or swimming away. They also do not appear to react strongly to icebreaking or on-ice surveys. Some bears keep their distance or move away at some point but others may approach vehicles and equipment out of curiosity. The types of effects of most concern for polar bears during exploration activities involve the risk of bear-human encounters. Mitigation measures and polar bear safety/interaction plans required by USFWS LOAs since the early 1990s have reduced the risk of these encounters for both people and bears. None of the data collected to date on polar bear reactions to exploration activities indicate that polar bears would be displaced from key areas or resources for more than a few minutes or hours and they are unlikely to experience any measurable effects on their reproductive success or survival as a result. Polar bears are legally protected, have a unique ecological role in the Arctic, and are important subsistence resources and are therefore considered a unique resource. Given the mitigation measures that would be required by USFWS LOAs and NMFS as considered in this EIS, the effects of exploration activities that could be authorized under Alternative 3 on polar bears would likely be medium in magnitude, distributed over a wide geographic area, and interim in duration. The effects of Alternative 3 would therefore be considered minor for polar bears according to the criteria established in Section 4.1.3.

4.6.2.4.6.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to polar bears are discussed under Alternative 2 (Section 4.5.2.4.16).

4.6.2.5 Terrestrial Mammals

Alternative 3 is the same as Alternative 2 except with increased levels of activity. The impacts discussed in Section 4.5.2.5 for Alternative 2 are also applicable for this alternative. The increased levels of activity would not generate different types of impacts to terrestrial mammals. The conclusions for Alternative 2 are applicable to Alternative 3. While the level of activity would increase, due to the relatively small area affected and short term, infrequent nature of crew changes, the overall impact to terrestrial mammals from aircraft activity would be minor.

4.6.2.6 Time/Area Closure Locations

The analysis of the direct and indirect effects associated with time/area closures can be found in Sections 4.6.2.4 (Marine Mammals), 4.6.2.3 (Marine and Coastal Birds) and 4.6.3.2 (Subsistence).

4.6.2.7 Standard and Additional Mitigation Measures

Standard and additional mitigation measures that could reduce impacts to the biological environment, other than marine mammals and marine and coastal birds, are discussed under Alternative 2 (Section 4.5.2.7).

4.6.3 Social Environment

4.6.3.1 Socioeconomics

The following discussion of direct and indirect effects of Alternative 3 evaluates effects on public revenues and expenditures, employment and personal income, demographic characteristics, and demand on social organizations and institutions associated with an increased “Level 2” of oil and gas exploration activity.

4.6.3.1.1 Direct and Indirect Effects

Public Revenue & Expenditures

Under Alternative 3 (Level 2 activity), the categories of revenue generation are the same as Alternative 2. There could be an increased level of economic activity generated in communities hosting vessel crew changes or purchasing/staging support materials, particularly if they have a tax regime to capture direct revenue (see Table 4.5-2).

Employment & Personal Income

Under Alternative 3, there would be similar types of (direct) new local hire opportunities associated with the standard mitigation measure D2 to reduce subsistence interference, and A3 and A6 to reduce marine mammal disturbance and deflection. The level of (direct) new local hire employment opportunities may increase under Level 2 activity or remain relatively the same as Level 1, if certain positions are duplicative in nature. For example, a Com Center position would be staffed continuously during the open-water season whether there are 1 or 2 exploratory drilling operations occurring in the Chukchi Sea, and PSOs may work for multiple programs, schedule permitting. The establishment of Com Centers, prescribed in standard mitigation measure D2, would not change the employment opportunities described under Alternative 2.

Table 4.6-7 demonstrates a maximum hypothetical quantity of PSOs hired under Alternative 3. It represents an increase of less than three percent of the potential work force for the region for seasonal, part-time labor.

Table 4.6-7 Maximum PSO Positions Under Alternative 3[1]

	Alternative 3 (Annual Activity Level 2)	Vessels Deployed (PSOs required)[2]	Aerial Observers	PSOs/survey	Total PSOs
Beaufort Sea	**Six 2D/3D seismic surveys**	Source (5)	4	15	90
		2 chase/monitoring and/or icebreaker (3 each)			
	Five site clearance and high resolution shallow hazards survey programs	Source (5)	4	9	45
	Two exploratory drilling program	Drilling rig (5)	4	21	42
		2 ice management (3 each)			
		3 other various (2 each)			
Chukchi Sea	**Five 2D/3D seismic**	See Beaufort examples	4	15	75
	Five site clearance and high resolution shallow hazards survey programs		4	9	45
	Two exploratory drilling		4	21	42
			TOTAL PSOs per year	**88**	**339**

Notes:

1) Assumes all positions are unique; one PSO would not be hired for multiple surveys.
2) Numbers based on (Funk 2011) and (NMFS 2009 IHA permit)

The indirect employment opportunities associated with Alternative 3 may increase marginally under Level 2 activity because shore-based support and logistical service demands would increase, including: transport of equipment; room and board of survey/seismic crews; and administration of permits to conduct the surveys. Native Corporations and private entities may capitalize on these opportunities. As described under Alternative 2, these services are seasonal and temporary in nature.

Demographic Characteristics

As described under Alternative 2, Alternative 3 would not have a direct or indirect contribution to demographics in the EIS project area communities because Level 1 and 2 activities are seasonal and short-term in nature. It is not anticipated any workers would move themselves or their families to any of the coastal communities.

Social Organizations & Institutions

The implementation of Alternative 3 would result in marginal increases in revenues to Municipal Governments associated with sales and special taxes and employment and service contracts with Regional and Village Corporations. In the communities where crew changes occur or vessels are based, there could be marginal increases in short-term, seasonal demand on institutions and social services in Barrow, Wainwright, Nome and Unalaska/Dutch Harbor.

4.6.3.1.2 Conclusion

The magnitude of the socioeconomic impact under Alternative 2 is positive and greater than a Level 1 activity. However, the magnitude of increase of total personal income and local employment rates are still not increased by more than five percent. The duration of the socioeconomic impacts is temporary because it is not year-round; however, the activity is scheduled to occur over a fixed number of years. The positive economic impacts of the activity are statewide and even national. The context of the socioeconomic impacts is unique because the people that would experience the flow of workers and research vessels are predominantly Iñupiat communities. The summary impact level for socioeconomic resources under Alternative 3 is minor.

4.6.3.2 Subsistence

4.6.3.2.1 Direct and Indirect Effects

The potential effects to subsistence resources and harvest from disturbance of the seismic survey (both open-water and on-ice) and exploratory drilling, aircraft and vessel traffic, icebreaking and ice management, permitted discharges under Alternative 3 would be the same as those described under Alternative 2 (Section 4.5.3.2). Table 4.5-26 describes the different subsistence hunts that occur within the EIS project area by resource, where these subsistence hunts occur, the seasons of occurrence and the potential for overlapping with proposed activities of Alternatives 2 through 5. Detailed information regarding the seasonal cycles of subsistence resources and harvest patterns is described in Section 3.3.2.

Even with the increase in the number of activities/programs that could potentially occur under Alternative 3, the impacts to subsistence resources and harvest are anticipated to be similar in type, generally of similar intensity, and comparable duration, but occurring in more locations.

Assumptions regarding the level of activity used in the analysis of impacts to subsistence for Alternative 3 are described in Table 4.5-26. Under Alternative 3, only these activities would be permitted. In the Beaufort and Chukchi seas, it is assumed that the activity/programs described in Table 2.4 would involve the sound sources and sound levels associated with individual sources, the same types of source and support vessels, and the same types of icebreakers for ice management and/or icebreaking. However, there would be more vessels conducting the activities in more sites with more support vessels and more aircraft traffic from the addition of more programs being potentially permitted. The number of days the activities could occur in a season would be the same as those as Alternative 2.

Under Alternative 3, the activity area(s) and or number of wells to be drilled could be increased with up to two exploratory drilling programs potentially permitted in both the Beaufort and Chukchi seas.

4.6.3.2.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to subsistence resources are discussed under Alternative 2 (Section 4.5.3.2).

4.6.3.2.3 Conclusion

Impacts of Seismic, High Resolution Shallow Hazard Surveys and Exploratory Drilling Noise Disturbance to Subsistence Resources

Bowhead Whales

Section 4.5.2.4.9 and Section 4.2.4.6.1 (Bowhead Whales) describe the mechanisms by which activities associated with oil and gas exploration in the Beaufort and Chukchi seas could directly or indirectly affect bowhead whales. Any impacts of seismic and high resolution shallow hazard surveys and exploratory drilling noise that affect bowhead whales are expected to result in some temporary deviation in migratory path in the vicinity of the disturbance. However when the standard and additional mitigation measures contemplated in this EIS are applied, the impact of disturbance to subsistence resources and hunters could be of low intensity and temporary duration (i.e. for the duration of the activities). The geographic extent could be local to regional, affecting a resource of unique context, due to listing under the ESA. Impacts would not be expected at the population level, reducing long term opportunities to subsistence harvest bowhead whales. The summary impact to subsistence harvest from disturbance of bowhead whales could be considered moderate based upon the fact that the resource is considered unique in context.

Beluga Whales

Sections 4.5.2.4.10 and 4.2.4.6.2 (Beluga Whales) describe the mechanisms by which activities associated with oil and gas exploration in the Beaufort and Chukchi seas could directly or indirectly affect beluga whales. In the Chukchi Sea, beluga whales could be displaced, i.e. would avoid areas in the vicinity of seismic survey and exploratory drilling operations in July through October during their spring and fall migrations. This would have the potential to impact and disrupt some communal beluga subsistence hunts (particularly Point Lay which heavily depends on this resource) by disturbing and altering the course of these migrating whales. In turn this could make belugas more difficult to herd into the lagoons and harvest (as in the case of Point Lay).

However, the impacts would be minimized or avoided by the required mitigation measures of this EIS. As mitigated, the effects of disturbance would be considered to be of low intensity and temporary duration, occurring for the duration of the activities offshore. These impacts are considered regional in geographic extent and affecting a resource that is unique in context. There would not be expected impacts on a population level that would result in long term impacts reducing the subsistence harvest. The summary impact to subsistence harvest from disturbance of beluga whales could be moderate based upon the fact that the resource is considered locally important in context.

Seals

Sections 4.5.2.4.12 and 4.6.2.4.4 (Ice Seals) describe the mechanisms by which activities associated with oil and gas exploration in the Beaufort and Chukchi seas could directly or indirectly affect these seals. Subsistence hunts of seals occur either in nearshore coastal areas or onshore in the spring and winter seasons when seismic and high resolution shallow hazards surveys and exploratory drilling operations would not be present. Most ringed and bearded seals are harvested in the winter or in the spring before these assumed activities would occur. While spotted seals are harvested during the summer, the activities of seismic survey and exploration drilling activities would be expected to occur offshore from subsistence use areas. Activities within the lease areas offshore that that are likely to be explored during the open water season would have no impact on subsistence hunting for seals. One on-ice seismic survey could have the potential to disturb or displace seals in their lairs but would be mitigated to lessen the impact to seals. Any impacts to seal subsistence harvests from the on-ice seismic survey would be characterized as a low intensity, limited to a local area, temporary in duration, and important in context. Therefore the summary impact to subsistence seal harvests is negligible.

Walrus, Polar Bears, Subsistence Fishing, Bird Harvest and Egg Gathering and Harvest of Caribou

Impact to these subsistence resources and their harvests are expected to be the same as described under Alternative 2.

The potential impact of the noise produced by the proposed seismic and high resolution shallow hazards surveys and exploratory drilling on subsistence resources and harvest activities under Alternative 3 could be major in the absence of mitigation measures. However mitigation measures would be required to be implemented to minimize or completely avoid adverse effects on all marine mammals and other subsistence resources and to ensure no unmitigable adverse impact on the availability of marine mammals for subsistence uses. In consideration of the standard and additional mitigation measures, these activities are not expected to disturb or disrupt subsistence activities at a level that would make resources unavailable for harvest or significantly alter the existing levels of harvests. The summary impact of Alternative 3 is considered moderate to subsistence harvests of bowhead and beluga whales. Summary impacts to seals, walrus, polar bears, subsistence fishing, bird harvest and egg gathering, and harvest of caribou are the same as those described in Alternative 2.

Impacts of Disturbance from Aircraft Overflights to Subsistence Resources

Bowhead Whales

Information on the impacts of aircraft sounds associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Sections 4.5.2.4.9 and 4.6.2.4.1 (Bowhead Whales) of this EIS. The sound emitted by aircraft overflights potentially could cause some disruption to bowhead whale harvest, but aircraft overflights as mitigated are not expected to make bowhead whales unavailable to subsistence hunters. Whales could be expected to temporarily deflect from overflights, but mitigation measures analyzed in and contemplated by this EIS would limit the probability of this impact occurring. It is expected that helicopters servicing offshore seismic and high resolution shallow hazard surveys and exploratory drilling operations could traverse areas utilized by subsistence whalers during fall whaling in the Beaufort Sea and limited areas of the Chukchi Sea. Mitigation measures prescribing flight path and altitude restrictions are expected to reduce any such potential impacts to a low level.

If bowhead whales were affected by aircraft overflights, it is unlikely that large numbers or a large area used by active whaling crews would be affected, so the intensity of the impact would be considered low, and the duration would be temporary. Effects of increased levels of activity permitted under Alternative 3 are low in intensity, temporary in duration, local to regional in extent, and affecting a resource that is unique in context, due to listing under the ESA. The summary impact is considered moderate based upon the fact that the resource is considered unique in context.

Beluga Whales

Information on the impacts of aircraft sounds associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Sections 4.5.2.4.10 and 4.6.2.4.4 (Beluga Whales) of this EIS. Summer beluga hunting could be impacted by increased numbers of trips/aircraft overflights given the levels of activity associated with Alternative 3. Mitigation measures applied to this impact would lessen the disturbance to a point that it would be considered low in intensity, temporary in duration, local or regional in extent, and affecting a resource that is important in context.

The required mitigation measures are expected to minimize and/or avoid impacts to beluga whales and their subsistence harvest as the mitigation measures for flight path and altitude restrictions are expected to reduce impacts to the point that the summary rating is considered moderate based upon the fact that the resource is considered locally important in context.

Caribou Hunting

The higher levels of activity permitted under Alternative 3 would result in increased helicopter traffic between the expected support shorebases (Barrow, Deadhorse and potentially Wainwright) and the offshore drilling locations. It is likely that there would be a disturbance to caribou subsistence hunting from the helicopter traffic that may disturb caribou on the coast. Helicopters would be traversing routes offshore from the shorebases and small proportions of available subsistence hunting areas would be affected at altitudes of less than 305 m (1,000 ft) – most likely during takeoff and landings.

Aircraft overflights are unlikely to have an adverse effect on caribou availability for subsistence harvest. Impacts that did occur would be considered low in intensity and temporary in duration. The impact would be local to regional in extent and affecting a resource that is common to important in context. The summary impact is considered moderate.

Seals, Walrus, Polar Bears, Subsistence Fishing, Bird Hunting and Egg Gathering

Impact to these subsistence resources and their harvests are expected to be same as under Alternative 2.

The higher levels of activity permitted under Alternative 3 would increase aircraft traffic associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities, which could cause some temporary behavioral disturbance and possibly deflection away from the sound source by terrestrial or marine mammals. The level of the disturbance would depend on the size of the aircraft and repeated exposure or displacement occurring to the resources, as well as whether or not the overflights overlap in time and space with subsistence hunting grounds.

Aircraft overflights are unlikely to have an adverse effect on subsistence harvest as mitigated. Impacts that did occur would be considered of low intensity but temporary in duration. The impact would be local to regional in extent, affecting resources that range from common to unique in context. The impacts are considered moderate for bowhead whales, beluga whales, and caribou. Impacts to seals, walrus, polar bears, subsistence fishing, bird harvest and egg gathering are the same as those described in Alternative 2.

Impact of Vessel Traffic to Subsistence Resources

Bowhead Whales

Information on the impacts of vessel sounds associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Sections 4.5.2.4.9 and 4.6.2.4.1 (Bowhead Whales) of this EIS. The higher levels of activity permitted under Alternative 3 would increase vessel traffic and vessels present in the area associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities, which could cause bowhead whales to alter their behavior during migration and avoid the area(s) within a few kilometers of vessel activities. However the required mitigation measures would limit impacts to late migrating bowhead whales and subsistence hunting from vessel traffic. The levels of activity permitted under Alternative 3 increase the potential for disturbance on a more regional level. Impacts to bowhead whale subsistence hunting are likely to be of low intensity, temporary duration, though could be local to regional extent, and affecting a resource that is unique terms of the context, due to the listing under the ESA. The summary impact could be considered moderate in terms of the levels of subsistence hunting and sharing of the resource that would be affected.

Beluga Whales

Information on the impacts of vessel sounds associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Sections 4.5.2.4.10 and 4.6.2.4.4 (Beluga Whales) of this EIS. A limited number of late migrating spring beluga whales could encounter increased numbers of vessels and higher levels of activity permitted under Alternative 3 for seismic and high resolution shallow hazard surveys and exploratory drilling activities and operations. The impact of disruption to beluga whales from vessel traffic could result in temporary deflection of beluga whales from subsistence harvest areas and reduced success of these hunts. However, if additional mitigation measure D1 is applied there can be no transit of exploration vessels into the Chukchi Sea prior to July 15 or until the beluga hunt is completed at Point Lay. However the increased levels of activity permitted under Alternative 3 include the potential for disturbance on a regional level (impacts extending throughout the EIS project area) as defined in Section 4.1.3. The impact to beluga whales that do encounter vessels would be of low intensity, temporary duration, local to regional extent, and affect a resource that is important in terms of the context. The summary impact could be considered moderate in terms of the levels of subsistence hunting and sharing of the resource that would be affected.

Seals

Sections 4.5.2.4.12 and 4.6.2.4.4 (Ice Seals) describe the mechanisms by which activities associated with oil and gas exploration in the Beaufort and Chukchi seas could directly or indirectly affect seals. Seals could be displaced or avoid areas where vessels are transiting as part of seismic and high resolution shallow hazard surveys and exploratory drilling activities. However, under the required mitigation measures for vessels transiting into the Beaufort and Chukchi seas for these activities, impacts to seals would not be such as to adversely impact subsistence hunting activities. Subsistence seal hunts would occur in nearshore coastal areas away from areas likely to be transited by vessels. The majority of seal subsistence hunting occurs in the spring and winter seasons when vessels associated with seismic survey and exploratory drilling would not be expected to be present in subsistence harvest areas. However with the increased levels of activity permitted under Alternative 3 there would greater potential for disturbance on a regional level (impacts extending throughout the EIS project area as defined in Section 4.1.3). With spatial and seasonal separations, the impact to subsistence seal harvest would be of low intensity, temporary duration, local to regional extent, and affecting resources that are important in terms of the context. The summary impact could be considered minor in terms of the levels of subsistence hunting and sharing of the resource that would be affected.

Walrus, Polar Bears, Subsistence Fishing, Bird Harvest and Egg Gathering and Harvest of Caribou

Impact to these subsistence resources and their harvests are expected to be the same as under Alternative 2.

Under the increased level of activity with Alternative 3, the summary impacts of vessel traffic on subsistence harvest of bowhead whales, and beluga whales are expected to be moderate. The summary impact from vessel traffic to subsistence harvest of seals, walrus and polar bear is considered minor. Negligible summary impacts to subsistence harvest of fish, bird hunting and egg gathering, and caribou are expected as a result of vessel traffic and the same as Alternative 2.

Impacts of Icebreaking and Ice Management on Subsistence Resources

Bowhead Whales

Information on the impacts of icebreaking and ice management associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Sections 4.5.2.4.9 and 4.6.2.4.1 (Bowhead Whales) of this EIS. Seismic and high resolution shallow hazard surveys and exploratory drilling activities would be expected to occur during the open water season when seismic and high resolution shallow hazard surveys and exploratory drilling vessels would not encounter large amounts of sea ice. However icebreaking and ice management may be necessary during late fall or early winter when industry is still engaged in seismic and high resolution shallow hazard surveys and exploratory drilling activities in order to protect equipment, vessels, and infrastructure. Additionally, some operators have recently proposed to conduct seismic surveys during the in-ice or shoulder season (i.e. October through December). These surveys would require the use of an icebreaker to go ahead of the seismic survey vessel. The required mitigation measures limit the time frame in which these activities occur in, and, as a result, the likelihood of impacts to subsistence harvest as a result of ice management activities is reduced and unlikely to adversely affect subsistence harvest of bowhead whales. The majority of these types of in-ice surveys would occur after the completion of fall bowhead harvests in the Beaufort and Chukchi seas. With the increased levels of activity permitted under Alternative 3 the potential for disturbance on a more regional level becomes greater (impacts extending throughout the EIS project area as defined in Section 4.1.3). In the event that icebreaking does cause bowhead whales to avoid an area the impact to subsistence resources is expected to be low in intensity, short term in duration, local to regional in extent, and affecting a resource that is unique in context. This would be considered a moderate impact to subsistence harvest of bowhead whales based upon the fact that the resource is considered unique in context.

Beluga Whales

Information on the impacts of icebreaking and ice management associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Sections 4.5.2.4.10 and 4.6.2.4.4 (Beluga Whales) of this EIS. Icebreaking activities could increase under Alternative 3 with the greater level of permitted activity allowed for seismic survey and exploratory drilling activities. Ice management activities could be necessary as part of seismic and high resolution shallow hazard surveys and exploratory drilling activities when ice is encountered in the late fall through early winter months of exploration activities. Icebreaking and ice management would be limited to areas where industry is actively exploring or drilling. These activities would occur in the offshore waters and would not be expected to affect beluga whale subsistence hunting. Icebreaking and ice management activities would be conducted far removed from areas typically hunted in the Chukchi Sea. No impacts are anticipated for beluga subsistence hunts in the Beaufort Sea, as beluga hunting is conducted opportunistically during the bowhead hunt, and the required mitigation measures of this project would prohibit seismic survey and exploratory drilling activities (and associated ice management) from occurring during this time.

The required mitigation measures are expected to minimize and potentially avoid impacts on beluga whales so that no adverse impacts occur to subsistence harvest. There is a low probability that impacts could occur to subsistence users in the Chukchi Sea. With the increased levels of activity permitted under Alternative 3 there is greater potential for disturbance on a regional level (i.e. across the EIS project area). In the event that icebreaking or ice management does cause beluga whales to avoid an area the impact to subsistence resources is expected to be low in intensity, short term in duration, local to regional in extent, and affecting a resource that is important in context. This would be considered a moderate summary impact to the subsistence harvest of beluga whales based upon the fact that the resource is considered locally important in context.

Seals

Sections 4.5.2.4.12 and 4.6.2.4.4 (Ice Seals) describe the mechanisms by which icebreaking and ice management activities associated with oil and gas exploration in the Beaufort and Chukchi seas could directly or indirectly affect seals. Icebreaking could be associated with seismic survey plans that extend into the late open water season late fall to early winter (October to December) when daylight is very limited to absent and visibility is reduced making seals more difficult to spot although. At this time of year sealing efforts for subsistence are not concentrated or intense. Ice management activities could be necessary as part of seismic and high resolution shallow hazard surveys and exploratory drilling and would occur in the offshore waters during the open water season after sea ice has retreated and melted. Although a greater level of activity would occur under Alternative 3, these proposed activities would occur after the end of pupping and molting seasons for all ice seals. There would be few seals expected in the area of where the proposed activities would take place. Subsistence harvest of seals would not be expected to occur in areas of active ice management offshore. The required mitigation measures are expected to avoid and minimize impacts on seals and in turn on subsistence harvests so that no adverse impacts occur. There is a low probability that impacts would occur to subsistence users. In the event that icebreaking does cause seals to avoid an area, the impact is expected to be low in intensity, short term in duration, local to regional in extent, and affecting resources that are common to important in context. This would be considered a minor summary impact to subsistence harvest of seals.

Walrus, Polar Bears, Subsistence Fishing, Bird Harvest and Egg Gathering and Harvest of Caribou

Impact to these subsistence resources and their harvests are expected to be same as under Alternative 2.

Summary impacts to subsistence harvest of bowhead whales and beluga whales due to icebreaking and ice-management activities are expected to be moderate. Summary impacts to subsistence harvest of seals and polar bears are considered to be minor. Summary Impacts to walrus, fish, and bird hunting and egg gathering from icebreaking are expected to be negligible and the same as under Alternative 2. No impacts to caribou are expected.

Impacts of noise and vehicle movement from on-ice seismic surveys

No impacts are anticipated subsistence harvests of bowhead whales, beluga whales, Pacific walrus, and fishing as a result of the on ice seismic survey. Summary impacts to seals, marine and coastal birds and caribou are expected to be the same as under Alternative 2 and are considered negligible. The summary impacts to polar bears could be minor.

Indirect Impact to Subsistence Resources from Permitted Discharges

Permitted discharges would be conducted under the conditions and limitations of the required NPDES General Permits. Permitted discharge would be mitigated by additional mitigation measures C3 and C4, which would place requirements and limitations on the levels of discharge and discharge streams that could affect marine mammal habitat and eventually the diets of subsistence users. Under Alternative 3, there could be a higher level of activity, which would increase the levels of permitted discharges.

Mitigation measures may not alleviate the perception that a small oil spill or regulated wastewater discharge might contaminate subsistence resources. There is a perception the foods could become contaminated by discharges and/or small fuels spills could result in impacts to human health from consumption of the resources. The likelihood is low that subsistence resources or harvest would occur in the vicinity of the assumed areas where drilling and/or any associated discharge or spill might occur. In addition fuel transfers are not expected during transit between the Beaufort and Chukchi seas. The indirect impact of drill cuttings and mud discharges may displace marine mammals and fish a short distance from each drilling location. The impacts to subsistence users would be of low intensity, short term in duration, local in extent, and affecting resources that are common to unique in context. Therefore the summary impacts to subsistence resources, activities, and subsistence users would be minor, though the perception of the impact could be moderate.

Summary

Using the impact criteria identified in Table 4.5-25, the direct and indirect effect of oil and gas exploration activities on subsistence resources resulting from implementation of Alternative 3 would be of low intensity, temporary in duration, local to regional in extent, and the context would be common to unique. Protected resources (bowhead whales and polar bears are considered unique in context as these resources are protected by legislation (e.g. MMPA, ESA) or are considered an important subsistence resource (beluga whales). Therefore the summary impact level of Alternative 3 on subsistence resources and harvests would be considered to range from negligible to moderate depending upon the specific subsistence resource affected and source of disturbance.

<u>4.6.3.2.4 Additional Mitigation Measures</u>

Additional mitigation measures identified that could reduce adverse impacts to subsistence resources are discussed under Alternative 2 (Section 4.5.3.2).

4.6.3.3 Public Health

4.6.3.3.1 Direct and Indirect Effects

Anticipated effects to public health as a result of Alternative 3 are expected to be similar to those expected under Alternative 2, as discussed in Section 4.5.3.3.

4.6.3.3.2 Conclusion

Both potential beneficial and adverse impacts are anticipated as a result of Alternative 3. Possible changes could occur to health outcomes such as chronic disease and trauma and many of the pathways relate to traditional practices and subsistence activities. However, there is a very low likelihood of these health outcomes arising, and effects are unlikely to be large enough cause a measurable change in health outcomes. The magnitude or intensity of effects is estimated to be low: above background conditions, but small and within both the natural variation and adaptive ability of the local population. If health changes do occur, the duration of changes may be permanent, and multiple communities could be affected.

4.6.3.4 Cultural Resources

4.6.3.4.1 Direct and Indirect Effects

Alternative 3 is the same as Alternative 2 except with increased levels of activity. These mitigation measures do not affect cultural resources in the EIS project area, so the impacts discussed in Section 4.5.3.4 for Alternative 2 are the same for Alternative 3. The overall impact to cultural resources would be minor.

4.6.3.4.2 Conclusion

Direct and indirect impacts to cultural resources resulting from the implementation of Alternative 2 would be the same in Alternative 3. For a complete discussion of direct and indirect impacts on cultural resources, please see Section 4.5.3.2.

4.6.3.5 Land and Water Ownership, Use, and Management

4.6.3.5.1 Direct and Indirect Effects

Land and Water Ownership

The direct and indirect impacts to land and water ownership caused by Alternative 3 are similar to those caused by Alternative 2. Refer to Section 4.5.3.5 for a discussion on these topics. This includes federal, state, private, borough, and municipal owned lands and waters.

Land and Water Use

The actions in Alternative 3 are the same as for Alternative 2. However the activity levels are increased; numbers of allowed seismic surveys, shallow hazards survey programs, and exploratory programs are increased in the Beaufort and Chukchi seas. However, the amount of on-ice seismic surveys and icebreaking remained the same. Taking into consideration these increases, direct and indirect effects to the recreation, residential, mining, and protected land uses are similar to Alternative 2. Refer to Section 4.5.3.5 for a discussion on these topics.

With an increase in activity levels, the possibility for conflict increases between subsistence use and surveys. Section 4.6.3.2 discusses the direct and indirect impacts of Alternative 3 in detail.

The direct and indirect impacts caused by Alternative 3 for industrial, transportation, and commercial land uses are similar to those discussed under Alternative 2 in Section 4.5.3.5 but use would increase incrementally as survey activity levels go up. Beyond what is discussed in Section 4.5.3.5, there is a slightly higher possibility of new facilities and infrastructure, higher levels of air and vessel traffic, and commercial activity associated with survey support. No new roads or railroad lines are expected to be built under this alternative; therefore no changes are expected in land use to accommodate expanded land transportation systems. See Section 4.6.3.1 Socioeconomics for further discussion on economic opportunities under this alternative

Land and Water Management

BOEM has awarded leases in the Beaufort and Chukchi seas for the purpose of exploring for and developing petroleum resources in the federal OCS. The level of exploration activity in federal water under Alternative 3 is consistent with management of those waters. Similarly, the state applies Best Interest Findings before allowing seismic exploration activities and each must demonstrate individual consistency with state management policies before permits are issued on state lands or waters. Therefore, no inconsistencies or changes in federal or state land or water management are anticipated as a result of this alternative. The effects are similar to those discussed under Alternative 2, Section 4.5.3.5.

While no change in underlying land or water management is anticipated as a result of this project, compliance with NSB and NAB comprehensive plans and Land Management Regulations coastal management policies is undertaken on a voluntary basis for activities in state and federal waters; permit applicants for offshore exploration activities in state waters may attempt to be consistent with Borough Land Management Regulations. As activities increase under Alternative 3, the possibility for conflicts with borough offshore development and coastal management zoning policies goes up as well. As indicated in Section 3.3.6 Coastal Management, the Alaska Coastal Management Program was not reauthorized by the State legislature and is no longer in effect.

4.6.3.5.2 Conclusion

Based on Table 4.4-2, and the analyses provided in Section 4.5.3.5, the impacts on land and water ownership under Alternative 3 are described as follows. The magnitude of ownership impacts would be low because no changes in land or water ownership will result from this action. The duration of impact would be temporary because no ownership changes will occur. The extent of impacts would be local, occurring only in the activity area and involving no ownership change. The context of impact would be common because the federal waters affected have no special, rare, or unique ownership characteristics. In total, the direct and indirect impacts on land ownership/development rights are considered to be negligible; they would be low intensity, temporary, localized, and do not result in changes of ownership.

Based on Table 4.4-2 and the analyses provided above and in Section 4.5.3.5, the impacts of land and water use caused by Alternative 3 are described as follows. The magnitude of impact would be high where activity occurs where there is previously little to no activity (such as Wainwright), and the magnitude of impact would be low where activity occurs where previous activity is common (Prudhoe Bay, Barrow, Nome, Dutch Harbor). The duration of impact would be temporary because an increase in aircraft and shipping traffic would last only for that survey season, although the impact could be permanent if construction of a new facility or infrastructure to accommodate shipping traffic were built in Wainwright. The extent of impacts would be local because any changes in land use as a result of this alternative would be limited geographically to the communities that would support the survey vessels. The context of impact would be common because the areas of land and water use affected are extensively available and have no special, rare, or unique characteristics identified. In summary, the direct and indirect effects of Alternative 3 would be moderate because of the possibility for high intensity impact and long term structures in smaller communities

Based on Table 4.4-2 and the analyses provided above and in Section 4.5.3.5, the impacts on land and water management caused by Alternative 3 are described as follows. The magnitude of impact would be low because, while the level of activity would increase, they are consistent with existing management plans, subject to conditions of approval. The duration of impact would be temporary because project activities are short term in duration and would not result in long-term conflicts with management plans.

The extent of impacts would be local because proposed activities would not involve management plans beyond the localized areas of exploration and support activities. The context of impact would be common because the areas of land and water affected are extensively available and have no special, rare or unique characteristics identified in an adopted management plan. In total, the direct and indirect impacts of Alternative 3 on land and water management would be minor because they would be low intensity, would be temporary in nature, local, and common.

4.6.3.6 Transportation

4.6.3.6.1 Direct and Indirect Effects

The effects to transportation in Alternative 3 would be similar to those described under Alternative 2 (Section 4.5.3.6), though of an elevated intensity. The direct effect to transportation would be an increase in levels of air traffic and vessels present in these areas associated with the seismic survey and exploratory drilling activities in comparison to levels projected under Alternative 2. The intensity of the impact would be considered low and short term in duration (length of survey or exploratory drilling activities each year). The extent of increased aircraft presence may be on a local and regional scale given the increased number of seismic survey and exploratory drilling programs that could occur under Alternative 3. Impacts from the increased levels of air traffic would be low in intensity, temporary in duration, and local in extent and affect a common resource. The impact level could be considered minor to moderate.

4.6.3.6.2 Conclusion

Increased levels of marine vessel traffic in Alternative 3 associated with the seismic survey and exploratory drilling programs would be expected to occur in offshore areas where local marine transportation does not occur. Industry vessels would likely encounter local marine traffic when littering to designated nearshore marine facilities (which are limited). The impact of increased vessel presence and the potential for vessel strikes to marine mammals would be low in intensity, temporary in duration, limited in geographic extent to a local area, and common to potentially unique context (in respect to protected marine mammal resources). The summary impact from increases in vessel traffic would be considered minor.

4.6.3.7 Recreation and Tourism

4.6.3.7.1 Direct and Indirect Effects

Alternative 3 is the same as Alternative 2 except with increased levels of activity. The impacts discussed in Section 4.5.3.7 for Alternative 2 are applicable for this alternative. The increased levels of activity would not generate different types of impacts to recreation and tourism. The conclusions for Alternative 2 are applicable to Alternative 3; the overall impact to recreation and tourism would be minor.

4.6.3.7.2 Conclusion

The direct impacts to recreation and tourism would be low intensity, temporary duration, local extent, and common in context. Indirect impacts would be the same levels as direct impacts, except that the geographic area would be broader, extending beyond the region to a state-wide level and potentially beyond. In summary, the impact of Alternative 3 on recreation and tourism would be minor.

4.6.3.8 Visual Resources

This section discusses potential impacts on visual resources that could result from implementing Alternative 3 of the proposed project.

4.6.3.8.1 Direct and Indirect Effects

Implementation of Alternative 3 would be similar to that describe in Section 4.10.4.19, however there would be an increase in the level of permitted activity and a consequent potential increase in impacts to visual resources. The proposed action is expected to result in short-term moderate effects to scenic quality and visual resources similar to that described in Alternative 2. Because of the greater number of support vessels used in the two exploratory drilling programs proposed under Alternative 3, this action could be high intensity if both programs are implemented in close proximity to each other. Potential impacts could be of low to medium intensity depending if programs are geographically separated. In either case, actions would be temporary, localized and occur in an important context.

4.6.3.8.2 Conclusion

Implementation of Alternative 3 is expected to result in *short-term moderate effects* to scenic quality and visual resources. Potential impacts could be of low to medium intensity depending on specific location of drill sites. The geographic extent of potential impacts would be localized; however they would occur in an important ecosystem.

4.6.3.9 Environmental Justice

4.6.3.9.1 Direct and Indirect Effects

Impacts to Subsistence Foods and Human Health

The activity levels associated with Alternative 3 are expected to result in similar levels of disruption of subsistence hunts by disturbing and altering the course of marine mammals harvested in the EIS project area (described in Subsistence Section 4.5.3.2 for Alternative 2). Alternative 3 activity levels are expected to cause a negligible increase in contamination levels of subsistence food sources (described in the Public Health Section 4.5.3.3), which could have the indirect effect of adding a similar perception as Alternative 2 that subsistence foods are contaminated and alter confidence in their consumption.

4.6.3.9.2 Conclusion

Activities related to implementation of Alternative 3 would have a low intensity impact on subsistence resources and human health, a temporary duration, and a regional extent. Subsistence foods and human health are unique resources and they are protected under the MMPA and EO 12898. Thus, Alternative 3 is expected to have a minor impact to subsistence resources and human health. There would also be minor disproportionate impacts to Alaska Native communities under Alternative 3.

4.6.3.10 Standard and Additional Mitigation Measures

Standard and additional mitigation measures that could reduce impacts to the social environment, other than subsistence, are discussed under Alternative 2 (Section 4.5.3.10).

4.7 Direct and Indirect Effects for Alternative 4 – Authorization for Level 3 Exploration Activity

4.7.1 Physical Environment

4.7.1.1 Physical Oceanography

4.7.1.1.1 Direct and Indirect Effects

Water Depth and General Circulation

Under Alternative 4, changes in water depth resulting from exploratory drilling programs would be the same in nature as those described for Alternative 3. Alternative 4 would allow two additional drilling programs in each OCS Planning Area, and, as a result of the additional drilling programs, the intensity as well as the spatial extent of the impact would effectively be doubled, relative to Alternative 3. The effects of Alternative 4 on water depth would be low-intensity, long term, and would affect a common resource. Changes in water depth from discharged material would have only minor effects on the physical resource character of the proposed action area. Although common resources would be affected across increased spatial scales relative to Alternative 2, the overall effects of Alternative 4 on water depth would be minor.

Currents, Upwellings, and Eddies

Seismic surveys, site clearance and shallow hazards surveys, and on-ice seismic surveys would have only negligible effects on currents, upwellings, and eddies within the EIS project area under Alternative 4. Construction of artificial islands, which could occur in nearshore state waters of the Beaufort Sea at a rate of two islands per year under Alternative 4, would result in medium-intensity, temporary (ice), localized effects on nearshore currents in the waters adjacent to the artificial islands. Over the life of this EIS, those effects would be minor and would occur only if artificial ice islands are constructed to support exploratory drilling activities. Exploratory drilling activities in the Chukchi Sea are anticipated to occur from temporary structures, as opposed to artificial ice islands that could be built in the nearshore Beaufort Sea. Therefore, exploratory drilling activities in the Chukchi Sea would have only negligible effects on currents, upwellings, and eddies within the proposed action area.

Tides and Water Levels

The activities described under Alternative 4 would not affect tides or water levels within the EIS project area.

Stream and River Discharge

The activities described under Alternative 4 would not affect stream and river discharge within the EIS project area. Exploratory drilling in state waters on grounded ice could occur from manmade reinforced ice "islands" but would have negligible effects on stream and river discharge within the EIS project area.

Sea Ice

Under Alternative 4, impacts to sea ice resulting from the proposed activities would be the same in nature as those described for Alternative 2. Alternative 4 would allow additional drilling programs and additional artificial ice islands in the proposed action area, and, as a result of the additional drilling programs, the intensity as well as the spatial extent of the impact would effectively be doubled. Relative to Alternative 2, sea ice would be affected over a larger area due to more potential ice management activity and localized thermal inputs associated with exploratory drilling activities.

Although Alternative 4 would allow additional seismic surveys in both the Beaufort and Chukchi seas relative to Alternative 2, each action alternative would authorize only one survey per year in each of the seas to involve icebreaking activity. Likewise, only one on-ice seismic survey per year would be authorized under each of the action alternatives and only in the Beaufort Sea. Therefore, the level of activity contemplated for these specific types of exploration activities under Alternative 4 is the same as what is contemplated under Alternative 2.

The effects of these activities on sea ice would be medium intensity, local, temporary, and would affect a resource that is common in the EIS project area. The presence of sea ice in lease and non-lease areas targeted for open water seismic exploration and exploratory drilling could result in changes to the schedule, location, and duration of exploratory activities. The presence of sea ice also represents a potential hazard to vessels and exploratory drilling platforms. Industry operators in offshore areas have developed critical operation and curtailment procedures for managing sea ice, including changes to schedule, vessels dedicated to ice management, and procedures for taking drill platforms off location until potential hazards subside.

Within ice and on ice exploration activities could experience similar and additional hazards from sea ice, including the potential for ice override events. In-ice exploration activities would use icebreakers and other vessels for the purpose of ice management and/or ic breaking, and protocols would be established for response to potential ice hazards. Drilling on grounded ice from artificial ice islands would not be subject to potential hazards from moving ice but could experience potential effects from storm surge and ice override events. Within the Beaufort Sea, where drilling on constructed artificial ice islands could occur in state waters, much of the area is protected from ice override by barrier islands. Individual drilling operations would need to assess the potential for ice related hazards and develop appropriate design and operation protocols.

Although common resources would be affected across increased spatial and temporal scales relative to Alternative 2, the overall effects of Alternative 4 on sea ice would be minor.

4.7.1.1.2 Conclusion

The overall effects of the proposed actions on to physical oceanography attributes would be of medium intensity (due to the increase in impacts to sea ice), temporary, local, and would affect common resources as defined in the impact criteria in Section 4.1 of this EIS. The overall effects of the proposed activity described in Alternative 4 on physical ocean resources in the proposed action area would be minor.

4.7.1.2 Climate

Under this alternative, emissions would be higher when compared to either Alternative 2 or Alternative 3 because the alternative proposes additional exploration plans described as Level 3 Exploration Activity on the Arctic OCS. The number of annual EPs proposed for each Arctic OCS planning area would increase to four. The number of proposed seismic and other surveys would remain the same as described in Alternative 3. The majority of additional emissions are from the additional EPs proposed for Level 3 Exploration Activity.

Refer to Section 3.1.4.4 (*Climate Change in the Arctic*) for a thorough discussion of climate systems and the effects of GHG emissions.

4.7.1.2.1 Direct and Indirect Effects

Direct Effects

Direct effects under this alternative are the same as those described under Alternative 2.

Indirect Effects

Indirect Effects under this alternative are the same as those described under Alternative 2.

Regulatory Reporting and Permitting

Regulatory reporting and permitting under this alternative would be the same as those described under Alternative 2.

CO_2e Emissions Inventory

Under this alternative, emissions would be higher when compared to either Alternative 2 or Alternative 3 because the alternative proposes additional exploration plans described as Level 3 Exploration Activity on the Arctic OCS. The number of annual EPs proposed for each Arctic OCS planning area would increase to four. The number of proposed seismic and other surveys would remain the same as described in Alternative 3. The majority of additional emissions are from the additional EPs proposed for Level 3 Exploration Activity. The specific description and number of each of these programs and activities proposed for the Arctic OCS, on an annual basis, were summarized earlier in Table 2.4 (*Activity Definitions*) and Section 2.4.5 (*Alternative 2 – Authorization for Level 1 Exploration Activity*). The estimated potential annual emissions of CO_2e for each type of activity and program proposed under this alternative are provided in Table 4.7-1. The data in this table assume no controls to reduce emissions.

Effects of this Alternative on Climate Change

Reporting emissions of CO2e under this alternative would be the same as described under Alternative 2.

Table 4.7-1. Estimated CO_2e Emissions by Activity and Program Type for the Arctic OCS

Activity/Program Types	U.S. Chukchi Sea OCS Annual CO_2e Emissions (metric tons per year)
2D/3D Seismic Survey (including one survey using an ice breaker vessel)	72,048
Site Clearance and High Resolution Shallow Hazards Survey Program	12,392
Exploration Plan	372,026
Total	**456,467**
Activity/Program Types	**U.S. Beaufort Sea OCS Annual CO_2e Emissions** (metric tons per year)
2D/3D Seismic Survey (including one survey using an ice breaker vessel)	85,692
Site Clearance and High Resolution Shallow Hazards Survey Program	12,392
On-Ice Seismic Survey	25
Exploration Plan	372,026
Total	**470,136**

Sources: EPA. October 1996. Compilation of Air Pollutant Emission Factors (AP-42) 5th ed., Volume I, Chapter 3, Table 3.3-1 and Table 3.4-1.
EPA. July 2010. Median Life, Annual Activity and Load Factor Values for Nonroad Engine Emissions Modeling (EPa-420-R-10-016, NR-005d).
BOEM. 2012. ION Seismic Survey.
EPA. 2012. EPA and NHTSA Set Standards to Reduce GHG and Improve Fuel Economy for Model Years 2017-2025 Cars and Light Trucks. Table 1. http://www.epa.gov/oms/climate/documents/420f12051.pdf

Effects of Climate Change on Resources under this Alternative

Effects of climate change on resources under this alternative would be the same as described under Alternative 2.

4.7.1.2.2 Conclusion

Direct and indirect impacts associated with climate are associated mainly with potential emissions of CO_2e that could, decades from now, contribute to changes in the environmental conditions already occurring in the Arctic and throughout the world. As such, the impacts to climate change cannot be measured on a project-level basis and instead are global in scope. However, total emissions of CO_2e emissions should be disclosed in the NEPA review.

4.7.1.3 Air Quality

Under this alternative, emissions would be higher when compared to either Alternative 2 or Alternative 3 because the alternative proposes additional EPs described as Level 3 Exploration Activity on the Arctic OCS. The number of annual EPs proposed for each Arctic OCS planning area would increase to four. The number of proposed seismic and other surveys would remain the same as described in Alternative 3. The majority of additional emissions are from the additional EPs proposed for Level 3 Exploration Activity.

4.7.1.3.1 Direct and Indirect Effects

Direct and indirect effects under this alternative would be from the same sources of emissions as described under Alternative 2 in Section 4.5.1.3.

Exploration Plan Emission Inventory

The emission rates likely to reflect Level 3 Exploration Activity in each sea are presented in Table 4.7-2.

Table 4.7-2. Estimated Annual Emission Inventory of Four Exploration Plans for Each Sea

Pollutant Sources	Four (4) Exploratory Drilling Programs Annual Emissions (tons per year)					
	PM	NO_X	SO_2	CO	VOC	CO_2e*
Drill Rig	250.92	8,624.80	4.32	1,881.60	258.76	72,737
Ice Breakers (2 vessels each EP)	192.80	6,637.60	3.36	1,448.00	199.12	145,475
Anchor Handler	44.80	624.40	0.24	135.20	50.00	1,818
Oil Spill response Barge	96.40	3,318.80	1.68	724.00	99.56	72,737
Oil spill Response Tug	44.80	624.40	0.24	135.20	50.00	1,818
Tank Vessel for Spill Storage	96.40	3,318.80	1.68	724.00	99.56	72,737
Support Vessels (3 vessels each EP)	134.40	1,873.20	0.72	405.60	150.00	4,703
Aircraft	0.004	0.20	0.84	32.24	13.12	
Total	**860.52**	**25,022.20**	**13.08**	**5,485.84**	**920.12**	**372,026**

Notes: SO_x (sulfur oxides) includes emissions of sulfur dioxide (SO_2).
NO_x (nitrogen oxides) includes emissions of nitrogen dioxide (NO_2).
PM (particulate matter) includes emissions of coarse and fine particulate matter (PM_{10} and $PM_{2.5}$).
VOC is volatile organic compounds.
CO is carbon monoxide.
CO_2e (carbon dioxide equivalent) is a combination of emissions of the six most common greenhouse gases expressed as a rate in relation to the global warming potential of CO_2.
*CO_2e is expressed in metric tons; all other data are given in units of short tons.
** No information on CO_2e emissions is available from EPA for aircraft.
Sources: BOEM, Alaska OCS Region. 2012.

The inventory assumes no application of BACT or the use of ULSD fuel. The emission inventory presented in Table 4.7-2 assumes the same method of calculation and EP operational characteristics as described for Alternative 2.

Survey Emission Inventory

The number and type of seismic and other surveys would be the same as described for Alternative 3. The emission rates likely to reflect the increased level of seismic and other surveys under this alternative (Alternative 4) are presented in Table 4.7-3 and Table 4.7-4.

Table 4.7-3. Estimated Annual Emission Inventory of Multiple Surveys on the Chukchi Sea OCS

Vessels	**U.S. Chukchi Sea OCS Five (5) - 2D/3D Seismic Surveys Annual Emissions** (tons per year)					
	PM	**NO_X**	**SO_2**	**CO**	**VOC**	**CO_2e***
Seismic Vessel	28.60	795.10	117.55	177.95	30.15	33,448
Receiver Vessel	14.05	481.40	81.10	110.35	14.35	21,110
Monitoring Vessel	9.09	311.54	52.50	71.39	9.28	13,660
Ice Breaker Vessel (for 1 of 5 Surveys)	2.81	96.28	16.22	22.07	2.87	3,830
Total	**54.55**	**1,684.32**	**267.37**	**381.76**	**56.65**	**72,048**
Vessels	**U.S. Chukchi Sea OCS Five (5) - Site Clearance and High Resolution Shallow Hazards Surveys Annual Emissions** (tons per year)					
	PM	**NO_X**	**SO_2**	**CO**	**VOC**	**CO_2e***
Monitoring Vessel	9.09	311.54	52.50	71.39	9.28	12,392

Notes: SO_x (sulfur oxides) includes emissions of sulfur dioxide (SO_2).
NO_x (nitrogen oxides) includes emissions of nitrogen dioxide (NO_2).
PM (particulate matter) includes emissions of coarse and fine particulate matter (PM_{10} and $PM_{2.5}$).
VOC is volatile organic compounds.
CO is carbon monoxide.
CO_2e (carbon dioxide equivalent) is a combination of emissions of the six most common greenhouse gases expressed as a rate in relation to the global warming potential of CO_2.
*CO_2e is expressed in metric tons; all other data are given in units of short tons.
Sources: BOEM, Alaska OCS Region. 2012.
BOEM. 2012. ION Seismic Survey.

The survey inventories assume no application of BACT or the use of ULSD fuel. The emission inventory presented in Table 4.7-3 assumes the same method of calculation and survey vessel operational characteristics as described for Alternative 2.

Table 4.7-4. Estimated Annual Emission Inventory of Multiple Surveys on the Beaufort Sea OCS

Vessels	U.S. Beaufort Sea OCS Six (6) - 2D/3D Seismic Surveys Annual Emissions (tons per year)					
	PM	**NO_X**	**SO_2**	**CO**	**VOC**	**CO_2e***
Seismic Vessel	34.32	954.12	141.06	213.54	36.18	40,137
Receiver Vessel	16.86	577.68	97.32	132.42	17.22	25,332
Monitoring Vessel	10.90	373.84	63.00	85.67	11.14	16,392
Ice Breaker Vessel (for 1 of 6 Surveys)	2.81	96.28	16.22	22.07	2.87	3,830
Total	**64.89**	**2,001.92**	**317.60**	**453.70**	**67.41**	**85,692**
Vessels	**U.S. Beaufort Sea OCS Five (5) - Site Clearance and High Resolution Shallow Hazards Surveys Annual Emissions** (tons per year)					
	PM	**NO_X**	**SO_2**	**CO**	**VOC**	**CO_2e***
Monitoring Vessel	9.09	311.54	52.50	71.39	9.28	12,392
Equipment	**U.S. Beaufort Sea OCS One (1) – On-Ice Seismic Survey Annual Emissions** (tons per year)					
	PM	**NO_X**	**SO_2**	**CO**	**VOC**	**CO_2e***
Trucks (2 vehicles)	0.001	0.04	0.0002	0.24	0.02	2
Bulldozer	0.26	6.05	1.76	4.59	2.59	23
Total	**0.27**	**6.09**	**1.76**	**4.83**	**2.62**	**25**

Notes: SO_x (sulfur oxides) includes emissions of sulfur dioxide (SO_2).
NO_x (nitrogen oxides) includes emissions of nitrogen dioxide (NO_2).
PM (particulate matter) includes emissions of coarse and fine particulate matter (PM_{10} and $PM_{2.5}$).
VOC is volatile organic compounds.
CO is carbon monoxide.
CO_2e (carbon dioxide equivalent) is a combination of emissions of the six most common greenhouse gases expressed as a rate in relation to the global warming potential of CO_2.
*CO_2e is expressed in metric tons; all other data are given in units of short tons.
Sources: BOEM, Alaska OCS Region. 2012.
BOEM. 2012. ION Seismic Survey.

4.7.1.3.2 Air Quality Impact Analysis

The air quality impact analysis would be conducted as described under Alternative 2.

4.7.1.3.3 Level of Effect

The annual rate of air emissions and onshore pollutant concentrations are the two basic measurements for assessing a proposal's level of effect on air quality. The emission inventory provided in this section discloses the rate of emissions likely to reflect a proposal under this alternative, expressed in short tpy. When necessary, an emission inventory is translated into pollutant concentrations expressed in μg/m^3, a value that can be measured against the NAAQS allowing the level of effect to be categorized relative to the conditions summarized under Alternative 2 in Table 4.5-7. Further information regarding level of effect under this alternative would be the same as discussed under Alternative 2.

4.7.1.3.4 Conclusion

Emissions from exploratory drilling activities proposed under this alternative would be higher than emissions estimated for Alternative 2. Without emission reduction controls on the drillship engines, there is a greater potential for one or more of the EPA SILs to be exceeded onshore. The Level 3 Exploration Activity would almost certainly require additional modeling to demonstrate the effect of pollutant concentrations on the nearest onshore area. A moderate level of effect on air quality is expected, which may be mitigated by emission control strategies to result in a minor level of effect. Cumulatively, the total estimated emissions for each Arctic OCS planning area, when considering all plans and activities described under this alternative, are summarized in Table 4.7-5.

Control of oil and gas emission sources on the OCS, and levels of effect, are considered on a project-by-project basis, as each individual operator would have the responsibility to engage any engine emission controls required by BOEM AOCSR. Emission reduction strategies have the potential to reduce at least some emissions of all pollutant types, including CO_2e. Therefore, the data provided in Table 4.7-5 would represent a worst-case scenario for each Arctic OCS planning area.

Table 4.7-5. Estimated Annual Emission Inventory for Arctic OCS – Level 3 Exploration Activity

Plan/Activity	**U.S. Chukchi Sea OCS Annual Emissions** (tons per year)					
	PM	**NO_X**	**SO_2**	**CO**	**VOC**	**CO_2e***
2D/3D Seismic Surveys (1 of 5 Surveys with an Ice Breaker Vessel) - Five (5)	54.55	1,684.32	267.37	381.76	56.65	72,048
Site Clearance and High Resolution Shallow Hazards Survey Programs - Five (5)	9.09	311.54	52.50	71.39	9.28	12,392
Exploration Plans - Four (4)	860.52	2,5022.20	13.08	5,485.84	920.12	372,026
Total	**924.16**	**27,018.05**	**332.94**	**5,939.00**	**986.05**	**456,467**
Plan/Activity	**U.S. Beaufort Sea OCS Annual Emissions** (tons per year)					
	PM	**NO_X**	**SO_2**	**CO**	**VOC**	**CO_2e***
2D/3D Seismic Surveys (1 of 6 Surveys with an Ice Breaker Vessel) - Six (6)	64.89	2,001.92	317.60	453.70	67.41	85,692
Site Clearance and High Resolution Shallow Hazards Survey Programs - Five (5)	9.09	311.54	52.50	71.39	9.28	12,392
On-Ice Seismic Surveys – One (1)	0.27	6.09	1.76	4.83	2.62	25
Exploration Plans - Four (4)	860.52	25,022.20	13.08	5,485.84	920.12	372,026
Total	**934.77**	**27,341.75**	**384.94**	**6,015.77**	**999.43**	**470,136**

4.7.1.4 Acoustics

Under Alternative 4, the number and types of seismic surveys and site clearance and high resolution shallow hazards survey programs is identical to Alternative 3. This alternative differs from Alternative 3 in that it adds two additional EPs to each Arctic OCS Planning Area per year for a total of four in each Planning Area. Because the acoustic output from drillships and drill rigs is typically below 180-185 dB re 1 μPa (rms), the addition of these activities will not increase sound levels above these thresholds. As noted in Table 4.5-13, the 120 dB re 1 μPa (rms) from a drillship is estimated at 2 km (1.2 mi) from the source and at 210 m (689 ft) for a jack-up rig from the source. For the sake of a more comprehensive assessment, the table below (and those in the Acoustic section descriptions in previous alternatives) delineates a circle around a drilling rig with a 13-km radius that is meant to encompass the 120-dB ensonification created by both the rig and the support vessels associated with it (which are all producing noise and generaly creating an area that would suggest animals are exposed to disturbance from multiple stimuli). However, the addition of two EPs per season in each sea would only increase the total percentage of total area ensonified per season by about one percent versus Alternative 3. Refer to Section 4.6.1.4.1 for additional information on the direct and indirect effects of this resource.

Table 4.7-6 Total Surface Area Ensonified Above Sound Level Thresholds Under Alternative 4, From Averages Listed in Table 4.5-12.

		Total Surface Areas (km²) to sound level (90% rms SPL (dB re 1 μPa rms))			
		190	**180**	**160**	**120**
Chukchi Sea Shelf 40 to 52 m depth					
	5x ~3200 in³	4.41	48.7	1,798	141,764
	5x 40 in³	0.03	0.29	25.3	10,619
	4x drill/support*			2088	2,088
	% Chukchi	**0.00%**	**0.02%**	**1.48%**	**59%**
Beaufort Sea Shelf, 15 to 40 m depth					
	4x ~3200 in³	9.96	82.9	1,633	45,238
	3x 20 in³	0.003	0.03	5.59	2,535
	4x drill/support*			2088	2,088
Beaufort Coastal, inside and outside barrier islands to 10 m depth					
	2x 880 in³	0.46	2.02	46.9	2,206
	2x 20 in³	0.02	0.12	4.35	268
	% Beaufort	**0.00%**	**0.03%**	**1.48%**	**20%**
Entire Region					
		15	**134**	**7,689**	**206,806**
	% EIS area	**0.00%**	**0.03%**	**1.48%**	**40%**

*drill/support indicates area within 13-km radius around drill rig, notionally encompassing support

vessels. Indicated area is within 120-dB radius, included in 160-dB column for assessment.

4.7.1.4.2 Conclusion

The intensity rating of this alternative is high, as additional exploration activities will introduce sources with source sound levels that exceed 200 dB re 1 μPa. Because the exploration activities could continue for several years, the duration is considered as long term. The spatial extent of these activities is regional, since the distribution of exploration activities over the project areas will lead to approximately 40 percent of the EIS area being exposed to sound levels in excess of 120 dB re 1 μPa. Therefore, the overall impact rating for direct and indirect effects to the acoustic environment would be moderate.

4.7.1.5 Water Quality

Impacts to water quality from Alternative 4 are expected to be similar to those described for Alternative 2. The difference between the two alternatives is the level of activity. Differences in impacts between the two alternatives are noted below. The same level of seismic surveys and site clearance and high resolution shallow hazards survey programs contemplated under Alternative 3 are contemplated in this alternative.

4.7.1.5.1 Direct and Indirect Effects

Temperature and Salinity

Seismic Surveys

Similar to the impacts under Alternative 2, seismic surveys under Alternative 4 would not be expected to have any measureable impact on temperature or salinity in the EIS project area.

Site Clearance and Shallow Hazards Surveys

Similar to the impacts under Alternative 2, site clearance and shallow hazards surveys under Alternative 4 would not be expected to have any measureable impact on temperature or salinity in the EIS project area.

On-ice Seismic Surveys

Similar to the impacts under Alternative 2, on-ice seismic surveys under Alternative 4 would not be expected to have any measureable impact on temperature or salinity in the EIS project area.

Exploratory Drilling Programs

Under Alternative 4, changes in water quality related to temperature and salinity resulting from exploratory drilling programs would be the same in nature as those described for Alternative 2. Alternative 4 would allow additional drilling programs in the EIS project area, and as a result of those programs the intensity as well as the spatial extent of the impact may effectively be quadrupled. Relative to Alternative 2, salinity and temperature may be affected over a larger area. However, the effects of Alternative 4 on water quality resulting from changes in temperature and salinity would be low intensity, temporary, and local. Although common resources may be affected across increased spatial scales relative to Alternative 2, the overall effects of Alternative 4 on water quality related to temperature and salinity resulting from exploratory drilling programs would be minor.

Turbidity and Total Suspended Solids

Seismic Surveys

Effects on water quality resulting from increases in turbidity and total suspended solids from seismic surveys under Alternative 4, if any, would be low-intensity, temporary, local, and would affect a common resource. The nature of those effects would be similar to those described under Alternative 2.

Site Clearance and Shallow Hazards Surveys

Effects on water quality resulting from potential increases in turbidity and total suspended solids from site clearance and shallow hazard surveys under Alternative 4, if any, would be low-intensity, temporary, local, and would affect a common resource. The nature of those effects would be similar to those described under Alternative 2.

On-ice Seismic Surveys

On-ice seismic surveys would not affect turbidity or concentrations of suspended solids in the proposed action area. As they occur on the ice and not in the open-water environment, no contact is made with the seafloor during these types of surveys.

Exploratory Drilling Programs

Effects on water quality resulting from increases in turbidity and total suspended solids from exploratory drilling programs are described in detail under Alternative 2. Alternative 4 would allow additional drilling programs in the EIS project area. As a result of the additional drilling programs the intensity as well as the spatial extent of the impact may be effectively quadrupled. Relative to Alternative 2, turbidity and concentrations of suspended solids may be affected over a larger area. However, the effects of Alternative 4 on water quality resulting from changes in turbidity and concentrations of suspended solids would be low intensity, temporary, and local. Although common resources would be affected across increased spatial and temporal scales relative to Alternative 2, the overall effects of Alternative 4 on water quality related to turbidity and concentrations of suspended solids resulting from exploratory drilling programs are expected to be minor.

Metals

Seismic Surveys

Similar to the impacts under Alternative 2, seismic surveys are not expected to have any measureable impact on dissolved metal concentrations in the EIS project area.

Site Clearance and Shallow Hazards Surveys

Similar to the impacts under Alternative 2, site clearance and shallow hazards surveys are not expected to affect dissolved metal concentrations in the proposed action area.

On-ice Seismic Surveys

Similar to the impacts under Alternative 2, on-ice seismic surveys would not affect dissolved metal concentrations in the EIS project area.

Exploratory Drilling Programs

Direct and indirect effects on water quality resulting from increases in concentrations of metals from exploratory drilling programs are described in detail under Alternative 2. Alternative 4 would allow additional drilling programs in the EIS project area. As a result of the additional drilling programs, the intensity as well as the spatial extent of the impact may effectively be quadrupled. Relative to Alternative 2, metal concentrations may be affected over a larger area. However, the effects of Alternative 4 on water quality resulting from changes in metal concentrations would be low intensity, temporary, and local. Although common resources would be affected across increased spatial and temporal scales relative to Alternative 2, the overall effects of Alternative 4 on water quality related to metal concentrations resulting from exploratory drilling programs would be minor.

Hydrocarbons and Organic Contaminants

Seismic Surveys

Impacts under this alternative would be similar to the impacts under Alternative 2. While the level of activity would approximately double, seismic surveys are expected to have negligible impacts on concentrations of hydrocarbons and organic contaminants in the waters of the EIS project area.

Site Clearance and Shallow Hazards Surveys

Impacts under this alternative would be similar to the impacts under Alternative 2. While the level of activity would approximately double, site clearance and shallow hazards surveys are expected to have negligible impacts on concentrations of hydrocarbons and organic contaminants in the waters of the EIS project area.

On-ice Seismic Surveys

Similar to the impacts under Alternative 2, on-ice seismic surveys are expected to have minor impacts on concentrations of hydrocarbons and organic contaminants in the waters of the EIS project area under Alternative 4. Alternative 4 contemplates the same level of on-ice seismic activity as Alternative 2; therefore, the level of impacts is anticipated to be the same. Contaminants from fluids entrained in the ice roads would be discharged every spring during breakup. Any entrained hydrocarbons and other organic contaminants from vehicle exhaust, oil, grease, and other vehicle-related fluids not recovered would pass into the Beaufort and/or Chukchi Sea system at each breakup as a result of on-ice seismic surveys. The effects of these discharges on water quality would be temporary and local in nature, and overall impacts to water quality from on-ice seismic surveys under Alternative 4 are expected to be minor.

Exploratory Drilling Programs

Direct and indirect effects on water quality resulting from increases in concentrations of hydrocarbons and other organic contaminants from exploratory drilling programs are described in detail under Alternative 2. Relative to Alternative 2, Alternative 4 would allow additional drilling programs in the EIS project area, and, as a result of the additional drilling programs, the intensity as well as the spatial extent of the impact may effectively be quadrupled. Relative to Alternative 2, concentrations of hydrocarbons and other organic contaminants would be affected over a larger area. Impacts to water quality resulting from hydrocarbons and other organic contaminants would be temporary and would dissipate soon after the discharge is stopped. Such impacts would be local in nature due to rapid dilution of discharged compounds into the ocean. It is probable that inputs of hydrocarbons and other organic contaminants from exploratory drilling programs under Alternative 4 would have minor to moderate effects on water quality outside of the discharge plume area. However, due to lack of applicable water quality criteria for some organic compounds in drilling fluids (EPA 2006b), it is problematic to determine whether or not inputs of hydrocarbons and other organic compounds from the proposed activity would exceed water quality regulatory limits.

Although unlikely, it is plausible that accidental or emergency events may occur within the proposed action area. Due to the rarity of such unforeseen events, and the potential magnitude and extent of their impacts relative to the effects of normal operation and maintenance activities, such accidental or emergency events are not addressed in this section and are covered in Section 4.10 of this EIS. Regulations requiring operators to have plans in place to minimize the likelihood of a spill would reduce the potential for adverse impacts to water quality.

4.7.1.5.2 Conclusion

After mitigation, the effects of the proposed actions on water quality are expected to be low-intensity, temporary, local, and would affect a common resource. The overall effects of the proposed activity described in Alternative 4 on water quality in the EIS project area are expected to be negligible.

4.7.1.6 Environmental Contaminants and Ecosystem Functions

4.7.1.6.1 Direct and Indirect Effects

Contaminants of Concern

Contaminants of concern introduced to the EIS project area as a result of the activities proposed in Alternative 4 would be the same as those described for Alternative 2. Because Alternative 4 would authorize a greater level of activity relative to Alternative 2, the amounts of contaminants introduced to the EIS project area would potentially be greater under Alternative 4.

Proposed mitigation measures intended to reduce/ lessen non-acoustic impacts on marine mammals have the potential to reduce adverse impacts resulting from contaminants of concern.

Exposure of Habitat and Biological Resources

Pathways for exposure of habitat and biological resources to contaminants of concern as a result of the activities proposed in Alternative 4 would be the same as those described for Alternative 2.

Effects on Ecosystem Functions

In response to comments and suggestions received as part of the scoping process for this EIS, effects of (contaminants of concern from) the proposed activities on ecosystem functions are assessed in the following section. Effects of the activities proposed under Alternative 4 on the four categories of ecosystem functions (defined in Section 4.4.1.6) are assessed below.

Regulation Functions

The nature of the effects of the activities proposed under Alternative 4 on regulation functions would be the same as described under Alternative 2. The effects of greatest concern would be associated with exploratory drilling programs. Alternative 4 would authorize up to four exploratory drilling programs per year in the Beaufort Sea and up to four exploratory drilling programs per year in the Chukchi Sea, whereas Alternative 2 would authorize only one exploratory drilling program per year in each sea. Thus, the magnitude of the effects on regulation functions would be greater under Alternative 4 compared to Alternative 2. The magnitude and extent of effects of Alternative 4 on regulation functions would depend upon interrelationships between impacts to biological and physical resources, which are addressed in other sections of this EIS.

Habitat Functions

The nature of the effects of the activities proposed under Alternative 4 on habitat functions would be the same as described under Alternative 2. Effects of Alternative 4 on habitat functions would include impacts to refugium functions and nursery functions (provision of suitable reproduction habitat) associated with benthic habitats resulting from discharges from exploratory drilling. Overall effects to benthic habitat functions would be temporary, local, and low-intensity. Effects would also occur to functions associated with pelagic and epontic habitats. Functions associated with terrestrial habitats would be affected to a lesser degree. Overall, effects of Alternative 4 on habitat functions would be medium-intensity, temporary, and local. The functions affected could be common, important, or unique depending on the spatial location of the impact.

Proposed mitigation measures intended to reduce/ lessen non-acoustic impacts on marine mammals have the potential to reduce adverse impacts to habitat functions.

Production Functions

The nature of the effects of the activities proposed under Alternative 4 on production functions would be the same as described under Alternative 2. Impacts to production functions related to provision of raw materials and food (i.e. subsistence) could be affected by the activities proposed under Alternative 4.

These impacts are described in the subsistence section of this EIS. In addition to introducing contaminants to secondary and tertiary consumers via trophic transfer processes, contaminants of concern could interrupt trophic transfer processes resulting in shorter food chains (less complex food webs), and reduced throughput of energy and nutrients at higher trophic levels. Oil and gas are ecosystem goods, and the flows of energy that they represent are ecosystem services. These ecosystem goods and services could potentially be derived from historical production functions in the EIS project area under Alternative 4.

Information Functions

Information functions contribute to the maintenance of human health by providing opportunities for spiritual enrichment, cognitive development, recreation, and aesthetic experience (DeGroot et al. 2002). The effects of Alternative 4 on information functions in the EIS project area would depend upon interrelationships between impacts to cultural resources, social resources and aesthetic resources, which are addressed in other sections of this EIS.

4.7.1.6.2 Conclusion

Direct and indirect impacts to ecosystem functions resulting from the implementation of Alternative 4 would be medium-intensity, temporary, localized, and would affect common resources. The functional properties of ecosystems described in this section, such as nutrient cycling and habitat functions, are more robust (i.e. resistant to stressors) than are species composition and other structural properties. Because Alternative 4 would authorize a greater level of activity than Alternative 2 there is potential for increased volume of contaminants introduced to the project area. However, the overall effects of Alternative 4 on ecosystem functions would be considered minor.

4.7.2.7 Standard and Additional Mitigation Measures

Standard and additional mitigation measures that could reduce impacts to the physical environment are discussed under Alternative 2 (Section 4.5.1.7).

4.7.2 Biological Environment

4.7.2.1 Lower Trophic Levels

4.7.2.1.1 Direct and Indirect Effects

The direct and indirect impacts discussed in Section 4.5.2.1 for Alternative 2 are also applicable for this alternative. The increased levels of activity associated with Alternative 4 would not generate different types of impacts to lower trophic levels. The conclusions for Alternative 2 are applicable to Alternative 4; therefore, the overall impact to lower trophic levels would be moderate.

4.7.2.1.2 Conclusion

Given the implementation of the standard mitigation measures considered in this EIS, the direct and indirect effects on lower trophic levels associated with Alternative 4 would likely be low in intensity, temporary to long-term in duration, of local extent and could affect common resources. The resulting summary impact level would be negligible. The only exception to these levels of impacts would be the introduction of an invasive species due to increased vessel traffic, which could be of medium intensity, long-term or permanent duration, of regional geographic extent, and affect common or important resources, which could cause a summary impact of moderate.

4.7.2.2 Fish and Essential Fish Habitat

4.7.2.2.1 Direct and Indirect Effects

An increase in activity level from Level 2 to Level 3 would not change the effects on fish and EFH. The types and mechanisms of effects would remain the same in Alternative 4 as in Alternative 2. For a complete discussion of the types and mechanisms of effects on fish resources, please see Section 4.5.2.2, *Fish and Essential Fish Habitat*.

Marine Fish

The direct and indirect effects on marine fish resulting from Alternative 4 would be similar to those described under Alternative 2. Due to the uneven nature of the increases in activity levels by activity type, the increase in impacts to different fish assemblages would vary. The cryopelagic assemblage would have essentially no additional impacts, as the level for activities most likely to affect that group (icebreaking and on-ice seismic surveys) would not change from Alternative 3. Demersal assemblages would also have no increase in effects from seismic survey levels, but effects from the doubling of the numbers of exploratory drilling operations would create habitat loss and effects from noise. Effects to pelagic assemblages would be identical in terms of icebreaking and on-ice surveys but result in an increase in effects from doubling the number of drilling programs. These effects would be an increase in effluents and resultant effects on water quality, although likely to be short term and local. However, in spite of the potential for different resource groups to experience uneven increases in level of effect, the overall impact would remain the same given the limited area affected compared to the distribution of fish populations. The impacts to marine fish would remain at minor.

For a complete discussion of the effects on Marine Fish, please see Section 4.5.2.2.

Migratory Fish

The direct and indirect effects on migratory fish resulting from Alternative 4 would be similar to those described under Alternative 2. Because anadromous fish are more likely to be impacted by the activity types than amphidromous fish, as discussed under Alternative 2, they are likely to experience a disproportionate increase in adverse impacts when the two groups are compared. However, as described in Alternative 2, those anadromous species known to inhabit the area where project activities would occur are not abundant, and they are unlikely to be impacted. Therefore, the overall impact to the resource group would remain the same. The impacts to migratory fish would be considered negligible.

For a complete discussion of the effects on Migratory Fish, please see Section 4.5.2.2.

Essential Fish Habitat

The direct and indirect effects on essential fish habitat resulting from Alternative 4 would be similar to those described under Alternative 3, with an increase in effects due to the doubling of oil and gas exploration activities. In particular, the increase in exploratory drilling programs would result in increased habitat loss and alteration to EFH for saffron cod and salmon. Since there would be no increase in icebreaking activities, EFH for Arctic cod would be impacted the least. The opportunity for habitat loss or alteration resulting from Alternative 4 would be double than that for Alternative 3. However, most impacts would be of relatively low intensity for the environments of the species of concern and of such small geographic extent that their effects would be considered minor.

For a complete discussion of the effects on Essential Fish Habitat, please see Section 4.5.2.2.

4.7.2.2.2 Conclusion

The overall impact of Alternative 4 on Fish Resources and EFH is minor. Despite a substantial increase in level of activity over Alternative 2, there would be little corresponding increase in the overall impact level. Due to the small scale of any potential effects relative to overall population levels and available habitat, and the temporary nature of the majority of the activities associated with Alternative 4, there would be no measurable effect on the resource.

4.7.2.3 Marine and Coastal Birds

4.7.2.3.1 Direct and Indirect Effects

Alternative 4 includes all of the same types of exploration activities as Alternatives 2 and 3, so the discussion of potential direct and indirect effects on marine and coastal birds under Alternative 4 involves all the same mechanisms and types of effects as discussed for Alternative 2 in Section 4.5.2.3. The difference between alternatives concerning potential effects on marine and coastal birds is a matter of degree. Alternative 4 includes a larger number of some authorized exploration activities than do Alternatives 2 and 3. These activities take place in the same areas and timeframes and also involve the same standard mitigation measures. This EIS includes a number of standard mitigation measures as part of each alternative that are intended to reduce adverse effects on marine mammals but may also reduce adverse effects on birds. In addition to the mitigation measures imposed by NMFS and BOEM, ESA section 7 consultations with USFWS require certain mitigation measures specific to ESA-listed species under USFWS jurisdiction, including spectacled and Steller's eiders (USFWS 2012 [May 8 2012 Biological Opinion]). Section 4.5.2.3 summarizes the mitigation measures typically required for oil and gas exploration activities in the Beaufort and Chukchi seas to minimize impacts on birds, and these measures are incorporated into the analysis of potential effects under Alternative 4. A discussion of additional mitigation measures is also included.

The direct and indirect effects of oil and gas exploration activities on marine and coastal birds from seismic surveys under Alternative 4 would be similar to those described under Alternatives 2 and 3. Marine birds could be subject to increased disturbance from vessels and seismic sources due to the increase in seismic surveys that could be authorized under Alternative 4 in both Arctic seas. However, disturbance effects would be temporary even if they occurred over a wider area—birds could fly or swim away from acute disturbance.

Marine and coastal birds could experience some disruption of prey resources if multiple seismic operations operate in the same general area for an extended period of time. Seismic operations are required, however, to operate at specific distances from each other, which disperses effects across a wider area. Seismic operators also leave an area once the information has been collected, so it is unlikely that multiple operators would operate in the same area for an extended period of time. Also, seabirds are constantly seeking out new prey concentrations; therefore, if seismic operations were to displace a prey patch, this is equally likely to facilitate the seabirds' search for prey as it is to hinder it. Furthermore, such effects are temporary in space and time and do not persist from one season to another.

The risk of birds colliding with vessels associated with exploratory drilling operations under Alternative 4 is likely to increase as a consequence of the greater level of support vessel traffic. As an example, Shell had many vessels in the Bering, Chukchi, and Beaufort seas during the 2012 open water season but not the full complement—approximately eight larger vessels were in operation during the truncated open-water work season in 2012. Preliminary analysis of bird strike data from the 2012 season suggests that bird mortality from striking vessels may be greater than originally considered.

The bird strikes reported generally fall into four broad categories: tubenoses/alcids (shearwaters, storm petrels, and auklets), ducks (long-tailed ducks and eiders), shorebirds (phalaropes), and passerines (i.e., wagtails, pipits, arctic warbler, Northern wheatear, American tree sparrow, and dark-eyed junco). Reports of several ducks and storm petrels striking vessels at one time confirmed that strikes can be episodic. On August 30, 2012, the drillship *Kulluk* crew reported 12 strikes from a position 43.5 km (27 mi) offshore of the Chukchi Sea coastline. The *Kulluk* crew also reported eight strikes on September 2, 2012, when 96.6

km (60 mi) offshore. The icebreaker *Fennica* crew reported nine king eiders striking their vessel on October 22, 2012, when located 37 km (23 mi) offshore in the Beaufort Sea.

A full complement of vessels for a full season as considered under this alternative may result in a greater number of strikes than occurred during the 2012 drilling season. Based on the existing preliminary bird strike reports from 2012, eight simultaneous future drilling operations could result in as many as 713 bird strikes per open-water season—this could include an estimated 395 passerines, 90 shearwaters/storm petrels/auklets, 35 shorebirds, and 192 seaducks. Of the seaducks, 95 could be king eiders, 64 could be long-tailed ducks, and 33 could be common eiders. This potential mortality for each species is small by comparison with the post-breeding population; thus, no species would experience a population-level effect. However, small flocks of eiders can strike a vessel, suggesting that the authorized incidental take of listed eiders could be exceeded in one strike event.

4.7.2.3.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to marine and coastal birds are discussed under Alternative 2 (Section 4.5.2.3). These measures include aircraft flight paths and altitude restrictions to reduce the chance of disturbing marine and coastal birds, and development of an oil response plan and procedures for exploratory drilling to minimize the risk of spills occurring and to expedite clean-up responses. There is currently no way to evaluate the effectiveness of flight altitude restrictions.

Spatial/Temporal Considerations

With more exploratory drilling activities authorized under Alternative 4, the potential for adjacent activities to magnify effects on birds could be increased. The Ledyard Bay closure period would be the same under Alternative 4 as under Alternative 2, so this area would likely be unaffected by increases in support activities for increased exploratory drilling elsewhere.

4.7.2.3.3 Conclusion

Most marine and coastal birds are legally protected under the Migratory Bird Treaty Act and several are protected under the ESA. Birds fulfill important ecological roles in the Arctic and are therefore considered to be important or unique resources. The effects of disturbance, injury/mortality, and changes in habitat for marine and coastal birds would likely be temporary, localized, and not likely to have population-level effects for any species. The overall effects of oil and gas exploration activities authorized under Alternative 4 on marine and coastal birds would therefore be considered moderate according to the impact criteria in Table 4.5-17.

4.7.2.3.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to marine and coastal birds are discussed under Alternative 2 (Section 4.5.2.3).

4.7.2.3.5 Additional Mitigation Measures Conclusion

Most of the additional mitigation measures considered in this EIS would not appreciably reduce potentially adverse effects on birds except for Additional Mitigation Measures C3 and C4. These two measures would reduce the risk of contamination from discharges and drilling muds, although the reduction in adverse effects relative to the standard mitigation measures would be limited to small numbers of birds and small areas of benthic habitat. Given the implementation of standard and additional mitigation measures considered by NMFS in this EIS, and assuming no large oil spill occurred during exploration activities, the effects on birds would likely be low in intensity, temporary to long-term in duration, of local extent, and would affect important or unique resources. The effects of Alternative 4 with additional mitigation measures would therefore remain moderate for birds.

4.7.2.4 Marine Mammals

4.7.2.4.1 Bowhead Whales

4.7.2.4.1.1 Direct and Indirect Effects

This section discusses the potential direct and indirect effects of Alternative 4 on bowhead whales. Alternative 4 includes all of the same types of exploration activities as in Alternatives 2 and 3, so the discussion of potential direct and indirect effects on bowhead whales under Atlernative 4 involves all of the same mechanisms and types of effects as discussed for Alternative 2 in Section 4.5.2.4.9. The only difference between alternatives 3 and 4 is the addition of drilling programs, levels of all other activity types stay the same. Specifically, Alternative 3 assumes a maximum of two exploration drilling programs active in each sea at any given time while Alternative 4 assumes a maximum of four exploration drilling programs active in each sea at any given time. These activities take place in the same areas and timeframes and also consider the same standard and additional mitigation measures. The following discussion focuses on the differences between alternatives rather than repeating the same information presented in Section 4.5.2.4.9.

Behavioral Disturbance

Each of the different types of exploration activities that would be authorized under Alternative 4 includes several mechanisms for potential disturbance to bowhead whales. Most result from noise generated by oil and gas exploration equipment and associated vessels and aircraft. The mechanisms for disturbance and the suite of potential reactions by bowheads to disturbance under Alternative 4 are as described in detail for Alternative 2 in Section 4.5.2.4.9.

There would be a moderate increase in the amount of open-water activities under Alternative 4 compared to Alternatives 2 and 3 as a result of the added drilling programs. Anticipated impacts from all types of activities, except drilling, would remain the same as in Alternative 3.

Alternative 4 could authorize up to four exploratory drilling programs in each sea, which would double the amount of exploratory drilling programs contemplated under Alternative 3. For bowhead whales, historical take estimates suggest that exploratory drilling results in more take of bowhead whales than other categories of activities (Tables 4.2-5 through 4.2-7). Alternative 4 doubles the level of potential drilling beyond alternative 3, which results in a significant increase in intensity. Anticipated impacts of four exploratory drilling programs in each sea under Alternative 4 would be similar to that for Alternative 3 in terms of magnitude (medium), duration (interim), extent (local to regional), and context (unique). The extent of impact resulting from the addition of one or two drilling programs in each sea would depend on the spatial and temporal distribution of the activities within the open water season.

Disturbance effects resulting from vessel and aircraft activity under Alternative 4 would be similar to Alternative 3. However, with the increase in the number of explatory drilling programs, this could require additional vessels and aircraft overflights for resupply and crew change, as well as for marine mammal monitoring. Disturbance effects of vessel and aircraft activity would likely be of medium intensity, and the duration of disturbance is expected to be temporary (long term effects are unknown). The extent of impact would depend on the number of support vessels in an area. Please refer to Section 4.5.2.4.9 for a complete discussion of the disturbance effects, by activity type, on bowhead whales.

Hearing Impairment, Injury, and Mortality

The primary mechanisms of potential injury or mortality due to oil and gas exploration activities are permanent hearing loss or damage (auditory injury) and collisions with vessels. These are discussed in detail in Section 4.5.2.4.9. As noted under Alternative 2, it is not currently possible to assess whether or not auditory impairment (TTS or PTS) is occurring in bowhead whales. The potential effects of ship strikes under Alternative 4 are similar to that discussed under Alternatives 2 and 3. The intensity of impact could be considered medium, given past low-level occurrence and potential increased occurrence with additional vessel traffic associated with oil and gas exploration activities. The impact would be temporary, although the results (injury or mortality) would be permanent for the impacted whale. The extent of impact would be local to regional, given the relative infrequency of occurrence and the non-random distribution of both bowhead whales and exploration activity in the EIS project area.

Please refer to Section 4.5.2.4.9 for a complete discussion of potential injury or mortality effects on bowhead whales.

Habitat Alterations

Doubling the number of potential drilling programs could increase the number of localized sites experiencing possible habitat effects of drilling activities. However, this addition only makes a relatively small change in the impacted acoustic habitat (an increase of 1% of EIS area ensonified) (see Table 4.7-7 in Section 4.7.1.4).

Please refer to Section 4.5.2.4.9 for a complete discussion of the potential effects on bowhead whale habitat.

4.7.2.4.1.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to bowhead whales are discussed under Alternative 2 (Section 4.5.2.4.15).

4.7.2.4.1.3 Conclusion

Impacts of individual activities associated with oil and gas exploration in the EIS project area under Alternative 4 are similar to Alternative 3, with the exception of the added drilling programs, which increase the impacts to acoustic habitat slightly beyond those anticipated in Alternative 3 and increase the anticipated behavioral disturbance by over 40%. Bowhead whales are listed as endangered, and the Arctic slope is an important area for them, through which the entire population migrates with calves, occasionally stopping to feed, which places them in the context of being a unique resource. The intensity and duration of the various effects and activities considered are high and interim, respectively. Potential long-term effects from repeated disturbance are, however, unknown. Although the various individual activities may affect bowhead whales on a local to regional level, the area and extent over which the combined effects occur, would likely increase with multiple activities occurring simultaneously or consecutively throughout much of the summer-fall range of this population and at that point would be considered regional. Considering these factors, along with potential reduced adverse impacts through the imposition of required standard mitigation measures, the overall impact of Alternative 4 on bowhead whales would be considered moderate to major.

Type of effect	Impact Component	Effects Summary	
Behavioral disturbance	Magnitude or Intensity	Low	
		Medium	
		High	Take of bowheads exceeds 30% of population
	Duration	Temporary	
		Interim	All activity types last more than month, but combination < 6 months
		Long-term	
	Geographic Extent	Local	
		Regional	Impacts considered regional
		State-wide	
	Context	Common	
		Important	
		Unique	ESA-listed species, impacts across migratory corridor through which mother/calve pairs traverse, potential disruption of feeding
Injury and mortality	Magnitude or Intensity	Low	Injury or death unlikley
		Medium	Though unlikely, cannot rule out PTS
		High	
	Duration	Temporary	
		Interim	Type of potential injury (though unlikely) would likely have moderate effects
		Long-term	
	Geographic Extent	Local	Since unlikely, any few impacts would be considered local
		Regional	
		State-wide	
	Context	Common	
		Important	ESA listed species, but population is increasing
		Unique	
Habitat alterations	Magnitude or Intensity	Low	
		Medium	Combination of potential habitat impacts, including acoustic habitat, are medium
		High	
	Duration	Temporary	
		Interim	Although other alterations shorter, acoustic habitat is altered for duration of activities
		Long-term	
	Geographic Extent	Local	
		Regional	Impacts considered regional, especially when consider area over which sound exceeds 120 dB, and the communication distances of baleen whales.
		State-wide	
	Context	Common	
		Important	ESA listed species, but population is increasing
		Unique	

4.7.2.4.1.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to bowhead whales are discussed under Alternative 2 (Section 4.5.2.4.16).

4.7.2.4.1.5 Additional Mitigation Measures Conclusion

Conclusions regarding the potential for these additional measures to reduce adverse impacts of oil and gas activities on bowhead whales allowed under Alternative 4 are the same as under Alternative 2. Refer to Section 4.5.2.4.9 for details.

4.7.2.4.2 Beluga

4.7.2.4.2.1 Direct and Indirect Effects

This section discusses the potential direct and indirect effects of Alternative 4 on beluga whales. Alternative 4 includes the same types of exploration activities as in Alternatives 2 and 3, so the discussion of potential direct and indirect effects on beluga whales under Alternative 4 is the same as those discussed in Section 4.5.2.4.10. The exploration activities discussed in Alternatives 2 and 3 take place in the same geographic areas and timeframes and also consider the same standard and additional mitigation measures. The difference between the alternatives is simply a matter of degree; Alternative 4 includes a larger number of authorized exploratory drilling activities than Alternative 3, but all other activity types remain at the same levels as Alternative 3.

The following discussion will focus on the differences between alternatives rather than repeating the same information presented in Section 4.5.2.4.10.

Behavioral Disturbance

There would be a moderate increase in the amount of open-water activities under Alternative 4 compared to Alternative 3 but only in the addition of exploratory drilling programs, which are expected to result in comparatively minor increases in impacts to belugas. Potential effects of seismic surveys and site clearance and high resolution shallow hazards survey programs would be identical to Alternative 3, since activity level would remain the same for these types of activities under Alternative 4.

Based on the historical take estimates used for beluga whales, in-ice seismic surveys are responsible for the vast majority of behavioral disturbance of beluga whales (Tables 4.2-5 through 4.2-7). Since neither the number of in-ice seismic surveys (1 each in Beaufort and Chukchi), nor the larger 2D/3D seismic surveys increased above Alternative 3, if one considers the combined impacts of all activity types, the overall increase in anticipated behavioral takes above Altenrative 3 was only about 2%.

These activities could affect beluga whales over a large area, especially with regard to the 2D/3D seismic streamer surveys, and the disturbance effects would be interim in duration and medium in magnitude, characterized by avoidance of vessels but with mild or unnoticeable behavioral reactions of beluga whales.

Hearing Impairment, Injury, and Mortality

As discussed under Alternative 2, the primary mechanism of potential injury or mortality to beluga whales due to oil and gas exploration activities are permanent hearing loss or damage (auditory injury) and collisions with vessels. The duration of an impact from an auditory impairment would be temporary for TTS, but permanent if PTS were to occur. The extent of such impacts would be local and the context unique, since beluga whales are an integral part of the Iñupiat subsistence lifestyle. It is not known whether there have been any ship strikes involving beluga whales and exploration vessels in the Arctic, but the intensity of the impact should be considered medium due to the belugas cultural significance. The impact would be temporary, although the results (injury or mortality) would be permanent for the impacted whale.

Habitat Loss/Alteration

Potential impacts on beluga whale habitat in the EIS project area under Alternative 4 would likely be slightly greater than those in Alternative 3. Additional exploratory drilling could increase the number of localized sites experiencing possible habitat effects of drilling activities and also increase the area of acoustic habitat impacts by about 1% within the EIS area (see Section 4.7.1.4). Please refer to Section 4.5.2.4.10 for a complete discussion of the potential effects on beluga whale habitat.

4.7.2.4.2.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to beluga whales are discussed under Alternative 2 (Section 4.5.2.4.15).

4.7.2.4.2.3 Conclusion

The overall impact to beluga whales from Alternative 4 is likely to be moderate. Beluga whales in the Arctic are not listed under the ESA, but there are a couple of important feeding areas in the Arcitc that are important for this population. The intensity and duration of the various effects and activities considered are mostly medium and interim. However, potential long-term effects from repeated disturbance are unknown. Although, individually, the various activities may elicit local effects on beluga whales, the area and extent over which the combined effects occur will likely increase with multiple activities occurring simultaneously or consecutively throughout much of the spring-fall range of this population and are considered regional.

4.7.2.4.2.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to beluga whales are discussed under Alternative 2 (Section 4.5.2.4.16).

Type of effect	Impact Component	Effects Summary	
Behavioral disturbance	Magnitude or Intensity	Low	
		Medium	Behavioral harassment occurring, but likely < 30% of population disturbed
		High	
	Duration	Temporary	
		Interim	All activity types last more than month, but combination < 6 months
		Long-term	
	Geographic Extent	Local	
		Regional	Combined activities considered regional
		State-wide	
	Context	Common	
		Important	Non-ESA listed, population status not well known, but thought not to be declining in Chukchi, important feeding and calving areas
		Unique	
Injury and mortality	Magnitude or Intensity	Low	Injury or death unlikley
		Medium	Though unlikely, cannot rule out PTS
		High	
	Duration	Temporary	
		Interim	Type of potential injury (though unlikely) would likely have moderate effects
		Long-term	
	Geographic Extent	Local	Since unlikely, any few impacts would be considered local
		Regional	
		State-wide	
	Context	Common	Not ESA listed, populations not thought to be decreasing
		Important	
		Unique	

Type of effect	Impact Component	Effects Summary	
Habitat alterations	**Magnitude or Intensity**	**Low**	
		Medium	Combination of potential habitat impacts, including acoustic habitat, are medium
		High	
	Duration	**Temporary**	
		Interim	Although other alterations shorter, acoustic habitat is altered for duration of activities
		Long-term	
	Geographic Extent	**Local**	
		Regional	When acoustic habitat is considered, impacts considered regional
		State-wide	
	Context	**Common**	Not ESA listed, populations not thought to be decreasing
		Important	
		Unique	

4.7.2.4.3 Other Cetaceans

4.7.2.4.3.1 Direct and Indirect Effects

This section discusses the potential direct and indirect effects of Alternative 4 on cetaceans in the EIS project area other than bowhead and beluga whales. Alternative 4 includes all of the same types of exploration activities as in Alternatives 2 and 3, so the discussion of potential direct and indirect effects on bowhead whales under Atlernative 4 involves all of the same mechanisms and types of effects as discussed for Alternative 2 in Section 4.5.2.4.11. The difference is that Alternative 4 includes a larger number of exploratory drilling operations than Alternative 3. Specifically, Alternative 3 assumes a maximum of two exploration drilling programs active in each sea at any given time while Alternative 4 assumes a maximum of four exploration drilling programs active in each sea at any given time. These activities take place in the same areas and timeframes and also consider the same standard and additional mitigation measures. The following discussion focuses on the differences between alternatives rather than repeating the same information presented in Section 4.5.2.4.11.

Behavioral Disturbance

Under Alternative 4, disturbance effects of oil and gas exploration activity on other cetaceans would be of low intensity (for those species that were not encountered or exposed) or medium, based on determinations for Alternative 2. Despite an increase in the level of exploratory drilling activity by a factor of two over Alternative 3, there would be little increase in the overall impact level for the species that occur in low densities (see Tables 4.2-5 through 4.2-7). Some whales may be displaced a short distance, but they would not be anticipated to leave the EIS project area entirely. The duration is expected to be interim. Long term effects are unknown. The extent of the impacts would depend on the number of seismic and exploratory drilling activities and associated support vessels in an area. Individual sound sources may produce localized impacts. Multiple activities in one area or in several areas across migratory corridors would be expected to lead to more widespread, regional impacts.

Please refer to Section 4.5.2.4.11 for a complete discussion of disturbance effects on Other Cetaceans.

Hearing Impairment, Injury, and Mortality

The primary mechanisms of potential injury or mortality due to oil and gas exploration activities are permanent hearing loss or damage (auditory injury) and collisions with vessels. These are discussed in detail in Section 4.5.2.4.11. As noted under Alternative 2, it is not currently possible to assess whether or not auditory impairment (TTS or PTS) is occurring in other cetaceans. The potential effects of ship strikes under Alternative 4 are similar to that discussed under Alternative 2. The intensity of impact could be considered medium, given past low-level occurrence and potential increased occurrence with additional vessel traffic associated with oil and gas exploration activities. The impact would be temporary, although the results (injury or mortality) would be permanent for the impacted whale. The extent of impact will be local, given the relative infrequency of occurrence and the non-random distribution of other cetacean species and exploration activity in the EIS project area.

Please refer to Section 4.5.2.4.11 for a complete discussion of potential injury or mortality effects on Other Cetaceans.

Habitat Alterations

The potential effects on cetacean habitat in the EIS project area under Alternative 4 would likely be similar to those under Alternative 3. Additional exploratory drilling could increase the number of localized sites experiencing possible habitat effects of drilling activities and increase the area over which temporary impacts to acoustic habitat could occur by about 1% (see Section 4.7.1.4).

Please refer to Section 4.5.2.4.11 for a complete discussion of the potential effects on Other Cetacean habitat.

4.7.2.4.3.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to other cetaceans are discussed under Alternative 2 (Section 4.5.2.4.15).

4.7.2.4.3.3 Conclusion

Evaluated collectively, the overall impact of Alternative 4 on Other Cetaceans is minor to moderate. Despite an increase in the level of exploratory drilling activity over Alternative 3, there would be little increase in the impact level. Due to the very small scale of any potential effects relative to overall population levels and available habitat, and the interim nature of the majority of the activities associated with Alternative 4, impacts on the resource would be low to medium in intensity, of interim duration, and regional extent. Long term impacts are unknown, but anticipated to be minor.

4.7.2.4.3.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to other cetaceans are discussed under Alternative 2 (Section 4.5.2.4.16).

Type of effect	Impact Component	Effects Summary	
Behavioral disturbance	Magnitude or Intensity	**Low**	Possible that some other species may not come into contact with activities or be impacted
		Medium	If behavioral harassment occurs, would be < 30% of population disturbed
		High	
	Duration	**Temporary**	
		Interim	All activity types last more than month, but combination < 6 months
		Long-term	
	Geographic Extent	**Local**	Effects primarily considered local
		Regional	Impacts from max levels of activity might be considered regional for gray whales when consider area ensonified over 120 dB (>10% EIS area) and fact that gray whales are more likely to be encountered than other species.
		State-wide	
	Context	**Common**	
		Important	Although not ESA listed, important areas exist for gray whales.
		Unique	

Type of effect	Impact Component	Effects Summary	
Injury and mortality	Magnitude or Intensity	**Low**	Injury or death unlikley
		Medium	Though unlikely, cannot rule out PTS
		High	
	Duration	**Temporary**	
		Interim	Type of potential injury (though unlikely) would likely have moderate effects
		Long-term	
	Geographic Extent	**Local**	Since unlikely, any few impacts would be considered local
		Regional	
		State-wide	
	Context	**Common**	Not ESA listed species, but trends of some species not known
		Important	Not ESA listed species, but trends of some species not known
		Unique	
Habitat alterations	Magnitude or Intensity	**Low**	
		Medium	Combination of potential habitat impacts, including acoustic habitat, are medium
		High	
	Duration	**Temporary**	
		Interim	Although other alterations shorter, acoustic habitat is altered for duration of activities
		Long-term	
	Geographic Extent	**Local**	Lower to mid-level of ativities considered regional
		Regional	
		State-wide	
	Context	**Common**	
		Important	Not ESA listed species, but trends of some species not known
		Unique	Not ESA listed species, but trends of some species not known

4.7.2.4.4 Ice Seals

4.7.2.4.4.1 Direct and Indirect Effects

This section discusses the potential direct and indirect effects of Alternative 4 on ice seals. Alternative 4 includes all of the same type of exploration activities as in Alternatives 2 and 3, so the discussion of potential direct and indirect effects on ice seals under Alternative 4 involves all the same mechanisms and types of effects as discussed for Alternative 2 in Section 4.5.2.4.12. The difference between alternatives concerning ice seals is a matter of degree. Alternative 4 includes a larger number of drilling activities, specifically, four programs in both the Chukchi and Beaufort seas instead of two programs in each sea (Table 4.2-2). These activities take place in the same areas and timeframes and also consider the same standard and additional mitigation measures.

The following discussion will focus on the differences between alternatives rather than repeating the same information presented in Section 4.5.2.4.12.

Behavioral Disturbance

Each of the different types of exploration activities that would be authorized under Alternative 4 include several mechanisms for potential disturbance to ice seals in the water and on the ice, primarily involving the noise generated by and the physical presence of vessels and associated exploration equipment. The two types of surveys which take place on or in sea ice, the preferred habitat of ice seals and where they are most likely to be concentrated, are the in-ice 2D surveys with icebreakers and the on-ice vibroseis surveys. For both of these types of surveys, the same number of surveys would be authorized under Alternative 4 as for Alternatives 2 and 3. The level of disturbance from these types of surveys would therefore be the same for Alternative 4 as is discussed for Alternative 3, which was considered to have temporary and low magnitude effects on ice seals.

There would be a moderate increase in the amount of open-water activities under Alternative 4 compared to Alternative 3. These activities could affect ice seals over a large area, but the disturbance effects would be of interim duration and medium in magnitude, characterized by avoidance of vessels but with mild or unnoticeable behavioral reactions of ice seals.

Alternative 4 could authorize up to four exploratory drilling programs in both Arctic seas. The level of disturbance to seals is likely more intense in terms of the physical presence of the ships than any types of exploratory surveys, but the geographic area involved is much smaller. The noise generated from drilling is produced on an almost continual basis, making it essentially a chronic sound source in one location, and seals could become habituated to it. Given the mild reaction of seals to marine vessels and the close distances to which they often approach vessels, it is unlikely that having up to four drilling programs operating in the same general area at the same time will result in any additive disturbance effects on particular seals, although more seals could be affected than would occur with only one or two drilling programs operating at any one time. Any disturbance and displacement of seals would cover a very small area and be considered short-term.

Based on the historical take estimates used for ice seals (Tables 4.2-5 through 4.2-7), in-ice seismic surveys are responsible for the vast majority of behavioral disturbance of ringed seals, with open water 2D/3D seismic surveys contributing to the majority of the behavioral disturbance takes for other species. Because the level of activity for these survey types did not increase in Alternative 4, total behavioral take numbers between Alternatives 3 and 4 only increased by a small amount.

Hearing Impairment, Injury, and Mortality

As discussed under Alternative 2, there is very little risk of any ice seals being injured as a result of high noise levels or ship strikes because they can easily detect and avoid vessels as they approach in the water or on/through the ice. There is a lack of data on the physiological thresholds for acoustic injury in ice seals, but that information could only be obtained through captive studies involving potential injury to the animals, and, given the behavioral avoidance of wild animals to loud seismic sources, this lack of data is not crucial for this analysis.

As discussed in Section 4.5.2.4.12, there is the potential for seals to be exposed to small accidental spills of oils, lubricants, and other compounds used by vessels, vehicles, and equipment during exploration activities. Spills in the offshore or onshore environments could occur during normal operations (e.g. transfer of fuel, handling of lubricants and liquid products, and general maintenance of equipment). Exposure of seals to oil products could lead to irritation of eyes, mouth, lungs, and anal and urogenital surfaces (St. Aubin 1990). Ice seals are commonly observed near exploratory activities during the open-water season and could be exposed to spills in the water or on ice. If a small spill did occur, cleanup efforts would begin immediately, and those activities would likely include the presence of PSOs to monitor for ice seals and other marine mammals and deter them from entering the spill area if possible. Alternative 4 could authorize a greater level of exploratory drilling activity than Alternative 3, and the resulting risk of small accidental spills occurring would be proportionally greater. However, given the mitigation measures in place to prevent and clean up spills, the risk of ice seals being exposed to small spills during exploration activities authorized under Alternative 4 is considered to be minor. The potential effects of a very large oil spill caused by a well blowout are much more serious and are discussed in Sections 4.10.6.11 and 4.10.7.11. Please refer to Section 4.5.2.4.12 for a complete discussion of potential injury or mortality effects on pinnipeds.

Habitat Alterations

The two types of activities that involve potential changes to ice habitat, icebreaking and on-ice vibroseis, would be at the same level as discussed under Alternative 2, and they were considered to have temporary effects that are similar in scope as those occurring due to natural forces in the dynamic sea ice environment. The increase from two exploratory drilling programs in each Arctic sea under Alternative 3 to four drilling programs in each sea under Alternative 4 would increase the amount of intentional and unintentional discharges of drilling muds and other wastes. There is a lack of information about how any of these discharges could interact directly with ice seals or be carried through the environment to affect the food supply of ice seals (primarily fish and crustaceans). Given this lack of ecological information on the effects of these discharges on ice seal habitat, it is not possible to say whether four drilling programs constitute a substantially larger risk to habitat quality for ice seals than one or two drilling programs. Unfortunately, the types of ecological monitoring studies required to address these issues are very difficult to conduct in the Arctic and even more difficult to interpret given the vast number of complicating factors. The addition of the drilling programs would also add to a slight increase in acoustic habitat impacts.

4.7.2.4.4.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to pinnipeds are discussed under Alternative 2 (Section 4.5.2.4.15).

4.7.2.4.4.3 Conclusion

The four species of ice seals would likely not be affected to the same extent by exploration activities in the Beaufort and Chukchi seas based on their respective abundance and distribution. Ringed seals and bearded seals have been the most commonly encountered species of any marine mammals in past exploration activities, and their reactions have been recorded by PSOs onboard source vessels and monitoring vessels. These data indicate that seals tend to avoid on-coming vessels and active seismic arrays but their behavioral responses are often neutral rather than swimming away, and they do not appear to react strongly even as ships pass fairly close with active arrays. They also appear to primarily react to icebreaking or on-ice surveys by keeping their distance or moving away at some point to an alternate breathing hole or haulout. None of the behavioral reactions observed to date indicate that any of the ice seal species would be displaced from key areas or resources for more than a few minutes or hours and would therefore be unlikely to experience any measurable effects on their reproductive success or survival. Ice seals are legally protected (two of which are also protected under the ESA) and are therefore considered to be important resources. Given the standard and additional mitigation measures considered in this EIS, the effects of exploration activities that could be authorized under Alternative 4 on ice seals would likely be medium to high (the latter for ringed seals) in magnitude, distributed over a wide geographic area, and interim in duration. The effects of Alternative 4 would therefore be considered minor to moderate (the latter for ringed seals) for ice seal species according to the criteria established in Section 4.1.3.

Type of effect	Impact Component	Effects Summary	
Behavioral disturbance	Magnitude or Intensity	Low	
		Medium	Behavioral harassment occurring, but likely < 30% of population disturbed for all species but ringed seals
		High	When maximum activities considered, more than 30% ringed seals may be taken
	Duration	Temporary	
		Interim	All activity types last more than month, but combination < 6 months
		Long-term	
	Geographic Extent	Local	Effects of activities considered local
		Regional	Max levels potentially regional
		State-wide	
	Context	Common	
		Important	ESA-listed species, but impacts not occurring in areas specifically important for feeding/pupping, etc.
		Unique	
Injury and	Magnitude	Low	Injury or death unlikely

Type of effect	Impact Component	Effects Summary	
mortality	or Intensity	Medium	Though unlikely, cannot rule out PTS
		High	
	Duration	Temporary	
		Interim	Type of potential injury (though unlikely) would likely have moderate effects
		Long-term	
	Geographic Extent	Local	Since unlikely, any few impacts would be considered local
		Regional	
		State-wide	
	Context	Common	
		Important	ESA listed species,no reliable data available to assess population trends
		Unique	
Habitat alterations	Magnitude or Intensity	Low	
		Medium	Combination of potential habitat impacts are medium
		High	
	Duration	Temporary	
		Interim	Although other alterations shorter, acoustic habitat is altered for duration of activities
		Long-term	
	Geographic Extent	Local	Lower to mid-level of ativities considered local
		Regional	Max levels potentially regional
		State-wide	
	Context	Common	
		Important	ESA listed species, population status unknown, no reliable data on trends
		Unique	

4.7.2.4.4.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to pinnipeds are discussed under Alternative 2 (Section 4.5.2.4.16).

4.7.2.4.5 Walrus

4.7.2.4.5.1 Direct and Indirect Effects

This section discusses the potential direct and indirect effects of Alternative 4 on Pacific walrus. This species is dependent on pack ice, barrier islands, and coastal shorelines for haul outs. Alternative 4 includes all of the same types of exploration activities as in Alternatives 2 and 3, so the discussion of potential direct and indirect effects on Pacific walrus under Alternative 4 involves all the same mechanisms and types of effects as discussed for Alternatives 2 and 3 in Section 4.5.2.4.13. The difference between alternatives concerning Pacific walrus is a matter of degree. Alternative 4 includes a larger number of some authorized exploration activities than Alternative 3. Specifically, Alternative 3 assumes a maximum of two exploration drilling programs active in each sea at any given time while Alternative 4 assumes a maximum of four exploration drilling programs active in each sea at any given time. These activities take place in the same areas and timeframes and also consider the same standard and additional mitigation measures. Walrus are distributed widely across the Chukchi Sea but are uncommon in the deeper offshore waters of the Beaufort Sea. Therefore activities that occur in the Beaufort Sea are not anticipated to impact Pacific walrus. The following discussion focuses on the differences between alternatives rather than repeating the same information presented in Section 4.5.2.4.13.

Behavioral Disturbance

Each of the different types of exploration activities that would be authorized under Alternative 4 include several mechanisms for potential disturbance to walrus in the water and on the ice, primarily involving the noise generated by and the physical presence of vessels and associated exploration equipment. The one type of survey that takes place on or in sea ice (the preferred habitat for walrus and where they are most likely to be concentrated) is the in-ice 2D survey with icebreakers. Only one such in-ice survey could be authorized for each Arctic sea under any of the action alternatives. On-ice vibroseis surveys would only occur in the Beaufort Sea at times when walrus would not be present. The level of disturbance from these types of surveys would therefore be the same for Alternative 4 as is discussed for Alternative 3, which was considered to have temporary and low magnitude effects on walrus.

There would be a moderate increase in the amount of open-water activities under Alternative 4 compared to Alternative 3. The increase in exploration drilling activities could affect walrus over a larger area, but the disturbance effects would be temporary and low in magnitude, characterized by avoidance of vessels associated with drilling and of the drill sites but with mild or unnoticeable behavioral reactions of walrus. Exploration drilling activities have a foot print of a few square kilometers. Alternative 4 increases the footprint of benthic foraging habitat that would be unavailable to walrus during exploration operations. Some walrus could be exposed to or displaced from more than one exploratory drilling site over time as it travels through an area. The addition of one or two additional exploration drilling operations to the Beaufort and /or Chukchi seas would slightly decrease the benthic foraging habitat available to walrus during drilling and afterward until the sea floor is recolonized by the benthic invertebrates which are primary food sources for walrus. This decrease in available habitat would be very small when compared with the available foraging habitat within the Chukchi Sea. Past exploration drilling activities in the Chukchi Sea have not been shown to impact either individual walrus or the walrus population.

Alternative 4 could authorize up to four exploratory drilling programs in each sea. The level of disturbance to walrus is likely more intense from the multiple support ships associated with a drilling rig than any types of exploratory surveys, but the geographic area involved is much smaller. The noise generated from drilling is produced on an almost continual basis, making it essentially a chronic sound source in one location, and walrus could become habituated to it. Given the mild reaction of walrus to marine vessels, it is unlikely that having four drilling programs operating in the same general area at the same time will result in any additive disturbance effects on particular walrus, although more walrus could be temporarily affected than would occur with only two drilling programs. Any disturbance and displacement of walrus would cover a small area and be considered short-term.

Hearing Impairment, Injury, and Mortality

As discussed under Alternative 2, there is very little risk of any walrus being injured or killed as a result of high noise levels or ship strikes because they can easily detect and avoid vessels as they approach in the water or on/through the ice. It is also very unlikely that any walrus would be exposed to very loud sounds from seismic or exploratory drilling operations to the point where they might be injured.

There is a potentially dangerous situation with walrus on land-based haulouts, primarily on the Chukchi coast from Point Lay to Barrow. Disturbance by low-flying aircraft or nearby vessels could cause stampedes and crushing deaths. USFWS LOA mitigation measures for exploration aircraft and vessels are intended to monitor and avoid such haulouts to avoid causing such deadly disturbance.

As discussed in Section 4.5.2.4.13 exposure to small accidental spills of oils, lubricants, and other compounds used by vessels, vehicles, and equipment during exploration activities could have substantial health effects on walrus and could spread among animals in a close herd. Alternative 4 could authorize a greater level of exploration activity than Alternative 3, and the resulting risk of small accidental spills occurring would be proportionally greater. However, given the mitigation measures in place to prevent and clean up spills and the occurrence of walrus primarily on or near the pack ice rather than swimming in open water where most exploration activities take place, the risk of walrus being exposed to small spills during exploration activities is considered to be negligible. The potential effects of a very large oil spill are much more serious and are discussed in Sections 4.10.6.11 and 4.10.7.11.

Please refer to Section 4.5.2.4.13 for a complete discussion of potential injury or mortality effects on walrus.

Habitat Alterations

Benthic prey of walrus may experience disturbance/mortality from bottom-contact equipment used in exploration activities such as OBC surveys in the Chukchi Sea, vessel anchors, and exploratory drilling. All of these activities could disturb benthic mollusks and other invertebrates temporarily and may cause mortality. Alternative 4 could authorize higher levels of exploration activities that involve benthic disturbance than Alternative 3. However, given the very small areas of benthic surface that could be impacted by all of these activities and the wide distribution of prey fields for walrus, these activities would be unlikely to affect the availability of prey to walrus.

Icebreaking ships intentionally disrupt pack ice in order to conduct seismic surveys or to help manage ice floes around exploratory drilling equipment. The amount of icebreaking and ice management activity and potential impacts to walrus under Alternative 4 would increase from that discussed in Alternatives 2 and 3. These impacts would primarily be limited to displacement of walrus from preferred sea ice habitat.

Alternative 4 could authorize a greater level of exploration activity than Alternative 3, including doubling the amount of exploratory drilling, and the resulting risk of small accidental spills and discharges occurring would be proportionally greater. The potential effects on the quality of walrus habitat would also increase. Please refer to Section 4.5.2.4.13 for further discussion of potential effects on walrus habitat.

4.7.2.4.5.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to Pacific walrus are discussed under Alternative 2 (Section 4.5.2.4.13).

4.7.2.4.5.3 Conclusion

Walrus have been regularly encountered during vessel-based exploration activities in the past, primarily in late summer as the pack ice recedes, as recorded by PSOs onboard seismic source vessels and monitoring vessels. These data indicate that walrus do not react strongly to vessels and active seismic arrays, and their behavioral responses are often neutral rather than swimming away. They tend to dive into the water as icebreaking ships approach from some distance and are therefore not exposed to the loudest of sounds generated by the ships. Mitigation measures required for walrus by USFWS LOAs since the early 1990s have reduced the risk of close encounters with seismic and other exploration vessels and have reduced the risk of accidental spills that may affect walrus or their prey. None of the data collected to date on walrus reactions to exploration activities indicate that they would be displaced from key areas or resources for more than a few minutes or hours. Careful avoidance of vessel and aircraft traffic around walrus haulouts on land would be important to minimize the risk of calf and juvenile mortality from stampedes.

Walrus are legally protected, fulfill an important ecological role in the Arctic, and are important subsistence resources and are therefore considered to be a unique resource for purposes of this analysis. Given the level and type of exploration activities that would be authorized under Alternative 4, and considering the mitigation measures that would be required by USFWS LOAs, the effects on walrus would likely be low in magnitude, distributed over a wide geographic area, and interim in duration. The effects of Alternative 4 would therefore be considered minor for Pacific walrus according to the criteria established in Section 4.1.3.

4.7.2.4.5.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to Pacific walrus are discussed under Alternative 2 (Section 4.5.2.4.13).

4.7.2.4.6 Polar Bears

4.7.2.4.6.1 Direct and Indirect Effects

This section discusses the potential direct and indirect effects of Alternative 4 on polar bears. This species is dependent on pack ice for much of their denning habitat and for hunting seals. Alternative 4 includes all of the same type of exploration activities as in Alternatives 2 and 3, so the discussion of potential direct and indirect effects on polar bears under Alternative 4 involves all the same mechanisms and types of effects as discussed for Alternatives 2 and 3 in Section 4.5.2.4.14. The difference between alternatives concerning polar bears is a matter of degree. Alternative 4 includes a larger number of some authorized exploration activities than Alternative 3. Specifically, Alternative 3 assumes a maximum of two exploration drilling programs active in each sea at any given time while Alternative 4 assumes a maximum of four exploration drilling programs active in each sea at any given time. These activities take place in the same areas and timeframes and also consider the same standard and additional mitigation measures as Alternatives 2 and 3. The following discussion focuses on the differences between alternatives rather than repeating the same information presented in Section 4.5.2.4.14.

Behavioral Disturbance

Each of the different types of exploration activities that would be authorized under Alternative 4 include several mechanisms for potential disturbance to polar bears along leads in the ice and in broken ice, primarily involving the noise generated by and the physical presence of vessels and associated exploration equipment including the potential for direct bear-human encounters. The two types of surveys which take place on or in sea ice, the hunting and denning habitats for polar bears, are the in-ice 2D surveys with icebreakers and the on-ice vibroseis surveys. For both of these types of surveys, the same number of surveys would be authorized under Alternative 4 as for Alternatives 2 and 3. The level of disturbance from these types of surveys would therefore be the same for Alternative 4 as is discussed for Alternatives 2 and 3, which were considered to have temporary and low magnitude effects on polar bears.

There would be a moderate increase in the amount of open-water activities under Alternative 4 compared to Alternative 3. These activities could affect polar bears over a larger area, but the disturbance effects would be temporary and low in magnitude, characterized by neutral or ambiguous behavioral reactions of polar bears. Some polar bears could be exposed to more than one exploration drilling operation over time as they travel through an area, but most encounters with exploration drilling operations and vessels typically occur while polar bears are on ice or land. The addition of one or more exploration drilling projects to either the Beaufort or Chukchi seas would increase the likelihood that two or more different projects could be in the same general area at the same time. Few polar bears are likely to be moving through offshore drilling areas during the open water season. Polar bears routinely move through the Prudhoe Bay oil field areas and do not appear to be excluded from available habitat by drilling operations taking place nearby.

Alternative 4 could authorize up to four exploratory drilling programs in both Arctic seas. The level of disturbance to polar bears is likely more intense from the multiple support ships associated with a drilling rig than any types of exploratory surveys, but the geographic area involved is much smaller. The noise generated from drilling is produced on an almost continual basis, making it essentially a chronic sound source in one location, and polar bears could become habituated to it. Given the mild reaction of polar bears to marine vessels or drilling rigs it is unlikely that having four drilling programs operating in the same general area at the same time will result in any additive disturbance effects on particular bears, although more bears could be temporarily affected than would occur with only one or two drilling programs. Any disturbance and displacement of polar bears would cover a very small area and be considered short-term.

Hearing Impairment, Injury, and Mortality

As discussed under Alternative 2, there is very little risk of any polar bears being injured or killed as a result of noise levels or ship strikes from oil and gas exploration activities because of the infrequency of polar bears being observed in the open-water areas where most exploration is conducted and their ability to detect and avoid vessels as they approach in the water or on/through the ice. It is also very unlikely that any polar bears would be exposed to very loud sounds from seismic operations to the point where they might be injured. Exposure to accidental spills of fuel, oils, and other compounds from exploration vessels and equipment could kill a polar bear (USFWS 2008b), but given the small volume of typical spills and clean-up requirements that would include PSOs to deter polar bears if necessary, the risk of polar bears being exposed to oil spills is considered minor. Polar bears are curious, so there is always the potential for bear-human interactions during oil and gas exploration in the Arctic, even if the activities are temporary, but continuation of diligent polar bear monitoring and safety management will decrease the risk of injury or death for humans and bears. The potential effects of a very large oil spill are much more serious and are discussed in Sections 4.10.6.11 and 4.10.7.11.

Habitat Alteration

One of the two types of activities that involve potential changes to polar bear habitat, icebreaking and ice management, could increase under Alternative 4 as compared to Alternatives 2 and 3. Ice management activities are sometimes necessary to move ice floes away from drilling rigs in offshore waters. These activities would have only temporary effects on the physical characteristics of the ice and are not likely to displace polar bear prey species (ice seals) for more than a few hours. Seal distribution and abundance would continue to be determined by ice conditions and other natural factors rather than the presence of exploration activities. Polar bear habitat quality would therefore not be affected by exploration activities. The increase from two exploratory drilling programs in each sea under Alternative 3 to four drilling programs in each sea under Alternative 4 would increase the footprint of the drilling operations and associated fleets of vessels and could increase the amount of ice management necessary. The effects of ice management would be short term and isolated to a small footprint and are not anticipated to impact the availability of sea ice for polar bears as habitat.

4.7.2.4.6.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to polar bears are discussed under Alternative 2 (Section 4.5.2.4.14).

4.7.2.4.6.3 Conclusion

Polar bears have been infrequently encountered during vessel-based exploration activities in the past, as recorded by PSOs on board source vessels and monitoring vessels. These sparse data indicate that polar bears do not react strongly to vessels and active seismic arrays or to exploration drilling operations, and their behavioral responses are often neutral rather than running or swimming away. They also do not appear to react strongly to icebreaking or on-ice surveys. Some bears keep their distance or move away at some point, but others may approach vehicles and equipment out of curiosity. The types of effects of most concern for polar bears during exploration activities involve the risk of bear-human encounters. Mitigation measures and polar bear safety/interaction plans required by USFWS LOAs since the early 1990s have reduced the risk of these encounters for both people and bears. None of the data collected to date on polar bear reactions to exploration activities indicate that polar bears would be displaced from key areas or resources for more than a few minutes or hours and they are unlikely to experience any measurable effects on their reproductive success or survival as a result. Polar bears are legally protected, have a unique ecological role in the Arctic, and are important subsistence resources and are therefore considered a unique resource. Given the mitigation measures that would be required by USFWS LOAs, the effects of exploration activities that could be authorized under Alternative 4 on polar bears would likely be low in magnitude, distributed over a wide geographic area, and interim in duration. The effects of Alternative 4 would therefore be considered minor for polar bears according to the criteria established in Section 4.1.3.

4.7.2.4.6.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to polar bears are discussed under Alternative 2 (Section 4.5.2.4.14).

4.7.2.5 Terrestrial Mammals

Activity levels in Alternative 4 are the same as in Alternative 3, except for the allowance of four exploratory drilling operations in the Beaufort and Chukchi seas in each season. By doubling the number of potential drilling operations, support activity such as air travel could be expected to increase. However, the effects of the additional drilling and corresponding support activities proposed under Alternative 4 would add very little to the direct and indirect effects of Alternative 4 on terrestrial mammals and their habitat in the EIS project area. Consequently, the impacts discussed in Section 4.5.2.5 and Section 4.6.2.5 for Alternatives 2 and 3, respectively, are slightly less than those for Alternative 4; however, overall level of effects on terrestrial mammals from the implementation of Alternative 4 would remain minor.

4.7.2.6 Time/Area Closure Locations

The analysis of the direct and indirect effects associated with time/area closures can be found in Sections 4.5.2.4 and 4.6.2.4 (Marine Mammals), 4.5.2.3 and 4.6.2.3 (Marine and Coastal Birds), and 4.5.3.2 and 4.6.3.2 (Subsistence).

4.7.2.7 Standard and Additional Mitigation Measures

Standard and additional mitigation measures that could reduce impacts to the biological environment, other than marine mammals and marine and coastal birds, are discussed under Alternative 2 (Section 4.5.2.7).

4.7.3 Social Environment

4.7.3.1 Socioeconomics

The following discussion of direct and indirect effects of Alternative 4 evaluates effects on employment and personal income, public revenues and expenditures, demographic characteristics, and demand on social organizations and institutions associated with an increased “Level 3” of oil and gas exploration activity.

4.7.3.1.1 Direct and Indirect Effects

Alternative 4 (Level 3 activity) would generate the same categories of activity as Alternative 3 (Section 4.6.3.1), with marginal increases in direct and indirect effects in each category. Alternative 4 would generate increases in the level of activity in communities hosting vessel crew changes and purchasing/staging of support materials and increases in direct revenues from property taxes derived from potential new onshore infrastructure.

The indirect employment opportunities associated with Alternative 4 may increase marginally under Level 3 activity because shore-based support and logistical service demands would increase, including: transport of equipment; room and board of survey/seismic crews; and administration of permits to conduct the surveys. Native Corporations and private entities may capitalize on these opportunities. As described under Alternative 2, these services are seasonal and temporary in nature.

4.7.3.1.2 Conclusion

The magnitude of the socioeconomic impact under Alternative 4 is positive and greater than a Level 2 activity. The socioeconomic impact under Alternative 4 is similar to Alternative 3, with Level 3 activities generating increased socioeconomic benefits from additional employment, income, and revenues. The increased socioeconomic benefits associated with Level 3 activity under Alternative 4 could be somewhat offset by potential time/area closures that could reduce total local employment rates and personal income, leading to a lower intensity of beneficial socioeconomic impact to communities, and a low to medium intensity economic impact to lease holders that incur costs or lose productivity. The duration of the socioeconomic impacts is temporary because it is not year-round; however, the activity is scheduled to occur over a fixed number of years. The positive economic impacts of the activity are statewide and even national. The context of the socioeconomic impacts is unique because the people that would experience the flow of workers and research vessels are predominantly Iñupiat communities. The summary impact level for Socioeconomics under Alternative 4 is minor.

The magnitude of the socioeconomic impact under Alternative 4 is positive and greater than a Level 1 activity. However, the magnitude of increase of total personal income and local employment rates are still not increased by more than five percent. The duration of the socioeconomic impacts is temporary because it is not year-round; however, the activity is scheduled to occur over a fixed number of years.

4.7.3.2 Subsistence

4.7.3.2.1 Direct and Indirect Effects

The potential effects to subsistence resources and harvest from disturbance of the seismic survey (both open-water and on-ice) and exploratory drilling, aircraft and vessel traffic, icebreaking and ice management, and permitted discharges under Alternative 4 would be the same as those described under Alternative 2 (Section 4.5.3.2). Table 4.5-26 describes the different subsistence hunts that occur within the EIS project area by resource, where these subsistence hunts occur, the seasons of occurrence, and the potential for overlapping with proposed activities of Alternatives 2 through 6. Detailed information regarding the seasonal cycles of subsistence resources and harvest patterns is described in Section 3.3.2.

Even with the increase in the number of activities/programs that could potentially occur under Alternative 4, the impacts to subsistence resources and harvest are anticipated to be similar in type, generally of similar intensity and comparable duration, but occurring in more locations.

Assumptions regarding the level of activity used in the analysis of impacts to subsistence for Alternative 4 are described in Table 4.5-26. Under Alternative 4, only these activities would be permitted. In the Beaufort and Chukchi seas, it is assumed that the activity/programs described in Table 2.4 would involve the sound sources and sound levels associated with individual sources, the same types of source and support vessels, and the same types of icebreakers for ice management and/or icebreaking. However, there would be more vessels conducting the activities in more sites with more support vessels and more aircraft traffic from the addition of more programs being potentially permitted. The number of days the activities could occur in a season would be the same as those in Alternative 3. Under Alternative 4, the activity area(s) and or number of wells to be drilled could be increased with up to four exploratory drilling programs potentially permitted in both the Beaufort and Chukchi seas.

4.7.3.2.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to subsistence resources are discussed under Alternative 2 (Section 4.5.3.2).

4.7.3.2.3 Conclusion

Impacts of Seismic, High Resolution Shallow Hazard Surveys and Exploratory Drilling Noise Disturbance to Subsistence Resources

Bowhead Whales

Section 4.5.2.4.9 (Bowhead Whales) describes the mechanisms by which activities associated with oil and gas exploration in the Beaufort and Chukchi seas could directly or indirectly affect bowhead whales. Any impacts of seismic and high resolution shallow hazard surveys and exploratory drilling noise that affect bowhead whales are expected to result in some temporary deviation in migratory path in the vicinity of the disturbance. However when the standard and additional mitigation measures contemplated in this EIS are applied, the impact of disturbance to subsistence resources and hunters could be of low intensity and temporary duration (i.e. for the duration of the activities). The geographic extent could be local to regional, affecting a resource of unique context, due to listing under the ESA. Impacts would not be expected at the population level, reducing long term opportunities to subsistence harvest bowhead whales. The summary impact to subsistence harvest from disturbance of bowhead whales could be considered moderate.

Beluga Whales

Sections 4.5.2.4.10 (Beluga Whales) describes the mechanisms by which activities associated with oil and gas exploration in the Beaufort and Chukchi seas could directly or indirectly affect beluga whales. In the Chukchi Sea, beluga whales could be displaced, i.e. would avoid areas in the vicinity of seismic survey and exploratory drilling operations in July through October during their spring and fall migrations. While belugas are harvested during late June through mid-July at Point Lay, the activities of seismic survey and exploration drilling activities would be expected to occur offshore from subsistence use areas. As described previously, Traditional Knowledge asserts that beluga whales have a keen sense of hearing; thus, activities would have the potential to impact and disrupt some communal beluga subsistence hunts (particularly Point Lay, which heavily depends on this resource) by disturbing and altering the course of these migrating whales. In turn this could make belugas more difficult to herd into the lagoons and harvest (as in the case of Point Lay).

However, the impacts would be minimized or avoided by the required mitigation measures of this EIS. As mitigated, the effects of disturbance would be considered to be of low intensity and temporary duration, occurring for the duration of the activities offshore. These impacts are considered regional in geographic extent. There would not be expected impacts on a population level that would result in long term impacts reducing the subsistence harvest. The summary impact to subsistence harvest from disturbance of beluga whales could be moderate.

Seals

Section 4.5.2.4.12 (Ice Seals) describes the mechanisms by which activities associated with oil and gas exploration in the Beaufort and Chukchi seas could directly or indirectly affect these seals. Subsistence hunts of seals occur either in nearshore coastal areas or onshore in the spring and winter seasons when seismic and high resolution shallow hazards surveys and exploratory drilling operations would not be present. Most ringed seals, an ESA-threatened species, are harvested in the winter or in the spring before these assumed activities would occur. While bearded and spotted seals are harvested during the summer, the activities of seismic survey and exploration drilling activities would be expected to occur offshore from subsistence use areas. Activities within the lease areas offshore that are likely to be explored during the open water season would have no impact on subsistence hunting for seals. One on-ice seismic survey could have the potential to disturb or displace ringed seals in their lairs but would be mitigated to lessen the impact to seals. Any impacts to seal subsistence harvests from the on-ice seismic survey would be low intensity, limited to a local area, temporary in duration, and unique in context. The geographic extent could be local to regional, affecting a resource of unique context due to the threatened status under the

ESA for two of the species and their importance to subsistence communities. Therefore the summary impact to subsistence ice seal harvests is moderate.

Walrus, Polar Bears, Subsistence Fishing, Bird Harvest and Egg Gathering and Harvest of Caribou

Impact to these subsistence resources and their harvests are expected to be the same as described under Alternative 3 with the exception of polar bear.

The potential impact of the noise produced by the proposed seismic and high resolution shallow hazards surveys and exploratory drilling on subsistence resources and harvest activities under Alternative 4 could be major in the absence of mitigation measures. However mitigation measures would be required to be implemented to minimize or completely avoid adverse effects on all marine mammals and other subsistence resources and to ensure no unmitigable adverse impact on the availability of marine mammals for subsistence uses. In consideration of the standard mitigation measures, these activities are not expected to disturb or disrupt subsistence activities at a level that would make resources unavailable for harvest or significantly alter the existing levels of harvests. The summary impact of Alternative 4 is considered moderate to subsistence harvests of bowhead, ice seals, walrus, and polar bear; due to the candidate or ESA status of these species, they are in the unique context, which means that any effect would likely be a moderate effect. The summary impact to beluga whales is also assessed at the moderate level due to TK observations that they possess keen senses of hearing and are easily disturbed. Summary impacts to subsistence fishing, bird harvest and egg gathering, and harvest of caribou are the same as those described in Alternative 3.

Impacts of Disturbance from Aircraft Overflights to Subsistence Resources

Bowhead Whales

Information on the impacts of aircraft sounds associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Sections 4.5.2.4.9 and 4.6.2.4.1 (Bowhead Whales) of this EIS. The sound emitted by aircraft overflights potentially could cause some disruption to bowhead whale harvest, but aircraft overflights as mitigated are not expected to make bowhead whales unavailable to subsistence hunters. Whales could be expected to temporarily deflect from overflights, but mitigation measures analyzed in and contemplated by this EIS would limit the probability of this impact occurring. It is expected that helicopters servicing offshore seismic and high resolution shallow hazard surveys and exploratory drilling operations could traverse areas utilized by subsistence whalers during fall whaling in the Beaufort Sea and limited areas of the Chukchi Sea. Mitigation measures prescribing flight path and altitude restrictions are expected to reduce any such potential impacts to a low level.

If bowhead whales were affected by aircraft overflights, it is unlikely that large numbers or a large area used by active whaling crews would be affected, so the intensity of the impact would be considered low, and the duration would be temporary. Effects of increased levels of activity permitted under Alternative 4 are low in intensity, temporary in duration, local to regional in extent, and affecting a resource that is unique in context, due to listing under the ESA. The summary impact is considered moderate.

Beluga Whales

Information on the impacts of aircraft sounds associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Sections 4.5.2.4.10 and 4.6.2.4.4 (Beluga Whales) of this EIS. Summer beluga hunting could be impacted by increased numbers of trips/aircraft overflights given the levels of activity associated with Alternative 4. Mitigation measures applied to this impact would lessen the disturbance to a point that it would be considered low in intensity, temporary in duration, local or regional in extent, and affecting a resource that is important in context.

The required mitigation measures are expected to minimize and/or avoid impacts to beluga whales and their subsistence harvest as the mitigation measures for flight path and altitude restrictions are expected to reduce impacts to the point that the summary rating is considered moderate.

Caribou Hunting

The higher levels of activity permitted under Alternative 4 would result in increased helicopter traffic between the expected support shorebases (Barrow, Deadhorse and potentially Wainwright) and the offshore drilling locations. It is likely that there would be a disturbance to caribou subsistence hunting from the helicopter traffic that may disturb caribou on the coast. Helicopters would be traversing routes offshore from the shorebases and small proportions of available subsistence hunting areas would be affected at altitudes of less than 305 m (1,000 ft) – most likely during takeoff and landings.

Aircraft overflights are unlikely to have an adverse effect on caribou availability for subsistence harvest. Impacts that did occur would be considered low in intensity and temporary in duration. The impact would be local to regional in extent and affecting a resource that is common to important in context. The summary impact is considered moderate.

Seals, Walrus, Polar Bears, Subsistence Fishing, Bird Hunting and Egg Gathering

Impact to these subsistence resources and their harvests are expected to be the same as under Alternative 2.

The higher levels of activity permitted under Alternative 4 would increase aircraft traffic associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities, which could cause some temporary behavioral disturbance and possibly deflection away from the sound source by terrestrial or marine mammals. The level of the disturbance would depend on the size of the aircraft and repeated exposure or displacement occurring to the resources, as well as whether or not the overflights overlap in time and space with subsistence hunting grounds.

Aircraft overflights are unlikely to have an adverse effect on subsistence harvest as mitigated. Impacts that did occur would be considered of low intensity but temporary in duration. The impact would be local to regional in extent, affecting resources that range from common to unique in context. The impacts are considered moderate for bowhead whales, beluga whales, and caribou. Impacts to seals, walrus, polar bears, subsistence fishing, bird harvest and egg gathering are the same as those described in Alternative 2.

Impact of Vessel Traffic to Subsistence Resources

Bowhead Whales

Information on the impacts of vessel sounds associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Sections 4.5.2.4.9 and 4.6.2.4.1 (Bowhead Whales) of this EIS. The higher levels of activity permitted under Alternative 4 would increase vessel traffic and vessels present in the area associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities, which could cause bowhead whales to alter their behavior during migration and avoid the area(s) within a few kilometers of vessel activities. However the required mitigation measures would limit impacts to late migrating bowhead whales and subsistence hunting from vessel traffic. The levels of activity permitted under Alternative 4 increase the potential for disturbance on a more regional level. Impacts to bowhead whale subsistence hunting are likely to be of low intensity, temporary duration, though could be local to regional extent, and affecting a resource that is unique in terms of the context (due to the listing under the ESA). The summary impact could be considered moderate in terms of the levels of subsistence hunting and sharing of the resource that would be affected.

Beluga Whales

Information on the impacts of vessel sounds associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Sections 4.5.2.4.10 and 4.6.2.4.4 (Beluga Whales) of this EIS. A limited number of late migrating spring beluga whales could encounter increased numbers of vessels and higher levels of activity permitted under Alternative 4 for seismic and high resolution shallow hazard surveys and exploratory drilling activities and operations. The impact of disruption to beluga whales from vessel traffic could result in temporary deflection of beluga whales from subsistence harvest areas and reduced success of these hunts. However, if additional mitigation measure D1 is applied there can be no transit of exploration vessels into the Chukchi Sea prior to July 15 or until the beluga hunt is completed at Point Lay. However, the increased levels of activity permitted under Alternative 4 include the potential for disturbance on a regional level (impacts extending throughout the EIS project area) as defined in Section 4.1.3. The impact to beluga whales that do encounter vessels would be of low intensity, temporary duration, local to regional extent, and affect a resource that is important in terms of the context. The summary impact could be considered moderate in terms of the levels of subsistence hunting and sharing of the resource that would be affected.

Walrus, Polar Bears, Seals

Section 4.5.2.4.12 (Ice Seals) describes the mechanisms by which activities associated with oil and gas exploration in the Beaufort and Chukchi seas could directly or indirectly affect seals. Seals could be displaced or avoid areas where vessels are transiting as part of seismic and high resolution shallow hazard surveys and exploratory drilling activities. However, under the required mitigation measures for vessels transiting into the Beaufort and Chukchi seas for these activities, impacts to seals would not be such as to adversely impact subsistence hunting activities. Subsistence seal hunts would occur in nearshore coastal areas away from areas likely to be transited by vessels. The majority of seal subsistence hunting occurs in the spring and winter seasons when vessels associated with seismic survey and exploratory drilling would not be expected to be present in subsistence harvest areas. However, with the increased levels of activity permitted under Alternative 4 there would greater potential for disturbance on a regional level (impacts extending throughout the EIS project area as defined in Section 4.1.3). With spatial and seasonal separations, the impact to subsistence seal harvest would be of low intensity, temporary duration, local to regional extent, and affecting resources that are important in terms of the context. The summary impact could be considered minor in terms of the levels of subsistence hunting and sharing of the resource that would be affected.

Subsistence Fishing, Bird Harvest and Egg Gathering and Harvest of Caribou

Impact to these subsistence resources and their harvests are expected to be the same as under Alternative 2.

Under the increased level of activity with Alternative 4, the summary impacts of vessel traffic on subsistence harvest of bowhead whales and beluga whales are expected to be moderate. The summary impact from vessel traffic to subsistence harvest of seals, walrus, and polar bear is considered minor. Negligible summary impacts to subsistence harvest of fish, bird hunting and egg gathering, and caribou are expected as a result of vessel traffic and the same as Alternative 2.

Impacts of Icebreaking and Ice Management on Subsistence Resources

Bowhead Whales

Information on the impacts of icebreaking and ice management associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Section 4.5.2.4.9 (Bowhead Whales) of this EIS. Seismic and high resolution shallow hazard surveys and exploratory drilling activities would be expected to occur during the open water season when seismic and high resolution shallow hazard surveys and exploratory drilling vessels would not encounter large amounts of sea ice. However icebreaking and ice management may be necessary during late fall or early winter when industry is still engaged in seismic and high resolution shallow hazard surveys and exploratory drilling activities in order to protect equipment, vessels, and infrastructure. Additionally, some operators have recently proposed to conduct seismic surveys during the in-ice or shoulder season (i.e. October through December). These surveys would require the use of an icebreaker to go ahead of the seismic survey vessel. The required mitigation measures limit the time frame in which these activities occur, and, as a result, the likelihood of impacts to subsistence harvest as a result of ice management activities is reduced and unlikely to adversely affect subsistence harvest of bowhead whales. The majority of these types of in-ice surveys would occur after the completion of fall bowhead harvests in the Beaufort and Chukchi seas. With the increased levels of activity permitted under Alternative 4 the potential for disturbance on a more regional level becomes greater (impacts extending throughout the EIS project area as defined in Section 4.1.3). In the event that icebreaking does cause bowhead whales to avoid an area the impact to subsistence resources is expected to be low in intensity, short term in duration, local to regional in extent, and affecting a resource that is unique in context. This would be considered a moderate impact to subsistence harvest of bowhead whales.

Beluga Whales

Information on the impacts of icebreaking and ice management associated with seismic and high resolution shallow hazard surveys and exploratory drilling activities is included in Section 4.5.2.4.10 (Beluga Whales) of this EIS. Icebreaking activities could increase under Alternative 4 with the greater level of permitted activity allowed exploratory drilling activities. Ice management activities could be necessary as part of seismic and high resolution shallow hazard surveys and exploratory drilling activities when ice is encountered in the late fall through early winter months of exploration activities. Icebreaking and ice management would be limited to areas where industry is actively exploring or drilling. These activities would occur in the offshore waters and would not be expected to affect beluga whale subsistence hunting, particularly since, as migratory species, they are not found in these waters during the late fall and winter. Icebreaking and ice management activities would be conducted far removed from areas typically hunted in the Chukchi Sea. No impacts are anticipated for beluga subsistence hunts in the Beaufort Sea, as beluga hunting is conducted opportunistically during the fall bowhead hunt, and the required mitigation measures of this project would prohibit seismic survey and exploratory drilling activities (and associated ice management) from occurring during this time.

The required mitigation measures are expected to minimize and potentially avoid impacts on beluga whales so that no adverse impacts occur to subsistence harvest. There is a low probability that impacts could occur to subsistence users in the Chukchi Sea. With the increased levels of activity permitted under Alternative 4 there is greater potential for disturbance on a regional level (i.e. across the EIS project area). In the event that icebreaking or ice management does cause beluga whales to avoid an area the impact to subsistence resources is expected to be low in intensity, short term in duration, local to regional in extent, and affecting a resource that is important in context. This would be considered a moderate summary impact to the subsistence harvest of beluga whales.

Seals

Section 4.5.2.4.12 (Ice Seals) describes the mechanisms by which icebreaking and ice management activities associated with oil and gas exploration in the Beaufort and Chukchi seas could directly or indirectly affect seals. Icebreaking could be associated with seismic survey plans that extend into the late open water season late fall to early winter (October to December) when daylight is very limited to absent and visibility is reduced, making seals more difficult to spot. At this time of year sealing efforts for subsistence are not concentrated or intense. Ice management activities could be necessary as part of seismic and high resolution shallow hazard surveys and exploratory drilling and would occur in the offshore waters during the open water season after sea ice has retreated and melted. Although a greater level of activity would occur under Alternative 4, these proposed activities would occur after the end of pupping and molting seasons for all ice seals. There would be few seals expected in the area where the proposed activities would take place. Subsistence harvest of seals would not be expected to occur in areas of active ice management offshore. The required mitigation measures are expected to avoid and minimize impacts on seals such that no adverse impacts to subsistence harvests of seals would occur. In the event that icebreaking does cause seals to avoid an area, the impact is expected to be low in intensity, short term in duration, local to regional in extent, and affecting resources that are common to important in context. This would be considered a moderate summary impact to subsistence harvest of seals because of their unique context attributable to the threatened status for two of the species.

Walrus, Polar Bears, Subsistence Fishing, Bird Harvest and Egg Gathering and Harvest of Caribou

Impact to these polar bears and walrus is expected to be moderate based on their listing as threatened or candidate species under the ESA, thus elevating the context to unique and effects to moderate. Subsistence resources of other species and their harvests are expected to be same as under Alternative 4. Summary impacts to subsistence harvest of bowhead whales, ringed seals, and beluga whales due to icebreaking and ice-management activities are expected to be moderate. Summary impacts to subsistence harvest of walrus and polar bears are considered to be moderate. Summary impacts to other seals species, fish, and bird hunting and egg gathering from icebreaking are expected to be negligible and the same as under Alternative 3. No impacts to caribou are expected.

Impacts of noise and vehicle movement from on-ice seismic surveys

No impacts are anticipated to subsistence harvests of bowhead whales, beluga whales, Pacific walrus, and fishing as a result of the on ice seismic survey. Summary impacts to seals, marine and coastal birds, and caribou are expected to be the same as under Alternative 3 and are considered negligible. The summary impacts to polar bears could be minor.

Indirect Impact to Subsistence Resources from Permitted Discharges

Permitted discharges would be conducted under the conditions and limitations of the required NPDES General Permits. Permitted discharge would be mitigated by additional mitigation measures C3 and C4, which would place requirements and limitations on the levels of discharge and discharge streams that could affect marine mammal habitat and eventually the diets of subsistence users. Under Alternative 4, there could be a higher level of activity, which would increase the levels of permitted discharges.

Mitigation measures may not alleviate the perception that a small oil spill or regulated wastewater discharge might contaminate subsistence resources. There is a perception the foods could become contaminated by discharges and/or small fuels spills could result in impacts to human health from consumption of the resources. The likelihood is low that subsistence resources or harvest would occur in the vicinity of the assumed areas where drilling and/or any associated discharge or spill might occur. In addition fuel transfers are not expected during transit between the Beaufort and Chukchi seas. The indirect impact of drill cuttings and mud discharges may displace marine mammals and fish a short distance from each drilling location. The impacts to subsistence users would be of low intensity, short term in duration, local in extent, and affecting resources that are common to unique in context. Therefore the summary impacts to subsistence resources, activities, and subsistence users would be minor, though the perception of the impact could be moderate.

Summary

Using the impact criteria identified in Table 4.5-25, the direct and indirect effect of oil and gas exploration activities on subsistence resources resulting from implementation of Alternative 4 would be of low to medium intensity, temporary to interim in duration, local to regional in extent, and the context would be common to unique. Therefore the summary impact level of Alternative 4 on subsistence resources and harvests would be considered to range from negligible to moderate depending upon the specific subsistence resource affected and source of disturbance.

4.7.3.2.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to subsistence resources are discussed under Alternative 2 (Section 4.5.3.2).

4.7.3.3 Public Health

4.7.3.3.1 Direct and Indirect Effects

Anticipated effects to public health as a result of Alternative 4 are expected to be similar to those expected under Alternative 2, as discussed in Section 4.5.3.3.

4.7.3.3.2 Conclusion

Both potential beneficial and adverse impacts are anticipated as a result of Alternative 4. Possible changes could occur to health outcomes such as chronic disease and trauma and many of the pathways relate to traditional practices and subsistence activities. However, there is a very low likelihood of these health outcomes arising, and effects are unlikely to be large enough cause a measurable change in health outcomes. The magnitude or intensity of effects is estimated to be low: above background conditions, but small and within both the natural variation and adaptive ability of the local population. If health changes do occur, the duration of changes may be permanent, and multiple communities could be affected.

4.7.3.4 Cultural Resources

4.7.3.4.1 Direct and Indirect Effects

Alternative 4 is the same as Alternative 3 except with increased levels of exploratory drilling activity. These mitigation measures do not affect cultural resources in the EIS project area, so the impacts discussed in Section 4.5.3.4 for Alternative 2 are the same for Alternative 4. The overall impact to cultural resources is difficult to assess in an offshore context, but disturbance would be limited to setting arrays of cables on the seabed, jackup rigs positioning for drilling, drill ships anchoring preparatory to drilling, and drilling associated with exploratory and G&G coring. If any of these activities were to impact a previously unidentified cultural resource, the impacts would be adverse, and all such actions would require consultation with the Alaska State Historic Preservation Officer in compliance with 36 CFR 800.

4.7.3.4.2 Conclusion

The overall impact to cultural resources is difficult to assess in an offshore context, but disturbance would be limited to setting arrays of cables on the seabed, jackup rigs positioning for drilling, drill ships anchoring preparatory to drilling, and drilling associated with exploratory and G&G coring.

4.7.3.5 Land and Water Ownership, Use, and Management

4.7.3.5.1 Direct and Indirect Effects

Land and Water Ownership

The direct and indirect impacts to land and water ownership caused by Alternative 4 are similar to those caused by Alternative 2. Refer to Section 4.5.3.5 for a discussion on these topics. This includes federal, state, private, borough, and municipal owned lands and waters.

Land and Water Use

The actions in Alternative 4 are the same as for Alternative 2. However the activity levels are increased; numbers of allowed seismic surveys, shallow hazards survey programs, and exploratory programs are increased in the Beaufort and Chukchi seas. However, the amount of on-ice seismic surveys and icebreaking remained the same. Taking into consideration these increases, direct and indirect effects to the recreation, residential, mining, and protected land uses are similar to Alternative 2. Refer to Section 4.5.3.5 for a discussion on these topics.

With an increase in activity levels, the possibility for conflict increases between subsistence use and surveys. Section 4.7.3.2 discusses the direct and indirect impacts of Alternative 4 in detail.

The direct and indirect impacts caused by Alternative 4 for industrial, transportation, and commercial land uses are similar to those discussed under Alternative 2 in Section 4.5.3.5 but use would increase incrementally as survey activity levels go up. Beyond what is discussed in Section 4.5.3.5, there is a slightly higher possibility of new facilities and infrastructure, higher levels of air and vessel traffic, and commercial activity associated with survey support. No new roads or railroad lines are expected to be built under this alternative; therefore no changes are expected in land use to accommodate expanded land transportation systems. See Section 4.7.3.1 Socioeconomics for further discussion on economic opportunities under this alternative

Land and Water Management

BOEM has awarded leases in the Beaufort and Chukchi seas for the purpose of exploring for and developing petroleum resources in the federal OCS. The level of exploration activity in federal water under Alternative 4 is consistent with management of those waters. Similarly, the state applies Best Interest Findings before allowing seismic exploration activities and each must demonstrate individual consistency with state management policies before permits are issued on state lands or waters. Therefore, no inconsistencies or changes in federal or state land or water management are anticipated as a result of this alternative. The effects are similar to those discussed under Alternative 2, Section 4.5.3.5.

While no change in underlying land or water management is anticipated as a result of this project, compliance with NSB and NAB comprehensive plans and Land Management Regulations coastal management policies is undertaken on a voluntary basis for activities in state and federal waters; permit applicants for offshore exploration activities in state waters may attempt to be consistent with Borough Land Management Regulations. As activities increase under Alternative 3, the possibility for conflicts with borough offshore development and coastal management zoning policies goes up as well. As indicated in Section 3.3.6 Coastal Management, the Alaska Coastal Management Program was not reauthorized by the State legislature and is no longer in effect.

4.7.3.5.2 Conclusion

Based on Table 4.4-2, and the analyses provided in Section 4.5.3.5, the impacts on land and water ownership under Alternative 4 are described as follows. The magnitude of ownership impacts would be low because no changes in land or water ownership will result from this action. The duration of impact would be temporary because no ownership changes will occur. The extent of impacts would be local, occurring only in the activity area and involving no ownership change. The context of impact would be common because the federal waters affected have no special, rare, or unique ownership characteristics. In total, the direct and indirect impacts on land ownership/development rights are considered to be negligible; they would be low intensity, temporary, localized, and do not result in changes of ownership.

Based on Table 4.4-2 and the analyses provided above and in Section 4.5.3.5, the impacts of land and water use caused by Alternative 4 are described as follows. The magnitude of impact would be high where activity occurs where there is previously little to no activity (such as Wainwright), and the magnitude of impact would be low where activity occurs where previous activity is common (Prudhoe Bay, Barrow, Nome, Dutch Harbor). The duration of impact would be temporary because an increase in aircraft and shipping traffic would last only for that survey season, although the impact could be permanent if construction of a new facility or infrastructure to accommodate shipping traffic were built in Wainwright. The extent of impacts would be local because any changes in land use as a result of this alternative would be limited geographically to the communities that would support the survey vessels. The context of impact would be common because the areas of land and water use affected are extensively available and have no special, rare, or unique characteristics identified. In summary, the direct and indirect effects of Alternative 3 would be moderate because of the possibility for high intensity impact and long term structures in smaller communities

Based on Table 4.4-2 and the analyses provided above and in Section 4.5.3.5, the impacts on land and water management caused by Alternative 4 are described as follows. The magnitude of impact would be low because, while the level of activity would increase, they are consistent with existing management plans, subject to conditions of approval. The duration of impact would be temporary because project activities are short term in duration and would not result in long-term conflicts with management plans. The extent of impacts would be local because proposed activities would not involve management plans beyond the localized areas of exploration and support activities. The context of impact would be common because the areas of land and water affected are extensively available and have no special, rare or unique characteristics identified in an adopted management plan. In total, the direct and indirect impacts of Alternative 3 on land and water management would be minor because they would be low intensity, would be temporary in nature, local, and common.

4.7.3.6 Transportation

4.7.3.6.1 Direct and Indirect Effects

The effects to transportation in Alternative 4 would be similar to those described under Alternative 2 (Section 4.5.3.6), though of an elevated intensity. The direct effect to transportation would be an increase in levels of air traffic and vessels present in these areas associated with the seismic survey and exploratory drilling activities in comparison to levels projected under Alternative 2. The intensity of the impact would be considered low and short term in duration (length of survey or exploratory drilling activities each year). The extent of increased aircraft presence may be on a local and regional scale given the increased number of seismic survey and exploratory drilling programs that could occur under Alternative 4. Impacts from the increased levels of air traffic would be low in intensity, temporary in duration, and local in extent and affect a common resource. The impact level could be considered minor to moderate.

4.7.3.6.2 Conclusion

Increased levels of marine vessel traffic in Alternative 4 associated with the seismic survey and exploratory drilling programs would be expected to occur in offshore areas where local marine transportation does not occur. Industry vessels would likely encounter local marine traffic when littering to designated nearshore marine facilities (which are limited). The impact of increased vessel presence and the potential for vessel strikes to marine mammals would be low in intensity, temporary in duration, limited in geographic extent to a local area, and common to potentially unique context (in respect to protected marine mammal resources). The summary impact from increases in vessel traffic would be considered minor.

4.7.3.7 Recreation and Tourism

4.7.3.7.1 Direct and Indirect Effects

Alternative 4 is the same as Alternative 2 except with increased levels of activity. The impacts discussed in Section 4.5.3.7 for Alternative 2 are applicable for this alternative. The increased levels of activity would not generate different types of impacts to recreation and tourism. The conclusions for Alternative 2 are applicable to Alternative 4; the overall impact to recreation and tourism would be minor.

4.7.3.7.2 Conclusion

The direct impacts to recreation and tourism would be low intensity, temporary duration, local extent, and common in context. Indirect impacts would be the same levels as direct impacts, except that the geographic area would be broader, extending beyond the region to a state-wide level and potentially beyond. In summary, the impact of Alternative 4 on recreation and tourism would be minor.

4.7.3.8 Visual Resources

This section discusses potential impacts on visual resources that could result from implementing Alternative 4 of the proposed project.

4.7.3.8.1 Direct and Indirect Effects

Implementation of Alternative 4 would be similar to that described in Section 4.5.3.8.1; however, there would be an increase in the level of permitted activity and a consequent potential increase in impacts to visual resources. The proposed action is expected to result in short-term moderate effects to scenic quality and visual resources similar to that described in Alternative 2. Because of the greater number of support vessels used in the two exploratory drilling programs proposed under Alternative 4, this action could be high intensity if both programs are implemented in close proximity to each other. Potential impacts could be of low to medium intensity depending if programs are geographically separated. In either case, actions would be temporary, localized and occur in an important context.

4.7.3.8.2 Conclusion

Implementation of Alternative 4 is expected to result in short-term moderate effects to scenic quality and visual resources. Potential impacts could be of low to medium intensity depending on specific location of drill sites. The geographic extent of potential impacts would be localized; however they would occur in an important ecosystem.

4.7.3.9 Environmental Justice

4.7.3.9.1 Direct and Indirect Effects

Impacts to Subsistence Foods and Human Health

The activity levels associated with Alternative 4 are expected to result in similar levels of effects to subsistence hunts by potential deflection of marine mammals harvested in the EIS project area (described in Subsistence Section 4.5.3.2 for Alternative 2). Alternative 4 activity levels are expected to cause a negligible increase in contamination levels of subsistence food sources (described in the Public Health Section 4.5.3.3), which could have the indirect effect of adding a similar perception as Alternative 2 that subsistence foods are contaminated and alter confidence in their consumption.

4.7.3.9.2 Conclusion

Activities related to implementation of Alternative 4 would have a low intensity impact on subsistence resources and human health, a temporary duration, and a regional extent. Subsistence foods and human health are unique resources and they are protected under the MMPA and EO 12898. Thus, Alternative 4 is expected to have a minor impact to subsistence resources and human health. There would also be minor disproportionate impacts to Alaska Native communities under Alternative 4.

4.7.3.10 Standard and Additional Mitigation Measures

Standard and additional mitigation measures that could reduce impacts to the social environment, other than subsistence, are discussed under Alternative 2 (Section 4.5.3.10).

4.8 Direct and Indirect Effects for Alternative 5 – Authorization for Level 3 Exploration Activity with Additional Required Time/Area Closures

4.8.1 Physical Environment

4.8.1.1 Physical Oceanography

4.8.1.1.1 Direct and Indirect Effects

Water Depth and General Circulation

The effects of Alternative 5 on water depth and general circulation would be the same as those described for Alternative 4.

Currents, Upwellings, and Eddies

The effects of Alternative 5 on currents, upwellings, and eddies would be the same as those described for Alternative 4.

Tides and Water Levels

The time/area closures described under Alternative 5 would not affect tides or water levels within the EIS project area.

Stream and River Discharge

The time/area closures described under Alternative 5 would not affect stream and river discharge within the EIS project area.

Sea Ice

The effects of Alternative 5 on sea ice would be substantially the same as those described for Alternative 4. The time area closures included as additional mitigation measures in Alternative 5 would not substantially change the effects of the alternative on sea ice resources in the proposed action area.

4.8.1.1.2 Conclusion

The effects of Alternative 5 on physical ocean resources would be medium-intensity, temporary, local, and would affect common resources as defined in the impact criteria in Section 4.1 of this EIS. The overall effects of the proposed activity described in Alternative 4 on physical ocean resources in the EIS project area would be minor.

4.8.1.2 Climate

Under this alternative, emissions would be the same as for Alternative 4 because the alternative proposes exploration plans described as Level 3 Exploration Activity on the Arctic OCS. The specific description and number of each of these programs and activities proposed for the Arctic OCS, on an annual basis, were summarized earlier in Table 2.4 (*Activity Definitions*) and Section 2.4.5 (*Alternative 2 – Authorization for Level 1 Exploration Activity*).

Refer to Section 3.1.4.4 (*Climate Change in the Arctic*) for a thorough discussion of climate systems and the effects of GHG emissions.

4.8.1.2.1 Direct and Indirect Effects

Direct Effects

Direct effects under this alternative are the same as those described under Alternative 2.

Indirect Effects

Indirect effects under this alternative are the same as those described under Alternative 2.

Regulatory Reporting and Permitting

Regulatory reporting and permitting under this alternative would be the same as those described under Alternative 2.

CO_2e Emissions Inventory

The CO_2e emissions inventory is the same for this alternative as given for Alternative 4.

Effects of this Alternative on Climate Change

The effects of this alternative are the same as those described for Alternative 4.

Effects of Climate Change on Resources under this Alternative

Effects of climate change on resources under this alternative would be the same as described under Alternative 2.

4.8.1.2.2 Conclusion

The conclusion of the assessment under this alternative is the same as for Alternative 4.

4.8.1.3 Air Quality

Under this alternative, emissions would be the same as described for Alternative 4 and proposes Level 3 Exploration Activity on the Arctic OCS, which is four EPs for each planning area. The majority of additional emissions are from the EPs proposed for Level 3 Exploration Activity.

4.8.1.3.1 Direct and Indirect Effects

Direct and indirect effects under this alternative would be from the same sources of emissions as described under Alternative 2 in Section 4.5.1.3.

Exploration Plan Emission Inventory

The emission rates likely to reflect Level 3 Exploration Activity in each sea are the same as those presented for Alternative 4 in Table 4.7-3.

The inventory assumes no application of BACT or the use of ULSD fuel. The emission inventory presented in Table 4.7-3 assumes the same method of calculation and EP operational characteristics as described for Alternative 2.

Survey Emission Inventory

The number and type of seismic and other surveys would be the same as described for Alternative 4. The emission rates likely to reflect the increased level of seismic and other surveys under this alternative are the same as those presented for Alternative 4 in Tables 4.7-3 and 4.7-4.The survey inventories assume no application of BACT or the use of ULSD fuel. The emission inventory presented in Table 4.7-5 assumes the same method of calculation and survey vessel operational characteristics as described for the previous alternatives.

4.8.1.3.2 Air Quality Impact Analysis

The air quality impact analysis would be conducted as described under Alternative 2.

4.8.1.3.3 Level of Effect

The annual rate of air emissions and onshore pollutant concentrations are the two basic measurements for assessing a proposal's level of effect on air quality. The emission inventory provided in this section discloses the rate of emissions likely to reflect a proposal under this alternative, expressed in short tpy. When necessary, an emission inventory is translated into pollutant concentrations expressed in micrograms per cubic meter (µg/m3), a value that can be measured against the NAAQS allowing the level of effect to be categorized relative to the conditions summarized under Alternative 2 in Table 4.5-7 *Impact Levels for Effects on Air Quality*. Further information regarding level of effect under this alternative would be the same as discussed under Alternative 4.

4.8.1.3.4 Conclusion

Emissions from exploratory drilling activities proposed under this alternative would be higher than emissions estimated for Alternative 2. Without emission reduction controls on the drillship engines, there is a greater potential for one or more of the EPA SILs to be exceeded onshore. The Level 2 Exploration Activity would almost certainly require additional modeling to demonstrate the effect of pollutant concentrations on the nearest onshore area. A moderate level of effect on air quality is expected, which may be mitigated by emission control strategies to result in a minor level of effect. Cumulatively, the total estimated emissions for each Arctic OCS planning area, when considering all plans and activities described under this alternative, are the same as those summarized for Alternative 4 in Table 4.7-5.

Control of oil and gas emission sources on the OCS, and levels of effect, are considered on a project-by-project basis, as each individual operator would have the responsibility to engage any engine emission controls required by BOEM AOCSR. Emission reduction strategies have the potential to reduce at least some emissions of all pollutant types, including CO_2e. Therefore, the data provided in Table 4.7-5 would represent a worst-case scenario for each Arctic OCS planning area.

4.8.1.4 Acoustics

Under Alternative 5, the number and types of exploration programs envisioned is identical to Alternative 4 (see Section 4.7.1.4). A detailed discussion of the acoustic properties of the noise sources is given in Section 4.5.1.4.

Alternative 5 differs from Alternative 4 only in that it implements time/area closures for avoidance of higher marine mammal densities during migration or periods of feeding or subsistence use.

4.8.1.4.1 Direct and Indirect Effects

Implementation of time closures does not reduce the spatial distribution of sound levels. The distances and areal extent to the pertinent thresholds for Alternative 5 are identical to those provided in Alternative 4 in the case of time closures. Area closures would reduce the sound levels in the closure area, but may result in higher sound levels should the activities be concentrated to an area outside of the closure.

4.8.1.4.2 Conclusion

While Alternative 5 presents the same level of activity as Alternative 4, lower levels of exploration activities may actually occur under Alternative 5 due to inclusion of periods of closure. The amount by which activity will be reduced depends on the ability of seismic operators to schedule around blackouts. One potential effect of the time/area closures associated with Alternative 5 would be that available exploration time in certain locations will be compressed. As a consequence, there could be less ability for different exploration operators to schedule activities to avoid working in close vicinity of each other. Operations in close vicinity could lead to higher exposures for marine mammals that happen to be near the activities outside of the closure periods or areas. This issue is discussed in Section 4.5.1.4.

Alternative 5 could represent a smaller increase in activity over current levels than Alternatives 2, 3, and 4. The intensity rating of this alternative is high, as the exploration activities in non-closure periods will introduce sources with source sound levels that exceed 200 dB re 1 μPa. Because the exploration activities could continue for several years, the duration is considered as long term. Under a closure the sound levels will be decreased at a regional scale, however the spatial extent for Alternative 5 is still considered to be regional, as in Alternatives 2, 3, and 4. Therefore, the overall impact rating for direct and indirect effects to the acoustic environment under Alternative 5 would be moderate.

4.8.1.5 Water Quality

Impacts to water quality from Alternative 5 are expected to be very similar to those described above for Alternative 4. The only difference between Alternative 4 and Alternative 5 is the addition of required time/area closures; the level of activity would stay the same, but may vary by area and when the activity will occur. Any differences in impacts between Alternative 4 and Alternative 5 are noted below.

4.8.1.5.1 Direct and Indirect Effects

Temperature and Salinity

Seismic Surveys

Similar to impacts for Alternatives 2, 3, and 4, seismic surveys would not be expected to have any measureable impact on temperature or salinity in the proposed action area.

Site Clearance and Shallow Hazards Surveys

Similar to impacts for Alternatives 2, 3, and 4, site clearance and shallow hazards surveys would not be expected to have any measureable impact on temperature or salinity in the proposed action area.

On-ice Seismic Surveys

Similar to impacts for Alternatives 2, 3, and 4, on-ice seismic surveys would not be expected to have any measureable impact on temperature or salinity in the proposed action area.

Exploratory Drilling Programs

Effects on water quality resulting from increases in temperature and salinity from exploratory drilling programs would be similar to those described under Alternatives 2, 3, and 4. Time/area closures established under Alternative 5 as additional mitigation measures would eliminate adverse impacts to water quality in sensitive areas during certain times. Overall, the effects of Alternative 5 on water quality resulting from changes in temperature and salinity would be low intensity, temporary, and local. The overall effects of Alternative 5 on water quality related to temperature and salinity resulting from exploratory drilling programs are expected to be minor.

Turbidity and Total Suspended Solids

Seismic Surveys

Similar to impacts for Alternatives 2, 3, and 4, effects on water quality resulting from increases in turbidity and total suspended solids from seismic surveys under Alternative 5, if any, are expected to be low-intensity, temporary, local, and would affect a common resource. The nature of those effects would be the same described under Alternative 2.

Site Clearance and Shallow Hazards Surveys

Similar to impacts for Alternatives 2, 3, and 4, effects on water quality resulting from potential increases in turbidity and total suspended solids from site clearance and shallow hazard surveys under Alternative 5, if any, are expected to be low-intensity, temporary, local, and would affect a common resource. The nature of those effects would be the same described under Alternative 2.

On-ice Seismic Surveys

On-ice seismic surveys would not affect turbidity or concentrations of suspended solids in the proposed action area.

Exploratory Drilling Programs

Effects on water quality resulting from increases in turbidity and total suspended solids from exploratory drilling programs are described in detail under Alternatives 2 and 3. Time/area closures established under Alternative 5 as additional mitigation measures would eliminate adverse impacts to water quality in sensitive areas during certain times. The effects of Alternative 5 on water quality resulting from changes in turbidity and concentrations of suspended solids are expected to be low intensity, temporary, and local. The overall effects of Alternative 5 on water quality related to turbidity and concentrations of suspended solids resulting from exploratory drilling programs are expected to be minor.

Proposed mitigation measures intended to reduce/lessen non-acoustic impacts on marine mammals have the potential to further reduce adverse impacts to water quality.

Metals

Seismic Surveys

Similar to impacts for Alternatives 2, 3, and 4, seismic surveys are not expected to have any measureable impact on dissolved metal concentrations in the proposed action area.

Site Clearance and Shallow Hazards Surveys

Similar to impacts for Alternatives 2, 3, and 4, site clearance and shallow hazards surveys would not affect dissolved metal concentrations in the proposed action area.

On-ice Seismic Surveys

Similar to impacts for Alternatives 2, 3, and 4, on-ice seismic surveys would not affect dissolved metal concentrations in the proposed action area.

Exploratory Drilling Programs

Effects on water quality resulting from increases in turbidity and total suspended solids from exploratory drilling programs are described in detail under Alternatives 2, 3, and 4. Time/area closures established under Alternative 5 as additional mitigation measures would eliminate adverse impacts to water quality in sensitive areas during certain times. The effects of Alternative 5 on water quality resulting from changes in metal concentrations are expected to be low intensity, temporary, and local. The overall effects of Alternative 5 on water quality related to metal concentrations resulting from exploratory drilling programs are expected to be minor.

Hydrocarbons and Organic Contaminants

Seismic Surveys

Similar to impacts for Alternatives 2, 3, and 4, seismic surveys are expected to have negligible impacts on concentrations of hydrocarbons and organic contaminants in the waters of the proposed action area. Despite being negligible, time/area closures established under Alternative 5 as additional mitigation measures would eliminate adverse impacts to water quality in sensitive areas during certain times.

Site Clearance and Shallow Hazards Surveys

Similar to impacts for Alternatives 2, 3, and 4, site clearance and shallow hazards surveys are expected to have negligible impacts on concentrations of hydrocarbons and organic contaminants in the waters of the proposed action area. Despite being negligible, time/area closures established under Alternative 5 as additional mitigation measures would eliminate adverse impacts to water quality in sensitive areas during certain times.

On-ice Seismic Surveys

Similar to impacts for Alternatives 2, 3, and 4, on-ice seismic surveys are expected to have minor impacts on concentrations of hydrocarbons and organic contaminants in the waters of the proposed action area under Alternative 5. The effects of these discharges on water quality would be temporary and local in nature, and overall impacts to water quality from on-ice seismic surveys under Alternative 5 are expected to be minor (i.e. effects are below regulatory thresholds for marine water quality).

Exploratory Drilling Programs

Direct and indirect effects on water quality resulting from increases in concentrations of hydrocarbons and other organic contaminants from exploratory drilling programs are described in detail under Alternatives 2, 3, and 4. Time/area closures established under Alternative 5 as mitigation measures would reduce adverse impacts to water quality in sensitive areas during certain times. The effects of Alternative 5 on water quality resulting from changes in concentrations of hydrocarbons and other organic compounds are expected to be temporary and local. It is probable that inputs of hydrocarbons and other organic contaminants from exploratory drilling programs under Alternative 5 would have minor to moderate effects on water quality outside of the discharge plume area. However, due to lack of applicable water quality criteria for some organic compounds in drilling fluids (EPA 2006b), it is problematic to determine whether or not inputs of hydrocarbons and other organic compounds from the proposed activity would exceed water quality regulatory limits.

4.8.1.5.2 Conclusion

After mitigation, the effects of the proposed actions on water quality are expected to be low-intensity, temporary, local, and would affect a common resource. The overall effects of the proposed activity described in Alternative 5 on water quality in the EIS project area are expected to be minor.

4.8.1.6 Environmental Contaminants and Ecosystem Functions

4.8.1.6.1 Direct and Indirect Effects

Contaminants of Concern

Contaminants of concern introduced to the EIS project area as a result of the activities proposed in Alternative 5 would be the same as those described for Alternative 2.

Proposed mitigation measures intended to reduce/ lessen non-acoustic impacts on marine mammals have the potential to reduce adverse impacts resulting from contaminants of concern.

Exposure of Habitat and Biological Resources

Pathways for exposure of habitat and biological resources to contaminants of concern as a result of the activities proposed in Alternative 5 would be the same as those described for Alternative 2.

Potential Effects on Ecosystem Functions

In response to comments and suggestions received as part of the scoping process for this EIS, effects of (contaminants of concern from) the proposed activities on ecosystem functions are assessed in the following section. Effects of the activities proposed under Alternative 5 on the four categories of ecosystem functions (defined in Section 4.4.1.6) are assessed below.

Regulation Functions

Additional mitigation measures related to time area closures under Alternative 5 would potentially result in decreased impacts to regulation functions relative to Alternative 4. The capacity of natural systems to maintain essential ecological processes (such as nutrient cycles) and life support systems (such as provision of clean water) is not distributed evenly over space and time (Naidoo et al. 2008). Coastal areas, as well as nutrient rich convergence zones in the open ocean, generally involve greater and more dynamic levels of chemical and biological activity relative to oligotrophic open ocean areas, and therefore generally play a greater role in the maintenance of essential ecological processes. The time area closures proposed under Alternative 5 would limit impacts to certain coastal areas and convergence zones during particular times and therefore have the potential to reduce adverse impacts to regulation functions.

Habitat Functions

Additional mitigation measures related to time area closures under Alternative 5 would potentially result in decreased impacts to habitat functions relative to Alternative 4. The capacity of natural systems to provide refuge and reproduction habitat is not distributed evenly over space and time. Coastal areas, as well as nutrient rich convergence zones in the open ocean, generally involve greater and more dynamic levels of chemical and biological activity relative to oligotrophic open ocean areas, and therefore generally play a greater role in the provision of refuge and reproduction habitats. The time area closures proposed under Alternative 5 would limit impacts to certain coastal areas and convergence zones during particular times, and therefore have the potential to reduce adverse impacts to habitat functions.

Production Functions

Additional mitigation measures related to time area closures under Alternative 5 would potentially result in decreased impacts to production functions relative to Alternative 4. The capacity of natural systems to convert energy and nutrients into biomass and support subsequent trophic transfers and biogeochemical processes is not distributed evenly over space and time (Naidoo et al. 2008). Coastal areas, as well as nutrient rich convergence zones in the open ocean, generally involve greater and more dynamic levels of chemical and biological activity relative to oligotrophic open ocean areas, and therefore generally play a greater role in energy conversion and production processes. The time area closures proposed under Alternative 5 would limit impacts to certain coastal areas and convergence zones during particular times and therefore have the potential to reduce adverse impacts to production functions.

Oil and gas are ecosystem goods, and the flows of energy that they represent are ecosystem services. These ecosystem goods and services could potentially be derived from historical production functions in the EIS project area under Alternative 5.

Information Functions

Additional mitigation measures related to time area closures under Alternative 5 would potentially result in decreased impacts to information functions relative to Alternative 4. The capacity of natural systems to contribute to the maintenance of human health by providing opportunities for spiritual enrichment, cognitive development, recreation, and aesthetic experience is not distributed evenly over space and time. Coastal areas, as well as nutrient rich convergence zones in the open ocean, generally involve greater and more dynamic levels of chemical and biological activity relative to oligotrophic open ocean areas, and therefore generally play a greater role in providing the opportunities associated with information functions. The time area closures proposed under Alternative 5 would limit impacts to certain coastal areas and convergence zones during particular times, and therefore have the potential to reduce adverse impacts to information functions.

4.8.1.6.2 Conclusions

Direct and indirect impacts to ecosystem functions resulting from the implementation of Alternative 5 would be medium-intensity, temporary, and local. The functional properties of ecosystems described in this section, such as nutrient cycling and habitat functions, are more robust (i.e. resistant to stressors) than are species composition and other structural properties. Overall effects of Alternative 5 on ecosystem functions would be minor.

4.8.1.7 Standard and Additional Mitigation Measures

Standard and additional mitigation measures that could reduce impacts to the physical environment are discussed under Alternative 2 (Section 4.5.1.7).

4.8.2 Biological Environment

4.8.2.1 Lower Trophic Levels

4.8.2.1.1 Direct and Indirect Effects

Activity levels in Alternative 5 are the same as in Alternative 4, and there are additional mitigation measures for seasonal closures for certain areas. These mitigated closures do not affect lower trophic levels in the EIS project area, so the impacts discussed in Sections 4.5.2 and 4.6.2 for Alternatives 2 and 3 are the same for Alternative 5, making the overall impact to lower trophic levels be minor.

4.8.2.1.2 Conclusion

Given the potential for implementation of the standard mitigation measures considered in this EIS, the direct and indirect effects on lower trophic levels associated with Alternative 5 would likely be low in intensity, temporary to long-term in duration, of local extent and could affect common resources; resulting in a summary impact level of negligible. The only exception to these levels of impacts would be the introduction of an invasive species due to increased vessel traffic, which could be of medium intensity, long-term or permanent duration, of regional geographic extent, and affect common or important resources, which could cause a summary impact of moderate.

4.8.2.2 Fish and Essential Fish Habitat

4.8.2.2.1 Direct and Indirect Effects

Alternative 5 assumes the same level of oil and gas exploration activity as Alternative 4, described as Level 3. The activities are divided identically among the different activity types in both alternatives, and the number and types of surveys, exploration, and drilling are all assumed to be the same. Likewise, the Standard and Additional Mitigation Measures are also identical. The analyses for direct and indirect effects are the same for Alternative 5 as for Alternative 4.

Alternative 5 differs from Alternative 4 in the creation and application of time/area closures that would be required for all activities as opposed to being considered on a case-by-case basis under the Additional Mitigation Measures for Alternatives 2, 3, 4, and 5. Time/area closures are intended to reduce impacts to marine mammals during sensitive times and locations in their life cycle and to decrease conflict with Native Alaskan marine mammal subsistence activities. Specific locations have been identified and will be closed to oil and gas exploration activities during periods of high use by marine mammals.

It is important to note that under this alternative, there would be no reduction in the overall amount of activity occurring. The total noise emitted or habitat lost or altered would remain the same, only the times and locations of those impacts would change. However, fish are not evenly distributed across the EIS project area and instead congregate in desirable habitats. Many of the areas identified as being important to marine mammals are also likely to be important to other marine species as well. Productive marine environments are shared by many animal groups; therefore, the time/area closures will likely correspond to locations and periods important to fish species and will result in unintended beneficial impacts to fish resources. A seismic survey performed in an area of low fish density will have lower adverse impacts on fish resources than a seismic survey performed in an area of high fish density. If activities can be reduced or eliminated in areas of high fish density, the overall number of fish likely to be impacted will be smaller by reducing the total number of fish exposed to high sound levels, and the amount of altered or damaged habitat would also be reduced.

An analysis of each time/area closure area is included here, as well as the anticipated mitigating impact each closure could have on fish and fish resources. Any benefits or mitigated effects described would only occur if exploration activities in other, less productive areas replaced activities that would otherwise occur within the time/area closures. Additionally, impacts in these areas would be reduced if the exploration activity occurred at other times of year when fewer marine mammals (and possibly other marine species) were present in those locations. The temporal offset of activity within these areas is unlikely to result in any discernible reduction in overall impact levels.

For a complete discussion of the effects of direct and indirect effects on fish resources, please see Section 4.5.2.2.

4.8.2.2.2 Time/Area Closures

Barrow Canyon/Western Beaufort Sea

The northwest corner of the Beaufort Sea, near the Chukchi Sea, has been shown to be the most productive fish habitat in the region (see Section 3.2.2.1, Logerwell and Rand 2010). Although Barrow Canyon sits on the southern boundary of this highly productive area, it is still much more productive than surrounding areas of the Beaufort Sea. Fish densities are higher here and to the north than in surrounding areas. This closure area does not contain any lease areas, eliminating drilling from the list of activities potentially impacting the resources. Therefore, the main consideration to fish resources would be a reduction in sound emitted from seismic surveys, with a small amount of habitat loss or alteration potentially mitigated through the elimination of anchoring and icebreaking in the area.

Reducing oil and gas exploration activities in this area would reduce overall impacts to fish resources primarily by decreasing the overall amount of exposure to sound by fish on a population level and also providing a small decrease in habitat loss and alteration. The elimination of all exploration activities would benefit all assemblages of marine fish the most, with some anticipated benefit to migratory fish.

Shelf Break of the Beaufort Sea

The shelf break of the Beaufort Sea has been shown to be the most productive fish habitat in the region, particularly the northwest corner near the Chukchi Sea (see Section 3.2.2.1, Logerwell and Rand 2010). As such, reducing oil and gas exploration activities in this area would reduce overall impacts to fish resources by decreasing the amount of high quality habitat lost or altered and reducing the overall amount of exposure to sound by fish on a population level. The elimination of all exploration activities would benefit all assemblages of marine fish the most, with some anticipated benefit to migratory fish.

Hanna Shoal

The Hanna Shoal is known to be a highly productive and important biological area, with high concentrations of sea birds, walrus and whales (Nelson et al. 1993). Although the fish resources in the area are not well understood, studies are currently being undertaken to better catalogue and describe the importance of the area. From the number of other species known to use the area, it can be assumed that it is important fish habitat, likely showing a high density of fish resources, particularly compared to the rest of the Chukchi Sea. This closure area contains very few lease sales, with a limited number located in the far southwestern corner. Therefore, drilling would be essentially eliminated from the list of activities potentially impacting the resources. The main consideration to fish resources would be a reduction in sound emitted from seismic surveys, with a small amount of habitat loss or alteration potentially mitigated through the elimination of anchoring and icebreaking in the area.

Reducing oil and gas exploration activities in this area would reduce overall impacts to fish resources by decreasing the amount of high quality habitat lost or altered and reducing the overall amount of exposure to sound by fish on a population level. The elimination of all exploration activities would benefit all assemblages of marine fish the most, with some anticipated benefit to migratory fish.

Kasegaluk Lagoon and Ledyard Bay

The Kasegaluk Lagoon and Ledyard Bay are shallow, nearshore areas of the Chukchi Sea. These closure areas do not contain any lease areas, eliminating drilling from the list of activities potentially impacting the resources. Therefore, the main consideration to fish resources would be a reduction in sound emitted from surveys, with a small amount of habitat loss or alteration potentially mitigated through the elimination of anchoring and icebreaking in the area.

Migratory fish are likely to benefit from this closure. Juvenile salmon are known to congregate in shallow estuaries near river mouths before moving off to sea, and many amphidromous species also use brackish water for substantial portions of their lives (see Section 3.2.2.6). Therefore, increased protection of these areas would be beneficial to the migratory species that use these habitats regularly. Nearshore marine species would also benefit from this closure, due to the shallow habitat characterizing the area.

4.8.2.2.3 Conclusion

The effect of the Time/Area Closures outlined in Alternative 5 on Fish Resources and EFH would be a reduction in the overall impact. Although the overall impact is considered to be negligible based on Alternative 4 alone, any further reduction in impacts resulting from the Time/Area Closures would be beneficial. The already low impact levels would be decreased by each of the individual closures, and any combination would reduce the impacts further. Implementing all of the Time/Area Closures would substantially decrease all effects on fish resources by protecting the most important fish habitats where the highest fish densities are found. Due to the substantial decrease to the already very small scale of any potential effects relative to overall population levels and available habitat, there would be no measurable effect on the resource.

4.8.2.3 Marine and Coastal Birds

4.8.2.3.1 Direct and Indirect Effects

Alternative 5 includes all of the same type of exploration activities as in Alternative 2 so the discussion of potential direct and indirect effects on birds under Alternative 5 involves all the same mechanisms and types of effects as discussed for Alternative 2 in Section 4.5.2.3. Rather than repeating the same information presented in Section 4.5.2.3, the following discussion will focus on the differences between Alternative 2 and Alternative 5.

The difference between alternatives concerning birds is a matter of degree. Alternative 5 includes a larger number of some authorized exploration activities than Alternative 2. Alternative 5 would authorize the same number and types of exploration activities in the Arctic seas as Alternative 4, including the same suite of standard mitigation measures with the addition of mandatory time/area closures. The closure areas are the same as those discussed in Additional mitigation measure B1: Kaktovik and Cross Island, the Beaufort Sea Shelf Break, Barrow Canyon and the Western Beaufort Sea, Hanna Shoals, Kasegaluk Lagoon, and Ledyard Bay. The difference between Additional Mitigation Measure B1 and Alternative 5 is that specific time periods have been specified under Alternative 5 corresponding to periods of high biological productivity or important life functions for some species, primarily bowhead and beluga whales. However, the most important of these areas to birds, the LBCHU, would be subject to the same closure period as any of the other alternatives, after July 1, because this restriction is one of the mitigation measures imposed by the USFWS and BOEM to protect ESA-listed spectacled eiders.

The direct and indirect effects of oil and gas exploration activities on marine and coastal birds would be very similar under Alternative 5 as those described under Alternative 2. Marine birds would be subject to increased disturbance from vessels and seismic sources due to the increase in seismic surveys that could be authorized under Alternative 5 in both Arctic seas. However, disturbance effects would be temporary even if they occurred over a wider area and birds could fly or swim away from acute disturbance. With more exploration activities authorized under Alternative 5, the potential for adjacent activities to magnify effects on birds could be increased. However, the requirement to maintain a minimum distance of 24 km (15 mi) between two seismic surveys conducted concurrently would effectively limit the intensity of seismic survey effects on birds no matter where the activities take place during the open water season. The Ledyard Bay closure period would be the same under Alternative 5 as under Alternative 2 so this area would be unaffected by increases in exploration elsewhere.

The risk of birds colliding with vessels would increase incrementally but, given mitigation measures to adjust lighting strategies to reduce those effects, fatal collisions are still expected to be rare and not likely to affect the population of any species. The risk of small oil spills would also increase incrementally as the number of vessels increase but these effects are also mitigated and considered to present very small risks to birds unless the spill occurred in or persisted in a lead or polynya system. A very large oil spill due to an exploration well blowout could have much more serious effects on birds and is discussed in Section 4.10.

4.8.2.3.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to marine and coastal birds are discussed under Alternative 2 (Section 4.5.2.3).

4.8.2.3.3 Conclusion

Most marine and coastal birds are legally protected under the Migratory Bird Treaty Act and several are protected under the ESA. Birds fulfill important ecological roles in the Arctic and many are important subsistence resources. Depending on the species, they are considered to be important or unique resources from a NEPA perspective. The effects of disturbance, injury/mortality, and changes in habitat for marine and coastal birds would likely be temporary or short-term, localized, and not likely to have population-level effects for any species. The overall effects of oil and gas exploration activities authorized under Alternative 5 on marine and coastal birds would therefore be considered minor according to the impact criteria in Table 4.5-17.

4.8.2.3.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to marine and coastal birds are discussed under Alternative 2 (Section 4.5.2.3).

4.8.2.3.5 Additional Mitigation Measures Conclusion

Most of the additional mitigation measures considered in this EIS would not appreciably reduce potentially adverse effects on birds except for Additional C3 and C4. These two measures would reduce the risk of contamination from discharges and drilling muds, although the benefits relative to the standard mitigation measures would be limited to small numbers of birds and small areas of benthic habitat. Given the implementation of standard and additional mitigation measures considered by NMFS in this EIS, and assuming no large oil spill occurred during exploration activities, the effects on birds would likely be low in intensity, temporary to long-term in duration, of local extent, and would affect important or unique resources. The effects of Alternative 5 with additional mitigation measures would therefore be considered minor for birds.

4.8.2.4 Marine Mammals

Alternative 5 differs from Alternative 4 in the creation and application of Time/Area Closures that would be required for all oil and gas exploration activities within a particular time and location. The closure areas are the same as those discussed in Additional Mitigation Measure B1: Kaktovik, the Beaufort Sea Shelf Break, Barrow Canyon and the Western Beaufort Sea, Hanna Shoal, Kasegaluk Lagoon, and Ledyard Bay. No oil and gas industry exploration activities would be permitted to occur in the areas specified here during the listed timeframes. Under this alternative, buffer zones around these time/area closures would 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. The purpose of Time/Area Closures is twofold: 1) to reduce adverse impacts to marine mammals (in either number or severity) in areas (and times) of known importance to marine mammals (e.g., feeding or calving areas), in which behavioral disturbance could potentially result in a reduction in the fitness of the disturbed individuals, either through energetic effects or direct interference with critical behaviors (e.g, cow/calf communication), and/or 2) to minimize conflicts with Alaska Native marine mammal subsistence hunting activities. Table 4.8-1 summarizes the resources and mitigated functions associated with each area. Analyses of the Time/Area Closure areas, along with the anticipated mitigating impact each closure could have on the indicated species, are described in the species sections below.

Of note, in this alternative, only the buffer zone noted above is considered, and only the implementation of *all* the areas is considered. However, when time/area limitations are considered as additional mitigations in the other alternatives, we may consider the implememntation of some subset of the areas or a smaller buffer, depending on the situation and practicability for the specific project in consideration.

Table 4.8-1 Proposed required Time/Area closure locations under Alternative 5. This table identifies the species and subsistence hunts that would be mitigated by requiring these closures.

	Kaktovik	**Barrow Canyon and the Western Beaufort Sea**	**Beaufort Sea Shelf Break**	**Hanna Shoal**	**Kasegaluk Lagoon and Ledyard Bay**
Proposed closure period under Alternative 5	August 25 - September 15	Mid-July - October	Mid-July - late September	September 15 - early October	Mid-June - mid-July for the Lagoon and July 1 – November 15 for the LBCHU
Bowhead Whale	Migrating and feeding: late August - October	Migrating and feeding: late August - October	Migrating: late August - October	Part of migratory corridor: September - October	Do not occur (migrate offshore)
Beluga Whale	Uncommon	Migrating and feeding: mid-July - late August	Feeding: mid-July - late September	Unknown	Feeding, molting, calving: June and July
Spotted Seal	Present	Present	Present	Present	Present; Some feeding habitat
Walrus	Not present	Not present	Not Present	Feeding: July - August	Resting habitat: Spring and early winter
Whaling Hunts	bowheads: late August - mid-September	bowheads: September - October	Uncommon	None	belugas: mid-June - mid-July in the Lagoon only
Sealing Hunts	Mostly October - June	Mostly November - January and spring	Uncommon	None	Mostly October - June

4.8.2.4.1 Bowhead Whales

4.8.2.4.1.1 Direct and Indirect Effects

Alternative 5 includes the same level of oil and gas exploration activity as Alternative 4 (Level 3 Exploration). The number and types of surveys, exploration, and drilling are all assumed to be the same. Standard and Additional Mitigation Measures for Alternative 5 are also identical to those for Alternatives 2, 3, and 4 except that the time/area closures discussed as additional measures in Alternatives 2, 3, and 4 are required in this alternative. The analyses for Direct and Indirect Effects, Standard Mitigation Measures, and Additional Mitigation Measures are the same for Alternative 5 as for Alternative 4, with the exception of the anticipated effects of restricting activities from occurring in the time/area closure areas. The time/area closures expected to affect impacts on bowhead whales (Kaktovik and Barrow Canyon and the Western Beaufort Sea) are discussed below.

Time/Area Closures Required Under Alternative 5

Kaktovik

Kaktovik is considered a time/area closure location by NMFS for analysis purposes in this EIS (Figure 3.2-25) and would be closed to all exploration activities from August 25 to September 15. Data collected during ASAMM surveys in the Beaufort Sea from 2008-2011 noted feeding groups of bowhead whales in September most of those years (Clarke et al. 2011b, c, 2012). Additionally, hunters from Kaktovik traditionally conduct hunts in the nearshore waters from the community in the fall. Hunts typically begin in late August/early September and continue until mid- to late September, depending on upon migration patterns, weather and ice conditions, etc. Closing the area to oil and gas activities during this time period would reduce adverse impacts, particularly those associated with noise disturbance (e.g. displacement and avoidance), on bowhead whales feeding, resting, or migrating through this area. Reducing impacts on concentrations of bowhead whales in an important feeding area could be energetically beneficial to the whales. Prohibiting activities in this area during the period of highest use by bowheads could result in a decreased intensity of effects during the closure period. Reduced adverse impacts on bowhead whales would, however, be limited to the closure area. Noise effects of activities occurring outside of this closure area could continue to impact bowhead whales in the vicinity that are either outside the closure zone or within the zone, but at a distance from the sound source within which behavioral reactions are still possible. However, the implementation of the buffer zones around the required closure areas would help to reduce further impacts from occurring within this important location.

The nearshore waters of Kaktovik are also used for bowhead hunting during this time period, as discussed in further detail in Section 4.8.3.2.

Barrow Canyon/Western Beaufort Sea

Barrow Canyon/Western Beaufort Sea is considered a time/area closure location by NMFS for analysis purposes in this EIS (Figure 3.2-25) and would be closed to all exploration activities from mid-July – October. Due to sub-sea topography and the ocean currents, Barrow Canyon is one of the two primary concentration areas for bowhead whales in the Beaufort Sea, particularly as a staging/feeding area during the fall migration of bowheads out of the Beaufort Sea. Physical and oceanographic features of Barrow Canyon promote a bowhead whale feeding “hotspot” here during late-summer and fall. Bowhead whales congregate in the area to exploit dense prey concentrations (Ashjian et al. 2010, Moore et al. 2010, Okkonen et al. 2011). Barrow Canyon is also an important feeding area for beluga whales (Clarke et al. 2011b, 2011c, Moore et al. 2000). Time/Area closures for this area proposed under Alternative 5 are to mitigate effects on bowhead whales (late August to early October), belugas (mid-July to late August), and the fall bowhead whale subsistence hunt out of Barrow (September 15 to close of the hunt). Closing the area to oil and gas activities during these time periods would reduce adverse impacts, particularly those associated with noise disturbance (e.g. displacement and avoidance), on bowhead whales feeding, resting, or migrating through this area, as well as for belugas. Reducing impacts on concentrations of bowhead whales in an important feeding area could be energetically beneficial to the whales. Prohibiting activities in this area during the period of highest use by bowheads could result in a decreased intensity of effects during the closure period. Reduced adverse impacts on bowhead whales would, however, be limited to the closure area. Noise effects of activities occurring outside of this closure area could continue to impact bowhead whales in the vicinity that are either outside the closure zone or within the zone, but at a distance from the sound source within which behavioral reactions are still possible. However, the implementation of the buffer zones around the required closure areas would help to reduce further impacts from occurring within these biologically important areas.

This area and time is also important for beluga feeding (Section 4.8.2.4.2), as well as the fall bowhead hunt (Section 4.8.3.2).

Behavioral Disturbance

Since the exploration activities that would be authorized under Alternative 5 are identical to those under Alternative 4, the types and mechanisms for disturbance to bowhead whales would be the same. As discussed above, though, implementation of time/area closures has the potential to reduce the intensity of behavioral disturbance to bowhead whales through potential reduction in the numbers of disturbed whales (if whales were more densely congregated in these areas) or reduction in the severity by avoiding potential adverse energetic effects that might result from displacement from preferred feeding habitat. The degree of reduced impacts would depend on the level of acticvities which would otherwise have occurred in these areas, which is difficult to predict (of note, these areas do not overlap any leases), however, the same total level of activities would still be expected to occur outside of these closures (still in the bowhead migratory corridor), so the degree of reduced impacts, as compared to the whole, would be relatively minor and would not change the impact criteria conclusions, which are of high intensity, interim duration, regional extent, and unique context.

Please refer to Section 4.5.2.4.9 for a complete discussion of disturbance effects, by activity type, on bowhead whales.

Hearing Impairment, Injury, and Mortality

Since the exploration activities that would be authorized under Alternative 5 are identical to those under Alternative 4, the mechanisms for injury and mortality to bowhead whales would be the same. Because the proposed time/area closures are not expected to reduce the likelihood of injury or mortality, these remain identical to those discussed for Alternative 4 in Section 4.7.2.4: medium intensity, generally interim in duration (except in instances of mortality or serious injury), regional in extent and of important context.

Please refer to Section 4.5.2.4.9 for a complete discussion of potential injury or mortality effects on bowhead whales.

Habitat Alterations

Since the exploration activities that would be authorized under Alternative 5 are identical to those under Alternative 4, the mechanisms for habitat alteration would be the same. However, the implementation of these time/area closures could create some level of reduced effect on acoustic habitat in an area/time where interspecies communication and interpretation of acoustic cues may be of increased importance (i.e., for feeding), although, when compared to the overall level of effects outside these areas, the level of effects on bowhead whale habitat from Alternative 5 could be slightly less, but not significantly different than those discussed for Alternative 4 in Section 4.7.2.4.

Please refer to Section 4.5.2.4.9 for a complete discussion of the potential effects on bowhead whale habitat.

4.8.2.4.1.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to bowhead whales are discussed under Alternative 2 (Section 4.5.2.4.15).

4.8.2.4.1.3 Conclusion

As described above, effects of disturbance on bowhead whales, as well as impacts on acoustic habitat, from open-water exploration activities would be reduced in the closure areas during time periods specified in Alternative 5 relative to how much exploration activity would have occurred there if permitted to do so. 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. Overall, exploration effort would not likely be reduced, but, rather, redistributed and possibly concentrated in other areas. Time/Area closures that mitigate adverse impacts on feeding bowhead whales could reduce impacts to a lower intensity. However, bowhead whale habitat use in the EIS project area is dynamic and extensive, and, when migration corridors are considered (through which mothers and calves are passing), it includes large portions of the Beaufort and Chukchi seas not included in the Time/Area closures that could coincide with oil and gas exploration activities throughout the region. Effects of concurrent closures also need to be considered. Time/area closures in the Beaufort Sea (Kaktovik, Barrow Canyon and Beaufort Sea Shelf Break) overlap in September and, for the former two, in October as well. Concurrent closures could result in excluded activities concentrating in areas not included in the closure areas, such as on the Beaufort shelf between Harrison Bay and Camden Bay, during those time periods. Although the Time/Area closures specified in Alternative 5 could mitigate adverse impacts in particular times and locations, the overall impact on bowhead whales of oil and gas exploration activities allowed under this alternative would be similar to Alternative 4 (Section 4.7.2.4) however, with a slight decrease, and would be considered moderate.

Type of effect	Impact Component	Effects Summary	
Behavioral disturbance	Magnitude or Intensity	Low	
		Medium	
		High	Take of bowheads exceeds 30% of population
	Duration	Temporary	
		Interim	All activity types last more than month, but combination < 6 months
		Long-term	
	Geographic Extent	Local	
		Regional	Impacts considered regional
		State-wide	
	Context	Common	
		Important	
		Unique	ESA-listed species, impacts across migratory corridor through which mother/calve pairs traverse, potential disruption of feeding
Injury and mortality	Magnitude or Intensity	Low	Injury or death unlikely
		Medium	Though unlikely, cannot rule out PTS
		High	
	Duration	Temporary	
		Interim	Type of potential injury (though unlikely) would likely have moderate effects
		Long-term	
	Geographic Extent	Local	Since unlikely, any few impacts would be considered local
		Regional	
		State-wide	
	Context	Common	
		Important	ESA listed species, but population is increasing

Type of effect	Impact Component	Effects Summary	
		Unique	
Habitat alterations	**Magnitude or Intensity**	**Low**	
		Medium	Combination of potential habitat impacts, including acoustic habitat, are medium
		High	
	Duration	**Temporary**	
		Interim	Although other alterations shorter, acoustic habitat is altered for duration of activities
		Long-term	
	Geographic Extent	**Local**	
		Regional	Impacts considered regional, especially when consider area over which sound exceeds 120 dB, and the communication distances of baleen whales.
		State-wide	
	Context	**Common**	
		Important	ESA listed species, but population is increasing
		Unique	

4.8.2.4.1.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to bowhead whales are discussed under Alternative 2 (Section 4.5.2.4.16). All time/area closures included in Additional Mitigation Measure B1 would be required under Alternative 5.

4.8.2.4.1.5 Additional Mitigation Measures Conclusion

Conclusions regarding the potential for these additional measures to reduce adverse impacts of oil and gas activities on bowhead whales allowed under Alternative 5 are the same as under Alternative 2. Refer to Section 4.5.2.4.16 for details.

4.8.2.4.2 Beluga Whales

4.8.2.4.2.1 Direct and Indirect Effects

Alternative 5 includes the same level of oil and gas exploration activity as Alternative 4 (Level 3 Exploration). The number and types of surveys, exploration, and drilling are all assumed to be the same. Standard and Additional Mitigation Measures for Alternative 5 are also identical to those for Alternatives 2, 3, and 4 except that the time/area closures discussed as additional measures in Alternatives 2, 3, and 4 are required in this alternative. The analyses for Direct and Indirect Effects, Standard Mitigation Measures, and Additional Mitigation Measures are the same for Alternative 5 as for Alternative 4, with the exception of the anticipated effects of restricting activities from occurring in the time/area closure areas. The time/area closures expected to affect impacts on beluga whales (Barrow Canyon and the Western Beaufort Sea, the Beaufort Sea Shelf, and Kasegaluk Lagoon) are discussed below.

Time/Area Closures Required Under Alternative 5

Barrow Canyon/Western Beaufort Sea

Barrow Canyon/Western Beaufort Sea is considered a time/area closure location by NMFS for the purposes of analysis in this EIS and would be closed to all oil and gas exploration activities from mid-July – October. Barrow Canyon is an important feeding area for beluga whales, primarily during summer to early fall (Clarke et al. 2011b, 2011c, Moore et al. 2000). Closing the area to oil and gas activities during these time periods could reduce adverse impacts, particularly those associated with noise disturbance (e.g. displacement, avoidance, potential adverse energetic impacts from interrupted feeding). Reduced adverse impacts on beluga whales would likely be limited to the closure area. Implementing buffer zones around the required closure areas could, however, help to reduce impacts of noise from activities occurring in areas adjacent to the closure areas.

This area is also important for bowheads (feeding area; Section 4.8.2.4.1) and the fall bowhead whale subsistence hunt (Section 4.8.3.2).

Shelf Break of the Beaufort Sea

The shelf break of the Beaufort Sea is considered a time/area closure location by NMFS for the purposes of analysis in this EIS and would be closed to all oil and gas exploration activities from mid-July – to late September. It is an important feeding habitat for belugas whales, prompting proposed closure of the area. Active leases in the Beaufort Sea are generally on the shelf, inshore of the shelf break; drilling activities would, therefore, not be impacted through this closure. Seismic activities and associated vessel traffic would be affected, thereby reducing potential adverse impacts on beluga whales, particularly those associated with noise disturbance. The time and location of reduced adverse impacts would be limited to the area defined by the shelf break. Implementing buffer zones around the required closure areas could further reduce impacts of noise on the closure area generated by activities occurring in areas adjacent to the closure areas.

Kasegaluk Lagoon and Ledyard Bay

Kasegaluk Lagoon and Ledyard Bay are considered a biologically important area for analysis purposes in this EIS (Figure 3.2-26). Kasegaluk Lagoon provides important habitat for beluga whales and spotted seals. Belugas of the eastern Chukchi Sea stock congregate in Kasegaluk Lagoon in June and July (Frost et al.1993, Huntington et al. 1999). Omalik Lagoon, south of Kasegaluk Lagoon, is also an important gathering area for belugas in June, except in years when there is heavy ice along the shore (Huntington et al. 1999). This closure area does not contain any lease areas, so drilling activities would not be affected by the closure. Seismic surveys and associated vessel and aircraft traffic would, except in emergency situations, be required to divert around the closure area. This could decrease disturbance effects of vessel activity within these important habitats and closure areas, while shifting vessel activity further offshore.

Behavioral Disturbance

Since the exploration activities that would be authorized under Alternative 5 are identical to those under Alternative 4, the types and mechanisms for disturbance to beluga whales would be the same. As discussed above, though, implementation of time/area closures has the potential to reduce the intensity of behavioral disturbance to beluga whales through potential reduction in the numbers of disturbed whales (if whales were more densely congregated in these areas) or reduction in the severity by avoiding potential adverse energetic effects that might result from displacement from preferred feeding or calving habitat. The degree of reduced impacts would depend on the level of acticvities which would otherwise have occurred in these areas, which is difficult to predict (of note, these areas do not overlap any leases), however, the same total level of activities would still be expected to occur outside of these closures, so the degree of reduced impacts, as compared to the whole, would be relatively minor and would not change the impact criteria conclusions, which are medium intensity, interim duration, regional extent, and important context.

Hearing Impairment, Injury, and Mortality

As discussed under Alternatives 2 and 3 (Sections 4.5.2.4.10 and 4.6.2.4.2), the primary mechanism of potential injury or mortality to beluga whales due to oil and gas exploration activities are permanent hearing loss or damage (auditory injury) and collisions with vessels. Since the exploration activities that would be authorized under Alternative 5 are identical to those under Alternative 4, the mechanisms for injury and mortality to beluga whales would be the same. Because the proposed time/area closures are not expected to reduce the likelihood of injury or mortality, these remain identical to those discussed for

Alternative 4 in Section 4.7.2.4, medium intensity, interim in duration (except in instances of mortality or serious injury), regonal in extent and of important context.

Habitat Loss/Alteration

Since the exploration activities that would be authorized under Alternative 5 are identical to those under Alternative 4, the mechanisms for habitat alteration would be the same. However, the implementation of these time/area closures could create some level of reduced effect on acoustic habitat in an area/time where interspecies communication and interpretation of acoustic cues may be of increased importance (i.e., for feeding), although, when compared to the overall level of effects outside these areas, the level effects on beluga whale habitat from Alternative 5 could be slightly less, but not significantly different than thos discussed for Alternative 4 in Section 4.7.2.4.

4.8.2.4.2.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to beluga whales are discussed under Alternative 2 (Section 4.5.2.4.15).

4.8.2.4.2.3 Conclusion

As described above, effects of disturbance on beluga whales, as well as impacts on acoustic habitat from open-water exploration activities would be reduced in the closure areas during time periods specified in Alternative 5 relative to how much exploration activity would have occurred there if permitted to do so. In addition, industry may relocate exploration activities to other, possibly adjacent, areas until the closure areas are available. Overall, exploration effort would not be reduced, but, rather, redistributed and possibly concentrated in other areas.

Time/Area closures that mitigate adverse impacts on concentrations of beluga whales (feeding and caluving areas) could reduce impacts to a lower intensity. However, beluga whale habitat use in the EIS project area is dynamic and extensive and, includes large portions of the Beaufort and Chukchi seas not included in the Time/Area closures that could coincide with oil and gas exploration activities throughout the region. Although the Time/Area closures specified in Alternative 5 could mitigate adverse impacts in particular times and locations, the overall impact on beluga whales of oil and gas exploration activities allowed under this alternative would be similar to Alternative 4 (Section 4.7.2.4) however, could be slightly reduced, and would be considered minor to moderate.

4.8.2.4.2.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to beluga whales are discussed under Alternative 2 (Section 4.5.2.4.16).

Type of effect	Impact Component	Effects Summary	
Behavioral disturbance	Magnitude or Intensity	Low	
		Medium	Behavioral harassment occurring, but likely < 30% of population disturbed
		High	
	Duration	Temporary	
		Interim	All activity types last more than month, but combination < 6 months
		Long-term	
	Geographic Extent	Local	
		Regional	Combined activities considered regional
		State-wide	
	Context	Common	
		Important	Non-ESA listed, population status not well known, but thought not to be declining in Chukchi, important feeding and calving areas
		Unique	

Type of effect	Impact Component	Effects Summary	
Injury and mortality	Magnitude or Intensity	**Low**	Injury or death unlikley
		Medium	Though unlikely, cannot rule out PTS
		High	
	Duration	**Temporary**	
		Interim	Type of potential injury (though unlikely) would likely have moderate effects
		Long-term	
	Geographic Extent	**Local**	Since unlikely, any few impacts would be considered local
		Regional	
		State-wide	
	Context	**Common**	Not ESA listed, populations not thought to be decreasing
		Important	
		Unique	
Habitat alterations	Magnitude or Intensity	**Low**	
		Medium	Combination of potential habitat impacts, including acoustic habitat, are medium
		High	
	Duration	**Temporary**	
		Interim	Although other alterations shorter, acoustic habitat is altered for duration of activities
		Long-term	
	Geographic Extent	**Local**	
		Regional	When acoustic habitat is considered, impacts considered regional
		State-wide	
	Context	**Common**	Not ESA listed, populations not thought to be decreasing
		Important	
		Unique	

4.8.2.4.3 Other Cetaceans

Alternative 5 assumes the same level of oil and gas exploration activity as Alternative 4, described as Level 3. The activities are divided identically among the different activity types in both alternatives, and the number and types of surveys, exploration, and drilling are all assumed to be the same. Likewise, the Standard and Additional Mitigation Measures are also identical. The analyses for Direct and Indirect Effects, Standard Mitigation Measures, and Additional Mitigation Measures are the same for Alternative 5 as for Alternative 4.

Alternative 5 differs from Alternative 4 in the creation and application of Time/Area Closures. Time/Area Closures are intended to reduce impacts to certain marine mammal species during sensitive times and locations in their life cycle, and to decrease conflict with Native subsistence. The Time/Area Closures have been chosen to coincide with periods and locations important for marine mammal development and subsistence activities. Specific locations have been identified, and will be closed to oil and gas exploration activities during periods of high use. The closure areas are the same as those discussed in Additional Mitigation Measure B1: Kaktovik, the Beaufort Sea Shelf Break, Barrow Canyon and the Western Beaufort Sea, Hanna Shoal, Kasegaluk Lagoon, and Ledyard Bay. Oil and gas exploration activities also would not be allowed to occur outside of these areas within a certain distance (i.e. buffer zones).

The table below indicates the occurrence of other cetacean species in the specified Time/Area Closures. However, these areas do not coincide with areas that are of specific importance for these other cetacean species, with the exception of gray whales, which use some of the same feeding areas as bowheads (see Bowhead Barrow Canyon in Section 4.8.2.4.1), although they are not generally present during the time that the Kaktovik area is closed. Therefore, addition of these Time/Area closures in Alternative 5 is not expected to notably change the anticipated impacts to these other species, and the analysis remains identical to Alternative 4.

Table 4.8-2 Other Cetaceans Presence in Closure Areas Required Under Alternative 5

Species	Shelf Break of the Beaufort Sea	Kaktovik and Cross Island	Barrow Canyon	Hanna Shoals	Ledyard Bay
Baleen whales (mysticetes)					
Gray whale	Uncommon -- July-September	Unknown – very rare, if present	Present July-September, possibly overwintering	Present July-September	Not present
Humpback whale	Rare – August to October	Unknown – very rare, if present	Rare – August to October	Rare – August to October	Not present
Fin whale	Rare – August to October	Not present	Not present	Rare – August to October	Not present
Minke whale	Rare – August to October	Unknown – very rare, if present	Unknown – very rare, if present	Rare – August to October	Not present
Toothed whales (Odontocetes)					
Harbor porpoise	Present	Present	Present	Present	Present
Killer whale	Occasionally present during open water season	Occasionally present during open water season	Occasionally present during open water season	Occasionally present during open water season	Occasionally present during open water season
Narwhal	Very rare, likely extra-limital	Very rare, likely extra-limital	Very rare, likely extra-limital	Very rare, likely extra-limital	Very rare, likely extra-limital

4.8.2.4.3.1 Direct and Indirect Effects

As Alternative 5 has the same level of activity as Alternative 4, the Direct and Indirect Effects for the two alternatives are identical. For a complete discussion of the effects of Direct and Indirect Effects on other cetaceans, please see Section 4.5.2.4.

4.8.2.4.3.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to other cetaceans are discussed under Alternative 2 (Section 4.5.2.4.15). Because the activity levels in both alternatives are identical, the effects of the Standard Mitigating Measures will also be the same.

4.8.2.4.3.3 Conclusion

As noted above, these measure are not expected to change the anticipated impacts to other cetacean species, with the possible exception of a slight reduction of impacts to feeding gray whales (see section 4.8.2.4.1). Gray whales are the most common species of the baleen and toothed whales (excluding bowhead and beluga whales) within the EIS project area, and share many migratory, feeding and life history traits with bowhead whales. Although the Time/Area closures specified in Alternative 5 could potentially mitigate adverse impacts in Barrow Canyon when gray whales are feeding there or nearby, the overall impact on Other Cetaceans of oil and gas exploration activities allowed under this alternative would be similar to Alternative 4 (see Section 4.7.2.4) and would be considered minor.

4.8.2.4.3.5 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to other cetaceans are discussed under Alternative 2 (Section 4.5.2.4.16). Because the activity levels in both alternatives are identical, the effects of the additional mitigating measures will also be the same. For a complete discussion of the effects of additional mitigation measures on other cetaceans, please see Section 4.5.2.4.11.

Type of effect	Impact Component	Effects Summary	
Behavioral disturbance	Magnitude or Intensity	Low	Possible that some other species may not come into contact with activities or be impacted
		Medium	If behavioral harassment occurs, would be < 30% of population disturbed
		High	
	Duration	Temporary	
		Interim	All activity types last more than month, but combination < 6 months
		Long-term	
	Geographic Extent	Local	Effects primarily considered local
		Regional	Impacts from max levels of activity might be considered regional for gray whales when consider area ensonified over 120 dB (>10% EIS area) and fact that gray whales are more likely to be encountered than other species.
		State-wide	
	Context	Common	
		Important	Although not ESA listed, important areas exist for gray whales.
		Unique	
Injury and mortality	Magnitude or Intensity	Low	Injury or death unlikley
		Medium	Though unlikely, cannot rule out PTS
		High	
	Duration	Temporary	
		Interim	Type of potential injury (though unlikely) would likely have moderate effects
		Long-term	
	Geographic Extent	Local	Since unlikely, any few impacts would be considered local
		Regional	
		State-wide	
	Context	Common	Not ESA listed species, but trends of some species not known
		Important	Not ESA listed species, but trends of some species not known
		Unique	
Habitat alterations	Magnitude or Intensity	Low	
		Medium	Combination of potential habitat impacts, including acoustic habitat, are medium
		High	
	Duration	Temporary	
		Interim	Although other alterations shorter, acoustic habitat is altered for duration of activities
		Long-term	
	Geographic Extent	Local	Lower to mid-level of ativities considered regional
		Regional	
		State-wide	
	Context	Common	
		Important	Not ESA listed species, but trends of some species not known
		Unique	Not ESA listed species, but trends of some species not known

4.8.2.4.4 Ice Seals

4.8.2.4.4.1 Direct and Indirect Effects

Alternative 5 assumes the same level of oil and gas exploration activity as Alternative 4, described as Level 3. The activities are divided identically among the different activity types in both alternatives, and the number and types of surveys, exploration, and drilling are all assumed to be the same. Likewise, the Standard and Additional Mitigation Measures are also identical. The analyses for Direct and Indirect

Effects, Standard Mitigation Measures, and Additional Mitigation Measures are the same for Alternative 5 as for Alternative 4.

Alternative 5 differs from Alternative 4 in the creation and application of Time/Area Closures. Time/Area Closures are intended to reduce impacts to certain marine mammal species during sensitive times and locations in their life cycle, and to decrease conflict with Native subsistence. The Time/Area Closures have been chosen to coincide with periods and locations important for marine mammal development and subsistence activities. Specific locations have been identified, and will be closed to oil and gas exploration activities during periods of high use. The closure areas are the same as those discussed in Additional Mitigation Measure B1: Kaktovik and Cross Island, the Beaufort Sea Shelf Break, Barrow Canyon and the Western Beaufort Sea, Hanna Shoals, Kasegaluk Lagoon, and Ledyard Bay. Oil and gas exploration activities also would not be allowed to occur outside of these areas within a certain distance (i.e. buffer zones).

Although the time/area closures are primarily designed to protect bowhead and beluga whales, Hanna Shoal has been noted as an important feeding habitat for bearded seals and Kasegaluk Lagoon and Ledyard Bay are noted as an important haulout/feeding area for spotted seals. The other areas also support ice seals so time/area closures would reduce potentially adverse effects on seals in those areas.

Behavioral Disturbance

The exploration activities that would be authorized under Alternative 5 are identical to those under Alternative 4, so the types and mechanisms for disturbance to ice seals would be the same. The level of disturbance and potential direct and indirect effects on pinnipeds would therefore be the same for Alternative 5 as is discussed for Alternative 4 in Section 4.7.2.4.4, the components of which were considered to be of medium to high intensity, interim duration, local to regional in extent, and of important context. See Section 4.5.2.4 for a complete discussion of disturbance effects, by activity type, on ice seals.

Hearing Impairment, Injury, and Mortality

The exploration activities that would be authorized under Alternative 5 are identical to those under Alternative 4, so the types and mechanisms for injury and mortality to ice seals would be the same. The level of potential direct and indirect physical effects on ice seals would therefore be the same for Alternative 5 as is discussed for Alternative 4 in Section 4.7.2.4.4. See Section 4.5.2.4.12 for a complete discussion of potential injury or mortality effects on ice seals.

Habitat Alterations

The exploration activities that would be authorized under Alternative 5 are identical to those under Alternative 4, so the types and mechanisms for habitat alteration would be the same. The level of potential direct and indirect effects on pinniped habitat would therefore be the same for Alternative 5 as is discussed for Alternative 4 in Section 4.7.2.4.4. See Section 4.5.2.4.12 for a discussion of potential effects oil and gas exploration activities on ice seal habitat.

4.8.2.4.4.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to ice seals are discussed under Alternative 2 (Section 4.5.2.4.15). They would all function to the same level in regard to minimizing disturbance to ice seals as discussed under Alternative 2. The key mitigation measures in this respect concern on-ice activities.

4.8.2.4.4.4 Conclusion

The four species of ice seals would likely not be affected to the same extent by exploration activities in the Beaufort and Chukchi seas based on their respective abundance and distribution. The time/area closures would also have variable capacities to reduce effects on different species proportional to their presence and abundance in the area. Given the standard and additional mitigation measures considered in this EIS, the effects of exploration activities that could be authorized under Alternative 5 on ice seals would likely be medium to high in magnitude, interim in duration, local to regional in extent, and important in context. The effects of Alternative 5 would therefore be considered minor for all ice seal species according to the criteria established in Section 4.1.3.

Type of effect	Impact Component	Effects Summary	
Behavioral disturbance	Magnitude or Intensity	**Low**	
		Medium	Behavioral harassment occurring, but likely < 30% of population disturbed for all species but ringed seals
		High	When maximum activities considered, more than 30% ringed seals may be taken
	Duration	**Temporary**	
		Interim	All activity types last more than month, but combination < 6 months
		Long-term	
	Geographic Extent	**Local**	Effects of activities considered local
		Regional	Max levels potentially regional
		State-wide	
	Context	**Common**	
		Important	ESA-listed species, but impacts not occurring in areas specifically important for feeding/pupping, etc.
		Unique	
Injury and mortality	Magnitude or Intensity	**Low**	Injury or death unlikley
		Medium	Though unlikely, cannot rule out PTS
		High	
	Duration	**Temporary**	
		Interim	Type of potential injury (though unlikely) would likely have moderate effects
		Long-term	
	Geographic Extent	**Local**	Since unlikely, any few impacts would be considered local
		Regional	
		State-wide	
	Context	**Common**	
		Important	ESA listed species,no reliable data available to assess population trends
		Unique	
Habitat alterations	Magnitude or Intensity	**Low**	
		Medium	Combination of potential habitat impacts are medium
		High	
	Duration	**Temporary**	
		Interim	Although other alterations shorter, acoustic habitat is altered for duration of activities
		Long-term	
	Geographic Extent	**Local**	Lower to mid-level of ativities considered local
		Regional	Max levels potentially regional
		State-wide	
	Context	**Common**	
		Important	ESA listed species, population status unknown, no reliable data on trends
		Unique	

4.8.2.4.4.5 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to pinnipeds are discussed under Alternative 2 (Section 4.5.2.4.16).

4.8.2.4.5 Walrus

4.8.2.4.5.1 Direct and Indirect Effects

Alternative 5 includes the same level of oil and gas exploration activity as Alternative 4 (Level 3 Exploration). The number and types of surveys, exploration, and drilling are all assumed to be the same. Standard and Additional Mitigation Measures for Alternative 5 are also identical to those for Alternatives 2, 3, and 4 except that the time/area closures discussed as additional measures in Alternatives 2, 3, and 4 are required in this alternative. The analyses for Direct and Indirect Effects, Standard Mitigation Measures, and Additional Mitigation Measures are the same for Alternative 5 as for Alternative 4, with the exception of the anticipated effects of restricting activities from occurring in the time/area closure areas. The time/area closure expected to affect impacts on walrus (Hanna Shoal) is discussed below.

Time/Area Closures Required Under Alternative 5

Hanna Shoal

Hanna Shoal is considered as a time/area closure location for analysis purposes in this EIS (Figure 3.2-26) from September 15 to early October. It is currently an important feeding area for Pacific walrus (USGS 2011) and was historically important as a feeding area for gray whales (Moore et al. 2000, Nelson et al. 1994). Additionally, the area is used as part of the bowhead whale fall migratory corridor. Closure of Hanna Shoal proposed under Alternative 5 is primarily to mitigate potential impacts on subsistence hunters during the fall bowhead whale hunt (September 15 to close of the hunt). Barrow and Wainwright conduct fall subsistence hunts for bowhead whales in the northeast Chukchi Sea where they could be impacted by vessels transiting between the coast and Hanna Shoal. Harvested whales are generally taken well inshore of Hanna Shoal (Ashjian et al. 2010). Closure of the area to all oil and gas exploration activities during September and October could reduce adverse effects of these activities, especially those associated with noise disturbance, such as displacement, on marine mammals migrating across the area.

Behavioral Disturbance

The exploration activities that would be authorized under Alternative 5 are identical to those under Alternative 4, so the types and mechanisms for disturbance to walrus would be the same. The level of disturbance and potential direct and indirect effects on walrus would therefore be the same for Alternative 5 as is discussed for Alternative 4 in Section 4.7.2.4.5. A more thorough discussion of disturbance effects, by activity type, on walrus can be found in Section 4.5.2.4.13.

Hearing Impairment, Injury, and Mortality

The exploration activities that would be authorized under Alternative 5 are identical to those under Alternative 4, so the types and mechanisms for injury and mortality to walrus would be the same. The level of potential direct and indirect physical effects on walrus would therefore be the same for Alternative 5 as is discussed for Alternative 4 in Section 4.7.2.4.5. A more thorough discussion of potential injury or mortality effects on walrus can be found in Section 4.5.2.4.13.

Habitat Alterations

The exploration activities that would be authorized under Alternative 5 are identical to those under Alternative 4, so the types and mechanisms for habitat alteration would be the same. The level of potential direct and indirect effects on walrus habitat would therefore be the same for Alternative 5 as is discussed for Alternative 4 in Section 4.7.2.4.5. A more thorough discussion of potential impacts on walrus habitat can be found in Section 4.5.2.4.13.

4.8.2.4.5.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to Pacific walrus are discussed under Alternative 2 (Section 4.5.2.4.15). They would all function to the same level in regard to minimizing disturbance to walrus as discussed under Alternative 2. The key mitigation measures in this respect concern in-ice activities and the presence of PSOs.

4.8.2.4.5.3 Conclusion

Walrus have been regularly encountered during vessel-based exploration activities in the past, primarily in late summer as the pack ice recedes, as recorded by PSOs on board seismic source vessels and monitoring vessels. This data indicates that walrus do not react strongly to vessels and active seismic arrays and their behavioral responses are often neutral rather than swimming away. They tend to dive into the water as icebreaking ships approach from some distance and are therefore not exposed to the loudest of sounds generated by the ships. Mitigation measures required for walrus by USFWS LOAs since the early 1990s have reduced the risk of close encounters with seismic and other exploration vessels and have reduced the risk of accidental spills that may affect walrus or their prey. None of the data collected to date on walrus reactions to exploration activities indicate that they would be displaced from key areas or resources for more than a few minutes or hours. Careful avoidance of vessel and aircraft traffic around walrus haulouts on land would be important to minimize the risk of calf and juvenile mortality from stampedes.

Walrus are legally protected, fulfill an important ecological role in the Arctic, and are important subsistence resources and are therefore considered to be a unique resource for NEPA purposes. Given the level and type of exploration activities that would be authorized under Alternative 4, and considering the mitigation measures that would be required by USFWS LOAs and NMFS in this EIS, the effects on walrus would likely be low in magnitude, distributed over a wide geographic area, and interim in duration. The effects of Alternative 5 would therefore be considered minor for Pacific walrus according to the criteria established in Table 4.5-17.

4.8.2.4.5.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to Pacific walrus are discussed under Alternative 2 (Section 4.5.2.4.16). They would all function to the same level in regard to minimizing the risk to walrus and their habitats as discussed under Alternative 2 except that Additional Mitigation Measure B1 would be further defined to include specific closure dates or time periods determined by real-time information. The key additional mitigation measures in this respect concern in-ice activity, the reduction or elimination of discharges from drilling, and the presence of PSOs.

4.8.2.4.6 Polar Bears

4.8.2.4.6.1 Direct and Indirect Effects

This section discusses the potential direct and indirect effects of Alternative 5 on polar bears. This species is dependent on pack ice for much of their denning habitat and for hunting seals. Alternative 5 includes all of the same type of exploration activities as in Alternative 2 so the discussion of potential direct and indirect effects on polar bears under Alternative 5 involves all the same mechanisms and types of effects as discussed for Alternative 2 in Section 4.5.2.4.

Alternative 5 would authorize the same number and types of exploration activities in the Arctic seas as Alternative 4, including the same suite of standard mitigation measures with the addition of mandatory time/area closures. The closure areas are the same as those discussed in Additional Mitigation Measure B1: Kaktovik and Cross Island, the Beaufort Sea Shelf Break, Barrow Canyon and the Western Beaufort Sea, Hanna Shoal, Kasegaluk Lagoon, and Ledyard Bay. Oil and gas exploration activities also would not be allowed to occur outside of these areas within a certain distance (i.e. buffer zones). Specific time periods have been specified for each closure area corresponding to periods of high biological productivity or important life functions for some species. Although the time/area closures are primarily designed to protect bowhead and beluga whales and to avoid conflicts with subsistence hunts during the open-water season, these areas may also be important for ice seals, a primary food source for polar bears. Because

Hanna Shoal is relatively shallow, sea ice often gets grounded and contributes to the consistent formation of leads and polynyas which are important habitat for migrating whales, walrus, ice seals, and hunting polar bears. Additional discussion of the time/area closures follows the summary information on direct and indirect effects and standard mitigation measures.

The exploration activities that would be authorized under Alternative 5 are identical to those under Alternative 4, so the types and mechanisms for disturbance, injury and mortality, and habitat alteration to polar bears would be the same. The level of disturbance and potential direct and indirect effects on polar bears would therefore be the same for Alternative 5 as is discussed for Alternative 4 in Section 4.7.2.4.6. A more thorough discussion of disturbance effects of oil and gas exploration activities on polar bears, and potential impacts to polar bear habitat can be found in Section 4.5.2.4.14.

4.8.2.4.6.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to polar bears are discussed under Alternative 2 (Section 4.5.2.4.15). They would all function to the same level in regard to minimizing disturbance to polar bears as discussed under Alternative 2. The key mitigation measures in this respect concern on-ice activity and the presence of PSOs to monitor for polar bears and help reduce the risk of bear-human encounters.

4.8.2.4.6.3 Conclusion

The specified time/area closures under Alternative 4 are primarily intended to reduce impacts on bowhead and beluga whales and avoid interference with subsistence hunts, not to reduce overall exploration activity. The overall effects on polar bears would therefore be similar to what would occur under Alternative 4 but it may occur in somewhat different times and places. Polar bears have been infrequently encountered during vessel-based exploration activities in the past, as recorded by PSOs on board source vessels and monitoring vessels. These sparse data indicate that polar bears do not react strongly to vessels and active seismic arrays and their behavioral responses are often neutral rather than running or swimming away. They also do not appear to react strongly to icebreaking or on-ice surveys. Some bears keep their distance or move away at some point but others may approach vehicles and equipment out of curiosity. The types of effects of most concern for polar bears during exploration activities involve the risk of bear-human encounters. Mitigation measures and polar bear safety/interaction plans required by USFWS LOAs since the early 1990s have reduced the risk of these encounters for both people and bears. None of the data collected to date on polar bear reactions to exploration activities indicate that polar bears would be displaced from key areas or resources for more than a few minutes or hours and they are unlikely to experience any measurable effects on their reproductive success or survival as a result. Polar bears are legally protected, have a unique ecological role in the Arctic, and are important subsistence resources and are therefore considered a unique resource. Given the mitigation measures that would be required by USFWS LOAs and NMFS as considered in this EIS, the effects of exploration activities that could be authorized under Alternative 4 on polar bears would likely be low in magnitude, distributed over a wide geographic area, and interim in duration. The effects of Alternative 5 would therefore be considered minor for polar bears according to the criteria established in Section 4.1.3.

4.8.2.4.6.5 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to polar bears are discussed under Alternative 2 (Section 4.5.2.4.16). They would all function to the same level in regard to minimizing the risk to polar bears and their habitats as discussed under Alternative 2 except that Additional B1 would be further defined under Alternative 5 to include specific closure dates or time periods determined by real-time information. The key mitigation measures in this respect concern on-ice activity and the presence of PSOs to monitor for polar bears and help reduce the risk of bear-human encounters.

4.8.2.5 Terrestrial Mammals

Activity levels in Alternative 5 are the same as in Alternative 4, with the added requirement for seasonal closures for certain areas. These required closures under Alternative 5 do not affect terrestrial mammals in the EIS project area, so the impacts discussed in Section 4.5.2.5 for Alternatives 2 and 3 are the same for Alternative 5; the overall impact to terrestrial mammals would be minor.

4.8.2.6 Time/Area Closures

The analysis of the direct and indirect effects associated with time/area closures can be found in Sections 4.8.2.4 (Marine Mammals), 4.8.2.3 (Marine and Coastal Birds) and 4.8.3.2 (Subsistence).

4.8.2.7 Standard and Additional Mitigation Measures

Standard and additional mitigation measures that could reduce impacts to the biological environment, other than marine mammals and marine and coastal birds, are discussed under Alternative 2 (Section 4.5.2.7).

4.8.3 Social Environment

4.8.3.1 Socioeconomics

4.8.3.1.1 Direct and Indirect Effects

Time/area closures may cause a reduction in or shift the timing of some support service activities described under Alternative 4. To the extent that time/area closures provide additional benefits to marine mammals and reduce impacts on subsistence activities, there would be some potential socioeconomic benefits. This would apply to all time/area closure areas. Time/area closures may result in productivity costs to lease holders. For example, the underutilization of equipment and the employment of “caretaker” crews to maintain idle equipment, vessels, and camps during closures.

4.8.3.1.2 Conclusion

The socioeconomic impact under Alternative 5 is similar to Alternative 4 except there could be a lower intensity beneficial impact to local communities because time/area closures could reduce total local employment rates and personal income, and a low to medium intensity economic impact to lease holders that incur costs or lose productivity. The duration of the socioeconomic impacts is temporary because it is not year-round; however, the activity is scheduled to occur over a fixed number of years. The positive economic impacts of the activity are statewide and even national. The context of the socioeconomic impacts is unique because the people that would experience the flow of workers and research vessels are predominantly Iñupiat communities. The summary impact level for Socioeconomics under Alternative 4 is minor, not exceeding the significance threshold.

4.8.3.2 Subsistence

4.8.3.2.1 Direct and Indirect Effects

Direct and indirect effects to subsistence resources and subsistence harvest would be expected to be at reduced levels relative to those discussed under Alternative 2 (Section 4.5.3.2.). Alternative 5 differs from Alternative 4 in the creation and application of Time/Area Closures that would be required for all oil and gas exploration activities within a particular time and location. The closure areas are the same as those discussed in Additional Mitigation Measure B1: Kaktovik and Cross Island, the Beaufort Sea Shelf Break, Barrow Canyon and the Western Beaufort Sea, Hanna Shoal, Kasegaluk Lagoon and Ledyard Bay. The intent of Time/Area Closures is to reduce adverse impacts to marine mammals in areas (and times) important to biological productivity and life history functions and to minimize conflicts with Alaskan

Native marine mammal subsistence hunting activities. Section 4.8.2.4 contains a full description of the importance of these required closures to individual marine mammal species. In addition to their importance to life functions of certain marine mammal species, some of the areas are also important subsistence hunting grounds, as noted in Section 4.8.2.4. The areas of Kaktovik and Barrow Canyon and the Western Beaufort Sea are important areas for fall bowhead whaling. Hunters from Point Lay hunt beluga whales in Kasegaluk Lagoon from mid-June to mid-July. Seal hunts also occur at various times of the year near Kaktovik and in the waters of Barrow Canyon and the Western Beaufort Sea, Kasegaluk Lagoon, and Ledyard Bay. Limiting activities in these locations during times when hunts also occur will reduce impacts to subsistence resources in those areas.

4.8.3.2.2 Standard Mitigation Measures

The same Standard Mitigation Measures described for subsistence harvest and subsistence resources in Alternative 2 (Section 4.5.3.2) would be contemplated in Alternative 5. However, under Alternative 5, required time/area closures would be applied in all circumstances instead of being considered as additional mitigation measures, as is the case for Alternatives 2, 3, 4, and 6. These required closures would be considered beneficial as they would further limit potential impacts to subsistence harvests and users. The required time/area closures for Kaktovik, Barrow Canyon, the Western Beaufort Sea, and the Shelf Break in the Beaufort Sea would reduce potential impacts from disturbance on specific subsistence harvests areas utilized by the communities of Kaktovik and Barrow for marine mammal harvest of bowhead whales, seals, walrus, and polar bear.

As noted by Harry Brower of the AEWC in written comments submitted for this EIS on April 9, 2010:

> *We strongly encourage NMFS to implement protective measures for critical subsistence use areas, including: - areas used by the Village of Kaktovik in the eastern Beaufort; - areas around Cross Island used by the Village of Nuiqsut; - areas used by the Village of Barrow in the western Beaufort; and - areas used by Wainwright and Pt. Lay along the Chukchi Sea coast. NMFS should consider deferring these areas from industrial activity or implementing seasonal closure and restrictions … Because of the potential impacts to bowhead whales, we encourage NMFS to implement specific protections for areas that provide important habitat characteristics, including deferring industrial activity in these areas or implementing seasonal closures and restrictions. In particular, NMFS must provide proven protections for the following areas: - critical feeding and resting grounds near Camden Bay in the mid-Beaufort; and - critical feeding grounds in the eastern Beaufort and near Barrow Canyon in the western Beaufort. NMFS should also focus on key behavioral characteristics and vulnerable members of the population, including feeding and resting during the migration, communication, and impacts to mothers and calves.*

The time/area closures required under Alternative 5 for Kasegaluk Lagoon and Ledyard Bay in the Chukchi Sea would be reduce any potential adverse impacts from distribution of subsistence harvest and use for the communities of Wainwright, Point Lay, and Point Hope. These are areas where marine mammal hunting is concentrated and where important bird hunting and fishing occur. Kasegaluk Lagoon and Ledyard Bay are areas where Point Lay subsistence hunts occur for harvest of beluga whales, walrus, bearded, ringed and spotted seals, and polar bear, as well as birds and fish. Point Hope subsistence users would benefit from this time/area closure, as they hunt in Ledyard Bay for seals and walrus. However, the protection would be in addition to that provided by BOEM OCS Lease Stipulation 7, which requires that "except for emergencies or human/navigation safety, surface vessels associated with exploration and delineation of drilling operations will avoid travel within the LBCHU between July 1 and November 15."

4.8.3.2.3 Conclusion

Direct and indirect impacts to subsistence harvest and subsistence resources are likely to be similar or less than those of Alternative 2 as discussed in Section 4.5.3.2. The impacts of implementing Alternative 5 could be considered beneficial to subsistence harvests and users as the time and area closures would be applied in all circumstances instead of being considered as additional mitigation measures. Using the impact criteria identified in Table 4.5-25, the direct and indirect effect of oil and gas exploration activities on subsistence resources resulting from implementation of Alternative 5 would be of low intensity, temporary to interim in duration, local to regional in extent, and the context would be common to important. Therefore the summary impact level of Alternative 5 on subsistence resources and harvests would be considered to range from negligible to minor depending upon the specific subsistence resource affected and source of disturbance, as there is the potential for these time/area closures to reduce the impact levels from those for Alternative 4.

4.8.3.2.4 Additional Mitigation Measures

The same Additional Mitigation Measures described for subsistence harvest and subsistence resources in Alternative 2 (Section 4.5.3.2) would be contemplated in Alternative 5.

4.8.3.3 Public Health

4.8.3.3.1 Direct and Indirect Effects

Anticipated effects to public health as a result of Alternative 5 are expected to be similar to those expected under Alternative 2, as discussed in Section 4.5.3.3. The effect of the time/area closures on subsistence resources is described in Section 4.8.3.2, which concludes that the closures will have a beneficial effect on subsistence harvests in Kaktovik and Barrow of bowhead whales, seals, walrus, and polar bear. Section 4.8.3.2 concludes that there would be beneficial effects for the communities of Wainwright, Point Lay, and Point Hope because of the closure of Kasegaluk Lagoon and Ledyard Bay. To the extent that these time/area closures improve the likelihood of maintaining a strong subsistence harvest, there will also be resulting benefits to public health. Similarly, insofar as time and area closures minimize dispersion of marine mammals and allow hunters to complete their hunts with less travel time, the potential impact to safety should be reduced. However, these benefits do not affect the overall impact criteria rating, as the anticipated results to public health are already negligible.

4.8.3.3.2 Conclusion

Both potential beneficial and adverse impacts are anticipated as a result of Alternative 5. Possible changes could occur to health outcomes such as chronic disease and trauma and many of the pathways relate to traditional practices and subsistence activities. However, there is a very low likelihood of these health outcomes arising, and effects are unlikely to be large enough cause a measurable change in health outcomes. The magnitude or intensity of effects is estimated to be low: above background conditions, but small and within both the natural variation and adaptive ability of the local population. If health changes do occur, the duration of changes may be permanent, and multiple communities could be affected.

4.8.3.4 Cultural Resources

4.8.3.4.1 Direct and Indirect Effects

Activity levels in Alternative 5 are the same as in Alternative 4. These mitigation measures do not affect cultural resources in the EIS project area, so the impacts discussed in Section 4.5.3.4 for Alternative 2 are the same for Alternative 5. The overall impact to cultural resources would be minor.

4.8.3.4.2 Conclusion

Direct and indirect impacts to cultural resources resulting from the implementation of Alternatives 2, 3, and 4 would be the same in Alternative 5. For a complete discussion of direct and indirect impacts on cultural resources, please see Section 4.5.3.4.

4.8.3.5 Land and Water Ownership, Use, and Management

4.8.3.5.1 Direct and Indirect Effects

Land and Water Ownership

The direct and indirect impacts to land and water ownership resulting from Alternative 5 are similar to those resulting from Alternative 4. Refer to Section 4.5.3.5 for a discussion on these topics. This includes federal, state, private, borough, and municipal owned lands and waters.

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. See Section 4.8.3.2, Subsistence for further discussion.

The direct and indirect impacts to land and water use resulting from Alternative 5 are similar to those resulting from Alternative 4 for recreational, residential, and mining land uses. Refer to Section 4.5.3.5 for a discussion on these topics.

Alternative 5 includes the same activity level as Alternative 4 but with required time/area closures during important biological and subsistence activities. This would effectively remove these areas from uses other than subsistence activities during the closure season and temporarily increase the area of land and water devoted to ecological and subsistence purposes.

The direct and indirect impacts caused by Alternative 5 for industrial, transportation, and commercial land uses are similar to those discussed under Alternative 4 in Section 4.7.3.5, except that 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.

Land and Water Management

Constraining exploration to certain times and locations may have varied effects on state and federal management policies. On the one hand, the use of time/area closures may result in more moderate state and federal resource development goals, while on the other hand 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 one approach to balanced management and do not prohibit resource development, no inconsistencies or changes in federal or state land or water management are anticipated as a result of this alternative. The effects are the same as discussed under Alternative 2, Section 4.5.3.5.

The direct and indirect impacts to borough land and water management caused by Alternative 5 are similar to those caused by Alternative 4. Refer to Section 4.6.3.5 for a discussion on these topics.

4.8.3.5.2 Conclusion

Based on Table 4.4-2 and the analyses provided in Section 4.5.3.5, the impacts on land and water ownership under Alternative 5 are described as follows. The magnitude of ownership impacts would be low because no changes in land or water ownership will result from this action. The duration of impact would be temporary because no ownership changes will occur. The extent of impacts would be local, occurring only in the activity area and involving no ownership change. The context of impact would be common because the federal waters affected have no special, rare, or unique ownership characteristics. In total, the direct and indirect impacts on land ownership are considered to be negligible; they would be low intensity, temporary, localized, and do not result in changes of ownership.

Based on Table 4.4-2 and the analyses provided above and in Sections 4.5.3.5 and 4.6.3.5, the impacts of land and water use caused by Alternative 5 are described as follows. The magnitude of impact would be high when activity occurs in areas of little to no previous activity (such as Wainwright), and the magnitude of impact would be low in areas where previous activity is common (Prudhoe Bay, Barrow, Nome, Dutch Harbor). The duration of impact would be temporary because an increase in aircraft and shipping traffic would last only for that survey season, although the impact could be permanent if construction of a new facility or infrastructure to accommodate shipping traffic were built in Wainwright. The extent of impacts would be local because any changes in land use as a result of this alternative would be limited geographically to the communities that would support the survey vessels. The context of impact would be common because the areas of land and water use affected are extensively available and have no special, rare, or unique characteristics identified. In summary, the direct and indirect effects of Alternative 4 would be moderate because of the possibility for high magnitude activities and long term construction in smaller communities.

Based on Table 4.4-2 and the analyses provided above and in Sections 4.5.3.5 and 4.6.3.5, the impacts on land and water management caused by Alternative 5 are described as follows. The magnitude of impact would be low because the action is consistent with existing management plans. The duration of impact would be long term because area closures would happen annually for several years. The extent of impacts would be local because proposed activities would not involve management plans beyond the localized areas of seismic exploration and support activities. The context of impact would be common because the areas of land and water affected are extensively available and have no special, rare, or unique characteristics identified in an adopted management plan. In total, the direct and indirect impacts of Alternative 4 on land and water management would be moderate because they would be low intensity, long term in nature, local, and common.

4.8.3.6 Transportation

4.8.3.6.1 Direct and Indirect Effects

The effects to transportation in Alternative 5 would be similar to those described under Alternative 2 (Section 4.5.3.6) though of elevated intensity and over a wider range of the spatial and temporal orientations given the potential simultaneous occurrence of activities that could occur under Alternative 5 versus Alternative 2. Increased traffic outside of the time/area closures could be the result.

Under Alternative 5, the required time/area closures associated with Kaktovik and Cross Island, Barrow Canyon and the Western Beaufort Sea, the Beaufort Sea shelf break, Hanna Shoal, Kasegaluk Lagoon, and Ledyard Bay would prevent activities from occurring in these areas and would therefore limit the amount of aircraft overflights in these areas associated with seismic survey and exploratory drilling programs. Because of the additional requirements associated with Alternative 5, aircraft could be prevented from overflying and/or operating in these areas, and there would therefore be no direct or indirect impact from transportation in these areas. In the event that inclement weather necessitated emergency flights through these special use areas, the intensity of the action would be low and temporary in duration. Any direct impact would be limited in geography to a local area and common in context. The probability of occurrence would be low, and any direct impact that did occur would be considered negligible to minor.

The direct impact in an increase in the amount of oil and gas exploration activities would be an increase in levels of air traffic and vessels present in these areas associated with seismic survey and exploratory drilling activities in comparison to levels projected under Alternative 2. The intensity of the impact would be considered low and short term in duration (length of survey or exploratory drilling activities each year). The extent of increased aircraft presence may be on a local and regional scale given the increased number of seismic survey and exploratory drilling programs that could occur. Impacts from the increased levels of air traffic would be to a common to potentially unique context (in respect to protected marine mammal resources), and, as a result, the impact level could be considered minor.

4.8.3.6.2 Conclusion

It is assumed that vessel traffic associated with the seismic survey and exploratory drilling programs would be prevented from transiting or operating in these closed areas under Alternative 5. Any direct impact to regional marine transportation would be low in intensity, temporary in duration, and limited in geographic extent to a local area and common in context. The probability of occurrence would be low, and any summary impact that did occur would be considered minor.

4.8.3.7 Recreation and Tourism

4.8.3.7.1 Direct and Indirect Effects

To the extent that the required time/area closures contemplated in Alternative 5 provide benefit to marine mammals, they would be beneficial to tourism based on wildlife viewing, and similar to the benefits of other standard and additional mitigation measures. The potential impacts discussed in Sections 4.5.3.7 and 4.6.3.7 for Alternatives 2 and 3 are the same for Alternative 5; the overall impact to recreation and tourism would be minor.

4.8.3.7.2 Conclusion

The direct impacts would be low intensity, temporary duration, local extent, and common in context. Indirect impacts would be the same levels as direct impacts, except that the geographic area would be broader, extending beyond the region to a state-wide level and potentially beyond. In summary, the impact of Alternative 4 on recreation and tourism would be minor.

4.8.3.8 Visual Resources

This section discusses potential impacts on visual resources that could result from implementing Alternative 5 of the proposed project.

4.8.3.8.1 Direct and Indirect Effects

Implementation of Alternative 5 is expected to result in short-term moderate effects to scenic quality and visual resources identical to those described in Alternative 4. Potential impacts could be of low to medium intensity, depending on the geographic separation of programs. In either case, actions would be temporary, localized and occur in an important context.

4.8.3.8.2 Conclusion

Implementation of Alternative 5 is expected to result in *short-term moderate effects* to scenic quality and visual resources. Potential impacts could be of low to medium intensity depending on specific location of drill sites. The geographic extent of potential impacts would be localized; however they would occur in an important ecosystem.

4.8.3.9 Environmental Justice

4.8.3.9.1 Direct and Indirect Effects

With the incorporation of time/area closures, the impacts to subsistence activities could be further minimized but would remain as minor impacts to subsistence foods and human health (see Subsistence Section 4.7.3.2). Contamination of subsistence foods would be the same as discussed under Alternative 4.

4.8.3.9.2 Conclusion

Activities related to implementation of Alternative 5 would have a low intensity impact on subsistence resources and human health, a temporary duration, and a regional extent. Subsistence foods and human health are unique resources, and they are protected under the MMPA and EO 12898. Thus, Alternative 5 is expected to have a minor impact to subsistence resources and minor disproportionate impacts to Alaska Native communities.

4.8.3.10 Standard and Additional Mitigation Measures

Standard and additional mitigation measures that could reduce impacts to the social environment, other than subsistence, are discussed under Alternative 2 (Section 4.5.3.10).

4.9 Direct and Indirect Effects for Alternative 6 – Authorization for Level 3 Exploration Activity with Use of Alternative Technologies

This section analyzes how the alternative technologies described in Section 2.3.5 of this EIS could potentially reduce impacts to the physical, biological, and social environments, especially for marine mammals and subsistence uses of marine mammals. Under Alternative 6, the number of exploration programs envisioned is identical to Alternatives 4 and 5 (see Sections 4.7.1.4 and 4.8.1.4), but allows for the use of alternative technologies to replace or augment traditional airgun-based seismic exploration techniques used for some of these surveys. Alternative 6 contemplates Level 3 activities with the number of activity types to be considered for analysis purposes defined in Table 4.2-2.

The level of reduction in impacts is dependent upon how many traditional seismic surveys (i.e. use of airgun arrays) can be replaced or augmented by these alternative technologies. Because the majority of these technologies have not yet been built and/or tested, it is difficult to fully analyze the level of impacts from these devices. Therefore, additional NEPA analyses (i.e. tiering) will likely be required if applications are received requesting to use these technologies during seismic surveys. Additional detail on the implementation of this EIS is discussed in Chapter 5.

4.9.1 Physical Environment

4.9.1.1 Physical Oceanography

4.9.1.1.1 Direct and Indirect Effects

Water Depth and General Circulation

The effects of Alternative 6 on water depth and general circulation would be the same as those described for Alternative 4 and remain minor.

Currents, Upwellings, and Eddies

The effects of Alternative 6 on currents, upwellings, and eddies would be the same as those described for Alternative 4.

Tides and Water Levels

The activities described under Alternative 6 would not affect tides or water levels within the EIS project area.

Stream and River Discharge

The activities described under Alternative 6 would not affect stream and river discharge within the EIS project area.

Sea Ice

The effects of Alternative 6 on sea ice would be the same as those described for Alternative 4. The additional mitigation measures included in Alternative 6 would not substantially change the effects of the alternative on sea ice resources in the proposed action area.

4.9.1.1.2 Conclusion

The effects of the proposed actions on physical ocean resources would be medium-intensity, temporary, local, and would affect common resources as defined in the impact criteria in Section 4.1 of this EIS. The overall effects of the proposed activity described in Alternative 6 on physical ocean resources in the proposed action area would be minor.

4.9.1.2 Climate

Under this alternative, emissions would be the same as for Alternative 4 and Alternative 5 because the alternative proposes exploration plans described as Level 3 Exploration Activity on the Arctic OCS. The specific description and number of each of these programs and activities proposed for the Arctic OCS, on an annual basis, were summarized earlier in Table 2.4 (*Activity Definitions*) and Section 2.4.5 (*Alternative 2 – Authorization for Level 1 Exploration Activity*).

Refer to Section 3.1.4.4 Climate Change in the Arctic for a thorough discussion of climate systems and the effects of GHG emissions.

4.9.1.2.1 Direct and Indirect Effects

Direct Effects

Direct effects under this alternative are the same as those described under Alternative 2.

Indirect Effects

Indirect effects under this alternative are the same as those described under Alternative 2.

Regulatory Reporting and Permitting

Regulatory reporting and permitting under this alternative would be the same as those described under Alternative 2.

CO_2e Emissions Inventory

The CO_2e emissions inventory is the same for this alternative as given for Alternative 4.

Effects of this Alternative on Climate Change

The effects of this alternative are the same as those described for Alternative 4.

Effects of Climate Change on Resources under this Alternative

Effects of climate change on resources under this alternative would be the same as described under Alternative 2.

4.9.1.2.2 Conclusion

The conclusion of the assessment under this alternative is the same as for Alternative 4.

4.9.1.3 Air Quality

Under this alternative, emissions would be the same as described for Alternative 4 and Alternative 5 and proposes any level of EPs up to the maximum which is four EPs for each planning area. The majority of additional emissions are from the EPs proposed for Level 3 Exploration Activity.

4.9.1.3.1 Direct and Indirect Effects

Direct and indirect effects under this alternative would be from the same sources of emissions as described under Alternative 2 in Section 4.5.1.3.

Exploration Plan Emission Inventory

The emission rates likely to reflect Level 3 Exploration Activity in each planning area are the same as those presented for Alternative 4 in Table 4.7-2.

The inventory assumes no application of BACT or the use of ULSD fuel. The emission inventory assumes the same method of calculation and EP operational characteristics as described for Alternative 2.

Survey Emission Inventory

The number and type of seismic and other surveys would be the same as described for Alternative 4 and Alternative 5. The emission rates likely to reflect the increased level of seismic and other surveys under this alternative are the same as those presented for Alternative 4 in Tables 4.7-3 and 4.7-4.The survey inventories assume no application of BACT or the use of ULSD fuel. The emission inventory assumes the same method of calculation and survey vessel operational characteristics as described for the previous alternatives.

4.9.1.3.2 Air Quality Impact Analysis

The air quality impact analysis would be conducted as described under Alternative 2.

4.9.1.3.3 Level of Effect

The annual rate of air emissions and onshore pollutant concentrations are the two basic measurements for assessing a proposal's level of effect on air quality. The emission inventory provided in this section discloses the rate of emissions likely to reflect a proposal under this alternative, expressed in short tpy. When necessary, an emission inventory is translated into pollutant concentrations expressed in micrograms per cubic meter ($\mu g/m^3$), a value that can be measured against the NAAQS allowing the level of effect to be categorized relative to the conditions summarized under Alternative 2 in Table 4.5-7 *Impact Levels for Effects on Air Quality*. Further information regarding level of effect under this alternative would be the same as discussed under Alternative 4.

4.9.1.3.3 Conclusion

Emissions from exploratory drilling activities proposed under this alternative would be higher than emissions estimated for Alternative 2. Without emission reduction controls on the drillship engines, there is a greater potential for one or more of the EPA SILs to be exceeded onshore. The Level 2 Exploration Activity would almost certainly require additional modeling to demonstrate the effect of pollutant concentrations on the nearest onshore area. A moderate level of effect on air quality is expected, which may be mitigated by emission control strategies to result in a minor level of effect. Cumulatively, the total estimated emissions for each Arctic OCS planning area, when considering all plans and activities described under this alternative, are the same as those summarized for Alternative 4 in Table 4.7-5.

Control of oil and gas emission sources on the OCS, and levels of effect, are considered on a project-by-project basis, as each individual operator would have the responsibility to engage any engine emission controls required by BOEM AOCSR. Emission reduction strategies have the potential to reduce at least some emissions of all pollutant types, including CO_2e. Therefore, the data provided in Table 4.7-5 would represent a worst-case scenario for each Arctic OCS planning area.

4.9.1.4 Acoustics

Under Alternative 6, the number of exploration programs envisioned is the same as for Alternatives 4 and 5 (see Sections 4.7.1.4 and 4.8.1.4), but this alternative considers the use of alternate technologies to replace airgun array systems used in these surveys.

Section 2.3.5 provides a discussion of possible alternate technologies that are in various stages of development. The benefits of using these sources would primarily be at reducing impulsive sound levels near seismic survey sources. Some of the alternate technologies use longer-duration signals at lower amplitude. Extended duration signals may be more audible to marine mammals than short duration impulsive signals having the same amplitude. Nevertheless, the possible reduction in ensonification zone radii corresponding to reductions in source signal amplitude only is considered for this alternative.

The source pressure level reductions that will be achieved using alternate sources are presently unknown, but might expect reductions by approximately 10 to 20 dB from current airgun array source levels. For this analysis it will be assumed that source pressure level can be reduced by up to 10 dB. The received SPL at distance from the source depends on sound transmission loss between the source and receiver. Transmission loss is frequency dependent and also influenced by source depth and source directivity. If the alternate source operates at a different depth than standard airguns or has different directivity or spectral density function (sound energy at different frequencies), then received SPL will be different than that of an airgun array with the same broadband source level. A further complicating factor is that the 90% rms SPL metric used for impulsive source pressure signals is dependent on the pulse duration. Three assumptions have to be made to estimate reductions in received SPL for alternate source types: (a) the alternate source operates at the same depth as the airgun array source, (b) the alternate source has the same spectral distribution and directivity as the airgun array source and (c) the pulse duration remains the same as that of the airgun array.

Under the above assumptions, the reduction in distances to sound level thresholds can be made based on the sound level versus distance functions that have been measured for all of the seismic survey programs listed in Table 4.5-9. As an example, the function for Statoil's 2010 3-D survey near their Amundsen prospect in the Chukchi Sea is defined by L_{P90}. = 235.1 – 17.5 Log(r) – 0.00051 r, where L_{P90} is the 90% rms received SPL and r is the distance from the source in meters (O'Neill et al., 2011). Using this formula, and a 10 dB source level reduction factor, the distance reductions to several acoustic thresholds is given in Table 4.9-1.

Table 4.9-1 Acoustic threshold radii reductions from use of an alternate source operating with source level 10 dB less than a 3000 in^3 airgun array (see text).

SPL Threshold 90% rms (dB re 1 µPa)	Original radius (m)	Reduced radius (m)
190	370	100
180	1290	370
160	10000	4000
120	61000	46000

It is helpful to consider the change in ensonified area arising from assumed reductions in sound for various source intensity reductions under different acoustic propagation conditions. Table 4.9-2 shows the total ensonified surface area (as a percentage of the full EIS project area) to threshold levels of 120 and 160 dB for the case of no reduction (Alternative 3; see Table 4.6-6) and reductions of 3, 5 and 10 dB. The influence of the sound reduction on the area depends on the acoustic propagation regime; transmission loss rates (drop in dB level with distance from the source) of 25, 20 and 15 log (range) are shown in the table, encompassing conditions potentially encountered in the EIS project area. When considering the notional results shown in this table it should be noted that sound propagation at long ranges is subject to losses that may exceed the predictions of a geometric spreading law k log(r) applicable at shorter ranges. Because of this, the reduction in ensonified area size associated with a given decrease in source level may be not as pronounced as shown in the table.

Table 4.9-2 Ensonified area (as % of EIS project area) for assumed reductions in source level using alternative technologies. Estimates are shown for three propagation loss rates.

	Percent Surface Area Ensonified to 120 dB re 1 μPa (90% rms SPL)				Percent Surface Area Ensonified to 160 dB re 1 μPa (90% rms SPL)		
Reduction in source intensity	25 log R	20 log R	15 log R		25 log R	20 log R	15 log R
0 dB (none)	40%	40%	40%		0.67%	0.67%	0.67%
3 dB	22%	20%	15%		0.39%	0.34%	0.27%
5 dB	15%	12%	8%		0.27%	0.21%	0.15%
10 dB	6%	4%	2%		0.11%	0.07%	0.03%

<u>4.9.1.4.1 Direct and Indirect Effects</u>

Table 4.9-1 provides examples of sound level threshold distance reductions that would result from an alternate source type capable of lowering the source levels of a standard 3000 in^3 airgun array by 10 dB. The 190 dB re 1 µPa radius is reduced by 73 percent, while the 120 dB re 1 µPa radius is reduced by 24 percent. The reduction of surface area ensonified to 120 dB re 1 µPa assuming a 10 dB in source level varies from an 85 percent reduction assuming 25logR geometric spreading loss to a 95 percent reduction for a spreading loss of 15logR.

<u>4.9.1.4.2 Conclusion</u>

Alternative 6 proposes the same level of exploration activities as Alternative 4 but suggests the implementation of alternative technologies that reduce sound emission levels from seismic survey sources. The intensity rating of this alternative is maintained at high because it is unlikely the technologies will entirely preclude the generation of source sound levels exceeding 200 dB re 1 μPa. Likewise the duration is unchanged from the other alternatives and remains long term, as no change in activity duration is anticipated. The extent for this alternative is still considered to be regional if the alternate source has a source sound level that is lower than that for a 3,000 in^3 airgun array by less than 10dB. However, the estimates in Table 4.9-2 indicate that a 10dB reduction in source intensity would change the extent for this alternative to local since less than 10 percent of the EIS project area would be exposed to sound levels in excess of 120 dB re 1 μPa in this case. Because implementation of these technologies is not certain within the timeframe for this EIS, the overall impact rating for direct and indirect effects to the acoustic environment would be moderate.

4.9.1.5 Water Quality

Impacts to water quality resulting from the activities proposed under Alternative 6 are expected to be very similar to those described above for Alternatives 4 and 5. Alternative 6 includes mitigation measures that focus on the use of alternative technologies to replace or augment traditional airgun-based seismic exploration techniques. However, these mitigation measures are not expected to affect the level of water quality impacts. Any differences in impacts between Alternative 5 and the previous alternatives are noted below. See Chapter 2 for descriptions of the mitigation measures included under Alternative 6.

4.9.1.5.1 Direct and Indirect Effects

Temperature and Salinity

Seismic Surveys

Similar to impacts for Alternatives 2, 3, 4, and 5, seismic surveys would not be expected to have any measureable impact on temperature or salinity in the proposed action area.

Turbidity and Total Suspended Solids

Seismic Surveys

Similar to impacts for Alternatives 2, 3, 4, and 5, effects on water quality resulting from increases in turbidity and total suspended solids from seismic surveys under Alternative 6, if any, are expected to be low-intensity, temporary, local, and would affect a common resource.

Proposed mitigation measures intended to reduce/lessen non-acoustic impacts on marine mammals have the potential to further reduce adverse impacts to water quality.

Metals

Seismic Surveys

Similar to impacts for Alternatives 2, 3, 4, and 5, seismic surveys are not be expected to have any measureable impact on dissolved metal concentrations in the proposed action area.

Hydrocarbons and Organic Contaminants

Seismic Surveys

Similar to impacts for Alternatives 2, 3, 4, and 5, seismic surveys are expected to have negligible impacts on concentrations of hydrocarbons and organic contaminants in the waters of the proposed action area.

4.9.1.5.2 Conclusion

Alternative 6 could potentially require the use of alternative technologies that may replace or augment traditional airgun-based seismic exploration techniques. Such alternative technologies are not expected to affect impacts to water quality. After mitigation, the effects of the proposed actions on water quality are expected to be low-intensity, temporary, local, and would affect a common resource. The overall effect of the proposed activity described in Alternative 5 on water quality in the proposed action area would be minor.

4.9.1.6 Environmental Contaminants and Ecosystem Functions

4.9.1.6.1 Direct and Indirect Effects

Contaminants of Concern

Contaminants of concern introduced to the EIS project area as a result of the activities proposed in Alternative 6 would be the same as those described for Alternative 2.

Proposed mitigation measures intended to reduce/ lessen non-acoustic impacts on marine mammals have the potential to reduce adverse impacts resulting from contaminants of concern.

Exposure of Habitat and Biological Resources

Pathways for exposure of habitat and biological resources to contaminants of concern as a result of the activities proposed in Alternative 6 would be the same as those described for Alternative 2.

Potential Effects on Ecosystem Functions

In response to comments and suggestions received as part of the scoping process for this EIS, effects of (contaminants of concern from) the proposed activities on ecosystem functions are assessed in the following section. Effects of the activities proposed under Alternative 6 on the four categories of ecosystem functions (defined in Section 4.4.1.6) are assessed below.

Regulation Functions

The effects of the activities proposed under Alternative 6 on regulation functions would be the same as those described under Alternative 4.

Habitat Functions

Alternative technologies associated with Alternative 6 have the potential to decrease adverse impacts to habitat functions that could result from traditional airgun-based exploration techniques. The extent and nature of the reduction to adverse impacts to habitat functions are described in detail in the sections of this EIS related to acoustics and marine mammals.

Production Functions

The effects of the activities proposed under Alternative 6 on production functions would be the same as those described under Alternative 4.

Information Functions

The effects of the activities proposed under Alternative 6 on information functions would be the same as those described under Alternative 4.

4.9.1.6.2 Conclusion

Direct and indirect impacts to ecosystem functions resulting from the implementation of Alternative 6 would be medium-intensity, temporary, and local. The functional properties of ecosystems described in this section, such as nutrient cycling and habitat functions, are more robust (i.e. resistant to stressors) than are species composition and other structural properties. Overall effects of Alternative 6 on ecosystem functions would be minor.

4.9.1.7 Standard and Additional Mitigation Measures

Standard and additional mitigation measures that could reduce impacts to the physical environment are discussed under Alternative 2 (Section 4.5.1.7).

4.9.2 Biological Environment

4.9.2.1 Lower Trophic Levels

4.9.2.1.1 Direct and Indirect Effects

Activity levels in Alternative 6 are the same as in Alternative 4, but this alternative includes the option of using alternative technologies for seismic exploration. This requirement does not affect lower trophic levels in the EIS project area, so the impacts discussed previously for Alternatives 2, 3, 4, and 5 are the same for Alternative 6; the overall impact to lower trophic levels would be minor.

4.9.2.1.2 Conclusion

The direct and indirect effects associated with Alternative 6 would likely be low in intensity, temporary to long-term in duration, of local extent and would affect common resources; resulting in a summary impact level of negligible. The only exception to these levels of impacts would be the introduction of an invasive species due to increased vessel traffic, which could be of medium intensity, long-term or permanent duration, of regional geographic extent, and affect common or important resources, which could cause a summary impact of moderate.

4.9.2.2 Fish and Essential Fish Habitat

4.9.2.2.1 Direct and Indirect Effects

Alternative 6 applies the same levels of activity as Alternative 4, described as Level 3. The activities are divided identically among the different activity categories in both alternatives, and the number and types of surveys, exploration, and drilling are all assumed to be the same. Likewise, the Standard and Additional Mitigation Measures are also identical. Alternative 6 differs from Alternative 4 in the application of alternative technologies.

Five different technologies are currently being developed, and all are at different stages in the testing process, although none of the systems with the potential to augment or replace airguns as a seismic source are currently commercially available. For the purposes of this EIS, it is assumed that they will be implemented over time as further testing and refinement makes them available for general application.

The analysis for this alternative focuses on the mitigating effects of each of the individual alternative technologies and how they would reduce impacts from the levels described in Alternative 4. Many of these technologies are in the early stages of development or have not yet been developed, and it is therefore difficult to offer a thorough analysis. Instead, general impacts based on limited information have been provided.

For a complete analysis of the effects on fish and fish resources from Alternative 2, see Section 4.5.2.2.

4.9.2.2.2 Alternative Technologies

Hydraulic Marine Vibrators

The replacement of each airgun with a hydraulic marine vibrator would likely reduce adverse impacts through the manner in which sound is emitted into the marine environment. Marine vibrators emit sounds at lower pressure levels than airguns and over a narrower range of frequencies than do airguns, thereby potentially reducing the amount of damage caused to any fish in the immediate vicinity of the source, and reducing the number of fish able to hear the sound.

Electric Marine Vibrators

The replacement of each airgun with an electric marine vibrator would likely reduce adverse impacts through the manner in which sound is emitted into the marine environment. Marine vibrators emit sounds at lower pressure levels than airguns and over a narrower range of frequencies than do airguns, thereby potentially reducing the amount of damage caused to any fish in the immediate vicinity of the source, and reducing the number of fish able to hear the sound.

Low Frequency Acoustic Source (LACS)

This technology is still in the early phases of development and therefore difficult to analyze. However, in theory, the LACS uses a sound generating method that results in lowered amounts of energy put into the water compared to a traditional airgun array. This would reduce potentially adverse impacts to fish by decreasing the number of fish exposed to high sound levels and potentially reduce the impacts from high sound levels as the maximum levels would be lower.

Deep-Towed Acoustics/Geophysics System (DTAGS)

For the purposes of analysis under this alternative, it is assumed that a DTAGS system could someday replace a single airgun array. Based on an analysis of its operations, it is possible that it could increase adverse impacts by increasing the total amount of exposure by fish resources to sound energy. By offsetting the location of the sound source from the near surface to the vicinity of the seafloor, the number of fish exposed to high sound levels would increase, provided the sound levels emitted were similar to airguns. Demersal habitats are typically more productive than pelagic ones, with higher fish densities and more feeding and spawning regions susceptible to sonic damage.

Low Frequency Passive Seismic Methods for Exploration

Low Frequency Passive Seismic Methods for Exploration are already in use but not yet proven in all environments. Of all the technologies, this one shows the most promise for mitigating adverse effects on fish, due to its passive acoustic nature. No sound would be emitted into the marine environment, resulting in the elimination of all seismic noise impacts.

4.9.2.2.3 Conclusion

The effect of the alternative technologies outlined in Alternative 6 on fish resources and EFH are difficult to determine with any certainty but are anticipated to result in a reduction in the overall impact. Although the overall impact is considered to be negligible based on Alternative 4 alone, any replacement of airgun arrays with alternative technologies would be reduce potentially adverse effects on fish. However, the limited number of airgun arrays that could be replaced by any of these technologies is fairly limited, thereby resulting in minimal reductions of overall impact levels. Therefore, there would be no measurable effect on the resource, and overall impact is considered to be negligible.

4.9.2.3 Marine and Coastal Birds

4.9.2.3.1 Direct and Indirect Effects

Alternative 6 includes all of the same type of exploration activities as in Alternative 2 so the discussion of potential direct and indirect effects on marine and coastal birds under Alternative 6 involves all the same mechanisms and types of effects as discussed for Alternative 2 in Section 4.5.2.3. This EIS includes a number of standard and additional mitigation measures as part of each alternative that are intended to reduce adverse effects on marine mammals but may also reduce adverse effects on birds. In addition to the mitigation measures imposed by NMFS, the USFWS requires certain mitigation measures specific to ESA-listed species under its jurisdiction, including spectacled and Steller’s eiders (USFWS 2009c). Section 4.5.2.3 summarizes the mitigation measures typically required by the USFWS and other agencies for oil and gas exploration activities in the Beaufort and Chukchi seas to minimize impacts on birds and these measures are incorporated into the analysis of potential effects under Alternative 6.

The number of different exploration activities authorized under Alternative 6 would be the same as under Alternatives 4 and 5. However, implementation of Alternative 6 could potentially encourage industry to gradually replace current seismic airgun technology with alternative methodologies intended to reduce the amount of loud seismic sounds introduced into the marine environment that could have adverse effects on marine mammals. Because birds are able to fly away from approaching seismic source vessels as they approach and thus effectively avoid potentially adverse effects from the seismic arrays, changes in technology to reduce seismic sound levels would not change the effects of seismic surveys on birds. The direct and indirect effects of oil and gas exploration activities on marine and coastal birds would therefore be the same under Alternative 6 as those described under Alternatives 4 and 5. Marine birds would be subject to disturbance from vessels and seismic sources but these effects would be temporary. With more exploration activities authorized under Alternative 6, the potential for adjacent activities to magnify effects on birds could be increased. However, the requirement to maintain a minimum distance of 24 km (15 mi) between two seismic surveys conducted concurrently would effectively limit the intensity of seismic survey effects on birds no matter where the activities take place during the open water season. The Ledyard Bay closure period would be the same under Alternative 6 as under Alternative 2 so this area would be unaffected by increases in exploration elsewhere.

The risk of birds colliding with vessels would be mitigated and fatal collisions are expected to be rare and not likely to affect the population of any species. The risk of small oil spills would also be mitigated and considered to present very small risks to birds unless the spill occurred in or persisted in a lead or polynya system. A very large oil spill could have much more serious effects on birds and is discussed in Section 4.10.

4.9.2.3.2 Conclusion

Most marine and coastal birds are legally protected under the Migratory Bird Treaty Act and several are protected under the ESA. Birds fulfill important ecological roles and many are important subsistence resources. Depending on the species, they are considered to be important or unique resources from a NEPA perspective. The effects of disturbance, injury/mortality, and changes in habitat for marine and coastal birds would likely be temporary or short-term, localized, and not likely to have population-level effects for any species. The overall effects of oil and gas exploration activities authorized under Alternative 6 on marine and coastal birds would therefore be considered negligible to minor according to the impact criteria in Table 4.5-17

4.9.2.4 Marine Mammals

4.9.2.4.1 Bowhead Whales

4.9.2.4.1.1 Direct and Indirect Effects

Alternative 6 includes the same level of oil and gas exploration activity as Alternative 4. The number and types of surveys, exploration, and drilling are all assumed to be the same. Standard and Additional Mitigation Measures for Alternative 6 are also identical to those considered for Alternative 4. The analyses for Direct and Indirect Effects, Standard Mitigation Measures, and Additional Mitigation Measures are the same for Alternative 6 as for Alternative 4. These are briefly summarized below.

Alternative 6 differs from Alternative 4 in the application of alternative technologies. Alternative 6 considers the gradual augmentation or replacement of current seismic airgun technology with alternative methodologies intended to reduce the amount of loud seismic sounds introduced into the marine environment. Five technologies are considered in this EIS (Table 2.3). All are in different stages of research or testing and development, and could be implemented over time if they become available for general application. Commercial availability at some point in the future is assumed for the purposes of this EIS. This, however, depends on research, development, and commercial implementation schedules.

The analysis for this alternative focuses on the potential mitigating effects of each of the individual alternative technologies and how they could reduce adverse impacts from levels described in Alternative 4. Many of these technologies are in the early stages of development and are difficult to assess. For example, Table 4.9-2 illustrates the estimated change in *near-field* ensonified area above different thresholds if certain incremental source level reductions are considered likely, from which we could infer some quantitative reduction of impacts. However, because of the early stages of development that many of these technologies are in, it is not always possible to know exactly what the operational trade-off of using the alternative technology might be (for example, is it 10 dB quieter, but needs to survey an area with twice the density of survey lines). Of potentially more important note, though, is the potential significant reduction in far-field effects on acoustic habitat and how that reduction could reduce chronic noise impacts to marine mammals. An analysis of each alternative technology follows the summary information on direct and indirect effects and standard mitigation measures.

Behavioral Disturbance

Since the exploration activities that would be authorized under Alternative 6 are identical to those under Alternative 4, the types and mechanisms for disturbance to bowhead whales would be the same. However, if several seismic surveys utilizing airguns are eventually able to be replaced by alternative technologies, some of which have much lower source levels than traditional airguns, behavioral disturbance to bowhead whales could also be reduced as the areas ensonified above behavioral disturbance thresholds could be reduced by anywhere from half to 50 times (i.e., only 2% the former area). Although the behavioral disturbance of marine mammals is quantitatively evaluated based on the number of animals likely to be exposed above a certain received level, which means that anticipated impacts from any given activity could majorly decrease (i.e., by an order of magnitude or more) if the technology were replaced, because of the current state of the technology , it is unlikely that enough activites would change technologies within the life of this EIS, to make a difference in our overall assessment of effects.

The level of disturbance and potential direct and indirect effects on bowhead whales would therefore be the same for Alternative 6 as is discussed for Alternative 4 in Section 4.7.2.4, the components of which were considered to be of medium intensity, interim duration, local to regional extent, and unique context.

Please refer to Section 4.5.2.4 for a complete discussion of disturbance effects, by activity type, on bowhead whales.

Hearing Impairment, Injury, and Mortality

The exploration activities that would be authorized under Alternative 6 are identical to those under Alternative 4; therefore, the mechanisms for hearing impairment, injury, and mortality to bowhead whales would be the same. Because of the low likelihood of injury from Alternative 4 activities, combined with the fact that the use of alternative technologies would only slightly lower injury risk of an acoustic nature, and would not lower the likelyhood of ship-strike or other injury, and the fact that only a small amount of alternate technology use would be anticipated pursuant to this alternative, the level of hearing impairment, injury, and mortality effects on bowhead whales would therefore be the same for Alternative 6 as is discussed for Alternative 4 in Section 4.7.2.4, the components of which were primarily considered to be of medium intensity, interim in duration (except in instances of mortality or serious injury), local in extent and of unique context.

Please refer to Section 4.5.2.4 for a complete discussion of potential injury or mortality effects on bowhead whales.

Habitat Alterations

The exploration activities that would be authorized under Alternative 6 are identical to those under Alternative 4; therefore, the mechanisms for habitat alteration would be the same. The effects of alternative technology on acoustic habitat and chronic effects on marine mammals (especially mysticetes) could be more significant than the more immediately quantifiable and near-field reduction in behavioral disturbance. High level, low frequency sounds (like those produced by airguns) contribute to growing ambient noise levels at great distances from the source (hundreds of miles). This increased noise can contribute to chronic, long-term effects on the ability of animals to effectively interact with their environment and conspecifics. Even small reductions in source levels can make big differences in the far-field reductions at lower levels and over very large areas. The level of potential direct and indirect effects on bowhead whale habitat would therefore be the same for Alternative 6 as is discussed for Alternative 4 in Section 4.7.2.4.

Please refer to Section 4.5.2.4 for a complete discussion of the potential effects on bowhead whale habitat.

4.9.2.4.1.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to bowhead whales are discussed under Alternative 2 (Section 4.5.2.4.15).

4.9.2.4.1.3 Alternative Technologies to Augment and/or Replace Traditional Airgun-Based Seismic Surveys

The intent of implementing alternative technologies is to reduce impulsive sound levels generated during seismic exploration. As discussed in Section 4.9.1.4, Acoustics, sound pressure level reductions resulting from using these proposed technologies are not currently known, although reductions of 10 to 20 dB might be expected. Alternate sound sources with source levels 10 dB lower than standard 3,000 in^3 airgun arrays, could, theoretically, substantially reduce acoustic threshold radii and areas of ensonification (Tables 4.9-1 and 4.9-2).

Hydraulic Marine Vibrators

Replacing an airgun with a hydraulic marine vibrator could reduce adverse impacts by the manner and level in which sound is emitted into the marine environment. Marine vibrators emit sounds at lower pressure levels and over a narrower range of frequencies than do airguns. The low frequency (10 to 250 Hz) produced is within the hearing range of bowhead whales (7 Hz to 22 kHz [Southall et al. 2007]), so it could therefore still be in the range of detectability by this species. Potential auditory impacts to bowhead whales, as well as behavioral disturbance and displacement due to noise exposure, may, however, be reduced through reduced noise output. Any reduction in adverse impacts would be on a limited and localized scale with the current schedule of implementation. The use of this system by industry is currently uncertain as previous use did not result in increased data quality, reduced operation costs, or penetrate as deeply as some companies require.

Electric Marine Vibrators

The replacement of each airgun with an electric marine vibrator could reduce adverse impacts by the manner in which sound is emitted into the marine environment. Marine vibrators emit sounds at lower pressure levels and over a narrower frequency range than do airguns (6 to 100 Hz). This is within the hearing range of bowhead whales (7 Hz to 22 kHz [Southall et al. 2007]), so it could therefore still be in the range of detectability by this species. Potential auditory impacts to bowhead whales, as well as behavioral disturbance and displacement due to noise exposure, may, however, be reduced. Any reduction in adverse impacts would be on a limited and localized scale with the currently uncertain schedule of implementation. In addition, industry interest in this system may be limited by its inability to penetrate as deeply as some companies require for exploration.

Low Frequency Acoustic Source (LACS)

This technology is still in the early phases of development and currently impossible to analyze and compare with airgun arrays for effectiveness and noise generation. The shallow water system has been tested a few times, with only fair data quality. The larger system that could produce frequencies low enough to penetrate to exploration depths has not yet been developed. The LACS, theoretically, uses a sound generating method that results in lowered amounts of energy put into the water compared to a traditional airgun array. This could potentially reduce adverse acoustic impacts to bowhead whales, but the level of reduced impacts and efficacy for mitigating impacts cannot presently be determined.

Deep-Towed Acoustics/Geophysics System (DTAGS)

This system was developed by the Navy and is not currently available for commercial use. It has been used extensively to map out deep-water gas hydrate systems. The DTAGS system generates very high frequencies, so it cannot be used as a source for exploration seismic data collection. It is theoretically possible to create a DTAGS system that could penetrate to exploration depths below the seafloor, but the deep-tow configuration of the source would make it logistically difficult to use with a streamer array. This would need to be adjusted for the much shallower depths of the Beaufort and Chukchi seas where it could possibly augment shallow hazards data collection. The potential acoustic impacts or possible mitigation of auditory impairment or disturbance of bowhead whales through the use of DTAGS is impossible to assess without further information regarding sound level output and transmission in the EIS project area or in a comparable environment.

Low Frequency Passive Seismic Methods for Exploration

Low frequency passive seismic methods for exploration are already in use but not yet proven in all environments, nor have they been tested in the Arctic. Since low frequency passive seismic methods do not emit sound into the marine environment, this technology could mitigate adverse effects of noise on bowhead whales in the areas in which it is employed. Passive seismic surveys cannot, however, replace active seismic acquisition, so broad scale replacement of airguns is impossible in the future.

4.9.2.4.1.4 Conclusion

Mitigating capabilities and effects of alternative technologies introduced under Alternative 6 on bowhead whales are difficult to determine but could reduce adverse impacts (both behavioral impacts and acoustic habitat impacts, as described in the sections above) associated with the use of airgun arrays (see Section 4.5.2.4 for details on effects of airgun noise on bowhead whales). Because of the current state of the technology, however, the overall reduction during the life of this EIS would likely be minimal. The gradual introduction of these alternative technologies could, ultimately, reduce the amount of seismic noise introduced into the marine environment and the impacts on marine mammals. 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 as described in Section 4.5.2.4. A sizable ramp-up in the development and implementation of alternative technologies could potentially reduce behavioral and acoustic habitat impacts to the degree that the rating in the impact criteria might change. However, based on our understanding of the degree to which these technologies are expected to come into use in the next five to ten years, we expect that the impact categorization would not change. Effects of existing technology on bowhead whales, as described in Alternative 4, would be mostly of high intensity, interim duration, be of regional extent, and important to unique in context. 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. Despite possible localized mitigating capabilities of using alternative technologies in lieu of limited numbers of airgun arrays, the overall impact of Alternative 6 on bowhead whales is considered to be moderate to major.

4.9.2.4.1.5 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to bowhead whales are discussed under Alternative 2 (Section 4.5.2.4.16).

4.9.2.4.2 Beluga Whales

Alternative 6 includes the same types of exploration activities described in Alternative 2, and the same number of exploration activities as Alternative 4. Alternative 6 differs, however, from Alternatives 2, 3, and 4 as it considers the gradual augmentation or replacement of current seismic airgun technology with alternative methodologies intended to reduce the amount of loud seismic sounds introduced into the marine environment. Five technologies are considered (Table 2.3). All are in different stages of research, testing and development and could be implemented over time if they become available for general application. Commercial availability at some point in the future is assumed for the purposes of this EIS.

The analysis for this alternative focuses on the potential mitigating effects of each of the individual alternative technologies and how they could reduce adverse impacts from levels described in previous alternatives. Many of these technologies are in the early stages of development and are difficult to assess. For example, Table 4.9-2 illustrates the estimated change in *near-field* ensonified area above different thresholds if certain incremental source level reductions are considered likely, from which we could infer some quantitative reduction of impacts. However, because of the early stages of development that many of these technologies are in, it is not always possible to know exactly what the operational trade-off of using the alternative technology might be (for example, is it 10 dB quieter, but needs to survey an area with twice the density of survey lines). Of potentially more important note, though, is the potential significant reduction in far-field effects on acoustic habitat and how that reduction could reduce chronic noise impacts to marine mammals. An analysis of each alternative technology follows the summary information on direct and indirect effects and standard mitigation measures.

Behavioral Disturbance

The exploration activities that would be authorized under Alternative 6 are identical to those under Alternative 4. Therefore, the types and mechanisms for disturbance to beluga whales would be the same for Alternative 6 as is discussed for Alternative 4 in Section 4.7.2.4.2, as would the resulting level of disturbance and potential direct and indirect effects on beluga whales. Potential effects were considered to be of medium intensity, interim duration, regional in extent, and of important context. Refer to Sections 4.5.2.4.10 and 4.6.2.4.2 for complete discussions of disturbance effects, by activity type, on beluga whales.

Hearing Impairment, Injury, and Mortality

The level of exploration that would be authorized under Alternative 6 is identical to Alternative 4. Because of the low likelihood of injury from Alternative 4 activities, combined with the fact that the use of alternative technologies would only slightly lower injury risk of an acoustic nature, and would not lower the likelihood of ship-strike or other injury, and the fact that only a small amount of alternate technology use would be anticipated pursuant to this alternativeso the primary mechanisms of hearing impairment, injury, or mortality due to oil and gas exploration activities are anticipated to be the same. The potential direct and indirect physical effects on beluga whales would therefore be the same for Alternative 6 as is discussed for Alternative 4 in Section 4.7.2.4.

Habitat Loss/Alteration

The exploration activities that would be authorized under Alternative 6 are the same as under Alternative 4. The effects of alternative technology on acoustic habitat and chronic effects on marine mammals could be more significant than the more immediately quantifiable and near-field reduction in behavioral disturbance. High level, low frequency sounds (like those produced by airguns) contribute to growing ambient noise levels at great distances from the source (hundreds of miles). This increased noise can contribute to chronic, long-term effects on the ability of animals to effectively interact with their environment and conspecifics. Even small reductions in source levels can make big differences in the far-field reductions at lower levels and over very large areas. The potential direct and indirect effects on beluga whale habitat would therefore be the same for Alternative 6 as is discussed for Alternative 4 in Section 4.7.2.4.

4.9.2.4.2.1 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to beluga whales are discussed under Alternative 2 (Section 4.5.2.4.15).

4.9.2.4.2.2 Alternative Technologies to Augment and/or Replace Traditional Airgun-Based Seismic Surveys

See Bowhead Whales (Section 4.9.2.4.1) above for an analysis of the efficacy and practicability of using the proposed alternative technologies to reduce effects of noise from seismic exploration on marine mammals. Only technologies for which there is information specific to beluga whales (e.g. hydraulic and electric marine vibrators) are included below. Refer to the above bowhead whales section for information on LACS, DTAGS, and Low Frequency Passive Seismic Methods for Exploration.

Hydraulic Marine Vibrators

The low frequency (10 to 250 Hz) sounds produced by hydraulic marine vibrators are at the lower end of the estimated auditory bandwidth of belugas whales (150 Hz to 160 kHz [Southall et al. 2007]), so they could still be in the range of detectability by this species. Potential auditory impacts to beluga whales, as well as behavioral disturbance and displacement due to noise exposure, could be reduced through reduced noise output. Any reduction in adverse impacts would likely be on a limited and localized scale with the current schedule of implementation. The use of this system by industry is currently uncertain as previous use did not result in increased data quality, reduced operation costs, or penetrate as deeply as some companies require.

Electric Marine Vibrators

Marine vibrators emit sounds at lower pressure levels and over a narrower frequency range than do airguns (6 to 100 Hz). This is below the estimated auditory bandwidth of belugas whales (150 Hz to 160 kHz [Southall et al. 2007]), so it might not be detectable by this species. Potential auditory impacts to beluga whales, as well as behavioral disturbance and displacement due to noise exposure, could, therefore, be reduced. Any reduction in adverse impacts would likely be on a limited and localized scale with the current schedule of implementation. In addition, industry interest in this system may be limited by its inability to penetrate as deep as some companies require for exploration.

4.9.2.4.2.3 Conclusion

The use of alternative technologies would reduce noise impacts to beluga whales (both behavioral impacts and acoustic habitat impacts, as described in the sections above) as many of them produce sound outside the frequency range audible by belugas. The gradual introduction of these alternative technologies could eventually reduce the amount of seismic noise introduced into the marine environment and impacts to marine mammals. Airgun noise would not be completely 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 beluga whales as described in Section 4.5.2.4.10. A sizable ramp-up in the development and implementation of alternative technologies could potentially reduce behavioral and acoustic habitat impacts to the degree that the rating in the impact criteria might change. However, based on our understanding of the degree to which these technologies are expected to come into use in the next five to ten years, we expect that the impact categorization would not change

The overall impact to beluga whales is likely to be moderate. Beluga whales in the Arctic are not listed under the ESA, but are found feeding in certain essential areas, which places them in the context of being an importantresource. The intensity and duration of the various effects and activities considered are mostly medium and interim. However, potential long-term effects from repeated disturbance are unknown. Although, individually, the various activities may elicit local effects on beluga whales, the area and extent of the population over which effects occur will likely increase with multiple activities occurring simultaneously or consecutively throughout much of the spring-fall range of this population.

4.9.2.4.2.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to beluga whales are discussed under Alternative 2 (Section 4.5.2.4.16).

4.9.2.4.3 Other Cetaceans

Alternative 6 applies the same levels of activity as Alternative 4, described as Level 3. The activities are divided identically among the different activity categories in both alternatives, and the number and types of surveys, exploration, and drilling are all assumed to be the same. Likewise, the Standard and

Additional Mitigation Measures are also identical. Alternative 6 differs from Alternative 4 in the application of Alternative Technologies.

Alternative 6 considers the gradual augmentation or replacement of current seismic airgun technology with alternative methodologies intended to reduce the amount of loud seismic sounds introduced into the marine environment. Five technologies are considered (Table 2.3). All are in different stages of research, testing and development and could be implemented over time if they become available for general application. Commercial availability at some point in the future is assumed for the purposes of this EIS.

The analysis for this alternative focuses on the potential mitigating effects of each of the individual alternative technologies and how they could reduce adverse impacts from levels described in Alternative 4. Many of these technologies are in the early stages of development and are difficult to assess. For example, Table 4.9-2 illustrates the estimated change in *near-field* ensonified area above different thresholds if certain incremental source level reductions are considered likely, from which we could infer some quantitative reduction of impacts. However, because of the early stages of development that many of these technologies are in it is not always possible to know exactly what the operational trade-off of using the alternative technology might be (for example, is it 10 dB quieter, but needs to survey an area with twice the density of survey lines). Of potentially more important note, though, is the potential significant reduction in far-field effects on acoustic habitat and how that reduction could reduce chronic noise impacts to marine mammals.

An analysis of each alternative technology follows the summary information on direct and indirect effects and standard mitigation measures.

4.9.2.4.3.1 Direct and Indirect Effects

As Alternative 6 has the same level of activity as Alternative 4, the direct and indirect effects for the two alternatives are identical. For a complete discussion of the effects of direct and indirect effects on other cetaceans, please see Section 4.5.2.4.3.

4.9.2.4.3.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to other cetaceans are discussed under Alternative 2 (Section 4.5.2.4.15).

4.9.2.4.3.3 Alternative Technologies to Augment and/or Replace Traditional Airgun-Based Seismic Surveys

See Bowhead Whales (Section 4.9.2.4.1) above for an analysis of the efficacy and practicability of using the proposed alternative technologies to reduce effects of noise from seismic exploration on marine mammals. Only technologies for which there is information specific to beluga whales (e.g., hydraulic and electric marine vibrators) are included below. Refer to the above bowhead whales section for information on DTAGS and Low Frequency Passive Seismic Methods for Exploration.

Hydraulic Marine Vibrators

The low frequency (10 to 250 Hz) sound produced by hydraulic marine vibrators is within the hearing range of baleen whales (7 Hz to 22 kHz) and at the lower edge of most toothed whales (150 Hz to 160 kHz or 200 Hz to 180 kHz for mid- and high- frequency functional hearing groups, respectively) [Southall et al. 2007]), so could still be in the range of detectability. Potential auditory impacts to cetaceans, as well as behavioral disturbance and displacement due to noise exposure, may, however, be reduced through reduced noise output. Any reduction in adverse impacts would be on a limited and localized scale with the current schedule of implementation. The use of this system by industry is currently uncertain as previous use did not result in increased data quality, reduced operation costs, or penetrate as deeply as some companies require.

Electric Marine Vibrators

Electric marine vibrators emit sounds at lower pressure levels and over a narrower frequency range than do airguns. The low frequency (6 to 100 Hz) produced is within the hearing range of baleen whales (7 Hz to 22 kHz) but outside the range of most toothed whales (150 Hz to 160 kHz or 200 Hz to 180 kHz for mid- and high- frequency functional hearing groups, respectively) [Southall et al. 2007]). Therefore, baleen whales would be able to detect the sound, but toothed whales would likely not. Potential auditory impacts to baleen whales, as well as behavioral disturbance and displacement due to noise exposure, may, however, be reduced due to the lower frequency. Any reduction in adverse impacts would be on a limited and localized scale with the current schedule of implementation. In addition, industry interest in this system may be limited by its inability to penetrate as deep as some companies require for exploration.

Low Frequency Acoustic Source (LACS)

This could potentially reduce adverse acoustic impacts to cetaceans, but the level of reduced impacts and efficacy for mitigating impacts cannot presently be determined. See Section 4.9.2.4.1 for further details. Depending on the exact frequencies used, it is possible that baleen and toothed whales would have divergent benefits due to their different auditory ranges, similar to the implementation of marine vibrators.

4.9.2.4.3.4 Conclusion

Mitigating capabilities and effects of alternative technologies introduced under Alternative 6 on Other Cetaceans are difficult to determine, but could reduce adverse impacts (both behavioral impacts and acoustic habitat impacts, as described in the sections above) associated with the use of airgun arrays (see Section 4.5.2.4 for details on effects of airgun noise on marine mammals and other cetaceans). Because of the current state of the technology, however, the overall reduction during the life of this EIS would likely be minimal. The gradual introduction of these alternative technologies might reduce the frequency, although not the duration, of seismic noise introduced into the marine environment and the impacts to marine mammals. 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 as described in Section 4.5.2.4. A sizable ramp-up in the development and implementation of alternative technologies could potentially reduce behavioral and acoustic habitat impacts to the degree that the rating in the impact criteria might change. However, based on our understanding of the degree to which these technologies are expected to come into use in the next five to ten years, we expect that the impact categorization would not change. Effects of existing technology on cetaceans, as described in Alternative 4, would be mostly of low to medium intensity and interim duration and be of regional extent. 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. Species within the Other Cetacean group are considered common to unique, but many are very rarely encountered due to infrequent use of the habitat. Despite possible localized mitigating capabilities of using alternative technologies in lieu of limited numbers of airgun arrays, the overall impact of Alternative 6 on Other Cetaceans is considered to be minor to moderate.

4.9.2.4.3.5 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to other cetaceans are discussed under Alternative 2 (Section 4.5.2.4.16).

4.9.2.4.4 Ice Seals

4.9.2.4.4.1 Direct and Indirect Effects

Alternative 6 includes the same type of exploration activities as in Alternative 2 so the discussion of potential direct and indirect effects on ice seals under Alternative 6 involves the same mechanisms and types of effects as discussed for Alternative 2 in Section 4.5.2.4.

The number of the different exploration activities authorized under Alternative 6 would be the same as under Alternatives 4 and 5. However, under Alternative 6, NMFS could potentially require the industry to (or the industry could voluntarily) gradually replace current seismic airgun technology with alternative methodologies intended to reduce the amount of loud seismic sounds introduced into the marine environment that could have adverse effects on marine mammals. Cetaceans are the primary focus for consideration of these alternative technologies because they are the most susceptible of marine mammals to underwater noise disturbance. These technologies and their potentials for reducing impacts to cetaceans are described in sections 4.9.2.4.1 and 4.9.2.4.3 above. Analysis of the potential for these technologies to reduce impacts on ice seals is incorporated into the following subsections.

Behavioral Disturbance

Each of the different types of exploration activities that would be authorized under Alternative 6 include several mechanisms for potential disturbance to ice seals in the water and on the ice, primarily involving the noise generated by and the physical presence of vessels and associated exploration equipment. The two types of surveys which take place on or in sea ice, the preferred habitat of ice seals and where they are most likely to be concentrated, are the in-ice 2D surveys with icebreakers and the on-ice vibroseis surveys. For both of these types of surveys, the same number of surveys would be authorized under Alternative 6 as for Alternative 2. The physical presence of the icebreakers and vibroseis tracked vehicles likely have as much or more to do with the disturbance of ice seals during these surveys as does the introduced seismic sounds. Alternative seismic technologies for in-ice surveys would likely still require the use of ice breakers and would therefore have similar disturbance effects on ice seals as those technologies currently in use. Additional development and testing would be needed prior to use of any of the alternative technologies under consideration in sea ice. The level of disturbance from these types of in-ice/on-ice surveys would therefore be similar for Alternative 6 as is discussed for Alternative 2, which was considered to have temporary and low magnitude effects on ice seals.

The level of open-water activities under Alternative 6 would be the same as for Alternative 4. These activities could affect ice seals over a large area, especially for the 2D/3D seismic streamer surveys. The gradual introduction of various alternative technologies could reduce the amount of seismic noise introduced into the marine environment but would not eliminate it because these alternate technologies could not completely replace the existing technology and most of the alternative technologies still emit sound into the ocean. As described for Alternative 2 in Section 4.5.2.4, disturbance effects using the existing technology would be temporary and low in magnitude, characterized by avoidance of vessels but with mild or unnoticeable behavioral reactions of ice seals. Any surveys conducted with alternative technologies would presumably reduce the amount of noise introduced but would still use marine vessels which could disturb seals in the water. The effects on ice seals would still be considered temporary and low in magnitude with the same types of mild behavioral reactions.

Hearing Impairment, Injury, and Mortality

The exploration activities that would be authorized under Alternative 6 are identical to those under Alternative 4, so the types and mechanisms for injury and mortality to pinnipeds would be the same. The level of potential direct and indirect physical effects on pinnipeds would therefore be the same for Alternative 6 as is discussed for Alternative 4 in Section 4.7.2.4.4. Refer to Section 4.5.2.4.12 for a discussion of potential injury or mortality effects of oil and gas exploration activities on pinnipeds.

Habitat Alterations

The exploration activities that would be authorized under Alternative 6 are identical to those under Alternative 4, so the types and mechanisms for habitat alteration would be the same. The level of potential direct and indirect effects on pinnipeds habitat would therefore be the same for Alternative 6 as is discussed for Alternative 4 in Section 4.7.2.4.4. Refer to Section 4.5.2.4.12 for a discussion of potential effects oil and gas exploration activities on pinniped habitat.

4.9.2.4.4.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to pinnipeds are discussed under Alternative 2 (Section 4.5.2.4.15).

4.9.2.4.4.3 Alternative Technologies to Augment and/or Replace Traditional Airgun-Based Seismic Surveys

See Bowhead Whales (Section 4.9.2.4.1) above for an analysis of the efficacy and practicability of using the proposed alternative technologies to reduce effects of noise from seismic exploration on marine mammals. There is no specific information regarding how these technologies may reduce impacts to ice seals at this time. However, because of the different hearing frequencies of ice seals from mysticetes, impacts would likely be slightly different.

4.9.2.4.4.4 Conclusion

The four species of ice seals would likely not be affected to the same extent by exploration activities in the Beaufort and Chukchi seas based on their respective abundance and distribution. Ringed seals and bearded seals have been the most commonly encountered species of any marine mammals in past exploration activities and their reactions have been recorded by PSOs on board source vessels and monitoring vessels. These data indicate that seals do tend to avoid on-coming vessels and active seismic arrays but their behavioral responses are often neutral rather than swimming away and they do not appear to react strongly even as ships pass fairly close with active arrays. The gradual introduction of various alternative technologies could reduce the amount of seismic noise introduced into the marine environment but would not eliminate it because these alternate technologies could not completely replace the existing technology and most of the alternative technologies still emit sound into the ocean. Any surveys conducted with 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. Seals do not appear to react strongly to icebreaking or on-ice surveys, keeping their distance or moving away at some point to an alternate breathing hole or haulout, but the scope of these behavioral responses appears to be within their natural abilities and responses to their naturally dynamic environment. None of the behavioral reactions observed to date indicate that any of the ice seal species would be displaced from key areas or resources for more than a few minutes or hours and would therefore be unlikely to experience any measurable effects on their reproductive success or survival. Ice seals are legally protected (all under the MMPA and two under the ESA as well). Given the standard and additional mitigation measures considered in this EIS, the effects of exploration activities that could be authorized under Alternative 6 on ice seals would likely be medium to high in magnitude (the latter for ringed seals), distributed over a wide geographic area, and interim in duration. The effects of Alternative 6 would therefore be considered minor to moderate (the latter for ringed seals) for ice seal species according to the criteria established in Section 4.1.3.

4.9.2.4.4.5 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to pinnipeds are discussed under Alternative 2 (Section 4.5.2.4.16).

4.9.2.4.5 Pacific Walrus

4.9.2.4.5.1 Direct and Indirect Effects

This section discusses the potential direct and indirect effects of Alternative 6 on Pacific walrus. This species is dependent on pack ice and coastal shores for haul outs. Alternative 6 includes all of the same types of exploration activities as in Alternative 2 so the discussion of potential direct and indirect effects on Pacific walrus under Alternative 6 involves all the same mechanisms and types of effects as discussed for Alternative 2 in Section 4.5.2.4.

The number of different exploration activities authorized under Alternative 6 would be the same as under Alternatives 4 and 5. However, under Alternative 6, NMFS could potentially require the industry to (or the industry could voluntarily) gradually replace current seismic airgun technology with alternative methodologies intended to reduce the amount of loud seismic sounds introduced into the marine environment that could have adverse effects on marine mammals. Cetaceans are the primary focus for consideration of these alternative technologies because they are the most susceptible of marine mammals to underwater noise disturbance. These technologies and their potentials for reducing impacts to cetaceans are described in sections 4.9.2.4.1 and 4.9.2.4.3 above. Analysis of the potential for these technologies to reduce impacts on walrus is incorporated into the following subsections.

Behavioral Disturbance

The exploration activities that would be authorized under Alternative 6 include several mechanisms for potential disturbance to walrus in the water and on the ice, primarily involving the noise generated by and the physical presence of vessels and associated exploration equipment. The one type of survey that takes place on or in sea ice (the preferred habitat for walrus and where they are most likely to be concentrated) is the in-ice 2D survey with icebreakers. On-ice vibroseis surveys would only occur in the Beaufort Sea at times when walrus would not be present. Only one such in-ice survey could be authorized for each Arctic sea under any of the action alternatives. The physical presence of the icebreakers likely has as much or more to do with the disturbance of walrus during these surveys as does the introduced seismic sounds. Alternative seismic technologies for in-ice surveys would likely still require the use of ice breakers and would therefore have similar disturbance effects on walrus as do technologies currently in use. Additional development and testing would be needed prior to use of any of the alternative technologies under consideration in sea ice. The level of disturbance from these types of in-ice surveys would therefore be similar for Alternative 6 as is discussed for Alternative 2, which was considered to have temporary and low magnitude effects on walrus.

The number of open water activities authorized under Alternative 6 would be the same as under Alternative 4 and likely to elicit similar disturbance effects. These activities could affect walrus over a large area, especially for the 2D/3D seismic streamer surveys. The gradual introduction of various alternative technologies could reduce the amount of seismic noise introduced into the marine environment but would not eliminate it because these alternate technologies could not completely replace the existing technology. As described for Alternative 2 in Section 4.5.2.4, disturbance effects using the existing technology would be temporary and low in magnitude, characterized by avoidance of vessels but with mild or unnoticeable behavioral reactions of walrus. Any surveys conducted with alternative technologies would presumably reduce the amount of noise introduced but would still use marine vessels which could disturb walrus in the water. The effects on walrus would still be considered temporary and low in magnitude with the same types of mild behavioral reactions.

Hearing Impairment, Injury, and Mortality

Since the exploration activities that would be authorized under Alternative 6 are identical to those under Alternative 4, the types and mechanisms for injury and mortality to walrus would be the same. The level of potential direct and indirect physical effects on walrus would therefore be the same for Alternative 6 as is discussed for Alternative 4 in Section 4.7.2.4.5. A more thorough discussion of potential injury or mortality effects on walrus can be found in Section 4.5.2.4.13.

Habitat Alterations

Since the exploration activities that would be authorized under Alternative 6 are identical to those under Alternative 4, the types and mechanisms for habitat alteration would be the same. The level of potential direct and indirect effects on walrus habitat would therefore be the same for Alternative 6 as is discussed for Alternative 4 in Section 4.7.2.4.5. A more thorough discussion of potential impacts on walrus habitat can be found in Section 4.5.2.4.13.

4.9.2.4.5.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to Pacific walrus are discussed under Alternative 2 (Section 4.5.2.4.15). All mitigation measures required under the USFWS LOA will be applicable here.

4.9.2.4.5.3 Conclusion

Walrus have been regularly encountered during vessel-based exploration activities in the past, primarily in late summer as the pack ice recedes, as recorded by PSOs on board seismic source vessels and monitoring vessels. This data indicates that walrus do not react strongly to vessels and active seismic arrays and their behavioral responses are often neutral rather than swimming away. They tend to dive into the water as icebreaking ships approach from some distance and are therefore not exposed to the loudest of sounds generated by the ships. Mitigation measures required for walrus by USFWS LOAs since the early 1990s have reduced the risk of close encounters with seismic and other exploration vessels and have reduced the risk of accidental spills that may affect walrus or their prey. None of the data collected to date on walrus reactions to exploration activities indicate that they would be displaced from key areas or resources for more than a few minutes or hours. Careful avoidance of vessel and aircraft traffic around walrus haulouts on land would be important to minimize the risk of calf and juvenile mortality from stampedes.

Walrus are legally protected, fulfill an important ecological role in the Arctic, and are important subsistence resources and are therefore considered to be a unique resource for analysis purposes in this EIS. Given the level and type of exploration activities that would be authorized under Alternative 6, and considering the mitigation measures that would be required by USFWS LOAs and NMFS in this EIS, the effects on walrus would likely be low in magnitude, distributed over a wide geographic area, and interim in duration. The effects of Alternative 6 would therefore be considered minor for Pacific walrus according to the criteria established in Table 4.5-17.

4.9.2.4.5.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to Pacific walrus are discussed under Alternative 2 (Section 4.5.2.4.16).

4.9.2.4.6 Polar Bears

4.9.2.4.6.1 Direct and Indirect Effects

This section discusses the potential direct and indirect effects of Alternative 6 on polar bears. This species is dependent on pack ice for much of their denning habitat and for hunting seals. Alternative 6 includes all of the same type of exploration activities as in Alternative 2 so the discussion of potential direct and indirect effects on polar bears under Alternative 5 involves all the same mechanisms and types of effects as discussed for Alternative 2 in Section 4.5.2.4.

The number of different exploration activities authorized under Alternative 5 would be the same as under Alternatives 4 and 5. However, under Alternative 6, NMFS could potentially require the industry to (or the industry could voluntarily) gradually replace current seismic airgun technology with alternative methodologies intended to reduce the amount of loud seismic sounds introduced into the marine environment that could have adverse effects on marine mammals. Cetaceans are the primary focus for consideration of these alternative technologies because they are the most susceptible of marine mammals to underwater noise disturbance. These technologies and their potentials for reducing impacts to cetaceans are described in sections 4.9.2.4.1 and 4.9.2.4.3 above. Analysis of the potential for these technologies to reduce impacts on polar bears is incorporated into the following subsections, where relevant.

Behavioral Disturbance

The exploration activities that would be authorized under Alternative 6 include several mechanisms for potential disturbance to polar bears along leads in the ice and in broken ice, primarily involving the noise generated by and the physical presence of vessels and associated exploration equipment including the potential for direct bear-human encounters. The two types of surveys which take place on or in sea ice, the hunting and denning habitats for polar bears, are the in-ice 2D surveys with icebreakers and the on-ice vibroseis surveys. For both of these types of surveys, the same number of surveys would be authorized under Alternative 6 as for Alternative 2. The physical presence of the icebreakers and vibroseis, tracked vehicles likely have as much or more to do with the disturbance of polar bears during these surveys as does the introduced seismic sounds. Alternative seismic technologies for in-ice surveys would likely still require the use of ice breakers and would therefore have similar disturbance effects on polar bears as those technologies currently in use. The level of disturbance from these types of in-ice/on-ice surveys would therefore be similar for Alternative 6 as is discussed for Alternative 2, which was considered to have temporary and low magnitude effects on polar bears.

The number of exploration activities that would be authorized under Alternative 6 is identical to those under Alternative 4, so the types and mechanisms for disturbance to polar bears would be the same. Introduction of alternative technologies would likely have little impact on polar bears, so the overall level of disturbance and potential direct and indirect effects on polar bears would be the same for Alternative 6 as is discussed for Alternative 4 in Section 4.7.2.4.6. A more thorough discussion of disturbance effects of oil and gas exploration activities on polar bears can be found in Section 4.5.2.4.14.

Hearing Impairment, Injury, and Mortality

The exploration activities that would be authorized under Alternative 6 are identical to those under Alternative 4, so the types and mechanisms for injury and mortality to polar bears would be the same. The level of potential direct and indirect physical effects on polar bears would therefore be the same for Alternative 6 as is discussed for Alternative 4 in Section 4.7.2.4.5. A more thorough discussion of potential injury or mortality effects of oil and gas exploration activities on polar bears can be found in Section 4.5.2.4.14.

Habitat Alterations

Since the exploration activities that would be authorized under Alternative 6 are identical to those under Alternative 4, the types and mechanisms for habitat alteration would be the same. The level of potential direct and indirect effects on polar bear habitat would therefore be the same for Alternative 6 as is discussed for Alternative 4 in Section 4.7.2.4.6. A more thorough discussion of potential impacts on polar bear habitat can be found in Section 4.5.2.4.14.

4.9.2.4.6.2 Standard Mitigation Measures

Standard mitigation measures identified that could reduce adverse impacts to polar bears are discussed under Alternative 2 (Section 4.5.2.4.15).

4.9.2.4.6.3 Conclusion

Polar bears have been infrequently encountered during vessel-based exploration activities in the past, as recorded by PSOs on board source vessels and monitoring vessels. These sparse data indicate that polar bears do not react strongly to vessels and active seismic arrays and their behavioral responses are often neutral rather than running or swimming away. However, in 2012, Shell recorded a total of 49 sightings of 61 polar bears in the Chukchi Sea and a total of 29 sightings of 104 indvidual s in the Beaufort Sea during monitoring efforts in conjunction with exploratory drilling activities (Bisson et al. 2013). During the activities associated with the exploratory drilling programs, Bisson et al. (2013) noted the most common reactions to the presence of both moving and stationary vessels as looking at the vessel or no observable reaction. The gradual introduction of various alternative technologies could reduce the amount of seismic noise introduced into the marine environment but would not eliminate it because these alternate technologies could not completely replace the existing technology. Any surveys conducted with 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. Polar bears do not appear to react strongly to icebreaking or on-ice surveys. Some bears keep their distance or move away at some point but others may approach vehicles and equipment out of curiosity. The types of effects of most concern for polar bears during exploration activities involve the risk of bear-human encounters. Mitigation measures and polar bear safety/interaction plans required by USFWS LOAs since the early 1990s have reduced the risk of these encounters for both people and bears. None of the data collected to date on polar bear reactions to exploration activities indicate that polar bears would be displaced from key areas or resources for more than a few minutes or hours and they are unlikely to experience any measurable effects on their reproductive success or survival as a result. Polar bears are legally protected, have a unique ecological role in the Arctic, and are important subsistence resources and are therefore considered unique resources. Given the mitigation measures that would be required by USFWS LOAs and NMFS as considered in this EIS, the effects of exploration activities that could be authorized under Alternative 6 on polar bears would likely be low in magnitude, distributed over a wide geographic area, and interim in duration. The effects of Alternative 6 would therefore be considered minor for polar bears according to the criteria established in Section 4.1.3.

4.9.2.4.6.4 Additional Mitigation Measures

Additional mitigation measures identified that could reduce adverse impacts to polar bears are discussed under Alternative 2 (Section 4.5.2.4.16).

4.9.2.5 Terrestrial Mammals

Activity levels in Alternative 6 are the same as in Alternative 4, and this alternative includes mitigation measures that focus on alternative technologies for seismic exploration. These mitigation measures do not affect terrestrial mammals in the EIS project area, so the impacts discussed in Section 4.5.2.5 are the same for Alternative 6; the overall impact to terrestrial mammals would be minor.

4.9.2.6 Time/Area Closures

The analysis of the direct and indirect effects associated with time/area closures can be found in Sections 4.8.2.4 (Marine Mammals), 4.8.2.3 (Marine and Coastal Birds) and 4.8.3.2 (Subsistence).

4.9.2.7 Standard and Additional Mitigation Measures

Standard and additional mitigation measures that could reduce impacts to the biological environment, other than marine mammals and marine and coastal birds, are discussed under Alternative 2 (Section 4.5.2.7).

4.9.3 Social Environment

4.9.3.1 Socioeconomics

4.9.3.1.1 Direct and Indirect Effects

Impacts to the socioeconomic categories of public revenue and expenditures, employment and personal income, demographic characteristics, and social organizations and institutions would be the same as those discussed under Alternative 4 (Level 3 activity). With the incorporation of alternative technologies, there would be negligible impact to the monetized economy. It is feasible that the effectiveness and practicability of alternative technologies may result in longer surveys to get equivalent data, and as such result in additional costs to lease holders. The description of alternative technologies for hydrocarbon exploration (Section 2.3.5) discusses how 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. Therefore, the lease holders could be surveying for a longer period of time which would cause greater associated cost. For a discussion of reduced impacts to the non-monetized economy, see the Subsistence Section 4.9.3.2.

4.9.3.1.2 Conclusion

The socioeconomic impacts under Alternative 6 are similar to Alternative 4 except there could be additional costs incurred by lease holders associated with lost productivity. The duration of the socioeconomic impacts is temporary because it is not year-round; however, the activity is scheduled to occur over a fixed number of years. The positive economic impacts of the activity are statewide and even national. The context of the socioeconomic impacts is unique because the people that would experience the flow of workers and research vessels are predominantly Iñupiat communities. The summary impact level for Socioeconomics under Alternative 6 is minor.

4.9.3.2 Subsistence

4.9.3.2.1 Direct and Indirect Effects

Direct and indirect effects to subsistence resources and subsistence harvest would be expected to be the same as those discussed under Alternative 2 (Section 4.5.3.2). The number and types of surveys, exploration, and drilling are all assumed to be the same. Standard and additional mitigation measures for Alternative 6 are also identical to those for Alternative 4. Alternative 6 differs from Alternative 4 in the application of alternative technologies. The implementation of alternative technologies depends on research and development schedules, and usage during the timeframe of this EIS is unknown.

The use of alternative technology to either replace or traditional seismic surveys or augment the use of airguns in traditional seismic surveys would be introduced slowly if available during the timeframe of this EIS. At present, none of these alternative technologies are fully tested or developed. The number of airgun surveys these technologies could potentially replace or augment cannot be estimated until the technology is beyond the testing phase.

Hydraulic marine vibrators could be used as technologies that replace airguns or augment traditional seismic surveys for certain prospects in limited environments. This system is the only one that has been offered commercially. However, it is currently not considered successful because there was no increase in data quality or reduction in operations cost. The system does not have the low frequencies to penetrate as deep as some companies require for exploration. Low frequency passive seismic methods (not yet proven in all environments) may be used to enhance recovery through better resolutions than magnetic or gravimetric methods but would not replace airgun surveys. However, there is no evidence that this is a reliable new alternative technology reliable and therefore it is not likely to be used.

Electric marine vibrators would not be available to replace existing technologies. There has been no industry interest in supporting the development of this system. The system does not have the low frequencies to penetrate as deep as some companies require for exploration and electric marine vibrators would be available for use in only limited environments.

Low-frequency acoustic source (LACS) would not be available to replace or augment existing technologies. There has been no industry interest in supporting the development of this system. The system does not have the low frequencies to penetrate as deep as some companies require for exploration. The LACS 8A system has not yet been built and/or tested; therefore its availability to be used as an alternative technology to airguns and considered in this EIS is difficult.

The deep-towed acoustics/geophysics system (DTAGS) is not designed for conducting deep penetration for oil and gas explorations. Only one DTAGS currently exists. There is no projection of a timeframe in which a low-frequency DTAGS would be fully developed or available. However, it is impossible to compare this system to currently used airgun arrays, and the effectiveness of this alternative technology is unknown.

The effectiveness of these alternative technologies to be used to further reduce adverse impacts to subsistence uses is at present unknown. These alternative technologies are only expected to be employed in certain environments, and some are not yet proven in all environments.

Alternative 6 proposes the same level of exploration activities as Alternative 4 but suggests the implementation of alternative technologies that reduce sound emission levels from seismic survey sources. The gradual introduction of these alternative technologies could, ultimately, reduce the amount of seismic noise introduced into the marine environment. The intention is that the use of these alternative technologies would reduce the likelihood of disturbance to marine mammals (Section 4.9.1.4 and Section 4.9.2.4), which in turn could be beneficial in reducing any subsequent impacts to subsistence users.

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 marine mammals (Section 4.5.2) and in turn affect subsistence resources. Effects of existing technology on subsistence would be of low intensity and temporary duration and range from localized to regional in extent. The context would range from common to unique. Bowhead whales, beluga whales and polar bears would be considered unique in context. Despite possible localized mitigating capabilities of using alternative technologies in lieu of limited numbers of airgun arrays, the impact of Alternative 5 on subsistence resources would be considered to be negligible to moderate.

4.9.3.2.2 Conclusion

The summary impacts to subsistence harvest and subsistence resources from alternative technologies under Alternative 6 are likely to be similar to Alternative 2 as discussed in Section 4.5.3.2.

4.9.3.3 Public Health

4.9.3.3.1 Direct and Indirect Effects

Anticipated effects to public health as a result of Alternative 6 are expected to be similar to those expected under Alternative 2, as discussed in Section 4.5.3.3.

In addition, there could potentially be requirements for the use of alternative technologies under Alternative 5. The intention is that the use of these alternative technologies will reduce the likelihood of disturbance to marine mammals, which in turn could be beneficial in reducing detrimental impacts to subsistence users. However, as discussed in Section 4.9.3.2, the effectiveness of these alternative technologies in reducing adverse impacts to subsistence uses is at present unknown, and thus the benefits of the use of these technologies are theoretical.

Therefore, these additional mitigations do not affect the overall impact criteria rating for public health for Alternative 6. If, however, the alternative technologies are demonstrated to be effective and feasible to implement, there is the possibility that additional benefit to public health may accrue.

4.9.3.3.2 Conclusion

Both potential beneficial and adverse impacts are anticipated as a result of Alternative 6. Possible changes could occur to health outcomes such as chronic disease and trauma and many of the pathways relate to traditional practices and subsistence activities. However, there is a very low likelihood of these health outcomes arising, and effects are unlikely to be large enough cause a measurable change in health outcomes. The magnitude or intensity of effects is estimated to be low: above background conditions, but small and within both the natural variation and adaptive ability of the local population. If health changes do occur, the duration of changes may be permanent, and multiple communities could be affected.

4.9.3.4 Cultural Resources

4.9.3.4.1 Direct and Indirect Effects

Activity levels in Alternative 6 are the same as in Alternative 4, and this alternative includes mitigation measures for that focus on alternative technologies for seismic exploration. These mitigation measures do not affect cultural resources in the EIS project area, so the impacts discussed in Section 4.5.3.4 for Alternative 2 are the same for Alternative 6. The overall impact to cultural resources would be minor.

4.9.3.4.2 Conclusion

Direct and indirect impacts to cultural resources resulting from the implementation of Alternatives 2, 3, and 4 would be the same in Alternative 6. For a complete discussion of direct and indirect impacts on cultural resources, please see Section 4.5.3.2.

4.9.3.5 Land and Water Ownership, Use, and Management

4.9.3.5.1 Direct and Indirect Effects

Land and Water Ownership

The direct and indirect impacts to land and water ownership caused by Alternative 6 are similar to those caused by Alternative 4. Refer to Section 4.5.3.5 for a discussion on these topics. This includes federal, state, private owned, borough, and municipal lands and waters.

Alternative 6 also includes mitigation measures that focus on the use of alternative technologies that have the potential to augment or replace traditional airgun-based seismic exploration activities. Some of this technology may be impracticable or not yet available, which could violate lease compliance terms for the timing of exploration.

Land and Water Use

The direct and indirect impacts to land and water use resulting from Alternative 6 are similar to those resulting from Alternative 4 for recreational, residential, and mining land uses. Refer to Section 4.5.3.5 for a discussion on these topics.

The direct and indirect impacts to land and water use resulting from Alternative 6 are similar those resulting from Alternative 4 for protected lands, subsistence, industrial, transportation, and commercial land uses. Refer to Section 4.6.3.5 for a discussion on these topics

Land and Water Management

The direct and indirect impacts to land and water management resulting from Alternative 6 are similar to those resulting from Alternative 4 for federal, state and borough and lands and waters. Refer to Section 4.6.3.5 for a discussion on these topics.

4.9.3.5.2 Conclusion

Based on Table 4.4-2, and the analyses provided above and in Section 4.5.3.5, the impacts on land and water ownership under Alternative 6 are described as follows. The magnitude of ownership impacts would be low because no changes in land or water ownership will result from this action. The duration of impact would be temporary because no ownership changes will occur. The extent of impacts would be local, occurring only in the activity area and involving no ownership change. The context of impact would be common because the federal waters affected have no special, rare, or unique ownership characteristics. In total, the direct and indirect impacts on land ownership are considered to be negligible; they would be low intensity, temporary, localized, and do not result in changes of ownership.

Based on Table 4.4-2 and the analyses provided above and in Sections 4.5.3.5 and 4.6.3.5, the impacts of land and water use caused by Alternative 6 are described as follows. The magnitude of impact would be high where activity occurs in areas of little to no activity (such as Wainwright), and the magnitude of impact would be low in areas where previous activity is common (Prudhoe Bay, Barrow, Nome, Dutch Harbor). The duration of impact would be temporary because an increase in aircraft and shipping traffic would last only for that survey season, although the impact could be permanent if construction of a new facility or infrastructure to accommodate increased shipping traffic were built in Wainwright. The extent of impacts would be local because any changes in land use as a result of this alternative would be limited geographically to the communities that would support the survey vessels. The context of impact would be common because the areas of land and water use affected are extensively available and have no special, rare, or unique characteristics identified. In summary, the direct and indirect effects of Alternative 6 would be moderate because of the possibility for high intensity impact and long term structures in smaller communities.

Based on Table 4.4-2 and the analyses provided above and in Sections 4.5.3.5 and 4.6.3.5, the impacts on land and water management caused by Alternative 6 are described as follows. The magnitude of impact would be low because the action is consistent with existing management plans. The duration of impact would be temporary because project activities are short term in duration and would not result in long-term conflicts with management plans. The extent of impacts would be local because proposed activities would not involve management plans beyond the localized areas of seismic exploration and support activities. The context of impact would be common because the areas of land and water affected are extensively available and have no special, rare or unique characteristics identified in an adopted management plan. In total, the direct and indirect impacts of Alternative 6 on land and water management would be minor because they would be low intensity, would be short term in nature, local, and common.

4.9.3.6 Transportation

4.9.3.6.1 Direct and Indirect Effects

Direct and indirect regional transportation systems and existing infrastructure would be expected to be the same as those discussed under Alternative 2 as discussed in Section 4.5.3.2. Alternative technologies are likely to use the same types of transportation equipment and infrastructure at the same levels as that currently used for seismic surveys, on-ice surveys and exploratory drilling as Alternatives 2, 3, 4, and 5.

4.9.3.6.2 Conclusion

The impacts of using alternative technologies would occur slowly. It is assumed that these new alternative technologies would require the same levels of aircraft and surface and vessel support as under Alternative 4, and, therefore, the impacts would be expected to be similar.

4.9.3.7 Recreation and Tourism

4.9.3.7.1 Direct and Indirect Effects

Activity levels in Alternative 6 are the same as in Alternative 4, and this alternative includes mitigation measures for that focus on alternative technologies for seismic exploration. These mitigation measures do not affect recreation or tourism in the EIS project area, so the impacts discussed in Section 4.5.3.7 for Alternative 2 are the same for Alternative 6; the overall impact to recreation and tourism would be minor.

4.9.3.7.2 Conclusion

The direct impacts would be low intensity, temporary duration, local extent, and common in context. Indirect impacts would be the same levels as direct impacts, except that the geographic area would be broader, extending beyond the region to a state-wide level and potentially beyond. In summary, the impact of Alternative 6 on recreation and tourism would be minor.

4.9.3.8 Visual Resources

This section discusses potential impacts on visual resources that could result from implementing Alternative 6 of the proposed project.

4.9.3.8.1 Direct and Indirect Effects

Implementation of Alternative 6 is expected to result in short-term moderate effects to scenic quality and visual resources identical to those described in Alternative 4. Potential impacts could be of low to medium intensity, depending on the geographic separation of programs. In either case, actions would be temporary, localized and occur in an important context.

4.9.3.8.3 Conclusion

Implementation of Alternative 6 is expected to result in *short-term moderate effects* to scenic quality and visual resources. Potential impacts could be of low to medium intensity depending on specific location of drill sites. The geographic extent of potential impacts would be localized; however they would occur in an important ecosystem.

4.9.3.9 Environmental Justice

4.9.3.9.1 Direct and Indirect Effects

With the incorporation of alternative technologies, the impacts to subsistence foods and human health could be further minimized (see Subsistence Section 4.9.3.2). Contamination of subsistence foods would be the same as discussed under Alternative 4.

4.9.3.9.2 Conclusion

Activities related to implementation of Alternative 6 would have a lower intensity impact on subsistence resources and human health due to the incorporation of alternative technologies than Alternatives 4 and 5, but not eliminate all impacts. Level 3 activities are of a temporary duration and a regional extent. Subsistence foods and human health are unique resources, and they are protected under the MMPA and EO 12898. Thus, Alternative 6 is expected to have a minor impact to subsistence resources and minor disproportionate impacts to Alaska Native communities.

4.9.3.10 Standard and Additional Mitigation Measures

Standard and additional mitigation measures that could reduce impacts to the social environment, other than subsistence, are discussed under Alternative 2 (Section 4.5.3.10).

4.10 Very Large Oil Spill Scenario

This section contains a discussion of the potential environmental effects of a low-probability, high impact event, a hypothetical very large oil spill (VLOS) in the Chukchi Sea and also one in the Beaufort Sea. The analysis of a VLOS also allows NMFS and BOEM to understand possible effects of spills of smaller sizes as well. New rules and rulemaking procedures, as described below, have been instituted to help reduce even further the probability of a VLOS from occurring. Additionally, conditions at potential drill sites in the Beaufort and Chukchi seas are quite different from those at the site of the Deepwater Horizon oil spill event in the Gulf of Mexico (i.e., shallower water depths and lower formation pressures in the Beaufort and Chukchi seas), thereby reducing the likelihood of loss of well control in the EIS project area. Lastly, as described in Section 2.3.3 of this EIS, oil and gas operators are required to complete plans that reduce the likelihood of an oil spill from occurring.

The discussion of oil spill scenarios relies heavily on the recent BOEM Lease Sale 193 Final Supplemental EIS (BOEMRE 2011b) and the Outer Continental Shelf Oil and Gas Leasing Program: 2012-2017 Final Programmatic EIS (BOEM 2012). Much (although not all) of the information summarized in Sections 4.10.1 through 4.10.5 has been taken verbatim from these two documents.

4.10.1 Background and Rationale

The discussion provided in Section 4.10.1 is taken from the BOEM (2011b) Lease Sale 193 analysis and discussion. Summaries of this information are provided in the resource discussions below. As allowed by CEQ regulations in 40 C.F.R. 1502.21, NMFS has incorporated the information presented in the BOEM FSEIS into this EIS by reference.

On March 18, 2011, the U.S. Coast Guard (USCG) issued a final action memorandum that identified 4.9 million barrels (MMbbls) (and an unknown quantity of natural gas) as the total estimated amount spilled by the Deepwater Horizon (DWH) in 2010. Of that, most (74%) was recovered, burned, skimmed, chemically or naturally dispersed, or evaporated/dissolved. About 1.3 of the 4.9 MMbbls (26%) was categorized as residual oil (USCG 2011: Appendix V).

<u>**Government Reports and Recommendations**</u>

Since the DWH event, several entities within or commissioned by the Federal government have offered formal recommendations regarding review and regulation of OCS oil and gas activities.

Council on Environmental Quality (CEQ). As a direct result of the DWH event, the CEQ reviewed the MMS NEPA policies, practices and procedures relating to OCS oil and gas exploration and development and issued a report on August 16, 2010 (CEQ 2010b). This report recommended that MMS, since renamed BOEM, "ensure that NEPA documents provide decision makers with a robust analysis of reasonably foreseeable impacts, including an analysis of reasonably foreseeable impacts associated with low probability catastrophic spills for oil and gas activities on the Outer Continental Shelf." This report also asked BOEM to "Consider supplementing existing NEPA practices, procedures, and analyses to reflect changed assumptions and environmental conditions, due to circumstances surrounding the [Macondo] Oil Spill.

National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling. On January 11, 2011, the National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling (Commission) issued its final report. This report described the causes of the DWH event and recommended reforms intended to make offshore energy production safer. The Commission also reviewed and made recommendations concerning oil spill prevention and response.

U.S. Coast Guard. BOEM and the USCG are conducting a joint investigation to identify the causes of the DWH event and any procedural or policy changes that could prevent such tragedies in the future. On April 22, 2011, the Deepwater Horizon Joint Investigation Team released a preliminary report covering issues under Coast Guard jurisdiction. The investigation continues into the Deepwater Horizon's blowout preventer issue and other issues under the jurisdiction of BOEM. BOEMRE and the USCG conducted a joint investigation of areas under the jurisdiction of the Coast Guard and BOEMRE to investigate the causes of the Deepwater Horizon explosion, loss of life, and resulting oil spill, and to make recommendations for safe operations of future oil and gas activities on the U.S. Outer Continental Shelf (OCS). The JIT held seven sessions of public hearings, received testimony from more than 80 witnesses and experts, and reviewed a large number of documents and exhibits pertaining to all aspects of the investigation.

Volume I, released April 22, 2011, includes findings on five aspects of the disaster under Coast Guard jurisdiction – including the explosions on the Mobile Offshore Drilling Unit (MODU) Deepwater Horizon; the resulting fire; evacuations; the flooding and sinking of the Deepwater Horizon; and the safety systems of the MODU and its owner, Transocean.

Volume II, released September 14, 2011, includes findings on the causes, both direct and contributing, of the Macondo blowout and the resulting explosion and fire aboard the Deepwater Horizon.

Rule Changes Following the *Deepwater Horizon* Event

The aftermath of the DWH event provided new information about drilling on the OCS; in particular, it provided new information about (1) systemic safety issues, (2) deficiencies of blowout containment technologies and strategies, and (3) shortcomings in oil spill response strategies and resources relative to spills in deepwater. BOEM has addressed these issues by strengthening its regulations of OCS activities. Notable initiatives are discussed below. For additional discussion on advancements in safety and their meaning for OCS activities going forward, the reader is referred to an October 1, 2010 memorandum from the Director of BOEM to the Secretary, which supported lifting the suspension of certain offshore permitting and drilling activities on portions of the OCS (available at http://www.doi.gov/news/pressreleases/loader.cfm?csModule=security/getfile&PageID=64703).

New rules and rulemaking procedures, along with new and revised Notices to Lessees, are listed below. Further discussion of more notable developments is then provided.

- The Drilling Safety Rule, Oil and Gas and Sulphur Operations on the Outer Continental Shelf—Increased Safety Measures for Energy Development on the Outer Continental Shelf (Drilling Safety Rule). This rule strengthens requirements for safety equipment, well control systems, and blowout prevention practices in offshore oil and gas regulations.
- The Workplace Safety Rule on Safety and Environmental Management Systems (SEMS Rule). This rule requires operators to develop and implement a comprehensive SEMS for identifying, addressing, and managing operational safety hazards and impacts; for promoting both human safety and environmental protection; and for improving workplace safety by reducing risk of human error.
- NTL 2010-N06, "Information Requirements for Exploration Plans, Development and Production Plans, and Development Operations Coordination Documents on the OCS," effective June 18, 2010 (Plans NTL).
- NTL-2010-N10, "Statement of Compliance with Applicable Regulations and Evaluation of Information Demonstrating Adequate Spill Response and Well Containment Resources," effective November 9, 2010 (Certification NTL).

The Drilling Safety Rule. On August 22, 2012, BSEE issued a final rule entitled "Oil and Gas and Sulphur Operations on the Outer Continental Shelf— Increased Safety Measures for Energy Development on the Outer Continental Shelf" (77 FR 163). The final rulemaking revised selected sections of 30 CFR 250 Subparts D, E, F, O, and Q. The Drilling Safety Rule includes new standards and requirements related to the design of wells and testing of the integrity of wellbores, the use of drilling fluids, and the functionality and testing of well control equipment including blowout preventers. To these ends, the rule promulgated OCS-wide provisions that amended its drilling regulations related to subsea and surface blowout preventers, well casing and cementing, secondary intervention, unplanned disconnects, recordkeeping, well completion, and well plugging.

Safety and Environmental Management Systems Rule. A new subpart to 30 CFR Part 250: Subpart S – Safety and Environmental Management Systems (SEMS) is designed to reduce the hazards associated with drilling operations and further reduce the likelihood of a blowout scenario such as described for this VLOS analysis. The SEMS Rule requires all OCS operators to develop and implement 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. The interim final rule was published in the *Federal Register* on October 14, 2010 (75 FR 63345), requiring full implementation of a SEMS program by November 15, 2011. The 13 elements of the industry standard (American Petroleum Institute, Recommended Practice 75) that 30 CFR 250 Subpart S now makes mandatory are as follows:

- defining the general provisions for implementation, planning and management review, and approval of the SEMS program;
- identifying safety and environmental information needed for any facility such as design data, facility process such as flow diagrams, and mechanical components such as piping and instrument diagrams;
- requiring a facility-level risk assessment;
- addressing any facility or operational changes including management changes, shift changes;
- contractor changes;
- evaluating operations and written procedures;
- specifying safe work practices, manuals, standards, and rules of conduct;
- training, safe work practices, and technical training, including contractors;
- defining preventative maintenance programs and quality control requirements;
- requiring a pre-startup review of all systems;
- responding to and controlling emergencies, evacuation planning, and oil-spill contingency plans in place and validated by drills;
- investigating incidents, procedures, corrective action, and follow-up;
- requiring audits every 4 years, to an initial 2-year reevaluation and then subsequent 3-year;
- audit intervals; and
- specifying records and documentation that describe all elements of the SEMS program.

NTL (Notice to Lessees) 2010-N06. Though not a rulemaking, a recent NTL issued by BOEM warrants discussion here. Effective November 8, 2010, NTL No. 2010-NO6 requires that blowout intervention information be submitted with future Exploration or Development and Production Plans. The blowout scenarios required by 30 CFR 250.213(g) and 250.243(h) provide a potential blowout of the proposed well expected to have the highest volume of hydrocarbons, and must include supporting information for any assertion that well bridging will constrain or terminate the flow or that surface intervention will stop the blowout. The availability of a rig to drill a relief well and rig package constraints must also be addressed. These scenarios must also specify as accurately as possible the time it would take to contract for a rig, move it on site, and drill a relief well, including the possibility of drilling a relief well from a neighboring platform or an onshore location.

NTL (Notice to Lessees) 2010-N10. Also released on November 8, 2010 was NTL 2010-N10. This NTL explains that applications for well permits must include a statement that all authorized activities will be conducted in compliance with all applicable regulations, to include the new measures discussed above. For operations using subsea BOPs or surface BOPs on floating facilities, BOEM will evaluate whether each operator has submitted adequate information demonstrating that it has access to and can deploy subsea containment resources that can adequately and promptly respond to a blowout or other loss of well control. BOEM will also evaluate whether each operator has adequately described the types and quantities of surface and subsea containment equipment that the operator can access in the event of a spill or threat of a spill.

The operating regulations for BOEM and BSEE are at: http://www.gpo.gov/fdsys/pkg/FR-2011-10-18/pdf/2011-22675.pdf

Joint Industry Task Forces. In response to the DWH event, several entities within the oil and gas industry cooperatively formed Joint Industry Task Forces. The stated purpose of each Task Force is "to review and evaluate current capacities, and to develop and implement a strategy to address future needs and requirements in equipment, practices or industry standards" applicable to the studied activity. Where possible, information developed by these Tasks Forces will be augmented with input from regulatory agencies, oil spill response and well control specialists, investigation panels, and other public sector and non-governmental organizations. To date, Task Forces on "Oil Spill Preparedness and Response" and "Subsea Well Control and Containment" have submitted draft recommendations. Joint Industry Task Force recommendations will not have the force of regulation, but may provide the basis for enhanced industry standards or future rulemaking processes."

4.10.2 Very Large Oil Spill (VLOS) Scenario

Determining the appropriate volume to analyze for a VLOS can be difficult. In the BOEM Lease Sale 193 FSEIS document (2011), BOEM provided the rationale for using a spill volume of 2.2 MMbbls for the assessment of the potential environmental effects of a VLOS in the Chukchi Sea over a period of 74 days. In the 2012-2017 OCS Oil and Gas Leasing Program Draft Programmatic EIS (BOEM 2011d), BOEM provided the rationale for using a spill volume of 1.4 to 2.2 MMbbls over a period of 40 to 75 days for the Chukchi Sea and 1.7 to 3.9 Mbbl over a period of 60 to 300 days for the Beaufort Sea as the basis for considering impacts from a Catastrophic Discharge Event. These analyses from BOEM are incorporated into Sections 4.10.3 and 4.10.4 below.

Implicit in these analyses is the view that different hypothetical spill sizes are not expected to affect a particular individual of a species differently. The basic mechanisms by which individuals of the various Arctic species are affected by spilled oil are known to some extent and are not dependent on spill size. That is to say that if a bird were oiled from a crude oil spill, the effect on the particular bird would likely be essentially the same regardless of the size of the spill. A key difference that spill size makes is how many individuals of a species would have potential contact with a spill, be expected to die or be adversely affected, the extent of effects on their habitat, and whether those impacts would be significant under NEPA. Further investigation on fate and effects of dispersed crude oil on Arctic species is ongoing through a Joint Industry Program (Word et al. 2008).

4.10.3 General Assumptions

The discussion provided in Section 4.10.3 is taken from the BOEMRE FSEIS for the Chukchi Sea Oil and Gas Lease Sale 193 (BOEMRE 2011), which is substantially similar to the discussion presented in the 2012-2017 OCS Oil and Gas Leasing Program Draft Programmatic EIS (BOEM 2011d). Summaries of this information are provided in the resource discussions below. As allowed for by CEQ regulations in §1502.21, NMFS has incorporated the information presented in the BOEMRE FSEIS into this EIS by reference.

Very Large Spill Scenario vs. Worst Case Discharge

To facilitate analysis of the potential environmental impacts of a VLOS in the Chukchi and Beaufort seas, it is first necessary to develop VLOS scenarios. Scenarios are conceptual views of the future and represent possible sets of activities. They serve as planning tools that make possible an objective and organized analysis of hypothetical events. These VLOS scenarios are not to be confused with what would be expected to occur as a result of any of the action alternatives.

The VLOS scenario is sometimes confused with worst-case discharge (WCD) analyses which are used to evaluate an Exploration Plan (EP) or Development and Production Plan (DPP). Both calculations are alike to the extent that they are performed by BOEM using similar assumptions and identical analytical methods and software. However, these calculations differ in several important ways:

> ***Very Large Oil Spill:*** Rather than analyzing a specific drilling proposal, the VLOS model selected a prospect within an area that potentially maximizes the variables driving high flow rates. Therefore, the VLOS scenario in the Chukchi Sea represents an extreme case in flow rate and discharge period that, in turn, represents the largest discharge estimated from any site in the [EIS project area].
>
> ***Worst-Case Discharge:*** Site-specific WCDs at locations identified in a submitted plan in the [EIS project area] would typically result in much lower initial rates and aggregate discharges if discharge periods are held equal [i.e. regardless of the location of an exploration project in the Chukchi Sea, BOEM assumes that the discharge period would be the same]. The calculations also differ in their purpose. Whereas the VLOS scenario is a planning tool for NEPA environmental impacts analysis, a WCD is the calculation required by 30 CFR Part 250 to accompany an EP or DPP and provide a basis for an Oil Spill Response Plan.

The VLOS scenario is predicated on an unlikely event—a loss of well control during exploration drilling that leads to a long duration blowout and a resulting VLOS.

It is recognized that the frequency for a VLOS on the OCS from a well control incident is very low. From 1971-2010 there has been one very large oil spill during exploratory and development/production operations on 41,781 wells, or 2.39×10^{-5} per well.

The low ‘geological’ chance that the exploration well will successfully locate a large oil accumulation, coupled with the observed low incidence rates for accidental discharges in the course of actual drilling operations, predicts a very small, but not impossibly small, chance for the occurrence of a VLOS event. But this consideration of probability is not, nor should it be, integrated into the VLOS model. The VLOS discharge quantity is ‘conditioned’ upon the assumption that all of the necessary chain of events required to create the VLOS actually occur (successful geology, operational failures, escaping confinement measures, reaching the marine environment, etc.). The VLOS discharge quantity is, therefore, not “risked” or reduced by the very low frequency for the occurrence of the event.

Rate, Time and Composition of Hypothetical Spill

The [Chukchi Sea] VLOS scenario assumes a blowout leading to a very large oil spill. In developing this scenario, BOEM first generated a hypothetical oil discharge model that estimates the highest possible uncontrolled flow rate that could occur from any known prospect in the Lease Sale 193 area, given real world constraints. The discharge model was constructed using a geologic model for a specific prospect in conjunction with a commercially-available computer program (AVALON/MERLIN) that forecasts the flow of fluids from the reservoir into the well, models the dynamics of multiphase (primarily oil and gas) flow up the wellbore, and assesses constraints on flow rate imposed by the open wellbore and shallower well casing. This model utilized information and selected variables that, individually and collectively, provided a maximized rate of flow. The most important variables for the discharge model included thickness, permeability, oil viscosity, gas content of oil, and reservoir pressure. Many other variables of lesser importance were also required.

The oil discharge climbs rapidly to over 61,000 bbls/day during Day 1. After peaking in Day 1, (BOEMRE 2011: Figure 4) the oil discharge declines rapidly through the first 40 days of flow as the reservoir is depressurized by approximately 1,400 pounds per square inch (psi) (BOEMRE 2011: Table 2). The decline in the flow rate flattens somewhat after Day 40, falling to 20,479 bbls/day (33 percent of the Day 1 peak rate) by Day 74 when the near-wellbore reservoir pressure has fallen to [2,567 psi which is] 58 percent of the initial reservoir pressure (4,392 psi). The total oil discharge by the end of the flow period on Day 74 is 2,160,200 bbls.

Additional Parameters

The following discussion describes additional parameters of the Chukchi Sea VLOS scenario. These parameters are based on reasonably foreseeable factors related to oil spills based on past VLOS events (i.e. the Exxon Valdez Oil Spill (EVOS), DWH event, and the Ixtoc oil spill), published scientific reports, consideration of Arctic-specific conditions, and application of best professional judgment. The result is a framework for identifying the most likely and most significant impacts of the hypothetical VLOS event. Key aspects of the scenario are listed below:

- A loss of well control during exploration drilling leads to a blowout and an ongoing, high volume release of crude oil and gas that continues for up to 39-74 days;
- Oil remains on the surface of the water for up to a few weeks after flow has stopped or after meltout from sea ice during the Arctic spring;
- The total volume of the oil is nearly 2.2 MMbbls and the volume of the gas is [51 million cubic meters or] 1.8 billion cubic feet (Bcf)—within 74 days;
- Roughly 30 percent of the VLOS evaporates. A small portion of the spill remains in the water column as small droplets. The remaining oil could be physically or chemically dispersed, sedimented, beached, weathered into tar balls, or biodegraded; and
- Information about where a very large spill could go and how long it takes to contact resources is estimated by an oil spill trajectory model.
- For the Beaufort Sea, summer is defined as July 1-September 30 and winter October 1-June 30. For the Chukchi Sea, summer is defined as June 1-October 31 and winter November 1-May 31.

4.10.4 VLOS Scenario for the Chukchi Sea

The discussion provided in Section 4.10.4 is taken from the BOEM FSEIS for the Chukchi Sea Oil and Gas Lease Sale 193 (BOEM 2011b), which is substantially similar to the discussion presented in the 2012-2017 OCS Oil and Gas Leasing Program Draft Programmatic EIS (BOEM 2011d). Summaries of this information are provided in the resource discussions below. As allowed for by CEQ regulations in §1502.21, NMFS has incorporated the information presented in the BOEM documents (2011, 2011e) into this EIS by reference.

4.10.4.1 Cause of Spill

This scenario begins with an unlikely event – a loss of well control during exploration drilling that leads to a long duration blowout and a VLOS in the Chukchi Sea.

For the purpose of analysis in this EIS, an explosion and subsequent fire are assumed to occur. A blowout associated with the drilling of a single exploratory well could result in a fire that would burn for one or two days. The exploration drilling rig or platform may sink. If the blowout occurs in shallow water, the sinking rig or platform may land in the immediate vicinity; if the blowout occurs in deeper water, the rig or platform could land a great distance away. For example, the DWH drilling rig sank, landing [457 m or] 1,500 feet from the subsea wellhead. Water depths in the majority of the Lease Sale 193 area range from about [29 m or] 95 feet to approximately [80 m or] 262 feet; this range is considered shallow water. A small portion of the northeast corner of the Lease Sale 193 area deepens to approximately [2,987 m or] 9,800 feet.

For the purpose of modeling flow rates, the location of the blowout and leak was specified as occurring near the mudline (at the top of the BOP [blowout preventer]). For the purpose of environmental effects analysis, it is acknowledged that a blowout could occur in other locations, such as at the sea surface, along the riser anywhere from the seafloor to the sea surface, or below the seafloor (outside the wellbore). The forthcoming environmental effects analysis encompasses all these possibilities. As different blowout and leak locations may have bearing on spill response and intervention options, additional discussion of these issues is provided [below in] Opportunities for Intervention and Response.

DOI determines the risk of such an event occurring on a per EP basis; therefore, increasing the number of EPs increases the potential amount of risk. The amount of risk of such an event occurring can also increase when an operator needs to disconnect in the middle of operations.

4.10.4.2 Timing of the Initial Event

For purposes of analysis, the hypothetical VLOS in the Chukchi Sea is estimated to commence between July 15 and October 31. These dates coincide with the open water drilling season.

4.10.4.3 Volume of Spill

Well blowouts generally involve two types of hydrocarbons, namely crude oil (or condensate) and natural gas. The volume ratio of these two fluids is a function of the characteristics of the fluids and the producing reservoir.

Table 3 in BOEMRE (2011) summarizes the results of the discharge model for the hypothetical VLOS. The oil discharge climbs rapidly to over 61,000 bbls/day during day one. After peaking in Day 1, Figure 15 shows that the oil discharge declines rapidly through the first 40 days of flow as the reservoir is depressurized by approximately 1,400 psi (BOEMRE 2011: Table 3). The decline in the flow rate flattens somewhat after Day 40. As shown in BOEMRE (2011) Table 3, the cumulative oil discharge over a 74-day spill is 2,160,200 bbls.

To simplify the analysis, it is estimated 2.2 MMbbls of oil are spilled in the VLOS scenario.

4.10.4.4 Duration of Spill

The duration of the offshore spill from a blowout depends on the time required for successful intervention. Intervention may take a variety of forms. . . . [T]here exists a variety of methods by which an operator or responder can stop the flow of oil. The availability of some of these techniques could vary under individual drilling plans. [A]ll exploration plans must specify as accurately as possible the time it would take to contract for a rig, move it on site, and drill a relief well. For purposes of analysis within this VLOS scenario, it is estimated the discharge would be stopped within 74 days of the initial event.

This duration reflects the longest of three estimated time periods for completing a relief well as described in Table 4 in BOEMRE (2011).

4.10.4.5 Area of Spill

When oil reaches the sea surface, it spreads. The speed and extent of spreading depends on the type of oil and volume that is spilled. A spill of the size analyzed here would likely spread hundreds of square miles. Also, the oil slick may break into several smaller slicks, depending on local wind patterns that drive the surface currents in the spill area. Estimates of where the oil spill would go were taken from the OSRA [Oil Spill Risk Analysis] trajectory analysis [see Appendix B of BOEM (2011)].

4.10.4.6 Oil in the Environment: Properties and Persistence

The fate of oil in the environment depends on many factors, such as the source and composition of the oil, as well as its persistence (National Research Council 2003c). Persistence can be defined and measured in different ways (Davis et al. 2004), but the National Research Council (NRC) generally defines persistence as how long oil remains in the environment (National Research Council 2003c). Once oil enters the environment, it begins to change through physical, chemical, and biological weathering processes (National Research Council 2003c). These processes may interact and affect the properties and persistence of the oil through:

- evaporation (volatilization);
- emulsification (the formation of a mousse);
- dissolution;
- oxidation; and
- transport processes (National Research Council 2003c, Scholz et al., 1999).

Horizontal transport takes place via spreading, advection, dispersion, and entrainment, while vertical transport takes place via dispersion, entrainment, Langmuir circulation, sinking, overwashing, partitioning, and sedimentation (Sale 193 FEIS, Appendix A.1, Figure A.1 and A.2). The persistence of an oil slick is influenced by the effectiveness of oil-spill response efforts and affects the resources needed for oil recovery (Davis et al. 2004). The persistence of an oil slick may also affect the severity of environmental impacts as a result of the spilled oil.

Crude oils are not a single chemical but instead are complex mixtures with varied compositions. Thus, the behavior of the oil and the risk the oil poses to natural resources depends on the composition of the specific oil encountered (Michel 1992). Generally, oils can be divided into three groups of compounds: (1) light-weight, (2) medium-weight, and (3) heavy-weight components.

The oil discharged from the hypothetical Chukchi Sea VLOS well is 35° API [American Petroleum Institute] crude oil. This oil would be considered light-weight as shown in Table 5 in BOEMRE (2011). On average, light-weight crude oils are characterized as outlined in Table 5 in BOEMRE (2011).

Previous studies (Boehm and Fiest 1982) supported the estimate that most released oil in shallow waters similar to the Chukchi Sea would reach the surface of the water column. A small portion (one to three percent) of the Ixtoc oil remained in the water column (dispersants were used), although limited scientific investigation occurred and analytical chemical methods 30 years ago may not have been as sensitive as today (Boehm and Fiest 1982, Reible 2010). [BOEM (2011) does not indicate how long the oil would remain in the water column. The purpose of dispersants is to put the oil in suspension in the water column where it stays until diluted to the point of not being measurable and/or is ingested by bacteria.]

4.10.4.7 Release of Natural Gas

The quality and quantity of components in natural gas vary widely by the field, reservoir, or location from which the natural gas is produced. The oil in the VLOS reservoir is assumed to be initially saturated (with gas) at a gas-oil ratio of [26 cubic meters or] 930 cubic feet/barrel (cf/bbl) (quantities at standard conditions of 60°F and 1.0 atm.) and this is reflected by the fact that the initial (Day 0.1) produced gas-oil ratio in the model (BOEMRE 2011: Table 2) is also 930 cf/bbl. As shown in Table 2 in BOEMRE (2011), the produced gas-oil ratio falls to a minimum of 757 cf/bbl between Day 15 and Day 27—while early oil and gas production rates fall rapidly with de-pressurization of the reservoir near the wellbore—but then rises to 1,202 cf/bbl by Day 74 of the discharge.

Gas discharge reaches a peak of 50,677 Mcf/d [1 Mcf/d equals 1000 cf per day] in Day 1 of the flow, falls to a minimum rate of 19,513 Mcf/d by Day 45, then rises to 24,608 Mcf/d by Day 74. The pattern of gas flow reflects the process of gas break-out in the reservoir that progressively converts the initial oil reservoir into a gas reservoir. The cumulative gas discharge over the 74-day period (use of new platform and drilling equipment) estimated for completion of a relief well (very large discharge case) is 1,808 MMcf [1MMcf equals 1,000,000 cf]. For purposes of analysis, it is estimated 1.8 Bcf. Natural gas is primarily made up of methane (CH_4) and ethane (C_2H_6) which make up 85-90 percent of the volume of the mixture.

4.10.4.8 Duration of Subsea and Shoreline Oiling

The duration of the shoreline oiling is measured from initial shoreline contact until the well is capped or killed and the remaining surface oil dissipates offshore. Depending on the spill's location in relation to winds, ice, and currents and the well's distance to shore, oil could reach the coast within 10 days to 360 days based on BOEM oil spill trajectory analysis (MMS 2007, BOEMRE 2011). While it is estimated that the majority of spilled surface oil would evaporate and naturally disperse offshore within 30 days of stopping the flow or after meltout in the Arctic spring, some oil may remain in coastal areas until cleaned, as seen following the EVOS and DWH event (The State of Louisiana 2010a-d). The generation of oil suspended particulate material or subsurface plumes from the well head would stop when the well was capped or killed. Subsurface plumes would dissipate over time due to mixing and advection (Boehm and Fiest 1982).

4.10.4.9 Volume of Oil Reaching Shore

In the event of a VLOS, not all of the oil spilled would contact shore. The volume of oil recovered and chemically or naturally dispersed would vary. For example, the following are recovery and cleanup rates from previous high-volume, extended spills (Wolfe et al. 1994, Gundlach and Boehm 1981, Gundlach et al. 1983, Lubchenco et al. 2010):

- 10-40 percent of oil recovered or reduced (including burned, chemically dispersed, and skimmed);
- 25-40 percent of oil naturally dispersed, evaporated, or dissolved; and
- 20-65 percent of the oil remains offshore until biodegraded or until reaching shore.

[In the case of the DWH event] it is estimated that burning, skimming and direct recovery from the wellhead removed one quarter (25 percent) of the oil released from the wellhead. One quarter (25 percent) of the total oil naturally evaporated or dissolved, and just less than one quarter (24 percent) was dispersed (either naturally or as a result of operations) as microscopic droplets into Gulf waters. The residual amount— just over one quarter (26 percent)—is either on or just below the surface as light sheen and weathered tar balls, has washed ashore or been collected from the shore, or is buried in sand and sediments (Inter- agency 2010a). For planning purposes, USCG estimates that 5-30 percent of oil will reach shore in the event of an offshore spill (33 CFR Part 154, Appendix C, Table 2).

4.10.4.10 Length of Shoreline Contacted

While larger spill volumes increase the chance of oil reaching the shoreline, other factors that influence the length and location of shoreline contacted include the duration of the spill and the well's location in relation to winds, ice, currents, and the shoreline. As estimated from the OSRA model . . . the length of oiled shoreline increases over time as the spill continues (BOEMRE 2011: Table 6). Dependent upon winds and currents throughout the VLOS event, already impacted areas could have oil refloated and oil other areas increasing the estimates above.

A VLOS from a nearshore site would allow less time for oil to be weathered, dispersed, and/or recovered before reaching shore. This could result in a more concentrated and toxic oiling of the shoreline. A release site farther from shore could allow more time for oil to be weathered, dispersed, and recovered. This could result in a broader, patchier oiling of the shoreline.

4.10.4.11 Severe and Extreme Weather

Wind and wave action can drive oil floating on the surface into the water column, and oil stranded on shorelines can be moved into nearshore waters and sediment during storms. Episodes of severe and extreme weather over the Arctic could affect the behavior of sea-surface oil, accelerate biodegradation of the oil, impact shoreline conditions, and put marine vessels at risk. For instance, recovery of sea-surface oil could be impeded by the formation of sea ice during severe cold outbreaks that occur typically over the Arctic winter. In addition, episodes of severe storms characterized by strong winds (25 to 30 miles per hour) and precipitation can dictate the movement of sea-surface oil drift and also direct oil toward the coastline following a VLOS occurring during summer or winter. The severe storms, referred to as mesoscale cyclones (MCs), form when a cold air mass over land (or an ice sheet) moves over warmer open water (Nihoul and Kostianoy 2009). These storms are usually small-scale and short-lived; and the lower the atmospheric pressure in the storm center, the stronger the storm. More intense versions of MCs occur mainly during the Arctic winter when the lowest pressure polar mesoscale cyclones (PMCs) are associated with the semi-permanent Aleutian low. These storms can cause extreme weather conditions in areas near ice/ocean or land/ocean boundaries (Jackson and Apel 2004). While less common, these storms cover a larger area and can cause surface winds at or near gale force, up to 45 miles per hour, with waves [4.6 to 6 meters or] 15 to 20 feet. As such, a PMC is sometimes characterized as an arctic hurricane. Wind and wave action caused by these extreme storms can pose a risk to marine vessels, drive sea-surface oil into the water column, enhance weathering of the oil, or cause oil stranded on the coastline to move into nearshore waters and sediment. Any of these conditions could temporarily delay or stop the response and recovery effort.

4.10.4.12 Recovery and Cleanup

The hypothetical VLOS scenario outlined thus far for the Chukchi Sea would trigger an extensive spill recovery and cleanup effort. It is anticipated that efforts to respond to a VLOS in the Chukchi Sea would include the recovery and cleanup techniques and estimated levels of activities described below. A more detailed description of the available methods to respond to an oil spill is provided in the Arctic Multi-Sale Draft EIS, in Section 4.3.3.5.5 (USDOI, MMS, 2008a). It is noted that severe weather and/or the presence of ice could interfere with or temporarily preclude each of these methods. For a comprehensive summary report of the 31 Arctic oil spill response research projects that BOEM has funded, the reader is referred to a report called *Arctic Oil Spill Response Research and Development Program: A Decade of Achievement* which can be accessed at: http://www.bsee.gov/Research-and-Training/Technology-Assessment-and-Research/tarprojectcategories/MMSArcticResearch-pdf.aspx

In the event of a VLOS, two governmental organizations would assume prominent roles in coordinating response efforts: the Federal On-Scene Coordinator (FOSC) and the Alaska Regional Response Team (ARRT). The ARRT is an advisory board to the FOSC that provides federal, state, and local governmental agencies with means to participate in response to pollution incidents. During a response, the FOSC would consult with the ARRT on a routine basis for input regarding response operations and priorities. In addition to their advisory role during a response event, the ARRT is responsible for developing the Alaska Federal/State Preparedness Plan for Response to Oil and Hazardous Substance Discharges/Releases (Unified Plan) which details governmental incident response planning and responsibilities for the State of Alaska and 10 Subarea Contingency Plans that provide region-specific response planning information for establishing operations in the event of a major response effort to an oil spill or hazardous material release. The Subarea Contingency Plans identify notification requirements, emergency response command structures, response procedures, community profiles, in-region response assets, logistics guidance, spill scenarios that could be encountered in the region and sensitive areas identification along with geographic response strategies which provide suggested response actions to protect the resources at risk from a release of oil. For exploration activities in the Chukchi Sea, the North Slope Subarea Contingency Plan and the Northwest Arctic Subarea Contingency Plan are the applicable documents for addressing oil spill response in the region.

Mechanical Recovery. Both mechanical and non-mechanical methods of oil spill response can be utilized in the Chukchi Sea to mitigate the impacts of an oil spill on the environment. The preferred means of spill response is mechanical recovery of the oil, which physically removes oil from the ocean. Mechanical recovery is accomplished through the use of devices such as containment booms and skimmers. A containment boom is deployed in the water and positioned within an oil slick to contain and concentrate oil into a pool thick enough to permit collection by a skimmer. The skimmer collects the oil and transfers it to a storage vessel (storage barges or oil tankers) where it will eventually be transferred to shore for appropriate recycling or disposal.

Dispersants. Use of chemical dispersants is a response option for the Chukchi Sea. Research has shown that dispersants can be effective in cold and ice infested waters when employed in a timely manner (S.L. Ross Environmental Research Ltd., 2002, 2003, 2006, 2007; Belore 2003). Recently completed field scale tests conducted by Sintef (Sintef 2010) as part of the Oil in Ice Joint Industry Project (JIP) in the Barents Sea has demonstrated that results from lab scale and large wave tank tests hold true in actual ocean conditions. Oil released into the ocean during broken ice conditions was readily dispersed, and the dispersion was enhanced with the addition of vessel propeller wash for more energy in these conditions. It was also demonstrated that in these cold conditions, weathering of the oil was significantly slowed, providing a greater window of opportunity in which to successfully apply dispersants. Dispersant application can be accomplished by means of injection at the source or through aerial or vessel based application. There are dispersant stockpiles located in Prudhoe Bay, Anchorage, and the Lower 48 states [dispersants can be flown to Alaska from the Lower 48 if stockpiles are inadequate]. Dispersant use is limited to ocean application in waters generally deeper than 10 meters; this depth restriction is used to avoid or reduce potential toxicity concerns to nearshore organisms.

The State of Alaska does not have preapproved dispersant application zones for the Chukchi Sea, so each request for dispersant application would be evaluated and approved or disapproved on a case-by-case basis by the FOSC with the concurrence of the EPA representative to the RRT and, as appropriate, the concurrence of the RRT representative from the State of Alaska and COC and DOI natural resource trustees. The decision regarding how and when dispersants would be applied would also reside with the FOSC and the above listed agency representatives. Procedures governing the application of dispersants are provided in "The Alaska Federal and State Preparedness Plan for Response to Oil and Hazardous Substance Discharges and Releases" (Unified Plan) (ARRT 2010). However, the FOSC is not limited to this procedure and may utilize other sources of information in determining what the most appropriate dispersant method would be given a specific situation.

In-situ Burning. In-situ burning is also a viable response method for the Chukchi Sea and could be approved by the FOSC in consultation with the Unified Command and the above listed agency representatives. Any in-situ burning would be conducted in accordance with the Alaska Unified Plan In-situ Burn Guidelines (ARRT 2010). In-situ burning is a method that can be used in open ocean, broken ice, near shore, and shoreline cleanup operations. In broken ice conditions, the ice serves to act as a natural containment boom, limiting the spread of oil and concentrating it into thicker slicks, which aid in starting and maintaining combustion. In-situ burning has the potential to remove in excess of 90 percent of the volume of oil involved in the burn. In-situ burning experiments of oil in ice conducted as part of the Sintef JIP (Sintef 2010) has likewise demonstrated that cold temperatures serve to slow weathering of the oil, in turn expanding the window of opportunity for in-situ burning application over that experienced in more temperate regions.

Effect of Ice on Response Actions. For all response options, the presence of ice can both aid and hinder oil spill response activities. Ice acts as a natural containment device, preventing the rapid spread of oil across the ocean surface. It also serves to concentrate and thicken the oil, allowing for more efficient skimming, dispersant application, and in-situ burning operations. Once shore fast ice is formed, it serves as a protective barrier, limiting or preventing oil from contacting shorelines. Cold temperatures and ice will slow the weathering process by reducing volatilization of lighter volatile compounds of the oil, reducing impact of wind and waves, and extending the window of opportunity in which responders may utilize their response tools.

Conversely ice can limit a responder's ability to detect and locate the oil, access the oil by vessel, prevent the flow of oil to skimmers, require thicker pools to permit in-situ burning, and eventually encapsulate the oil within a growing ice sheet making access difficult or impossible. Once incorporated into the ice sheet, further recovery operations would have to cease until the ice sheet becomes stable and safe enough to support equipment and personnel to excavate and/or trench through the ice to access the oil. The other response option is embedding tracking devices in the ice and monitoring its location until the ice sheet begins to melt and the oil surfaces through brine channels at which time it could be collected or burned.

Levels of Recovery and Cleanup Activities. The levels of activities required to apply the techniques described above are dependent on the specific timing and location of a spill. As weather, ice, and logistical considerations allow, the number of vessels and responders would increase exponentially as a spill continues. The levels of activities described below are reasonable estimates provided as a basis for analysis. These estimates are based on Subarea Contingency Plans for the North Slope and Northwest Arctic subareas, past spill response and cleanup efforts, including the EVOS and DWH events, and the best professional judgment of BOEM spill response experts:

- Between five and 10 staging areas would be established;
- About 15 to 20 large skimming vessels (such as the Nanuq, Endeavor Barge, Tor Viking, other barges from Prudhoe Bay, USCG skimming vessels, vessels from Cook Inlet and Prince William Sound) could be used in offshore areas. The majority of open ocean vessels would be positioned relatively close to the source of the oil spill to capture oil in the thickest slicks, thus enabling the greatest rate of recovery;
- Thousands of responders (from industry, the federal government, private entities) could assist spill response and cleanup efforts as the spill progresses. Weather permitting, roughly 300-400 skimming, booming, and lightering vessels could be used in areas closer to shore. Based on the trajectory of the slick, shallow water vessels would be deployed to areas identified as priority protection sites;
- Booming would occur, dependent upon the location of the potentially impacted shoreline, environmental considerations, and agreed upon protection strategies involving the local potentially impacted communities. About 100 booming teams could monitor and operate in multiple areas;
- Use of dispersants and/or in-situ burning could occur if authorized by the FOSC. Use of dispersants would likely concentrate on the source of the flow or be conducted so as to protect

sensitive resources. In-situ burning operations would likewise be conducted in the area of thickest concentration to ensure the highest efficiency for the effort. In-situ burning may also be utilized in nearshore and shoreline response where approved by FOSC;

- Dozens of planes and helicopters would fly over the spill area, including impacted coastal areas. Existing airport facilities along the Arctic coast (including airports at Kotzebue, Point Hope, Point Lay, Wainwright, Barrow, and any other suitable airstrips) would be used to support these aircraft. If aircraft are to apply dispersants, they could do so from altitudes of [15 to 30.5 m or] 50 to 100 ft; and
- Workers could be housed offshore on vessels or in temporary camps at the staging areas.

Depending on the timing and location of the spill, the above efforts could be affected by seasonal considerations. In the event that response efforts continue into the winter season, small vessel traffic would come to a halt once the forming ice begins to cover the ocean surface. Larger skimming vessels could continue until conditions prevent oil from flowing into the skimmers. At this point, operations could shift to in-situ burning if sufficient thicknesses are encountered. The lack of daylight during winter months would increase the difficulties of response.

As ice formation progresses, the focus of the response would shift to placing tracking devices in the forming ice sheet to follow the oil as it is encapsulated into the ice sheet. Once the ice sheet becomes solid and stable enough, recovery operations could resume by trenching through the ice to recover the oil using heavy equipment. This would most likely occur in areas closer to shore because the ice will be more stable. In late spring and early summer, as the ice sheet rots, larger ice-class vessels could move into the area and begin recovery or in-situ burning operations as the oil is released from the ice sheet. The ice would work as a natural containment boom keeping the oil from spreading rapidly. As the ice sheet decays, oil encapsulated in the ice would begin surfacing in melt pools at which time responders will have additional opportunities to conduct in-situ burn operations. Smaller vessels could eventually re-commence skimming operations in open leads and among ice flows, most likely in a free skimming mode (without boom) along the ice edge.

While it is estimated that the majority of spilled oil on the water's surface would be dissipated within a few weeks of stopping the flow (Inter-agency 2010a) during open water or after meltout in the Arctic spring, oil has the potential to persist in the environment long after a spill event and has been detected in sediment 30 years after a spill (Etkin, McCay, and Michel 2007). On coarse sand and gravel beaches, oil can sink deep into the sediments. In tidal flats and salt marshes, oil may seep into the muddy bottoms (USFWS 2010g).

Effectiveness of intervention, response, and cleanup efforts depend on the spatial location of the blowout, leak path of the oil, and amount of ice in the area. For the purpose of analysis, effectiveness of response techniques is not factored into the spill volume posited by this scenario and considered during OSRA modeling.

4.10.4.13 Scenario Phases and Impact-Producing Factors

The events comprising the VLOS scenario are first categorized into five distinct phases. These phases, which range from the initial blowout event to long-term recovery, are presented chronologically. Within each phase are one or more components that may cause adverse impacts to the environment. These components are termed "Impact Producing Factors," or IPFs, and will be used later to guide the environmental impacts analysis. The specific IPFs listed here are intended to inform, rather than limit, the discussion of potential impacts.

4.10.4.13.1 Well Control Incident (Phase 1)

Phase 1 of the hypothetical VLOS scenario is comprised of the catastrophic blowout and its immediate consequences. Potential IPFs associated with Phase 1 include the following:

- **Explosion**. Natural gas released during a blowout could ignite, causing an explosion.
- **Fire**. A blowout could result in a fire that could burn for one to two days.
- **Re-distribution of Sediments**. A blowout could re-distribute sediment along the seafloor.
- **Sinking of Rig.** The drill rig could sink to the sea floor.
- **Psychological/Social Distress**. News and images of a traumatic event could cause various forms of distress.

4.10.4.13.2 Offshore Spill (Phase 2)

Phase 2 of the scenario encompasses the continuing release of an oil spill in federal and state offshore waters. Potential IPFs associated with Phase 2 include the following:

- **Contact with Oil**. Offshore resources (including resources at surface, water column, and sea floor) could be contacted with spilled oil.
- **Contamination**. Pollution stemming from an oil spill may contaminate environmental resources, habitat, subsistence resources, and/or food sources.
- **Loss of Access**. The presence of oil could prevent or disrupt access to and use of affected areas.

4.10.4.13.3 Onshore Contact (Phase 3)

Phase 3 of the scenario focuses on the continuing release of an oil spill and contact to coastline and state nearshore waters. Potential IPFs associated with Phase 3 include the following:

- **Contact with Oil**. Onshore resources could come into direct contact with spilled oil.
- **Contamination**. Pollution stemming from an oil spill may contaminant environmental resources, habitat, and/or food sources.
- **Loss of Access**. The presence of oil could prevent or disrupt access to and use of affected areas.

4.10.4.13.4 Spill Response and Cleanup (Phase 4)

Phase 4 of the scenario encompasses spill response and cleanup efforts in offshore Federal and State waters as well as onshore Federal, State and private lands along the coastline. Potential IPFs associated with Phase 4 include the following:

- **Vessels**. Vessels could be used in support of spill response and cleanup activities.
- **Aircraft**. Aircraft could be used in support of spill response and cleanup efforts.
- **In-situ burning**. Remedial efforts may include burning of spilled oil.
- **Animal Rescue**. Animals may be hazed or captured and sent to rehabilitation centers.
- **Dispersants**. Dispersants could be introduced into the environment.
- **Skimmers**. Boats equipped to skim oil from the surface.
- **Booming**. Responders could deploy booms—long rolls of oil absorbent materials that float on the surface and corral oil.

- **Beach cleaning**. Cleanup efforts including hot water washing, hand cleaning using oil absorbent materials, and placement and recovery of absorbent pads, could be used on beaches and other coastal areas contacted by an oil spill.
- **Drilling of Relief Well**. A relief well could be drilled by the original drilling vessel or by a second vessel with additional support.
- **Co-opting of resources**. Funds, manpower, equipment, and other resources required for spill response and cleanup would be unavailable for other purposes.
- **Bioremediation**. Contaminated material could be removed or treated by adding fertilizers or microorganisms that "eat" oil.

4.10.4.13.5 Post-Spill, Long-Term Recovery (Phase 5)

Phase 5 of the scenario focuses on the long-term. The exact length of time considered during this phase will vary by resource. Potential IPFs associated with Phase 5 include the following:

- **Unavailability of environmental resources**. Environmental resources and food sources may become unavailable or more difficult to access or use.
- **Contamination**. Pollution stemming from an oil spill may contaminate environmental resources, habitat, and/or food sources.
- **Perception of contamination**. The perception that resources are contaminated may alter human use and subsistence patterns.
- **Co-opting of human resources**. Funds, manpower, equipment, and other resources required to study long-term impacts and facilitate recovery would curtail availability for other purposes.
- **Psychological/Social Distress**. Distress stemming from a VLOS could continue into the long-term.

4.10.4.14 Opportunities for Intervention and Response

In providing a duration for the hypothetical oil spill described above, it is stated for the purposes of analysis that the discharge would cease within 74 days of the initial event. The use of 74 days corresponds to the longest of three time periods estimated for a second drilling vessel to arrive on scene from the far east and complete a relief well (see BOEMRE 2011: Table 3). This is a reasonable but conservative estimate because it does not take into consideration the variety of other methods that would likely be employed to halt the spill within this period. Moreover, specific exploration plans may include intervention and response methods that could control or contain the flow of oil sooner than 74 days. This point is illustrated by recent exploration plans submitted for the Alaska OCS, such as the Shell Gulf of Mexico, Inc. 2012 Revised Exploration Plan (EP) for leases in the Chukchi Sea (Shell 2011b). Between the Chukchi Sea Regional Exploration Oil Discharge Prevention and Contingency Plan (C-Plan) submitted with the EP application and this proposal contained measures including:

- Shell would use state-of-the-art automatic kick-detection equipment, including pit-volume totalizers, a flow detector, and various gas detectors placed about the rig, to provide early warning of a potential well-control event.
- The blowout preventer Shell would install on the high-pressure wellhead housing on the 20-in conductor casing on each exploration well includes redundant mechanical barriers to provide multiple means of closing in the well to prevent oil flow to the surface.
- Shell would install multiple barriers, including manual and automated valves, on the drilling rig to prevent flows from coming up the drill string.

- Shell has developed and would implement a Well Control Contingency Plan (WCCP) in the extremely unlikely event of a well-control event to minimize the risk of oil coming in contact with the water. As part of the WCCP, Shell would prepare a Relief Well Drilling Plan for each location in advance of spudding the well to ensure that a relief well can be started quickly to kill the well.
- Shell would station and maintain its OSRVs in the immediate vicinity of its drilling operations to ensure timely response to any spill event.
- In addition to the OSR fleet, capping stack equipment will be available for use in the unlikely event of a blowout. The capping stack system will be carried as equipment on an ice management vessel and the containment barge will be located in the Beaufort Sea where it can respond as required.
- Capping Stack equipment will be stored aboard one of the ice management vessels and will be available for immediate deployment in the unlikely event of a blowout. Capping Stack equipment consist of subsea devices assembled to provide direct surface intervention capability with the following priorities:
    - Attaching a device or series of devices to the well to affect a seal capable of withstanding the maximum anticipated wellhead pressure (MAWP) and closing the assembly to completely seal the well against further flows (commonly called “capping and killing”)
    - Attaching a device or series of devices to the well and diverting flow to surface vessel(s) equipped for separation and disposal of hydrocarbons (commonly called “capping and diverting”)

Potential intervention and response methods are qualitatively discussed below because their inclusion in individual exploration plans could serve to substantially decrease the duration, volume, and environmental effects of a VLOS. These methods are not mutually exclusive; several techniques may be employed if necessary. It may also be possible to pursue multiple techniques contemporaneously. Again, these opportunities for intervention and response could be employed prior to drilling a relief well and are not factored into the estimated spill duration as described in the VLOS scenario above. The availability and effectiveness of these techniques may vary depending on the nature of the blowout, as well as seasonal considerations, including the seasonal presence of sea ice.

Well Intervention. If a blowout occurred, the original drilling vessel would initiate well control procedures. The procedures would vary given the specific blowout situation, but could include:

- Activating blowout preventer equipment;
- Pumping kill weight fluids into the well to control pressures;
- Replacing any failed equipment to remedy mechanical failures that may have contributed to the loss of well control; and/or
- Activating manual and automated valves to prevent flows from coming up the drill string.
- These techniques cure loss-of-well-control events the vast majority of the time without any oil being spilled.

Natural bridging or plugging could also occur. These terms refer to circumstances where a dramatic loss of pressure within the well bore (as could occur in the event of a blowout) causes the surrounding formation to cave in, thereby bridging over or plugging the well. While natural bridging or plugging could render certain forms of operator-initiated well control infeasible, it could also impede or block the release of hydrocarbons from the reservoir from reaching the surface.

Containment Domes. In the event that well intervention is unsuccessful and the flow of oil continues, a marine well containment system (MWCS) could be deployed with associated support vessels. The design for a MWCS specific to Arctic operations is currently in progress and will be required to receive BOEM review under future permitting activities. The MWCS is anticipated to provide containment domes, well intervention connections, remotely operated vehicle capabilities, barge with heavy lift operations, separation equipment, and oil and gas flaring capabilities.

Relief Wells. If the above techniques are unavailable or unsuccessful, a relief well could be drilled. The relief well is a second well, directionally drilled, that intersects the original well at, near, or below the source of the blowout. Once the relief well is established, the operator pumps kill weight fluids into the blowout well to stop the flow and kill the well. Both wells are then permanently plugged and abandoned.

Some exploratory drilling vessels are capable of drilling their own relief well. Mobile Offshore Drilling Units, or MODUs, can disconnect from the original well, move upwind and up current from the blowout location, and commence the drilling of a relief well. Bottom-founded vessels are by definition not capable of maneuvering in this manner.

Second Vessel. Should the original drilling vessel sustain damage or prove otherwise incapable of stopping the blowout, a second vessel could be brought in to terminate or otherwise contain the blowout. A second vessel, with support from additional vessels as needed, could employ similar techniques to those described above. The time required by a second vessel to successfully stop the flow of oil must factor in the time needed for travel to the site of the blowout. The location of a second vessel is thus critical when considering a scenario in which same vessel intervention or response is unavailable. The estimate used in the VLOS scenario described above conservatively allots 30 days for transporting a second vessel across the Pacific Ocean. The availability of a second vessel in-theater (within the Chukchi Sea or possibly the Beaufort Sea) or on site would substantially reduce transport time and, therefore, the time needed for successful intervention. This could equate to shorter spill duration and smaller overall spill volume.

As previously mentioned, the availability and/or effectiveness of certain response and intervention techniques can depend on the type and exact location of the blowout. Five major distinctions with respect to the specific location of a blowout are important to consider. A blowout and leak could occur: (1) at the sea surface (but the rig is not destroyed or sunk on location), (2) along the riser anywhere from the seafloor to the sea surface, (3) at the seafloor through leak paths on the BOP/wellhead, (4) below the seafloor, outside the wellbore, or (5) at the sea surface (but the rig is destroyed and sinks at the location). Opportunities for operational intervention and response vary in each of these circumstances (BOEMRE 2011: Table 6).

4.10.5 VLOS Scenario for the Beaufort Sea

The 2012-2017 OCS Oil and Gas Leasing Program Final Programmatic EIS (BOEM 2012) contains the first post-DWH event scenario for the Beaufort Sea. Summaries of this information are provided in the resource discussions below. As allowed for by CEQ regulations in §1502.21, NMFS has incorporated the information presented in the BOEM Final Programmatic EIS (2012) into this EIS by reference.

Arctic Risk Profile. An ongoing concern in the Arctic is the environmental effects of a very large oil spill on sensitive marine and coastal habitats that occur there within a land sea-ice biome that supports a traditional subsistence lifestyle for Alaska native populations and provides important habitats for migratory and local faunal populations. The ability to respond to and contain a very large discharge event under the extreme climatic conditions and seasonal presence of ice is of particular concern.

Loss of Well Control. While some formation properties of the Arctic OCS are expected to have pressures, temperatures, and volumes sufficient to produce a discharge that could result in catastrophic consequences, drilling risks associated with these formation characteristics are not directly related to issues of extreme cold and presence of ice. Instead, the fact that the Arctic OCS is largely a frontier geologic province contributes risk to Arctic drilling operations (USGS 2011).

Human error while working under extreme weather conditions on the Arctic OCS could increase the risk of loss of well control in certain circumstances where established procedures are not followed. However, when accounting for other Arctic specific variables, the incident rate of loss of well control is expected to be lower than for exploration and development operations in the GOM (Bercha et al. 2008).

To address some of the risk inherent in Arctic operations, the BOEM regulations include specific requirements for conducting operations in the Arctic, such as locating the BOP in a well cellar (a hole constructed in the sea bed) to position the top of the BOP below the maximum potential ice gouge depth, using special cements in areas where permafrost is present, enclosing or protecting equipment to assure it will function under subfreezing conditions, and developing critical operations and curtailment procedures which detail the criteria and process through which the drilling program would be stopped, the well shut in and secured and the drilling unit moved off location before environmental conditions (such as ice) exceed the operating limits of the drilling vessel.

Containment and Response. Much of risk from a catastrophic event that is particular to the extreme climate of the Arctic is associated with containment and response issues at the well site. The time needed to drill a relief well in the Beaufort Sea under the scenario varies from 60 to 300 days depending on the timing of the event relative to the ice free season, since the well site may become inaccessible when solid or broken ice is present. During that time, the ability to mount effective containment and response efforts under broken or solid ice conditions is a critical factor.

Fate and Consequence. Response away from the well site could also be hindered and/or aided by broken and solid ice. In addition, some options available to manage fates of spills have not been previously used in larger-scale operations the Arctic to fully evaluate their effectiveness, such as burning and dispersant use, although state-of-the art research on these response techniques suggest they could decrease the volume of oil in the water (SINTEF 2010).

In summary, the Catastrophic Discharge Scenarios developed for the Beaufort Sea estimates a discharge rate of 1.7 to 3.9 Mbbl over a duration of 60 to 300 days. Factors affecting duration are timing of the event relative to the ice free season and/or the availability of a rig to drill a relief well. The foundation for the analysis in Section 4.10.7 of this EIS is taken from the 2012-2017 OCS Oil and Gas Leasing Program Draft Programmatic EIS (BOEM 2011), which contains the first post-DWH event scenario for the Beaufort Sea. Summaries of this information are provided in the applicable resource discussions below. As allowed for by CEQ regulations in §1502.21, NMFS has incorporated the information presented in the Draft Programmatic EIS (BOEM 2011d) into this EIS by reference.

Summaries of information from the former MMS (now BOEM) Final Environmental Impact Statement (FEIS) for the Beaufort Sea Planning Area Oil and Gas Lease Sales 186, 195, and 202 (MMS 2003) are also provided in this EIS where applicable.

4.10.6 Chukchi Sea – Analysis of Very Large Oil Spill Impacts

The foundation of the analysis provided in Section 4.10.6 of this EIS is taken from the BOEM (2011b) analysis for Lease Sale 193. Summaries of this information are provided in the resource discussions below. As allowed for by CEQ regulations in §1502.21, NMFS has incorporated the information presented in the BOEM FSEIS into this EIS by reference. The specific sections from BOEM (2011b) that are referenced in this EIS are noted in the sections below. BOEM (2011b) is available online at: http://www.boem.gov/ak-eis-ea. Additional information pertinent to this project is presented in each resource section as well. The information taken from BOEM (2011b) is identified as "Existing Analysis," and the analysis beyond what was presented in that document is listed as "Additional Analysis."

The scenario in BOEM (2011b) is substantially similar to the discussion presented in the 2012-2017 OCS Oil and Gas Leasing Program Final Programmatic EIS (BOEM 2012). NMFS has incorporated the information presented in the BOEM Draft Programmatic EIS into this EIS by reference. The specific sections from BOEM (2011e) that are referenced in this EIS are noted in the sections below.

4.10.6.1 Physical Oceanography

4.10.6.1.1 Existing Analysis (BOEM 2011b and BOEM 2012)

BOEM uses an OSRA (Oil Spill Risk Analysis) model to simulate estimated oil spill trajectories; in other words, the OSRA model is a method for estimating where a VLOS may go. Input for the OSRA model includes calculated values of wind, ice, currents, vectors, and numerous other physical, social, and economic parameters. A summary of the OSRA model structure, input, and output are provided in Section IV.E.1 of BOEM (2011b), and are incorporated here by reference.

Section 4.2.3.2 of the BOEM (2012) analysis describes the effects of sea ice and currents on the movement and weathering of spilled oil in the Beaufort Sea planning area. This information is incorporated herein by reference.

4.10.6.1.2 Additional Analysis for Physical Oceanography

Phase 1 (Initial Event)

Impact producing factors associated with a well control incident, such as explosion, fire, and redistribution of sediment would have minor effects on physical ocean resources within the EIS project area. Uncontrolled combustion of petroleum hydrocarbons in the environment would result in an increase in water temperature in the immediate vicinity of the fire. It is difficult to quantify the increase in water temperature that would result from fire associated with a well control incident, but it is likely that the geographic extent of changes in water temperature would be limited to areas immediately adjacent to the fire, and the duration of such thermal effects would be temporary. Redistribution of seafloor sediments would have minor impacts on the seafloor topography in the immediate vicinity of the well control incident. Although effects resulting from redistribution of seafloor sediment would likely be permanent, the intensity of the effects would be low and the geographic extent would be limited. Sinking of the drilling rig to the sea floor would effectively create an artificial reef (BOEM 2011b), which would have permanent, local, low-intensity effects on the physical character of the EIS project area. If the rig were to sink in shallow water it could be considered a navigational hazard. Overall, effects of the initial well control incident on the physical character of the EIS project area would be minor.

Phase 2 (Offshore Oil)

Oil in the water from a VLOS event would affect the physical character of the sea surface in the EIS project area. An oil slick covering hundreds of square kilometers of ocean surface would influence ocean-atmosphere interactions, including exchange of gasses across the air-water interface and the generation of wind driven waves in the affected area. The presence of an oil slick at the sea surface would impede normal gas exchange across the air-water interface, but the impacts of such effects would likely be surpassed by the release of large quantities of methane, ethane, propane and other hydrocarbon gasses into the water column (Kessler et al. 2011). The natural gas mixture released into the water during a VLOS event would have temporary effects on the dissolved gas content of seawater in the affected area. The fate and effects of dissolved hydrocarbons are discussed in more detail in Section 3.1.7 (Water Quality) and Section 3.1.8 (Ecosystem Processes) of this EIS. The presence of an oil slick at the sea surface would likely lead to decreases in the magnitude of wind-driven waves in the affected area. Effects on waves resulting from a VLOS would be low intensity, local, and temporary. Such effects would decrease concurrently with clean-up or partitioning of the oil into environmental compartments other than the sea surface. Due to limited water depths on the Chukchi Sea shelf, most fractions of the released oil would float to the surface, and effects on the physical character of pelagic and epibenthic zones would be expected to be minor during this phase of the VLOS. However, effects of an oil slick on the viscosity of the sea surface would be high-intensity and regional. The sea surface could be considered an important physical resource within the EIS project area because of its critical role in myriad chemical, physical, and biological processes. Due to the viscosity and stickiness of spilled oil, the overall effects of offshore oil on the physical character of the ocean would be major. In addition, an oil slick would effectively decrease the freezing point of the affected seawater and may have impacts on the formation of sea ice in affected areas.

Phase 3 (Onshore Contact)

Spilled oil could adhere to the shoreline and affect the composition of beach substrates by creating oil and sediment conglomerates.

Phase 4 (Spill Response and Cleanup)

Spill cleanup operations could have adverse impacts on the physical character of the ocean and shoreline. Minor impacts due to differential shoreline erosion would be possible if the removal of contaminated substrates affects beach stability.

In situ burning of oil would result in high-intensity effects on sea surface temperature, but these effects would be temporary and spatially limited to the area of *in situ* burning operations. The use of dispersants would effectively move the impacts associated with spilled oil from the sea surface into the water column. Dispersed oil in the pelagic environment would affect the density and viscosity of the water, but these effects would be low-intensity and would decrease as the dispersed oil is weathered, diluted, and degraded.

Phase 5 (Long-term Recovery)

Long-term direct effects on the physical character of the ocean would be negligible. Oil is a mixture comprised mostly of volatile and hydrophobic compounds. As a result of its volatility and hydrophobicity, oil has a strong tendency to associate with non-aqueous phase materials. Oil associated with solid phase particles may remain on beaches and in sediments on the sea floor for extended periods of time, but the long-term effects of weathered oil in the environment are expected to be related to the chemical properties and potential toxicity of certain hydrocarbon compounds.

Conclusion

The overall effects of the VLOS on the physical character of the ocean would initially be high-intensity due to the viscosity and stickiness of oil floating at the sea surface. The duration of these impacts would be limited by the properties of oil that cause it to associate with non-aqueous phase materials. If *in situ* burning is used as a response technique, high-intensity short term impacts would occur to the physical character of the sea surface. The overall effects of the VLOS on the physical character of the ocean in the EIS project area would be high-intensity, temporary, and would affect an area of hundreds of square kilometers. Such effects are classified as moderate due to their high-intensity and temporary duration.

4.10.6.2 Geology

The geology of the continental shelf and OCS within the EIS project area is discussed in Section 3.1.3 of this EIS. For the purpose of this EIS, geological processes would not be altered by a VLOS; therefore geology as a resource is not carried forward for analysis in Chapter 4. In addition, naturally occurring phenomena like ice gouging and strudel scouring would not likely be affected by a VLOS, nor would these phenomena be expected to significantly affect response to a VLOS.

4.10.6.3 Climate and Meteorology

<u>4.10.6.3.1 Existing Analysis (BOEM 2011b and BOEM 2011d)</u>

Discussions on GHG emissions from BOEM (2011b, 2011e) can be found in Section 4.10.6.4 (Air Quality) of this EIS.

4.10.6.3.2 Additional Analysis for Climate and Meteorology

A VLOS within the U.S. Chukchi Sea has the potential to impact climate change, especially during Phases 1 (Initial Event) and 4 (Spill Response and Cleanup) of the oil spill scenario.

During Phase I of a VLOS, the fire associated with the initial explosion of gas and oil would emit CO_2 and black carbon. CO_2 is a GHG, and its emissions have been linked to climate change. Black carbon, which could result from soot particles as a consequence of the initial fire, could have a warming effect which could lead to accelerated melting of sea and land ice and snow, also called radiative forcing. This is due to reflective ice and snow being covered by the blackness of black carbon, which has a greater ability to absorb heat rather than reflect it (BOEM 2011b). Section 4.10.6.4 (Air Quality) of this EIS has more information on black carbon and radiative forcing.

During Phase 4, impacts to climate change would be associated with in-situ burning and emissions from cleanup response equipment. In-situ burning would result in a plume of black smoke containing air pollutants including CO_2. The use of offshore vessels, aircraft, and surface vehicles used for removal of spilled oil and support of oil removal operations could result in thousands of tons of air pollutants including the GHG, CO_2 (BOEM 2011b).

During Phase 5, support vessels may be required to assist in a long-term recovery effort which would emit CO_2. Emissions from this phase are expected to be lower than those resulting from Phases 1 and 4 (BOEM 2011b).

The magnitude of impacts is a function of the mass of GHGs and amount of reflective surface covered by heat absorbing black carbon. Although these values are not specifically quantified, it is surmised that the magnitude would be largest in Phase 4 for GHG emission and Phase 1 for radiative forcing. The magnitude of effects associated with radiative forcing would also depend on the amount of daylight and amount of ice and snow present that could be covered by black carbon. Since CO_2 emissions and black carbon deposition resulting from a VLOS would occur in a relatively short timeframe, the magnitude of effects is expected to be less than those associated with the actual oil exploration activities (see Section 4.5.1.2).

The duration of actual activities leading to climate change impacts (deposition of black carbon and CO_2 emissions) would be short-term or temporary, however, as mentioned in Section 4.5.1.2, GHGs could remain in the atmosphere for decades up to centuries, and their effects are considered long-term.

Extent of impacts to climate change would be the same as those identified for the actual oil exploration activities (Section 4.5.1.2), and therefore would be considered at a minimum state-wide but could extend beyond state boundaries.

The context of the impacts associated with climate change would be the same as those identified for the actual oil and gas exploration activities (Section 4.5.1.2), and are considered to be unique.

As mentioned in Section 4.4.1.2 of this EIS, any activity emitting GHGs would be expected to contribute to an increase in global warming which, in turn, is believed to contribute to climate change. Direct impacts of a VLOS are assumed to be minor, due to their low magnitude and low contribution to GHG emissions on a state level. Indirect effects are considered minor to moderate, since the outcome of activities associated with a VLOS could lead to a greater continued increase in GHG emissions which is not in alignment with the goal to reduce GHG sources and emissions in an effort to minimize impacts to global climate change.

4.10.6.4 Air Quality

4.10.6.4.1 Existing Analysis (BOEM 2011b and BOEM 2011d)

Section IV.E.3 of BOEM (2011b) describes potential impacts to air quality during the five phases of a possible VLOS within the U.S. Chukchi Sea Planning Area. This information is incorporated herein by reference, and a summary of that information is provided here.

A VLOS could emit large amounts of regulated potentially harmful pollutants into the atmosphere. This will cause major air quality impacts during some phases of the event. The greatest impacts to air quality conditions would occur during Phase 1 and Phase 4, particularly if the spill occurs in the winter. Impacts continue for days during Phase 1 but could continue for months under Phase 4. Therefore, while the impacts are estimated to be major during these two phases, the emissions from the VLOS would be temporary and over time, air quality in the Arctic would return to pre-oil-spill conditions.

Likewise, Section 4.4.4.3.2 of the BOEM (2011e) analysis provides an analysis of the impacts of a catastrophic discharge event on air quality in the Chukchi Sea planning area. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that evaporation of oil from a catastrophic discharge event, and emissions from spill response and cleanup activities including in situ burning, if used, have the potential to affect air quality in Arctic Alaska. The greatest impacts on air quality would occur during the initial explosion of gas and oil and during spill response and clean up, particularly if the event occurs during the winter. Impacts could continue for days during the initial event and could continue for months during spill response and clean up. Therefore, while the impacts may be large during these two phases, overall, the emissions from a catastrophic discharge event would be temporary and, over time, air quality in Arctic Alaska would return to pre-oil spill conditions (BOEM 2011d).

4.10.6.4.2 Additional Analysis for Air Quality

The magnitude of pollutant emissions and resultant impact levels are the two basic measurements for assessing the level of effects of a project on air quality. The potential magnitude for pollutant emissions is greatest during both Phase 1 of the spill scenario (initial explosion emissions of PM and combustion products) and Phase 4 of the spill scenario (spill response and cleanup using large amounts of fuel burning equipment). Both of these phases have the potential for large amount of emissions which could have a major effect on air quality, at least during the event and in the vicinity of the emissions.

The duration of air pollution impacts is dependent on several factors, including duration of the emissions from the source, meteorological conditions (wind), and chemical transformations for specific pollutants. In general, there are no long-term, recurring effects from short-term releases, such as those associated with any of the potential VLOS phases. The expected short-term or temporary period of emissions from any of the phases indicates that the overall effects on air quality would also only be temporary and therefore considered minimal to moderate, even for phases with larger magnitudes of emissions.

The extent of air pollution impacts is dependent on several factors, including source location, duration of the emissions, and meteorological conditions. Increases in levels of air pollutants at different distances are attributed to the type of emissions, which are covered by the magnitude indicator. Typically, as a potential VLOS evolves, direct emissions from the spill itself are rapidly dissipated. The extent of emissions from Phase 4 activities may be more spread out, however the effects of this on overall air quality are expected to be only minimal to moderate as there would not be large concentrations of equipment emissions over the full extent of a potential spill.

As discussed in Section 3.1.5.2, there are no Class I air quality designations in or around the EIS project area. The potential for VLOS-related air quality effects at unique or sensitive locations would be attributed to Phase 4 activities, where equipment may be staged. Staging activities would include equipment transport and is expected to have low emissions and only a short-term occurrence. Therefore, the context of air quality effects is expected to be minimal.

Conclusion

Impacts to air quality resultant from a VLOS could be of minimal to moderate extent and duration, due to the short-term or temporary time frame when emissions would be strongest associated with the spill. There are no Class I air quality designations in or around the EIS project area, and overall effects on air quality would be temporary. Therefore, according to the criteria laid out in Section 4.1.3, the summary impact level could be minimal.

4.10.6.5 Acoustics

4.10.6.5.1 Existing Analysis (BOEM 2011d)

Section 4.4.5.4.2 of the BOEM (2011e) analysis provides a discussion of the impacts of a catastrophic discharge event on the acoustic environment in the Chukchi Sea planning area. This information is incorporated herein by reference, and a summary of the information is provided. The BOEM analysis concludes that the pressure wave and noise generated from an incident involving a loss of well control would affect marine mammals and could be large enough to harass or disturb them if they were close enough to the site of the event. In addition, accident response and support activities, including support aircraft and vessel activity, have the potential to cause noise impacts. These impacts would occur both at the site of the response activity and along the routes of support vessels and aircraft. The duration and magnitude of the impacts would depend on the volume, location, duration, and weather conditions during the catastrophic discharge event, and the response and cleanup activities (BOEM 2011d).

4.10.6.5.2 Additional Analysis for Acoustics

In the event of a VLOS, the acoustic environment could be changed by noise generating sources associated with the initial well control incident and with the subsequent cleanup effort.

Impact producing factors associated with the initial well control incident such as explosion and fire would have minor effects on the acoustic environment within the EIS project area. Although quantitative estimation of the sound pressure levels (SPLs) associated with an explosion is difficult, initial effects on the acoustic environment could be high-intensity. However, these effects would be restricted to areas in the immediate vicinity of the well control incident, and would be extremely temporary. Due to the limited geographic extent and temporary nature of the impacts, overall effects of the initial well control incident on the acoustic environment would be considered minor.

Increases in aircraft and vessel traffic associated with oil spill cleanup activities would result in impacts to the acoustic environment similar to those described in Section 4.5.1.4 of this EIS under 'Acoustic Footprints of Non-Airgun Sources.' Aircraft are used extensively during oil spill response to map and track real-time oil spill extent, to coordinate spill clean-up operations, to track marine wildlife affected by oil, and for deployment of dispersants. Fixed wing aircraft would typically be used for many of the more-offshore operations due to their extended flight capabilities. Helicopters would be used for near-shore operations and for personnel transport from shore to-and-from offshore vessels both near-shore and further offshore. Aircraft sounds are dominated by tonal harmonics of engine/turbine and blade rates and are largely within the frequency range of cetacean hearing. Due to limited sound transmissibility from air to water, except at steep incidence angles, aircraft underwater noise levels are low relative to vessel noise outside limited areas beneath the aircraft. The level of aircraft noise reaching the sea surface and transmitting into the water depends on the aircraft flight altitude and flight speed, with higher received levels at low flight altitudes and increased flight speed. Because aircraft travel at high speeds, the duration of aircraft noise events is typically just a few tens of seconds (Patenaude et al. 2002). However, aircraft involved in oil spill response duties may circle or remain in limited areas and thereby produce more prolonged noise than would straight-line flight paths.

Oil spill response would involve multiple vessels, including vessels for deploying booms, floating storage vessels, DP platforms for wellsite mechanical repair, observation vessels, drillships, tugs personnel transfer vessels and icebreakers. A response operation in the Chukchi or Beaufort seas could be limited to pre-purposed vessels due to the large amount of time required for other vessels to transit into the arctic. Section 4.5.1.4 provides information on the noise footprints of several vessel types. Standard support vessels could produce 120 dB re 1 µPa sound levels to distances near 1.6 km (1 mi) (see Table 4.5-12). Vessels or drillships on DP would produce higher noise emissions and would consequently have larger noise footprints with 120 dB re 1 µPa zones extending up to 10 km (6.2 mi) from the vessel. Ice breaking vessels would also produce high levels of sound due mainly to the very high thrust required to drive the vessel onto ice being broken. Icebreaker sound levels may be similar to or greater than large vessels on DP. Cosens and Dueck (1993) measured sound levels of three icebreakers during icebreaking activity. The measurements at 0.4 and 0.5 km range showed peak spectral levels near 110 dB re 1 $\mu Pa^2/Hz$ between 25 and 50 Hz. The broadband sound levels were not provided.

Impacts on the acoustic environment associated with spill response and cleanup would be medium-intensity, temporary, and regional. Due to the intensity, duration, and geographic extent associated with these impacts, the overall effects of spill response and cleanup on the acoustic environment would be considered moderate. In addition, impact producing factors associated with a VLOS could include the drilling of a relief well, which would result in effects on the acoustic environment similar to those described in Section 4.5.1.4 of this EIS.

4.10.6.6 Water Quality

4.10.6.6.1 Existing Analysis (BOEM 2011b and BOEM 2011d)

Section IV.E.2 of BOEM (2011b) describes potential impacts to water quality resources during the five phases of a possible VLOS in the Chukchi Sea. This information is incorporated herein by reference, and a summary of that information is provided here.

A VLOS and gas blowout would present sustained degradation of water quality from hydrocarbon contamination in exceedence of state and federal water and sediment quality criteria. These effects would be significant. Additional effects on water quality would occur from response and cleanup vessels, in-situ burning of oil, dispersant use, discharges and seafloor disturbance from relief well drilling, and activities on shorelines associated with clean-up, booming, beach cleaning, and monitoring.

Likewise, Section 4.4.3.3.2 of the BOEM (2011e) analysis provides a discussion of the impacts of a catastrophic discharge event on water quality in the Chukchi Sea planning area. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that a catastrophic discharge event in either coastal or marine waters could present sustained degradation of water quality from hydrocarbon contamination in exceedence of state and federal water and sediment quality criteria, and that these effects could be significant depending upon the duration and area impacted by the spill. Additional effects on water quality could occur from response and cleanup vessels, in situ burning of oil, dispersant use, discharges and seafloor disturbance from relief well drilling, and activities on shorelines associated with cleanup, booming, beach cleaning, and monitoring (BOEM 2011d).

4.10.6.6.2 Additional Analysis for Water Quality

The effects of a 2.2 MMbbl oil spill on water quality in the Chukchi Sea would include sustained exceedences of state and federal water quality criteria due to the introduction of large quantities of petroleum hydrocarbons and associated compounds to the environment. The magnitude of the effects of a VLOS on water quality in the Chukchi Sea could be high. The duration of such effects could be long-term, and the geographic extent of the effects could be either regional or state-wide depending on the specific launch area, meteorological conditions at the time of the spill, and effectiveness of the response effort. Chemical response techniques, such as the use of dispersants, could result in additional degradation of water quality, which may or may not offset the benefits of dispersant use. Although water is generally considered a common resource, a VLOS could impact water quality in sensitive areas that are protected by legislation. Overall, a VLOS could have major effects on water quality in the Chukchi Sea.

4.10.6.7 Environmental Contaminants and Ecosystem Functions

4.10.6.7.1 Existing Analysis (BOEM 2011d)

Section 4.4.6.2.4 of the BOEM (2011e) analysis provides some information about the impacts of a catastrophic discharge event on ecosystem functions in the Chukchi Sea planning area. This information is incorporated herein by reference, and a summary of the information is provided. The BOEM analysis states that sensitive benthic habitats could suffer long-term loss of ecological function because of both hydrocarbon toxicity and the subsequent cleanup activities. Hydrocarbons could persist at sublethal concentrations in sediments for decades, and sensitive habitats (i.e., kelp beds, intertidal zones; live-bottom and coral reef) damaged by a spill would likely recover slowly and possibly not recover at all. However, hydrocarbons would be broken down by natural processes, and most benthic habitats are likely to eventually recover. Pelagic habitats would eventually recover their habitat value as hydrocarbons broke down and were diluted. Recovery time would vary with local conditions and the degree of oiling. Overall, impacts on habitats from accidental hydrocarbon spills in open water could range from negligible to moderate, and impacts could be short term to long term; no permanent degradation of pelagic habitat would be expected (BOEM 2011d).

4.10.6.7.2 Additional Analysis for Environmental Contaminants and Ecosystem Functions

For the purposes of this section, ecosystem functions refer to the capacity of natural components and processes to provide goods and services that satisfy human needs directly or indirectly (DeGroot et al. 2002).

This section uses a typology for four classes of ecosystem functions proposed by DeGroot et al. (2002) to describe potential impacts that could occur to ecosystem functions as a result of a 2.2 million barrel oil spill in the Chukchi Sea. These classes include: regulation functions; habitat functions; production functions; and information functions, and were defined in Chapter 3, Section 3.1.8.

Phase 1 (Initial Event)

Regulation Functions

Impact producing factors resulting from the initial well control incident such as fire and explosion would have local effects on the ability of natural systems to maintain essential ecological processes. Inputs of heat and petroleum hydrocarbons would inhibit the use of water and nutrients by some organisms. The dampening capacity of the ecosystem in response to perturbation (i.e. resilience) would be overwhelmed in the immediate vicinity of the event. Trophic interactions would be disrupted, and the role of biota in the storage and cycling of nutrients would be perturbed in the vicinity of the event.

Release of large quantities of ethane, propane, and other hydrocarbon gasses into the water column would result in increased levels of respiration in microbial communities (Valentine et al. 2010). In response to perturbation, the respiration to biomass ratio (R/B) would increase, and production to respiration ratios (P/R) would decrease (Odum 1985). Efficiency of trophic transfers would decrease as a result of the initial well control incident. Valentine et al. (2010) reported oxygen depletion in plumes of oil and gas subsequent to the Deepwater Horizon oil spill caused by increased microbial respiration driven by hydrocarbon gasses. Propane and ethane were the primary drivers of microbial respiration in the plumes, resulting in local depletion of dissolved oxygen in the water. Low-diversity bacterial blooms resulted from biodegradation of some hydrocarbon fractions. Decreased diversity of microbial communities and reduced energy flow at higher trophic levels could be expected to occur in response to the initial well control incident (Valentine et al. 2010, Odum 1985).

Habitat Functions

Effects of the initial well control incident on habitat functions would be localized and high intensity. Spawning and refuge habitat functions would be affected for most communities in the immediate vicinity of the well control incident. The effects could be adverse with regard to habitat functions for most multi-celled organisms. However, the initial well control incident may have positive effects on habitat functions for bacteria with the ability to metabolize short-chain hydrocarbons (Valentine et al. 2010).

Production Functions

The initial well control incident would have both beneficial and adverse effects on production functions related to conversion of energy and nutrients into biomass. Levels of photosynthesis would likely decrease in the immediate vicinity of the event due to releases of heat and hydrocarbon compounds into the environment. In contrast, respiration would likely increase at the microbial level as a result of increased temperatures and bioavailability of carbon in the vicinity of the well control incident. Subsequent to the Deepwater Horizon oil spill, Hazen et al. (2010) reported enrichment of communities of hydrocarbon degrading bacteria in the vicinity of the oil spill. Metabolism of hydrocarbons would signify increased respiration in response to perturbation, and some measureable increases in biomass would likely occur in the vicinity of a VLOS in the Chukchi Sea. However, it is unlikely that the energy from hydrocarbons incorporated into lower trophic level organisms would be available for utilization by primary and secondary consumers due to toxic effects of petroleum hydrocarbon compounds at higher trophic levels (Peterson et al. 2003). Thus, the length of the food chain (or complexity of the food web) would decrease in response to inputs of oil and gas. Although some hydrocarbon compounds would be utilized as nutrients at lower trophic levels, flows of energy and nutrients would decrease at higher trophic levels in response to physical and chemical stress on primary and secondary consumers.

Information Functions

The effects of the initial well-control incident on information functions in the Chukchi Sea ecosystem would be related to impacts on social and cultural systems, and on human health, all of which are addressed in this EIS (see Sections 4.5.3.2 for Subsistence and 4.5.3.3 for Public Health).

Phase 2 (Offshore Oil)

Regulation Functions

Efficiency of trophic transfers would be impacted across regional scales. Hundreds of square kilometers of ocean area would be affected. Changes in the microbial community structure would occur in the oiled area. While populations of some bacteria would increase in response to the presence of offshore oil, transfer of nutrients and biomass to higher trophic levels would be impeded as a result of stress and physical effects on primary and secondary consumers. Species diversity would decrease in the affected area, resulting in decreases in food web complexity (Odum 1985).

It is likely that gas regulation functions (CO_2/O_2 balance) and climate regulation functions would be impacted (Kessler et al. 2011). Oxygen depletion was observed in large areas of the Gulf of Mexico as a result of metabolism of hydrocarbons released during the Deepwater Horizon oil spill (Valentine et al. 2010, Kessler et al. 2011). Although the impacts of this oxygen depletion are not likely to be measureable in the atmosphere, oxygen depletion would be likely to affect marine ecosystems in the Chukchi Sea. In addition, perturbation of the Chukchi Sea ecosystem could inhibit the growth of phytoplankton that produce dimethyl sulfide and other climate regulating gasses. Functions related to maintenance of water quality and assimilation of wastes would be adversely affected as a result of offshore oil and gasses released during a VLOS.

Habitat Functions

The effects of offshore oil on habitat functions would be high-intensity and regional in scale. Spawning and refuge habitats would be affected for most communities in the vicinity of the well control incident.

Production Functions

Offshore oil would have adverse effects on production functions in the Chukchi Sea. Photosynthesis would be limited by both a decrease in availability of light, as well as by chemical inhibition, both of which would result from exposure of primary producers to large quantities of petroleum hydrocarbons. Low concentrations of petroleum hydrocarbons could have a stimulatory effect on photosynthesis in some species of marine algae; however, photosynthesis would be inhibited at higher concentrations (Chan and Chiu 1985).

The effects of offshore oil on production functions associated with subsistence and cultural resources are discussed in other sections of this EIS.

Information Functions

The effects of offshore oil on information functions in the Chukchi Sea ecosystem would be related to impacts on social and cultural systems, and on human health, all of which are addressed in other sections of this EIS.

Phase 3 (Onshore Contact)

Regulation Functions

For planning purposes, the USCG estimates that 5 to 30 percent of the spilled oil (110,000 to 660,000 bbl) would reach the shore in the event of an offshore VLOS (BOEM 2011b). Coastlines, and especially coastal wetlands, are important areas for regulation functions, such as nutrient cycling, water regulation, and soil retention, and these areas generally support higher levels of biodiversity and species richness relative to either offshore or other onshore areas. Onshore contact of spilled oil would have adverse effects on regulation functions by impacting coastal biological communities and changing the natural patterns of nutrient cycling, water regulation, and soil retention to which biological communities are adapted.

Habitat Functions

Physical and chemical changes to the shoreline environment would impact spawning and refuge habitat functions for all shoreline communities; these impacts are discussed in other sections of this EIS.

Impacts to coastal wetlands, tidal flats, and sheltered beaches would generally be greater than impacts to exposed gravel or cobbled beaches (Gundlach and Hayes 1978), and the relative sensitivities of different shoreline types would be a consideration in establishing response priorities subsequent to a VLOS.

Production Functions

Impact producing factors associated with oil on the shoreline, such as contact with coastal wetlands and vegetation, would have long-term adverse effects on production functions. Marine algae and coastal vegetation respond variably to petroleum hydrocarbons. Presence of oil would likely inhibit the germination and growth of many species; however, in areas with persistent inputs of naturally-occurring hydrocarbons (e.g. natural oil seeps), some species of marine algae develop the ability to acclimate to the presence of otherwise toxic hydrocarbon compounds (Carrera-Martinez et al. 2011). Similarly, robust coastal plants such as Arctic Kelp (*Laminaria solidungula*) would be likely to recover subsequent to clean-up. Thus, overall levels of photosynthesis and primary production would decrease temporarily but would likely return to pre-VLOS levels within several years after the cessation of clean-up activity. Perturbations to community structure may result in *structural* changes to biological communities in nearshore areas, but functional properties of the system related to primary production and nutrient fixation would likely return to their pre-spill states within several years after cessation of clean-up activities.

Impacts of the VLOS on production functions related to subsistence and cultural resources (Sections 4.10.7.15 and 4.10.7.17, respectively) are discussed in other sections of this document, and those discussions are not duplicated here.

Information Functions

The effects of onshore contact of a VLOS event on information functions in the Chukchi Sea ecosystem would be related to impacts on social and cultural systems, and on human health, all of which are addressed in other sections of this document.

Phase 4 (Spill Response and Cleanup)

Regulation Functions

Activities associated with spill response and clean-up would have a variety of effects on regulation functions within the Chukchi Sea ecosystem. Effects on nutrient cycles, biological energy flows, and biological control of population cycles would depend heavily on the methods used to respond to spilled oil.

Dispersants would change the location of the impact of the spilled oil from the surface of the water to areas deeper in the water column. Application of dispersants would likely decrease the magnitude of impacts on the sea surface microlayer where gas exchange processes occur, leading to decreased impacts on gas regulation functions in the affected area. Distributing the oil deeper in the water column would also decrease the magnitude of impacts on marine nutrient cycles, which are largely driven by photosynthesis and respiration occurring in the photic zone (sunlit waters generally in the upper 50 m (164 ft) of the water column). Dispersion of oil out of the photic zone would limit the potential for phototoxic effects, which can occur as a result of sunlight driven photochemical reactions that increase the bioavailability and toxicity of certain petroleum hydrocarbon compounds including some PAHs and their derivatives. However, dispersants themselves would contribute to short term adverse effects on regulation functions by increasing the bioavailability of petroleum hydrocarbons, which could lead to increased respiration rates and oxygen depletion in some marine areas (Hazen et al. 2010). Some surfactants and solvents present in commercially available dispersant formulations would have toxic effects at high concentrations that could occur immediately after the application of the dispersants. Overall, dispersants would likely decrease the magnitude and duration of effects of spilled oil on regulation functions in the Chukchi Sea, although the intensity and spatial distribution of effects would be likely to increase for a short period of time immediately following dispersant application.

The effects of *in situ* burning on regulation functions would be similar to those described for dispersants. *In situ* burning would introduce large quantities of smoke and gasses into the atmosphere, which would result in temporary effects on gas regulation processes. Gasses released as products of the combustion reaction would also influence the climate regulation functions of the atmosphere; such effects are expected to be short-term and would become negligible as the released gasses become diluted in the atmosphere. Incomplete combustion of crude oil on the surface of the water would generate large quantities of toxic products; however, the impacts of the combustion products on regulation functions would be less than those of the greater quantities of unburned oil present prior to *in situ* burning.

Mechanical recovery in the offshore environment would have net positive impacts on regulation functions resulting from the removal of the spilled oil. However, beach cleaning could destabilize biological communities and physical substrates leading to temporary oscillations in the nutrient and energy cycles associated with regulation functions.

Application of fertilizer to enhance biodegradation of spilled oil would temporarily destabilize nutrient cycles in the treated area. By modifying nutrient stoichiometry (expressed as ratios of bioavailable carbon to nitrogen to phosphorus, or C:N:P) in the affected area, application of fertilizer would temporally concentrate assimilation of the oil into the environment. This assimilation of the spilled oil is itself an example of a regulation function. Rapid assimilation and detoxification of the oil resulting from augmented biodegradation processes would increase the intensity of effects on nutrient cycles in the affected area, but would decrease the duration of those effects.

Habitat Functions

Response and clean-up activities could have intense effects on habitat functions in sensitive areas. For example, the use of hot water hydraulic washing to clean oiled shoreline could destabilize physical substrates causing adverse impacts to spawning and refuge habitats for coastal species. Shoreline sensitivity indices would be used to establish oil spill response priorities and to help determine the most appropriate clean-up methods to be used in sensitive areas.

Production Functions

The effects of oil spill clean-up activities on production functions would depend on the particular response techniques used. As discussed above, the use of dispersants could effectively move oil out of the photic zone, thereby decreasing adverse effects on photosynthesis. Dispersants would also increase the bioavailability of the oil to organisms living deeper in the water column, leading to increased respiration in some classes of heterotrophs (Hazen et al. 2010), as well as toxic effects in most pelagic organisms. The use of dispersants would decrease the duration of VLOS impacts on production functions, but would increase the intensity of the effects.

In situ burning would have adverse effects on production functions. Release of heat and combustion products into the water would have adverse effects on primary producers. The duration of these effects would likely be short term. While cascades of indirect effects could lead to structural changes in biological communities over decadal timescales (Peterson et al. 2003), the functional properties of the ecosystem responsible for primary production would be expected to recover within several years after the cessation of cleanup activities.

Information Functions

The effects of spill cleanup operations on information functions in the Chukchi Sea ecosystem would be related to impacts on social and cultural systems, and on human health, all of which are addressed in other sections of this document.

Phase 5 (Long-term Recovery)

Regulation Functions

Regulation functions related to nutrient cycles, regulation of water and gasses, and waste assimilation would likely recover within several years of the cessation of clean-up activities. With regard to regulation functions at the system level, respiration to biomass ratios would likely return to pre-spill values within several years after the spill, and ratios of production to respiration would approach unity over a similar timescale. Species composition and community structure may change as a result of a VLOS in the Chukchi Sea, but the functions performed by interactions of biological communities with their chemical and physical environment would be more resistant to the stress associated with a VLOS event. Although the structural properties of the ecosystem may experience lasting effects, functional properties of the ecosystem would be expected to recover more rapidly from the effects of the perturbation (Odum 1985).

Recovery of biological control functions related to dynamic trophic interactions would be less certain. Fourteen years after the *Exxon Valdez* oil spill, Peterson et al. (2003) described ongoing impacts to biological control functions resulting from cascades of indirect effects triggered by the oil spill. The magnitude of natural oscillations in predator-prey population cycles would be expected to increase as a result of the VLOS event. For example, Peterson et al. (2003) report that cascades of indirect effects triggered by the *Exxon Valdez* oil spill were responsible for cyclic instability in the population cycles of several species in onshore communities. Although the species and habitats present in the EIS project area are different from those in Prince William Sound, the following account is useful for understanding how cascades of indirect effects may persist for decades following a VLOS event:

> *Indirect interactions lengthened the recovery process on rocky shorelines for a decade or more. Dramatic initial loss of cover by the most important biogenic habitat provider, the rockweed **Fucus gardneri**, triggered a cascade of indirect impacts. Freeing of space on the rocks and the losses of important grazing (limpets and periwinkles) and predatory (whelks) gastropods combined to promote initial blooms of ephemeral green algae in 1989 and 1990 and an opportunistic barnacle, **Chthamalus dalli**, in 1991. Absence of structural algal canopy led to declines in associated invertebrates and inhibited recovery of **Fucus** itself, whose recruits avoid desiccation under the protective cover of the adult plants. Those **Fucus** plants that subsequently settled on tests of **Chthamalus dalli** became dislodged during storms because of the structural instability of the attachment of this opportunistic barnacle. After apparent recovery of **Fucus**, previously oiled shores exhibited another mass rockweed mortality in 1994, a cyclic instability probably caused by simultaneous senility of a single-aged stand. The importance of indirect interactions in rocky shore communities is well established, and the general sequence of succession on rocky intertidal shores extending over a decade after the Exxon Valdez oil spill closely resembles the dynamics after the Torrey Canyon oil spill in the UK. Expectations of rapid recovery based on short generation times of most intertidal plants and animals are naıve and must be replaced by a generalized concept of how interspecific interactions will lead to a sequence of delayed indirect effects over a decade or longer* (Peterson et al. 2003).

Similar cascades of indirect effects could be expected to occur in both onshore and offshore communities in response to a VLOS in the Chukchi Sea. While most properties of the Chukchi Sea ecosystem responsible for performance of regulation functions could be expected to recover within several years of a VLOS event, the post-spill ecosystem would be less resilient to the effects of additional perturbations. Increased magnitude of oscillations in the populations of key species would likely destabilize the established system of trophic interactions in the Chukchi Sea ecosystem, putting the system at greater risk for major impacts from any subsequent perturbations.

Habitat Functions

Persistence of oil in sediments may have negative long-term effects on habitat functions within the affected area. Subsequent to the *Exxon Valdez* oil spill in Prince William Sound, Peterson et al. (2003) reported long-term impacts to habitat functions resulting from persistence of 3-5 ring PAHs (e.g. phenanthrene, anthracene, pyrene, triphenylene, and associated derivatives). Lighter non-aromatic hydrocarbon compounds released during a VLOS are more readily degraded in the environment as a result of physical weathering processes and biodegradation. Long-term effects on habitat functions would be limited to areas where oil may become trapped in sediments or other substrate, and shielded from weathering and degradation. Long-term effects on habitat functions would be local and medium intensity, but would have the potential to affect unique resources depending upon the location of the discharge and the efficacy of the response effort.

Changes in the structure of biological communities and food webs could result in long-term changes in habitat usage and resource utilization. Prediction of the direction and magnitude of such changes is problematic; however it is likely that small, short-lived organisms would begin to utilize habitat and resources that were previously used by larger, longer-lived organisms (Odum 1985).

Production Functions

Levels of primary production in the Chukchi Sea would be expected to return to pre-spill levels within several years of the cessation of clean-up activities associated with a VLOS event. However, lasting impacts on production functions at the system level would be related to human utilization of natural resources in the area. Long-term effects of a VLOS event on subsistence, cultural resources, and human health are discussed in other sections of this document.

Information Functions

The long-term effects of a VLOS event on information functions in the Chukchi Sea ecosystem would be related to impacts on social and cultural systems, and on human health, all of which are addressed in other sections of this document.

Conclusion

Effects of a VLOS on ecosystem functions in the Chukchi Sea would be high intensity, long-term, regional, and could affect unique resources. Overall, the effects of a VLOS on ecosystem functions in the Chukchi Sea would be considered major. However, with few exceptions, the ecosystem functions in the VLOS area would likely recover within several years of the cessation of clean-up activities. The functional properties of ecosystems described in this section, such as nutrient cycling and habitat functions, are more robust (i.e. resistant to stressors) than are species composition and other structural properties. As suggested by Peterson et al. (2003), a VLOS event would be likely to affect ecosystem structure over timescales of decades; ecosystem functions, from which humans derive value, would be likely to recover more quickly.

4.10.6.8 Lower Trophic Levels

4.10.6.8.1 Existing Analysis (BOEM 2011b and BOEM 2011d)

Section IV.E.4 of BOEM (2011b) describes potential impacts to lower trophic levels resources during the five phases of a possible VLOS in the Chukchi Sea. In addition, Section 4.4.7.5.3 of the BOEM (2011e) analysis provides a discussion of the impacts of a catastrophic discharge event on invertebrates and lower trophic levels in the Chukchi Sea. This information from these two documents is incorporated herein by reference, and a summary of that information is provided below.

A VLOS would likely have less than a one year effect on phytoplankton populations in the Chukchi Sea due to the influx of phytoplankton carried into the Chukchi Sea by the waters of the Gulf of Anadyr, the Bering Sea, and the Alaska Coastal currents that would supplement remaining endemic populations. However, short-term, local-level effects would have greater potential to affect local food webs. Severity of effects would be determined by duration of oil spill, weather patterns, and the resultant distribution and geographic coverage of surface oil slicks. Ice algae population effects would be determined by similar factors, as the presence of oil within polynyas and reaches, and if incorporated into first year ice would likely have at least a one-year effect on local populations due to effects on primary productivity and the probable inability of epontic communities reliant on ice algae to survive within oil-influenced ice.

Invertebrate populations within benthic, pelagic, and onshore environments are at greater risks from a VLOS due to their slower reproductive rate, longer life spans, and the potential of adult breeding populations being negatively affected by the VLOS and leading to a longer recovery rate. If population level effects resulting from a VLOS occur in breeding stocks of invertebrates of these Chukchi Sea environments, the recovery potential of populations would not be enhanced by the flow of Bering Sea and Anadyr waters as it is with phytoplankton populations. Phytoplankton and zooplankton populations extirpated by oil slicks that are constantly shifting and forming in new areas due to influences of wind, weather, and waves, would not be available to organisms that depend on them for food and survival. Food webs can be very short in the Arctic, with interactions between megafauna (i.e. whales, seals, walrus) and lower trophic organisms often comprising one or two trophic levels due to the tight benthic and pelagic coupling on the shallow continental shelf off the Alaskan Arctic coast (Dunton et al. 2005, Grebmeier et al. 2006). Bioaccumulation and biomagnification in these foodwebs is a concern. Long lived copepods (such as *Calanus glacialis*) may live two to three years, store lipids in the body cavity, undergo diapause (a form of hibernation), and be consumed by upper level predators (atlantic cod, bowhead whales, etc.) at a later date (USDOI, MMS, 2004). Toxicity studies carried out with benthic crabs and shrimp indicate they may not immediately die from toxins (living 24-96 hrs, depending on exposure and oil type), thus allowing greater opportunities for consumption by upper-level predators and biomagnification to occur (Brodersen, 1987). Phytoplankton themselves may not die immediately from the effects of exposure to oil; therefore, advective drift following bioaccumulation in their populations may allow them to be consumed by other organisms in locations away from contamination sites (Jiang et al., 2010). Recovery rates of one or more years may result from these effects on invertebrate populations.

4.10.6.8.2 Additional Analysis for Lower Trophic Levels

As outlined in the discussion in BOEM (2011b), a VLOS of approximately 2.2 MMbbl has the potential to adversely impact lower trophic levels. The scale of these impacts could vary greatly, depending on when, where, and how much oil would directly affect the given areas. The Oil Spill Trajectory Analysis described in BOEM (2011b) (Section IV.E.) provides an outline of various theoretical events, with detailed geographic summaries. The important conclusion is that oil has the potential to reach the entire EIS project area under certain conditions. Therefore, all lower trophic levels within the Chukchi Sea are vulnerable to long term impacts. The most likely impacts include:

- Mortality to all life stages resulting from pressure waves from an initial explosive event, toxicity to oil (acute and chronic), and coating with an oil layer;
- Impact to food web and resultant bioaccumulation and biomagnification as a result of the close interactions between megafauna (i.e. whales, seals, walrus) and lower trophic organisms (Dunton et al. 2005, Grebmeier et al. 2006) (see Section 4.10.6.11 for more information regarding the effects of bioaccumulation and biomagnification on marine mammals);
- Longer recovery rates due to species traveling outside the original contamination site or being consumed later, thereby prolonging the recovery, as a result of drift or diapause (a form of hibernation), respectively. This would delay recovery since these species surviving the initial incident would store toxins and be consumed at a later date by higher trophic level organisms (MMS 2004, Jiang et al. 2010, Brodersen 1987); and
- Habitat loss due to oiling of ice or benthic substrate and the resultant decrease in primary productivity or mortality events.

The magnitude of these impacts is dependent on a variety of factors. The primary factors influencing the level of impact include:

- Duration and volume of the spill;
- Distribution and geographic coverage of surface oil slicks;
- Persistence and dispersion of oil in the water column (epontic, pelagic, or benthic);
- Chemical composition of the oil;
- Efficacy of chemical dispersants;
- Incorporation of spill into first year ice; and
- Weather patterns, including hours of daylight and UV intensity, presence or absence of ice, presence or absence of polynyas, and reaches.

Depending upon the factors discussed above, the VLOS could have a summary impact level of major, should the spill persist in the environment or affect unique resources. However, should the spill not persist or affect unique resources, the impacts to the lower trophic levels would be of low to medium magnitude, temporary, local to regional geographic extent, and common context, with the exception of the time/area closures mentioned above. In this case, the impact criteria listed in Table 4.5-17 would lead to a summary impact level of moderate due to the shorter duration and regional impacts to common resources.

4.10.6.9 Fish and Essential Fish Habitat

<u>4.10.6.9.1 Existing Analysis (BOEM 2011b and BOEM 2011d)</u>

Fish

Section IV.E.5 of BOEM (2011b) describes potential impacts to fish and fish resources during the five phases of a possible VLOS in the Chukchi Sea. This information is incorporated herein by reference, and a summary of that information is provided here.

The level of effects of a very large oil spill in the Chukchi Sea on a fish species and its population would depend on many factors including:

- life stage affected (egg, larvae, juvenile, adult);
- species distribution and abundance (widespread, rare);
- habitat dependence (ocean water column, sea surface, benthos, sea ice, estuarine, freshwater);
- life history (anadromous, migratory, reproductive behaviors and cycle, longevity, etc.);
- extent and location of spawning areas in the estuarine or riverine systems;
- species exposure and sensitivity to oil and gas (toxicology, swimming ability);
- effect on prey species; and
- location of the oil spill (nearshore, further offshore), depth at which the hydrocarbon release occurs (seafloor, mid-column or surface), ratio of the mixture of oil and gas released, and time of year the oil spill occurs.

Considering all these factors, some species or life stages of a species could be significantly affected (defined here as greater than three generations to return) at a population level.

In addition, Section 4.4.7.3.3 of the BOEM (2011e) analysis provides a discussion of the impacts of a catastrophic discharge event on fish in Arctic Alaska. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that a catastrophic discharge event could have population-level consequences on some fish populations if vital habitat areas were affected or if the spill occurred in spawning areas or juvenile feeding grounds when fish populations are highly concentrated. In such cases, catastrophic spills could cause substantial reductions in population levels for one or more years. However, no permanent impacts on fish populations are expected (BOEM 2011d).

Essential Fish Habitat

Section IV.E.6 of BOEM (2011) describes potential impacts to EFH during the five phases of a possible VLOS in the Chukchi Sea. Likewise, Section IV.E.15 of BOEM (2011b) describes potential impacts to subsistence resources. This information is incorporated herein by reference, and a summary of that information is provided here.

The level of effects of a very large oil spill in the Chukchi Sea on EFH would depend on several factors including:

- location of the oil spill (nearshore, further offshore); depth at which the release occurs (seafloor, mid-column or surface), ratio of the mixture of oil and gas released, and time of year oil spill occurs;
- extent and location of spawning areas in the estuarine or riverine systems;
- species abundance and distribution (widespread, rare);
- the species and the sensitivity of their life stage affected (egg, larvae, juvenile, adult); and
- life history and reproductive cycle.

Considering these factors, EFH of some species' life stages could be significantly impacted by a VLOS.

Likewise, Section 4.4.6.4.3 of the BOEM (2011e) analysis provides an analysis of the impacts of a catastrophic discharge event on EFH in Arctic Alaska. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that a catastrophic discharge event could cause long-term declines of fish species that rely on shallow coastal, intertidal, and freshwater areas. Spills occurring under ice could result in long-term degradation of EFH because of the cleanup difficulties; severity of effects of accidental hydrocarbon spills on EFH would depend on the size of the spill, its location, environmental factors, and the uniqueness of the affected EFH (BOEM 2011d).

4.10.6.9.2 Additional Analysis for Fish and Essential Fish Habitat

As outlined in the discussion in BOEM (2011b), a VLOS of approximately 2.2 MMbbl has the potential to impact fish and fish resources. The scale of these impacts could vary greatly, which is primarily determined by the location of the spill. The Oil Spill Trajectory Analysis described by BOEM (2011b) (Section IV.E.1.) provides an outline of various theoretical events with detailed geographic summaries. The important conclusion from this exercise is that oil has the potential to reach the entire EIS project area under certain conditions. Therefore, all fish resources within the Chukchi Sea are vulnerable to impacts, potentially long term. The most likely impacts include:

- Mortality to all life stages resulting from pressure waves from an initial explosive event, toxicity to oil (acute and chronic), and coating with an oil layer;
- Reduction of individual fitness and survival due to physiological contaminant effects. These effects can, in turn, affect swimming, feeding, reproductive and migratory behaviors and the physiologic adjustment for anadromous fish as they move between freshwater and saltwater environments; and
- Onshore and offshore habitat loss due to oiling, resulting in displacement and stress. Displacement could result in blocked or impeded access to spawning, rearing, feeding, and migratory habitats important for survival.

The magnitude of these impacts is dependent on a variety of factors. The primary factors influencing the level of impact include:

- Location and time of year of the oil spill;
- Life stage affected (egg, larvae, juvenile, adult) and life history (anadromous, migratory, reproductive behaviors and cycle, longevity);
- Species distribution and abundance;
- Species exposure and sensitivity to oil and gas (toxicology, swimming ability); and
- Habitat dependence (marine vs. freshwater, onshore vs. offshore, location of spawning habitat, depth).

Based on the five oil spill phases, the greatest impacts could be felt during Phases 2 and 3, particularly in benthic and nearshore regions. The fish typically found in these areas are more susceptible to impacts from a VLOS due to their increased dependence on relatively limited habitat when compared to pelagic fish, or decreased swimming ability resulting in an inability to escape impacted areas. Most impacts to habitat could be short term in duration, with shoreline and substrate impacts lasting longer. The fish assemblages with an increased susceptibility include:

- Migratory and juvenile fish that use nearshore, shallow lagoons, estuaries, and bays;
- Benthic fish, which are typically poor swimmers; and
- Cryopelagic species such as Arctic cod, should the spill occur in winter or get entrained in seasonal pack ice.

Most fish and EFH within the EIS project area are important resources that are widespread and abundant. However, the impacts from a VLOS could be of high intensity, long term duration, and occur over a broad, regional extent. Therefore, according to the criteria laid out in Table 4.5-17, the summary impact level could be moderate.

4.10.6.10 Marine and Coastal Birds

4.10.6.10.1 Existing Analysis (BOEM 2011b and BOEM 2011d)

Section IV.E.9 of BOEM (2011b) describes potential impacts to marine and coastal bird resources during the five phases of a possible VLOS in the Chukchi Sea. In addition, Section 4.4.7.2.3 of the BOEM (2011e) analysis provides a discussion of the impacts of a catastrophic discharge event on birds in Arctic Alaska. The information from these two analyses is incorporated herein by reference, and a summary of that information is provided here.

A VLOS has the greatest potential for affecting large numbers of birds in part due to its toxicity to individuals and their prey and the amount of time these birds spend on the surface of marine and coastal waters. Under a hypothetical VLOS scenario, marine and coastal birds in key areas or at key times could experience a variety of negative effects from petroleum exposure and habitat loss. Key areas evaluated included:

- Kasegaluk Lagoon;
- Ledyard Bay;
- Peard Bay;
- barrier islands;
- the spring open-water lead systems;
- Cape Lisburne; and
- Cape Thompson.

All of the areas above provide important nesting, molting, or migration habitat to a variety of seabirds, waterfowl, and shorebirds. The Ledyard Bay Critical Habitat Unit is especially important to spectacled eiders that molt there in dense flocks from July to November.

A VLOS during periods of peak use could affect large numbers of marine and coastal birds, including listed eiders, loons, seabirds, and waterfowl. As a typical example, up to 45 percent of the estimated Pacific Flyway population of Pacific brant could be affected, if an oil spill reaches Kasegaluk Lagoon. Effects could range from direct mortality of approximately 60,000 brant to sublethal effects on an equal or smaller number of brant. The loss of up to 45 percent of the Pacific Flyway population would have conspicuous population-level effects. The situation with brant is similar to a wide variety of waterfowl and shorebirds that use similar areas of the Chukchi Sea.

A hypothetical VLOS could impact large numbers of murres, puffins, and kittiwakes at the Cape Lisburne and Cape Thompson colonies. The magnitude of potential mortality could result in significant adverse impacts to the colonies. Large-scale mortality could occur to migrating or molting concentrations of marine and coastal birds, including adult male and juvenile murres in the late summer molting area. Mortality from a hypothetical VLOS could result in population-level effects for most marine and coastal bird species that would take more than three generations to recover.

Large-scale mortality could occur with respect to pelagic distributions of auklets and shearwaters during the open-water period.

As a group, the Launch Areas (specifically LAs 8-13) affected by the deferral corridors contemplated in Alternatives III and IV tend to exhibit higher percentages of spill trajectories contacting sensitive nearshore and coastal habitats along the Chukchi Sea. These alternatives may offer protection to nearshore resources, spring lead systems and spring polynyas by decreasing the percentage of trajectories that would contact these resource areas. In this sense, the most protection to nearshore and coastal birds is afforded by the broadest coastal deferral, Alternative III. Deferrals may also afford more time for spill response and cleanup prior to a spill contacting nearshore resources. These benefits would not be expected to accrue to pelagic species of birds.

4.10.6.10.2 Additional Analysis for Marine and Coastal Birds

Direct and indirect exposure to oil is an impact producing factor that can adversely affect marine and coastal birds. The level of impact is dependent upon the timing of the VLOS, the seasonal effects of currents and subsequent advection of oil, timing and duration of the oil spill, presence or absence of fast or pack ice, location (within important habitat areas or outside), and general weather patterns (wind and storm events). If a VLOS occurs in important habitat areas, the magnitude of impacts to marine and coastal birds could be medium to high, with displacement from the area, impacts to prey resources and habitat quality, and a likelihood of injury or mortality from either direct contact with or ingestion of oil and associated contaminants. The duration of the impacts could be long-term to permanent because habitat areas could be abandoned or large portions of the population could be affected. The geographic extent could occur state-wide due to migrating, molting, and breeding bird populations. If the VLOS were to occur outside important habitat areas, the effects could be the same except the duration could be temporary to long-term rather than long-term to permanent. The chance of recovery could be greater due to less birds likely being affected, compared to a higher concentration of birds that could be found in many important habitat areas at certain periods of time.

Population level effects are likely, given the high concentration of migrating, molting, and breeding bird populations. The impacts from a VLOS could be of high intensity, long term duration, and occur over a broad, regional extent. Therefore, a VLOS in the Chukchi Sea during the lifetime of this EIS could result in a major impact to marine and coastal birds. This is due to the potential adverse effects to population levels, habitat, molting, and breeding areas, important habitat areas, toxicity to prey and individuals, and mortality of individuals.

Ledyard Bay Critical Habitat Area

The Ledyard Bay Critical Habitat Unit (LBCHU) was designated as a critical habitat for ESA-listed spectacled eiders in 2001 due to its importance for the persistence and recovery of spectacled eiders, its marine aquatic flora and fauna in the water column, and its abundant benthic community. The oil spill analysis from BOEM (2011b) reported the following model results for impacts to Ledyard Bay:

> ***Summer within 60 and 360 Days:*** *The OSRA model estimates that 38 percent and 22 percent of trajectories from a hypothetical VLOS originating from LA10 or LA11, respectively, could contact spectacled eiders molting in the LBCHU (ERA 10) during the summer within the 60 and 360 day periods.*
>
> ***Winter within 360 Days:*** *The OSRA model estimates that 16 percent and 10 percent of trajectories from a hypothetical VLOS originating from LA10 or LA11, respectively, could contact spectacled eiders molting in the LBCHU (ERA 10) during the winter within 360 days.*

Spectacled eiders make use of the spring lead system when they migrate from their wintering area in the Bering Sea. The spring lead system includes the LBCHU and typically has represented the only open-water area along their path. Once tundra nesting habitats are sufficiently melted to allow nesting (historically around June 10), most breeding pairs of spectacled eiders leave nearshore coastal areas to begin nesting on the Arctic Coastal Plain as far east as Canada. All three breeding populations of spectacled eiders molt in Ledyard Bay from July through October, including most females that nest on the

North Slope (Petersen et al. 1999). Many post-breeding male spectacled eiders slowly begin to converge in offshore aggregations in Ledyard Bay starting in July and begin an extended molt. While molting they are flightless for several weeks. Female spectacled eiders whose nests fail early on go to the coast and eventually end up in Ledyard Bay for flightless molt. Females with broods are the last to arrive at Ledyard Bay around the end of the first week of September, and they may be present into November. The post-breeding molt is an energetically demanding period and Ledyard Bay provides an abundant and accessible food supply with low levels of disturbance and predation.

Ledyard Bay is also important habitat for many other species of waterfowl and tundra nesting seabirds, including ESA-listed Steller's eider and ESA candidate species, yellow-billed loon and Kittlitz's Murrelet. Marine mammals are also important components of the ecosystem, with major migrations of bowhead whales and beluga whales coming through the area in spring. Ice seals and walrus are present all year but especially when sea ice is present. Spotted seals and walrus also use the coastline for haulouts.

Conclusion

Ledyard Bay is undoubtedly rich habitat for a variety of benthic invertebrates and fish species and it is an important habitat for many key marine mammal and bird species. It derives its special designation and protected status, however, from its tremendous importance to the threatened spectacled eider. All of the species from all taxa could be affected by a VLOS in Ledyard Bay to various degrees but the conclusion about the overall effect of a VLOS on this area is driven by the effects on spectacled eider. For this threatened species, Ledyard Bay is a unique habitat and one that is crucial to their continued existence because most of the population stages here in spring and spends their flightless molt period there in the fall. Molting eiders are especially vulnerable to oil spills because they cannot fly away. Molting eiders are present in Ledyard Bay from July through October, almost the entire open-water period when exploratory drilling and accidental spills are most likely to occur. Because of the potentially devastating effects on the world population of spectacled eiders, the overall effects of a VLOS on Ledyard Bay would be considered high in magnitude and intensity, permanent in duration (lasting more than five years), and state-wide in geographic extent. Similar but smaller effects could be expected for other populations of migrating birds and marine mammals. This would be considered a major effect on this important habitat area according to the criteria established in Table 4.5-17.

Kasegaluk Lagoon Time/Area Closure

Kasegaluk Lagoon is an estuary important to rearing fish, including out-migrating salmon smolts from the Kukpowruk, Kokolik, and Utukok rivers. Salmon, other fish, and abundant invertebrate populations are a major attractant for very large numbers of migratory birds that make use of Kasegaluk Lagoon during May to October. Threatened spectacled and Steller's eiders are among the many species of tundra-nesting waterfowl that stage in the lagoon in the spring and post-breeding periods. About half of the Pacific flyway population of brant use Kasegaluk Lagoon during the post-breeding period. Large numbers of phalaropes, dunlins, and other species of shorebirds also use the area during the open-water period. Concentrations of beluga whales use Kasegaluk Lagoon in the spring/summer for molting, where the relatively warm waters and gravelly substrate helps the process.

Conclusion

The effects of a VLOS on coastal vegetation and wetlands could involve hundreds of miles of shoreline and, if influenced by strong winds and waves, could be blown or washed some distance inland. Although barrier islands could protect lagoon areas to some extent, if oil entered a lagoon in substantial amounts, the barrier islands could inhibit weathering and flushing by waves, thereby leading to a more extended exposure of the lagoon environment to the oil than if it was on an outer coast. Kasegaluk Lagoon has a number of entrances to the open ocean and would thus be susceptible to oil spill penetration. BOEM (2011) VLOS analyses are prefaced with assumptions about when, where, and how much oil would directly affect given areas. Of great importance to biological resources is the timing of the spill and how it would overlap with migration and other critical life functions. If oil enters Kasegaluk Lagoon and persists for up to 10 years, as is projected in the BOEM model, most of the animals that use the area at any time of the year could be exposed at least one time and perhaps repeatedly over the years, with potentially permanent effects on all of the populations with intensive use of the lagoon, including many species of fish, waterfowl, shorebirds, beluga whales, and spotted seals. Kasegaluk Lagoon is a unique resource in the Chukchi Sea and the effects of a VLOS would be considered high in magnitude and intensity, permanent in duration (lasting more than five years), and state-wide in geographic extent because it would affect migrating populations of birds. This would be considered a major effect on this time/area closure location according to the criteria established in Table 4.5-17.

4.10.6.11 Marine Mammals

4.10.6.11.1 Existing Analysis (BOEM 2011b and 2011e)

Section 4.4.7.1.3 of the BOEM (2011e) analysis provides a discussion of the impacts of a catastrophic discharge event on marine mammals in Arctic Alaska. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that a catastrophic discharge event would impact marine mammals from direct contact, inhalation, and ingestion (either directly or indirectly through the consumption of oiled forage or prey species). These effects would be significant, causing a multitude of acute and chronic effects. Additional effects on marine mammals would occur from water and air quality degradation associated with response and cleanup vessels, in situ burning of oil, dispersant use, discharges and seafloor disturbances from relief well drilling, and activities on shorelines associated with cleanup, booming, beach cleaning, and monitoring. A catastrophic discharge event has the potential to increase the area and duration of an oil spill, thereby increasing the potential for population-level effects, or at a minimum, an increase in the number of individuals killed. For example, a catastrophic discharge event contaminating ice leads or polynyas in the spring could have devastating effects, trapping bowhead whales where they may encounter fresh crude oil. Beluga whales that also use the spring lead system to migrate would also be susceptible to a spill that concentrates in these leads (BOEM 2011d). Polar bears are most often found near open leads and polynyas where they hunt for seals, making them vulnerable to ingestion of oil through grooming or ingesting oiled prey.

Sections IV.E.7, IV.E.8, IV.E.10, and IV.E.11 of BOEM (2011b) describe potential impacts to marine mammal resources during the five phases of a possible VLOS in the Chukchi Sea. This information is incorporated herein by reference, and a summary of that information is provided here.

Cetaceans

Direct contact with spilled oil resulting from a VLOS would have the greatest potential to adversely affect cetacean species when toxic fumes from fresh oil are inhaled at times and places where aggregations of cetaceans may be exposed. Cetaceans likely would avoid oil spill response and cleanup activities, potentially causing displacement from preferred feeding habitats, and could alter migratory paths for the duration of those activities. Presence of oil on and in the water may be avoided by some and not other cetaceans. Cetaceans as a general group would likely experience some loss of seasonal habitat, reduction of prey, and contamination of prey. Consumption of contaminated prey may adversely affect the health of cetaceans. Human activities brought about by implementation of Oil Spill Response Plans, i.e. cleanup and remediation, post-spill event follow-up treatment and research, and monitoring efforts, may displace cetaceans. A variety of adverse effects on cetaceans could result from contact with and exposure to a VLOS event ranging from simple avoidance to mortality of cetaceans depending on timing, location, cetacean species involved, and circumstances unique to a given spill event.

Bowhead Whale

Depending on the timing of the spill, bowhead whales could experience contact with fresh oil during summer and/or fall feeding event aggregations and migration in the Chukchi Sea and western Beaufort

Sea. Skin and eye contact with oil could cause irritation and various skin disorders. Toxic aromatic hydrocarbon vapors are associated with fresh oil. The rapid dissipation of toxic fumes into the atmosphere from rapid aging of fresh oil and disturbance from response related noise and activity limits potential exposure of whales to prolonged inhalation of toxic fumes. Exposure of aggregations of bowheads, especially if calves are present could result in mortality. Surface feeding bowheads could ingest surface and near surface oil fractions with their prey, which may or may not be contaminated with oil components. Incidental ingestion of oil factions that may be incorporated into bottom sediments can also occur during near-bottom feeding. Ingestion of oil may result in temporary and permanent damage to bowhead endocrine function and reproductive system function; and if sufficient amounts of oil are ingested mortality of individuals may also occur. Population level effects are not expected; however in a very low probability, high impact circumstance where large numbers of whales experience prolonged exposure to toxic fumes and/or ingest large amounts of oil, injury and mortality could potentially affect population growth rates.

Exposure of bowheads could occur in the spring lead system during the spring calving and migration period. Exposure to aged winter spill oil (which has had a portion or all of the toxic aromatic compounds dissipated into the atmosphere through the dynamic open water and ice activity in the polynya) presents a much reduced toxic inhalation hazard. Some inhalation, feeding related ingestion of surface and near surface oil fractions may occur during this period and may result in temporary and/or permanent effects on endocrine and reproductive performance. It is possible that a winter spill would result in a situation where toxic aromatic hydrocarbons would be trapped in ice for the winter period and released in toxic amounts in the spring polynya system when bowheads are migrating through in large numbers. In this low probability situation, calves could die and recovery from the loss of a substantial portion of an age class cohort and its contribution to recruitment and species population growth could take decades.

Bowhead whales could be exposed to a multitude of short and longer term additional human activity associated with initial spill response, cleanup and post event human activities that include primarily increased and localized vessel and aircraft traffic associated with reconnaissance, media, research, monitoring, booming and skimming operations, in-situ burning, dispersant application and drilling of a relief well. These activities would be expected to be intense during the spill cleanup operations and expected to continue at reduced levels for potentially decades post event. Specific cetacean protection actions would be employed as the situation requires and would be modified as needed to meet the needs of the response effort. The response contractor would be expected to work with NMFS and state officials on wildlife management activities in the event of a spill. The two aforementioned groups most likely would have a presence at the Incident Command Post to review and approve proposed activities and monitor their impact on cetaceans. As a member of the team, NFMS personnel would be largely responsible for providing critical information affecting response activities to protect cetaceans in the event of a spill.

Bowheads would be expected to avoid vessel supported activities at distances of several kilometers depending on the noise energy produced by vessel sound sources; drill rig; numbers and distribution, size and class of vessels. Migrating whales would be expected to divert up to as much as 20-30 km around relief well drilling operations and up to a few km around vessels engaged in a variety of activities. Temporary and non-lethal effects are likely from the human activities that would be related to VLOS response, cleanup, remediation, and recovery. Displacement away from or diversion away from aggregated prey sources could occur, resulting in important feeding opportunity relative to annual energy and nutrition requirements. Frequent encounters with VLOS activities and lost feeding opportunities could result in reduced body condition, reproductive performance, increased reproductive interval, decreased in vivo and neonatal calf survival, and increased age of sexual maturation in some bowheads. Effects from displacement and avoidance of prey aggregations and feeding opportunities as a result of human activities associated with spill response, clean-up, remediation and recovery are not expected to result in population level effects.

Beluga Whale

Beluga whales are vulnerable to contact with a VLOS when large aggregations are gathered in the lagoons and nearshore habitats along the Alaska Chukchi Sea coast during molting and nursing. The fate of beluga prey, especially Arctic cod and other Arctic fisheries, could affect seasonal habitat use, determine if toxic amounts of contaminated fish are ingested, or possibly change distribution of these whales until fisheries recovery occurs. Temporary and/or permanent injury and non-lethal effects could occur.

Belugas would come into contact with the human activities associated with cleanup operations when near shore, where localized intensive boom and skimming efforts to protect lagoons and other coastal resources occur. Avoidance behavior and stress to belugas (that have also experienced small boat supported subsistence hunting) in coping with concentrated cleanup activities could occur. Once offshore, belugas could inhale fumes of fresh spilled oil. Prolonged inhalation of toxic fumes or accidental inhalation of surface oil could result in temporary and/or permanent injury or mortality to some individuals. Displacement from or avoidance of important nearshore habitats could occur in subsequent years after a spill, and belugas could redistribute from the seasonal use of the Chukchi Sea nearshore areas to less optimal molting and nursing areas and potentially reduce population productivity and recruitment. Should cleanup activities occur in or near lagoons or nearshore feeding areas, molting, or birthing habitats, beluga could potentially abandon these areas for as long as spill related activities persisted. Post spill recovery of belugas to pre-spill abundance and habitat use patterns would be dependent upon the recovery periods necessary to restore pre-spill levels of prey populations and the quality of near-shore preferred habitats. Recovery would also depend on the level of human activity in and adjacent to preferred habitats.

Fin Whale

A few individual fin whales could experience similar effects as noted for bowheads above if contacted by oil during the ice free period. Fin whale prey (schooling forage fish and zooplankton) could be reduced or contaminated, leading to modified distribution of fin whales and/or ingestion of oil contaminated prey. Temporary and/or permanent injury and non-lethal effects could occur, but mortality or population level effects are considered to be unlikely because of the low density of animals in the areas.

Fin whales would likely avoid the noise related to VLOS response, cleanup and post-event human activities similar to that noted for bowhead whales.

Humpback Whale

A few individual humpback whales could experience effects similar to those noted for bowheads above if contacted by oil during the ice free period. Humpback whale prey (primarily schooling forage fish) could be reduced and/or contaminated, leading to modified distribution of humpback whales or ingestion of oil contaminated prey. Temporary and/or permanent injury and non-lethal effects could occur, but mortality or population level effects are considered unlikely because of the low density of animals in the areas. If prey populations, presence, productivity and distribution are reduced due to VLOS effects, humpback habitat value would be reduced unless the humpbacks in the Alaska Chukchi and Beaufort Seas originate from the Western North Pacific stock.

Humpback whales would likely avoid the noise related to VLOS response, cleanup and post-event human activities in a manner similar to that noted for bowhead whales.

Gray Whale

Gray whale aggregations have consistently occurred near shore along the Alaska Chukchi Sea coast from west of Wainwright to northeast of Barrow. This zone would likely be the location of much of the cleanup operations to protect the coastline, lagoons, and river mouths. Avoidance of these intense clean-up activities could displace gray whales from preferred feeding areas. Oil contamination of benthic sediments and/or mortality of benthic invertebrates that these whales require could result in abandonment of these primary summer feeding areas that provide the majority of the annual nutritional and energy requirement of these whales and potentially take years to recover. Reduction in body condition, and potential mortality from insufficient body energy to complete the long distance migration of this species to and from as far south as Mexico could occur. Reduction or loss of the portion of the Western North Pacific stock of gray whales using the Chukchi Sea would likely take three generations or more to recover. Population level adverse effects from loss or reduction of prey resources nearshore could result in changes in distribution, habitat use, and/or presence in the Chukchi Sea. Loss of food sources could be reflected in individual body condition and mortality during the long stressful migrations this species endures.

Minke Whale

Individual minke whales could experience similar effects as noted for bowheads above if contacted by oil during the ice free period. Minke whale prey could be reduced or contaminated, leading to a modified distribution of minke whales or ingestion of oil contaminated prey. Temporary and/or permanent and non-lethal effects are likely and mortality or population level effects are considered to be unlikely. Changes in distribution of minke whales in the Alaska Chukchi Sea are not likely.

Minke whales would likely avoid the noise related to VLOS response, cleanup, and post-event human activities they may encounter in a manner similar to that noted for bowhead whales.

Killer Whale

Individual killer whales could experience similar effects as noted for bowheads above if contacted by oil during the ice free period. Killer whale marine mammal prey abundance and distribution could be reduced, or contaminated, leading to modified distribution of killer whales and/or ingestion of oil contaminated prey. Temporary and/or permanent injury and non-lethal effects could occur, but mortality or population level effects are considered to be unlikely because of the low density of animals in the areas.

Killer whales would likely avoid the noise related to VLOS response, cleanup and post-event human activities they may encounter in a manner similar to that noted for bowhead whales.

Harbor Porpoise

Individual harbor porpoise could experience similar effects as noted for bowheads above if contacted by oil during the ice free period. Harbor porpoise prey could be reduced or contaminated, leading to modified distribution of harbor porpoise or ingestion of oil contaminated prey. Temporary and/or permanent injury and non-lethal effects could occur, but mortality or population level effects are considered to be unlikely.

Harbor porpoise would likely avoid the noise related to VLOS response, cleanup, and post-event human activities. The apparent distribution of the porpoises near shore and in the various lagoons where forage fish are abundant puts these animals at risk of frequent contact with spill clean up activities. Such activities are concentrated (to place booms and skim oil) near the mouths of rivers and near lagoons to protect coastline resources. A reduction of coastal fisheries could reduce the capacity of the Chukchi Sea near shore to support harbor porpoise and, consequently, redistribution of porpoises could occur. Ingestion of contaminated fish could reach toxic levels and result in impaired endocrine function, reproductive impairment, or mortality. A substantial reduction in the low numbers that occur in offshore Alaska Chukchi Sea may take greater than three generations to recover due to the remoteness of this part of their range and the pioneering behavior required to recover.

Ice Seals

Section IV.E.10 of BOEM (2011b) describes potential impacts to ice seals during the five phases of a possible VLOS in the Chukchi Sea. This information is incorporated herein by reference, and a summary of that information is provided here.

In the event of a VLOS, ice seals could be adversely affected to varying degrees depending on habitat use, densities, season, and various spill characteristics.

Spotted seals are the only phocid species in the analysis area that habitually use shore-based haulouts. Their principle haulout locations that could be affected by a VLOS, ranked from largest to smallest, are Kasegaluk Lagoon, Kugrua Bay, Dease Inlet/Admiralty Bay, Smith Bay, and the Colville River Delta. Kasegaluk Lagoon is the largest haulout location that could be affected, and is several times larger than all of the others combined. Although spotted seals may forage for fishes in the open ocean, their presence is not known to be associated with the ice front. Consequently, their presence is associated with haulout areas and nearshore areas with open water.

In contrast, ribbon seals are the most pelagic seal species in the area, remaining in the open ocean for most of the year except for spring whelping and molting in the Bering and southern Chukchi Seas. Based on their very low presence in marine mammal surveys, BOEM concludes that they occur only in very low numbers spread across the Chukchi Sea and are virtually absent from the Beaufort Sea. Consequently, ribbon seal populations are not expected to be affected by a VLOS from any of the OSRA Launch Areas.

Both bearded and ringed seals closely associate with sea ice throughout the year, very rarely, if ever, coming ashore. Both species prefer to forage in proximity to the southern ice edge during the summer months, although some may be found in the open ocean away from areas of sea ice. Bearded seals feed on benthic organisms on the relatively shallow Chukchi continental shelf, while ringed seals forage for fishes and some invertebrates in the water column. These differences in food selection and foraging behavior help determine the presence or absence of each of these species in an area. Bearded seals are essentially restricted to areas over the continental shelf and the ice front where they can reach the seafloor to feed on benthic organisms. Ringed seals may be found under areas of solid ice as well as in the ice front where they predate fishes such as Arctic and saffron cod.

Presently there are no areas identified as important ringed, bearded, or ribbon seal habitat during the summer months. However, during the winter, conditions change drastically with the southward advance of sea ice, when only bearded and ringed seals persist in the Chukchi and Beaufort Seas. During winter, bearded seals loosely congregate around polynyas, and lead systems, generally avoiding areas of shorefast ice. Ringed seals, however, select shorefast ice zones as their primary habitat where they survive by making and maintaining breathing holes through the ice and by constructing subnivean lairs, particularly under pressure ridges where they are somewhat protected from predators. If lead systems or polynyas occur near the shorefast zone, ringed seals may often maintain a presence in proximity to the lead or polynya. However, because of their site fidelity and need for stable ice, they are strongly linked with stable shorefast ice. Any VLOS reaching a polynya or lead system could have serious effects on local ringed and bearded seal sub-populations, potentially oiling or even killing a number of bearded and/or ringed seals.

Pacific Walrus

Section IV.E.11 of BOEM (2011b) describes potential impacts to walrus during the five phases of a possible VLOS in the Chukchi Sea. This information is incorporated herein by reference, and a summary of that information is provided here.

In the event of a VLOS, the OSRA model estimates most of the contact between oil and walrus habitat would occur on the U.S. side of the Chukchi Sea, while the bulk of the walrus population hauls out on the Russian side of the Chukchi Sea. Contact with oil on the U.S. side of the Chukchi Sea would be most likely to occur at Herald or Hanna shoals, or at coastal haulouts near Wainwright or Pt. Lay. Walrus are less vulnerable to injury from contact than are furred seals, but more likely to be subjected to long term chronic ingestion of hydrocarbons from eating benthic prey than are seals that eat fish. In the event of a VLOS, key habitats to protect for walrus would include the Herald and Hanna Shoal polynyas and the Wainwright and Pt. Lay areas. Significant impacts to the walrus population would be most likely to occur if large scale contamination of prey and habitat persisted for years.

The Pacific walrus population is currently estimated at a minimum of 129,000. If a VLOS were to occur and to contact large portions of habitat inhabited by walrus, calves of the year would most likely be at risk.

Polar Bears

Section IV.E.8 of BOEM (2011b) describes potential impacts to polar bears during the five phases of a possible VLOS in the Chukchi Sea. This information is incorporated herein by reference, and a summary of that information is provided here.

In the event of a VLOS in this scenario, most of the contact between oil and polar bear habitat would occur on the U.S. side of the Chukchi Sea. The majority of the CBS stock is believed to den and come ashore on the Russian side of the Chukchi Sea, particularly at Wrangel Island. The majority of the SBS stock of polar bears come ashore and den further eastward in the Beaufort Sea. However there is a large area of overlap between the CBS stock and the SBS stock out on the sea ice in the northeastern portion of the Chukchi Sea. Both stocks are believed to be in decline. If a VLOS were to occur and if it resulted in the loss of large numbers of polar bears, particularly adult breeding age females, this would have a significant impact on the SBS and/or CBS stocks of polar bears. Contact with oil on the U.S. side of the Chukchi Sea would be most likely to occur along the U.S. Chukchi Sea coastline or the U.S. Chukchi Sea barrier islands. In the event of a VLOS, key habitats to protect for polar bears would include the barrier islands and shoreline.

4.10.6.11.2 Additional Analysis for Marine Mammals

Cetaceans

Conclusions regarding potential effects of a VLOS on cetaceans in the Chukchi Sea will be addressed separately for each species below. Narwhals, included in previous sections of this EIS, were omitted from BOEM (2011b) analysis. Narwhals in the Chukchi Sea are exceedingly rare. Because the co-occurrence of narwhals and a VLOS in the Chukchi Sea is highly unlikely this species is not considered in this additional analysis.

Bowhead Whale

Bowhead whales are most vulnerable to oil spills in the Chukchi Sea while feeding during late summer and fall and during the westward migration throughout the fall. A winter spill, or if oil persists in ice over winter, could impact bowheads migrating through the lead system during the spring.

Injury and mortality are most likely during Phase 1 (initial event) of a VLOS. Contact through the skin, eyes, or through inhalation and ingestion of fresh oil could result in temporary irritation or long-term endocrine or reproductive impacts, depending on the duration of exposure. Based on criteria described in Section 4.1.3, the magnitude of the resulting impact could be high. The duration of impacts could range from temporary (such as skin irritations or short-term displacement) to permanent (e.g. endocrine impairment or reduced reproduction) and would depend on the length of exposure and means of exposure, such as whether oil was directly ingested, the quantity ingested, and whether ingestion was indirect through prey consumption. Displacement from areas impacted by the spill due to the presence of oil and increased vessel activity is likely. If the area is an important feeding area, such as off Barrow, or along the migratory corridor, especially in the spring lead system, the impacts may be of higher magnitude. The extent of impact could be state-wide, given the migratory nature of bowhead whales. Bowhead whales are a unique resource, as they are a centerpiece of the Iñupiat subsistence lifestyle and listed as endangered under the ESA. Population level impacts are possible if a VLOS event coincided with and impacted a large feeding aggregation of bowhead whales during the open water season, particularly if calves were present. Mothers with young calves are also vulnerable to potential exposure to oil in the lead system during the spring migration. A VLOS could result in major impacts on bowhead whales.

Beluga Whale

Beluga whales of the eastern Chukchi Sea stock could be particularly vulnerable to a VLOS during June and July when congregating in the nearshore waters near Kasegaluk Lagoon and along the Alaskan Chukchi Sea coast. Belugas from this stock and the Beaufort Sea stock could encounter spilled oil during migrations through the Chukchi Sea in the spring and again later in the fall, although distribution is generally more dispersed during the fall. Impacts of a VLOS on beluga whales, especially while concentrated in lagoons and nearshore areas, are similar to those described for other cetaceans and include prey and habitat destruction and contamination, potential injury, illness, and mortality from contact with or ingestion of oil or dispersants, and displacement caused by avoidance of spills and clean-up activities. Using criteria described in Section 4.1.3, the magnitude of impacts could range from medium to high, depending on habitat and prey impairment and level of injury or mortality. Durations could range from temporary skin irritations to permanent endocrine or reproductive failure or long-term displacement, and the extent could be state-wide due to the migratory nature of belugas. Belugas are considered unique because of their importance as a subsistence resource. An impact to the eastern Chukchi Sea stock, particularly in the vicinity of Kasegaluk Lagoon and Point Lay, could substantially impact local subsistence hunters. Population level impacts would depend on the extent of the spill, damage to molting and calving areas and prey resources, how long it takes for resources to recover, and whether displacement from important habitat is long-term. A VLOS could have a major impact on beluga whales in the Chukchi Sea, particularly on the eastern Chukchi Sea stock.

Fin Whale

Fin whales are only present in the Chukchi Sea in small numbers during summer months. If, however, they were to encounter an oil spill during that time, physiological impacts of oiling may occur. Prey could also be impacted through reduced abundance or contamination that could lead to longer term habitat alterations, displacement, or contaminant loading in fin whales. In accordance with criteria established in Section 4.1.3 of this EIS, the magnitude of impacts to individual fin whales could be medium to high, with displacement from the area, impacts to prey resources and habitat quality, and a possibility of injury from either direct contact with or ingestion of oil or associated contaminants, such as dispersants. Duration could range from temporary to permanent, depending on the type of injury incurred or extent of habitat alteration. The geographic extent could be state-wide, since the fin whale is a migratory species and, as they are listed as endangered under the ESA, fin whales are considered a unique resource. Population level impacts are unlikely, given the low numbers of fin whales in the EIS project area, yet a VLOS could still result in a major impact to individual fin whales.

Humpback Whale

The impacts of a VLOS on humpback whales in the Chukchi Sea are anticipated to be similar to those described for fin whales.

The potential for population level impacts depends on the stock from which humpbacks in the Chukchi Sea originate. It is currently unknown whether they come from the Central North Pacific or the Western North Pacific stock. The Western North Pacific stock is more likely, given its known geographic range, and is a substantially smaller stock with an estimated minimum population estimate of 732 whales (Allen and Angliss 2010). As noted in BOEM (2011b) Section IV.E.7., recovery of the Western North Pacific stock from mortality resulting from a VLOS could take three or more generations. Therefore, the Western North Pacific stock of humpback whales could experience a major impact from a VLOS at the population level. BOEM further state that, if humpbacks in the Chukchi Sea Lease Sale 193 area originate from the Central North Pacific stock, then a negligible number would be expected to experience temporary and non-lethal effects from a VLOS. The Central North Pacific stock is more robust than the Western North Pacific stock, with an estimated minimum population of 7,469 whales (Allen and Angliss 2010). Population level impacts are, therefore, unlikely for this stock, but a VLOS could still result in a major impact to individual humpback whales.

Gray Whale

Gray whales may be particularly vulnerable to impacts from a VLOS in the Chukchi Sea. Summer feeding aggregations commonly occur nearshore between Wainwright and Barrow, where they are likely to experience displacement caused by increased vessel traffic in the aftermath of a spill, and/or physical impacts from direct contact with oil and contamination of benthic prey resources. The resulting impacts could be similar to those described for bowhead and fin whales. Reduced prey availability and loss of feeding habitat could have long-term impacts on body condition and fitness. Based on criteria described in Section 4.1.3, the magnitude of impact from a VLOS on gray whales could be medium to high, depending on level of injury or mortality. The duration could range from temporary (minor skin irritations) to permanent (loss of habitat), and impacts could extend state-wide, given that gray whales migrate well beyond the Chukchi Sea to as far south as Mexico. The species is no longer listed as endangered, so could be considered a common to important resource. Whether population level impacts occur depends on the extent of the spill and loss of nearshore prey resources and habitat, as well as availability of alternate habitat. A VLOS in the Chukchi Sea could have an overall moderate to major impact on gray whales.

Minke Whale

Minke whales are seen in low numbers and in small groups during the open water season in the Chukchi Sea. The likelihood of encountering a VLOS may, therefore, be low and would only occur in the event of a summer spill. If encountered, however, a VLOS could result in similar impacts to that described for bowhead, fin, and humpback whales. A difference in assessing overall impacts, as per the criteria in Section 4.1.3, would be that minke whales are not listed as depleted under the MMPA or listed under the ESA, so are not considered a unique resource. A population level impact is unlikely given the low sighting rate in the Chukchi Sea and apparent broad distribution in the North Pacific. The overall impact of a VLOS on minke whales could be moderate.

Killer Whale

Killer whales occur in the Chukchi Sea during the open water season. If they were to encounter an oil spill during that time, they could experience impacts similar to that described for other cetaceans. Duration of impacts resulting from consuming contaminated prey could be prolonged through bioaccumulation of toxins through the food chain, since killer whales in the Chukchi Sea are mammal-eating transients and considered apex predators. Killer whales are not listed as depleted under the MMPA or listed under the ESA, so, in accordance with criteria of Section 4.1.3 of this EIS, are not considered a unique resource. A population level impact of a VLOS on killer whales is unlikely given the low occurrence rate in the Chukchi Sea. The overall impact of a VLOS on killer whales could, therefore, be moderate.

Harbor Porpoise

Harbor porpoise are present in the Chukchi Sea during the open water season and have been sighted with increasing frequency in both the nearshore and offshore areas in recent years. This may indicate a range extension (Funk et al. 2010). Increasing frequency of occurrence may leave harbor porpoise more susceptible to an encounter with a VLOS and subsequent clean-up activities at the point of origin offshore, if the spill trajectory included nearshore waters, and nearshore clean-up activities. Impacts on harbor porpoise could be similar to that described for other cetaceans – displacement due to prey loss and vessel activity, potential injury, illness or mortality from contact with oil, consuming oiled prey, or otherwise consuming oil and associated chemicals. Impacts on individual porpoises, based on criteria described in Section 4.1.3 of this EIS, could range from medium to high intensity and from temporary to permanent duration, depending on level of injury or mortality, as well as long-term impacts on prey resources through reduced availability or contamination. The extent could be broad, reaching to the level of state-wide, given that harbor porpoise seasonally occur in the area and are a migratory species. Harbor porpoise, however, are not listed under the ESA so would be considered a common resource. Population level impacts are not likely, although BOEM (2011) states in Section IV.E.7., that recovery from a major reduction in numbers of harbor porpoise in the offshore waters of the Chukchi Sea may take longer than three generations. This may curtail the range extension but not necessarily the population as a whole. A VLOS could have a moderate impact on harbor porpoise in the Chukchi Sea.

Ice Seals

The impact of a VLOS on ice seals in the Chukchi Sea could vary by habitat requirements, prey preferences, and seasonality of occurrence in the area, among other factors. Potential impacts are, therefore, discussed separately for each species.

Bearded Seal

Bearded seals occur in the Chukchi Sea year round and could, thus, be vulnerable to impacts from fresh oil and overwintering residual oil from a VLOS. Direct contact with oil could result in injury or mortality events, particularly if it occurred in a polyna or lead system in which bearded seals aggregated (BOEM 2011b). Bearded seals are benthic feeders and are restricted to shallow shelf areas for feeding. Damage to these areas and prey resources could cause long-term displacement and possible loss of fitness due to inadequate prey availability. Based on criteria described in Section 4.1.3, impacts of a VLOS on bearded seals could be of medium to high intensity and of temporary to permanent duration, depending on extent of habitat loss, injury, or level of mortality. The geographic extent could be regional to state-wide, depending on how far bearded seals could be displaced or need to search for alternative habitat. Bearded seals are a unique resource in the Chukchi Sea due to their importance as a subsistence resource for coastal communities and recent proposal to be listed as threatened under the ESA. Population level impacts are possible if large portions of important benthic habitat are unavailable and if contact with a VLOS occurred in areas of high concentrations of seals. A VLOS in the Chukchi Sea could have a major impact on bearded seals.

Ringed Seal

Ringed seals may also occur in the Chukchi Sea year round, where they are closely associated with sea ice. During the open water season, they spend more time in the water foraging, leaving them vulnerable to impacts of a VLOS during that time of the year. During winter and spring, they associate with shorefast ice where ice entrained oil may persist. The intensity, duration, and extent of impacts of a VLOS on ringed seals are similar to those anticipated for bearded seals. A large-scale impact on prey resources could result in displacement, at a minimum, or even compromised fitness. Ringed seals are hunted for subsistence by Alaska Natives from communities along the coasts of the northern Bering, Chukchi and Beaufort seas, so are considered a unique resource. Population level impacts are possible if large portions of important habitat and prey are unavailable and if contact with a VLOS occurred in areas of high concentrations of seals. Based on criteria described in Section 4.1.3 of this EIS, a VLOS in the Chukchi Sea would have a major impact on ringed seals.

Ribbon Seal

Ribbon seals are infrequently seen in the northern or eastern Chukchi Sea and, based on satellite tags, disperse broadly with retreating sea ice. This leaves them less vulnerable to a VLOS in the Chukchi Sea. A small proportion of individuals that do contact oil from a VLOS could die (BOEM 2011b). On an individual level, impacts could be similar in intensity, duration, and extent to that described for other ice seals, but population level impacts are unlikely. 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, so are considered a unique resource, based on criteria described in Section 4.1.3. As a result, a VLOS could result in a major impact on individual ribbon seals.

Spotted Seal

Spotted seals are particularly vulnerable to impacts of a VLOS, as they are the only ice seal species in the Chukchi Sea that regularly hauls out on shore and concentrates nearshore in lagoons, such as Kasegaluk Lagoon. Spotted seals could be susceptible to impacts of floating oil in foraging areas in open water, oil that came ashore the Chukchi Sea coast, and the multitude of activities associated with clean-up, from boom deployment to vessels and airplanes. Displacement from important habitat areas is possible, as is direct impacts from contact with oil and dispersants. Based on criteria described in Section 4.1.3, impacts of a VLOS on spotted seals could be of medium to high intensity and of temporary to permanent duration, depending on extent of habitat loss, injury, or level of mortality and whether oil reached nearshore haul out concentrations. The geographic extent could be state-wide, given the migratory behavior of spotted seals. Spotted seals are an important species for Alaskan subsistence hunters, primarily in the Bering Strait and Yukon-Kuskokwim regions, so are considered a unique resource. Population level impacts are possible if large portions of important habitat are unavailable and if contact with a VLOS occurred in areas of high concentrations of seals. A VLOS in the Chukchi Sea could have a major impact on spotted seals.

Pacific Walrus

Pacific walrus are most susceptible to impacts of a VLOS during the summer months and can be impacted at sea, on ice floes, or onshore. In recent years, walrus have been hauling out in large numbers (up to >15,000 animals [Clarke et al. 2011a]) between Wainwright and Point Lay during late summer to early fall. Disturbance to such a large concentration could result in stampedes and subsequent trampling deaths and injury caused by increased overflights and vessels during spill response efforts. Oil coming ashore where walrus are densely concentrated could also impact large numbers of animals, including young of the year, through physical contact with the skin and membranes, inhalation of fumes, and impacts on benthic prey. Impacts of oil and dispersants on benthic prey resources (such as contamination or mortality) could have lasting impacts on prey and habitat availability for walrus in the Chukchi Sea. Based on criteria described in Section 4.1.3 of this EIS, impacts of a VLOS on Pacific walrus could be of medium to high intensity, with intensity greatest if the VLOS and subsequent clean-up activities coincide with dense aggregations of walrus, duration could range from temporary displacement to long term injury or displacement from important habitat, the geographic extent could be state-wide due to the migratory behavior of walrus and potential for decreased fitness and a need to seek alternate forage locations of benthic habitat and prey are severely altered. Walrus are an important subsistence species for several communities along the Bering and Chukchi Sea coasts of Alaska and the coast of Chukotka (Russia), so are considered a unique resource. Population level impacts are possible if young of the year are impacted or access to important habitat is curtailed. A VLOS in the Chukchi Sea could have major impacts on Pacific walrus.

Polar Bear

Polar bears are vulnerable to impacts of a VLOS in the Chukchi Sea, particularly if it occurred during the summer open water period or the broken ice period during the fall; most denning occurs on either the Russian side of the Chukchi Sea or in the Beaufort Sea. Polar bears are listed as threatened and critical habitat was recently designated in December 2010 along the Chukchi Sea coastline and barrier islands. Oil from a VLOS in the Chukchi Sea could foul these areas and impact critical habitat. A VLOS in the Chukchi Sea could involve either the Southern Beaufort Sea stock (SBS) or Chukchi/Bering Seas stock (CBS) in the region of overlap near Point Lay and the northeastern Chukchi Sea, but CBS are most likely to be impacted by a spill in the Chukchi Sea either nearshore, on land, at sea, or on offshore ice floes. Both populations are small and apparently not increasing. Based on criteria described in Section 4.1.3, impacts of a VLOS on polar bears could be of medium to high intensity, particularly if the fur were sufficiently fouled to result in loss of insulation, if oil were ingested, or if displacement from critical habitats affected overall fitness. Duration of impacts could range from temporary displacement to permanent habitat loss, reproductive impairment, or even death. Contamination and toxic impacts from either directly consuming oil or through consuming marine mammal prey in which contaminants accumulated could be long-lasting. The geographic extent of impacts could be state-wide, given the migratory movements of bears and possible need to relocate if local habitats are severely altered. It is also possible that, if the oil discharge were widespread, denning areas could be impacted. Polar bears are considered unique due to their threatened status and importance as a subsistence resource. Population level impacts are possible and dependent on numbers of polar bears directly injured or killed, extent of habitat loss, and chronic long-term impacts on reproduction and survival. Impacts of a VLOS on polar bears in the Chukchi Sea could be major.

4.10.6.12 Terrestrial Mammals

4.10.6.12.1 Existing Analysis (BOEM 2011b and BOEM 2012)

Section IV.E.12 of BOEM (2011b) describes potential impacts to terrestrial mammals during the five phases of a possible VLOS in the Chukchi Sea. This information is incorporated herein by reference, and a summary of that information is provided here.

Terrestrial mammals should not be significantly affected by a VLOS event. Caribou are the only species occurring onshore in the proposal area that might be affected in numbers greater than 1,000; however, this level of impact is unlikely. If a worst case scenario was to occur and several thousand caribou were to succumb to the effects of oil contamination, the herd sizes are sufficient to recover from losses within one and no more than two years. Grizzly bears in the Alaskan Arctic require extremely large home ranges to meet their needs. Consequently a VLOS is unlikely to involve more than a few bears at most. If those bears were to die as a result of consuming an oiled marine mammal carcass, contaminated salmon, or through grooming oiled fur, their home ranges could be reoccupied by other bears within that same season, and the population recovery would most likely occur within a year or two.

Effects on local muskox populations should also be small since they do not occur in large numbers, spending much of their time inland and away from the coast. The effects on furbearers such as foxes, wolves and wolverines would also be short-term since they either produce large litters (foxes), or occur in very low densities (wolverines, wolves). Any losses to fox populations would quickly be replenished, while the low population density and large home-ranges of wolverines and wolves would act to prevent more than a very few individuals from being exposed to a VLOS.

The presence of oil spill cleanup crews and the associated oil spill response activity (aircraft, landing craft, nearshore boats, etc.) should effectively haze most terrestrial mammal species from contaminated areas or sites. By unintentionally disturbing the animals, responders may provide a positive benefit by forcing those animals away from the spill and potential contamination.

In addition, Section 4.4.7.1.3 of the BOEM (2012) analysis provides a discussion of the impacts of a catastrophic discharge event on terrestrial mammals in Arctic Alaska. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that a catastrophic discharge event would result in sustained degradation of water quality, shoreline terrestrial habitats, and, to a lesser extent, air quality that could impact terrestrial mammals from direct contact, inhalation, and ingestion. These effects could be severe where persistent, heavy oil makes contact with important habitat and prey base, causing a multitude of acute and chronic effects (BOEM 2011d).

4.10.6.12.2 Additional Analysis for Terrestrial Mammals

There are approximately 30 species of terrestrial mammals within the vicinity of the EIS project area (Table 3.2-5). Among these species, it is expected that only barrenground caribou (*Rangifer tarandus* *granti*) may experience interactions with oil and gas exploration activities associated with this EIS during critical periods of their life cycle; therefore, this analysis will focus solely on caribou. Descriptions of distribution, life cycle, and habitat characteristics of other species are not included in this EIS.

The effects of a VLOS would be of medium intensity, temporary duration, local extent, and common context. While there could be a perceptible change to the caribou population, it would likely be temporary in duration, with a localized impact, and the caribou population would be expected to recover within one to two years even with a direct loss of several thousand animals (BOEM 2011b). For more information regarding the impact to subsistence or recreational hunting see Sections 4.10.6.15 and 4.10.6.20 in this EIS, respectively. Utilizing the impact criteria listed in Section 4.1.3, there would be a summary impact level of minor to moderate, depending on the magnitude and duration of the VLOS.

4.10.6.13 Time/Area Closure Locations

A low probability, high impact VLOS could affect marine mammals and marine and coastal birds in areas recommended for time/area closure in the Chukchi Sea. Discussion of impacts to marine mammals in Hanna Shoal and Kasegaluk Lagoon can be found in Section 4.10.6.11 and impacts to marine and coastal birds in Ledyard Bay Critical Habitat Area and Kasegaluk Lagoon can be found in Section 4.10.6.10.

Hanna Shoal Time/Area Closure

Hanna Shoal is a relatively shallow area of the offshore Chukchi Sea that is rich in marine life and adjacent to many existing oil lease areas. Phytoplankton, amphipods, polychaete worms, crab larvae, fish larvae, and other benthic invertebrates form the foundation of the marine food web and are abundant in the muddy substrate of Hanna Shoal. Numerous species of seabirds and waterfowl spend time feeding in Hanna Shoal at some point during the year, especially during post-breeding and fall migration periods.

Gray whales have historically used Hanna Shoal to feed on mud-dwelling benthic invertebrates. However, surveys in the last few years indicate they may not be using the area as much as in the past (Clarke et al. 2011a). Bearded and ringed seals are common in the area during summer, feeding on benthic invertebrates and fish. Pacific walrus are also common when the ice edge is near Hanna Shoal in either spring or fall. In the winter, walrus and bearded seals concentrate along leads and polynya regions, including Hanna Shoal. If oil collects or migrates into these small open-water areas in the ice, most if not all of the seals in the area could be adversely affected by direct contact, ingestion, and contamination of prey. Walrus are less vulnerable to injury from contact than are furred seals but more likely to be subjected to long term chronic ingestion of hydrocarbons from eating more sedentary benthic prey than are seals that eat fish.

Hanna Shoal is one of several areas in the Chukchi Sea that forms consistent polynyas in the winter and leads in the pack ice crucial to marine mammals and some seabird species. The closeness of Hanna Shoal to existing lease areas means it has relatively high probabilities for exposure to oil in BOEM's VLOS modeling exercise (BOEM 2011b). The majority of seabird species would be most susceptible to effects of a spill during the open-water season. The effects on marine mammals, especially Pacific walrus, bearded seals, and ringed seals would be much greater if the spill occurred in or persisted into the winter than if it was only in the summer, due to the concentration of these animals in polynyas and leads. Young of the year would be especially vulnerable. Benthic invertebrate species favored by walrus and diving seabirds could become contaminated and become a source of chronic exposure for years after a spill. Hanna Shoal is an important resource in the Chukchi Sea. If a VLOS occurred in or persisted into the winter, the effects would be considered high in magnitude and intensity due to effects on Pacific walrus and ice seals, long-term in duration (lasting more than five years), and state-wide in geographic extent because it would affect migrating populations of birds and marine mammals. A VLOS would be considered to have major effects on Hanna Shoal according to the criteria established in Section 4.1.3.

Kasegaluk Lagoon

Kasegaluk Lagoon is an estuary important to rearing fish, including out-migrating salmon smolts from the Kukpowruk, Kokolik, and Utukok rivers. Salmon, other fish, and abundant invertebrate populations are a major attractant for very large numbers of migratory birds that make use of Kasegaluk Lagoon during May to October. Concentrations of beluga whales use Kasegaluk Lagoon in the spring/summer for molting, where the relatively warm waters and gravelly substrate helps the process. Spotted seals haul out along the shores of Kasegaluk Lagoon in the summer and feed in nearby waters.

The effects of a VLOS on coastal vegetation and wetlands could involve hundreds of miles of shoreline and, if influenced by strong winds and waves, could be blown or washed some distance inland. Although barrier islands could protect lagoon areas to some extent, if oil entered a lagoon in substantial amounts, the barrier islands could inhibit weathering and flushing by waves, thereby leading to a more extended exposure of the lagoon environment to the oil than if it was on an outer coast. Kasegaluk Lagoon has a number of entrances to the open ocean and would thus be susceptible to oil spill penetration. BOEM (2011b) VLOS analyses are prefaced with assumptions about when, where, and how much oil would directly affect given areas. Of great importance to biological resources is the timing of the spill and how it would overlap with migration and other critical life functions. If oil enters Kasegaluk Lagoon and persists for up to 10 years, as is projected in the BOEM model, most of the animals that use the area at any time of the year could be exposed at least one time and perhaps repeatedly over the years, with potentially permanent effects on all of the populations with intensive use of the lagoon, including many species of fish, waterfowl, shorebirds, beluga whales, and spotted seals. Kasegaluk Lagoon is a unique resource in the Chukchi Sea and the effects of a VLOS would be considered high in magnitude and intensity, permanent in duration (lasting more than five years), and state-wide in geographic extent because it would affect migrating populations of birds and marine mammals. This would be considered a major effect on this time/area closure location according to the criteria established in Section 4.1.3.

4.10.6.14 Socioeconomics

4.10.6.14.1 Existing Analysis (BOEM 2011b and BOEM 2011d)

Section IV.E.14 of BOEM (2011b) describes potential impacts to socioeconomic resources during the five phases of a possible VLOS in the Chukchi Sea. This information is incorporated herein by reference, and a summary of that information is provided here.

A VLOS event of 2.2 MMbbl would generate several thousand direct, indirect, and induced jobs, and millions of dollars in personal income associated with oil spill response and cleanup in the short run. The effects would be significant in the short term. The expectation is that employment of cleanup workers to increase rapidly during Phase 2 and Phase 3, and to peak during Phase 4. Revenue impacts from a VLOS event include additional property tax revenues accruing to NSB from any additional onshore oil spill response infrastructure, and any potential decline in Federal, State, and local government revenues from displacement of other oil and gas production. A VLOS could also have significant adverse impacts on economic activity that does not currently take place in the area but could exist in the future, such as commercial fishing, recreational fishing, tourism, and increased Arctic marine shipping.

Section 4.4.13.3.2 of the BOEM (2011e) analysis provides a discussion of the impacts of a catastrophic discharge event on sociocultural systems in the Alaskan Arctic. This information is incorporated herein by reference, and a summary of the information is provided. The analysis notes that while local villagers would be employed in the cleanup for a catastrophic discharge event, it is likely that many additional workers would be necessary, placing stress on village facilities. An influx of outsiders is likely to result in some cultural conflict, stressing the local sociocultural systems. As is evident from the EVOS event, such cleanup efforts can be disruptive socially, psychologically, and economically for an extended period of time (BOEM 2011d).

4.10.6.14.2 Additional Analysis for Socioeconomics

The socioeconomic effects of historical oil spills provide indicators for estimating the future impact in a very large oil spill scenario. The Chukchi VLOS described in this hypothetical worst-case scenario would be 2.2 MMbbl and 1.8 Bcf of gas. The 1989 EVOS was 240,000 bbl. The socioeconomic effects researched after EVOS can serve as good indicators, but are of a different magnitude than this analysis.

Public Revenue & Expenditures

The BOEM (2011b) analysis describes potential new NSB revenues associated with property taxes assessed for the construction of worker infrastructure, as well as potential lost NSB, NAB, state and federal revenues due to permitting delays, or exploration moratoria. Local and state agencies may also increase expenditures associated with the administration of oil spill response and social services related to the influx of new workers.

Employment & Personal Income

The BOEM (2011b) analysis provides an estimate for the number of workers needed for spill clean-up, but does not estimate the number or percent of these workers that would be local from NSB and NAB. It is likely that a spill in the Chukchi Sea could induce some local employment.

A major impact to subsistence would occur after a VLOS (described in Section 4.10.6.15) and could change the components of the non-cash economy. Households could require cash to supplement the loss of subsistence resources. NSB and NAB residents may be able to access emergency assistance or employment in the short-term, but there could be long-term public health and environmental justice impacts related to a loss of subsistence opportunity. This is discussed further in the Environmental Justice Section 4.10.6.22 and Public Health Section 4.10.6.16 of this EIS.

Demographic Characteristics

The BOEM (2011b) sociocultural analysis, discussed in Section 4.10.6.16 of this EIS, describes that new oil spill clean-up employment opportunities could be generated from a VLOS. However, it is not likely that workers originating from elsewhere would relocate permanently to the region. The BOEM (2011b) sociocultural analysis indicates that an outmigration of residents did not take place in the case of the EVOS so it would not be expected in the case of a VLOS in the Chukchi Sea. However, a study in Northeast NPR-A states that: "workforce changes and demographic changes could occur through consolidation of households to save money, placement of dependents with relatives beyond the village, and outmigration of wage earners in search of employment" when subsistence-harvest patterns are disrupted for multiple years (BLM 2008a, BOEM 2011b).

Social Organizations & Institutions

The influx of clean-up workers would create a short to long-term demand on institutions and social services in North Slope communities. Regional and local non-profit organizations such as the AEWC and Eskimo Walrus Commission that mediate between industry and subsistence users would be impacted. BOEM (2011b) described "fears" about the:

> *…lack of local resources to mobilize for advocacy and activism with regional, state, and federal agencies; the lack of personal and professional time…capacity to interact with regional, state, and federal agencies…responding repeatedly to questions and information requests posed by researchers and regional, state, and federal outreach staff; and having to employ and work with lawyers to draft litigation in attempts to stop proposed development" (MMS 2007a:279, in BOEM 2011b).*

Fears about institutional capacity would be well-founded and it is likely that the quality of local community services would be diminished or halted in the short to long-term to respond to agencies, researchers, and litigation.

Private companies and regional corporations may be beneficially impacted in the short-term (Phases 1 to 4) through the sale of goods and services to spill response companies.

Conclusion

Employment and local revenues associated with VLOS would be high intensity, long-term in duration, statewide to national in extent, and unique in context. The impact to the non-monetary economy is discussed in detail in Section 4.10.7.15 (Subsistence), but would be high intensity, long-term in duration, regional in extent, and unique in context. Therefore, the summary impact level for socioeconomics would be major.

4.10.6.15 Subsistence

Existing Analysis (BOEM 2011b and BOEM 2011d)

Section IV.E.15 of BOEM (2011b) describes potential impacts to subsistence resources during the five phases of a possible VLOS in the Chukchi Sea. This information is incorporated herein by reference, and a summary of that information is provided here.

If a VLOS occurred and affected any part of the bowhead whale's migration route, it could taint this culturally important resource. Any actual or perceived disruption of the bowhead whale harvest from oil spills and any actual or perceived impacts anywhere during the bowhead's spring migration, summer feeding, and fall migration could disrupt the bowhead hunt for an entire season even though whales still would be available. In fact, even if whales were available for the spring and fall seasons, traditional cultural concerns of tainting could make bowheads less desirable and alter or stop the subsistence harvest in Barrow, Wainwright, Point Lay, and Point Hope, and the beluga whale hunt in Point Lay for at least two seasons. Concerns over the safety of subsistence foods could persist for many years past any actual harvest disruption. This would be a significant adverse effect. In terms of other species, this same concern also would extend to walrus, seals, polar bears, fish, and birds.

A spill originating within the Chukchi Sea region could produce indirect impacts felt by communities remote from the sale area and far removed from the spill. Essentially, concerns about subsistence harvests and subsistence food consumption would be shared by all Iñupiat and Yup'ik Eskimo communities in the Chukchi (including indigenous people on the Russian Chukchi Sea coast) and Bering seas adjacent to the migratory corridor used by whales and other migrating species. Major impacts are expected from a VLOS when contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together (USDOI, MMS, 2009).

In addition, Section 4.4.13.3.2 of the BOEM (2011e) analysis provides some information about the impacts of a catastrophic discharge event on subsistence harvest in the Alaskan Arctic regions. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that as the result of a catastrophic discharge event, the economically, socially, and culturally important bowhead whale hunt could be disrupted, as could the beluga harvest and the more general and longer hunt for walrus west of Barrow. Animals could be directly oiled, or oil could contaminate the ice floes or onshore haulouts they use on their northern migration. Such animals could be more difficult to hunt because of the physical conditions. Animals could be spooked and/or wary, either because use of the spill itself or because of the hazing of marine mammals, which is a standard spill-response technique in order to encourage them to leave the area affected by a spill. Oiled animals are likely to be considered tainted by subsistence hunters and would not be harvested, as occurred after the EVOS. This would also apply to terrestrial animals, such as bears that scavenge oiled birds and animals along the shore, or caribou that seasonally spend time along the shore or on barrier islands seeking relief from insects. The loss of subsistence harvest resources, particularly marine mammals, would have significant effects on Alaska native culture and society (BOEM 2011d).

4.10.6.16 Public Health

4.10.6.16.1 Existing Analysis (BOEM 2011b and BOEM 2011d)

Sections IV.E.15 Subsistence Harvest Patterns and IV.E.16 Sociocultural Systems of BOEM (2011b) describe potential impacts to public health from the potential for contamination of subsistence resources and disruption of sociocultural systems during the five phases of a possible VLOS in the Chukchi Sea. In addition, Section 4.3.2.4.2 of the BOEM (2011e) analysis provides some information about the impacts of a catastrophic discharge event on human health in the Alaska Arctic regions. This information is incorporated herein by reference, and a summary of that information is provided here.

The effects of a VLOS on sociocultural systems could cause significant adverse effects via chronic disruption to sociocultural systems for several years with a tendency for additional stress on the sociocultural systems. Longer term disruptions to subsistence resources and practices would impact sharing networks, subsistence task groups, and crew structures, as well as cause disruptions of the central Iñupiat cultural value: subsistence as a way of life (USDOI, MMS, 2007a).

These disruptions could cause breakdowns in family ties, a community's sense of well-being, and damage sharing linkages with other communities and could seriously curtail community activities and traditional practices for harvesting, sharing, and processing subsistence resources—a major impact on sociocultural systems. The effects of disruption to sociocultural systems would last beyond the period of oil-spill cleanup and could lapse into a chronic disruption of social organization, cultural values, and institutional organization with a tendency to displace existing social patterns. The accommodation response of Iñupiat culture in itself to the impacts of a VLOS could represent major impacts to social systems (USDOI, MMS, 2003a, 2006a, 2007a; USDOI, BLM and MMS, 2003). Similar to Subsistence Harvest-Patterns, the potential for significant impacts could be reduced by implementing larger a larger deferral area under Alternative IV or, to a greater extent, Alternative III.

4.10.6.16.2 Additional Analysis for Public Health

The above section describes in detail some of the effects of a VLOS on sociocultural systems, with subsequent impacts on health by way of disruptions in social organization, cultural values, and institutional organization. In addition to the long-term impacts on sociocultural systems, the short-term strain resulting from a large influx of outside workers following a VLOS would have a number of other health impacts. The presence of migratory workers in isolated areas is associated with the spread of infectious disease, particularly sexually transmitted infections (STIs) (Goldenberg 2008). Rates of Chlamydia, gonorrhea, and other STIs would be expected to increase during Phase 4 of a VLOS, as the population of extra-regional workers surges. Similarly, the population increase in response to a VLOS will strain the already limited capacity of the local health care system, particularly if the response results in temporary settlement of workers in villages outside of Barrow or Deadhorse. Additional strain on the health care system could result from increased burden of disease, starting with potential respiratory illness in the immediate post-spill environment and persisting through changes in chronic disease and social pathology resulting from long-term alterations in subsistence activities and sociocultural systems.

The impact of a VLOS on air quality is described in detail in Section 4.10.6.4. Potentially harmful emissions of several EPA criteria pollutants are likely to occur, likely resulting in severe levels of nitrogen dioxide (NO_2), carbon monoxide (CO), sulfur dioxide (SO_2), particulate matter (PM_{10} and $PM_{2.5}$), and volatile organic compounds (VOC). The impact is likely to be greatest during Phase 1, following the initial explosion and fire, and during Phase 4 due to the use of burning, dispersants and as a result of emissions from aircraft and offshore vessels operating during clean-up. The effect for both phases would be greater if the spill were to occur during winter. Respiratory irritation, asthma, and exacerbations of chronic obstructive lung disease are likely to increase in areas where concentrations of the pollutants are greatest. Pre-existing lung disease and prolonged exposure to respiratory irritants will be the greatest risk for exposed individuals.

The greatest and most persistent impacts to public health following a VLOS are likely to result from stress, anxiety, and changes to subsistence harvest patterns. Impacts on subsistence are described in detail in Section 4.10.6.15 and are likely to result from a combination of factors including diversion of hunters to jobs in the clean-up response; contamination and perception of contamination of food sources; and displacement and/or mortality of marine mammal stocks. The experience of the EVOS demonstrated that changes in consumption patterns may persist in some communities long after species themselves recover. Persistent changes in diet and nutrition are likely to result in increases in the rate of food insecurity and increased prevalence of diabetes and related chronic disease. To the degree to which contamination enters the food system, increases in cancer may occur.

Social pathology, including alcohol use and subsequent alcohol-related problems, is likely to occur following a VLOS as a result of stress, alterations in the social environment, and support networks and the influx of outside workers. These impacts are described in the Environmental Justice Section (4.10.6.22).

Conclusion

The magnitude of adverse impacts to public health is expected to be medium to high. Many predicted public health effects would be treatable and/or transient, which would be associated with a magnitude of medium. However, some impacts may be irreversible and thus should be classified as high. Duration of impacts would range from temporary to permanent, with some effects only lasting for a brief period associated with the influx of workers during the Phase 4 clean-up period. However, health effects resulting from changes in subsistence patterns would likely persist for many years. The extent would be regional, and the context would be unique, as a VLOS would affect two or more minority or low-income communities in the EIS project area. Therefore, the summary impact on public health of a VLOS in the Chukchi Sea is expected to be moderate to major depending on the size, nature, and location of the spill.

4.10.6.17 Cultural Resources

4.10.6.17.1 Existing Analysis (BOEM 2011b and BOEM 2011d)

Section IV.E.17 of BOEM (2011b) describes potential impacts to cultural and archaeological resources during the five phases of a possible VLOS in the Chukchi Sea. This information is incorporated herein by reference, and a summary of that information is provided here.

The greatest impacts on archaeological resources from a very large oil spill would be to onshore archaeological sites from oil-spill-cleanup activities. The potential for effects increases with oil-spill size and associated cleanup operations. Primary oil-spill impacts from cleanup activities would be expected on both prehistoric and historic archaeological sites. Following the EVOS, the greatest effects came from vandalism, because more people knew about the locations of the resources and were present at the sites. Offshore resources are at greatest risk from bottom-disturbing activities, notably anchoring and anchor dragging.

Although it is not possible to predict the precise numbers or types of sites that would be affected, contact with archaeological sites would probably be unavoidable and the resulting loss of information would be irretrievable. The magnitude of the impact would depend on the significance and uniqueness of the information lost. It is difficult to draw a distinct correlation between the potential for archaeological impacts from a VLOS under the different action alternatives. Because impacts to archaeological resources would not vary under the different action alternatives, additional information about the location of currently unknown resources is not essential to a reasoned choice among lease sale alternatives.

The most effective way to avoid adverse impacts from a VLOS would be to focus on effective surveying of potential exploration sites and the various mitigating measures used to protect archaeological sites while cleaning up oil spills. The latter category should include avoidance (preferred), site consultation and inspection, onsite monitoring, site mapping, scientific collection of artifacts, and programs to make people aware of cultural resources (Haggarty et al., 1991; USDOI, MMS 2007a, 2009).

In addition, Section 4.4.15.3.2 of the BOEM (2011e) analysis provides some information about the impacts of a catastrophic discharge event on archaeological resources in Alaskan Arctic regions. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that a catastrophic discharge event could result in extensive impacts on a large number of archaeological and historic resources. Due to the large area affected by a catastrophic event some resources such as coastal historic sites that are sensitive to prolonged contact with oil could be heavily impacted. Cleanup crews would be needed in a greater number of locations. This could allow oil to be in contact with resources for a significant amount of time before cleanup efforts could be applied, which could result in impacts to these resources. A greater threat to archaeological and historic resources during a catastrophic discharge event would result from the larger number of response crews being employed. A catastrophic discharge event would result in large impacts to numerous archaeological and historic resources from response activities (BOEM 2011d).

4.10.6.17.2 Additional Analysis for Cultural Resources

Given the limited data related to historic and prehistoric resources in the Chukchi Sea, it is difficult to determine how many historic properties might be located in areas affected by a VLOS event. The presence of oil and the various oil-spill response and cleanup activities could potentially impact both prehistoric and historic archaeological 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 Prehistoric and Historic Resources

As discussed in Chapter 3, Section 3.3.4, the presence of offshore prehistoric resources in the EIS project area is difficult to assess. In the event of a VLOS, submerged prehistoric and historic resources adjacent to a blowout could be damaged by the high volume of escaping gas, buried by large amounts of dispersed sediments, crushed by the sinking of the rig or platform, destroyed during relief well drilling, or contaminated by hydrocarbons (BOEM 2011b). Oil settling to the seafloor could contaminate organic materials associated with archaeological sites, resulting in erroneous dates from standard radiometric dating techniques (e.g. 14C-dating), and accelerate the deterioration of wooden shipwrecks and artifacts on the seafloor (BOEM 2011b). However, offshore resources are at greatest risk from bottom-disturbing activities, notably anchoring and anchor dragging. The potential to impact archaeological resources increases as the density of anchoring activities in these areas increases (BOEM 2011b). The anchoring of VLOS response and support vessels near a blowout site and in shallow water could result in damage to both known and undiscovered archaeological sites.

Onshore Prehistoric and Historic Resources

Archaeological resources have been recorded in greater numbers in the Chukchi Sea area, and unknown resources are more likely to be present. The greatest impacts on archaeological resources from a VLOS would be to onshore archaeological sites from oil-spill-cleanup activities. Cleanup activities could impact beached shipwrecks, or shipwrecks in shallow waters, and coastal historic and prehistoric archaeological sites. Any onshore activity (cleanup or otherwise) that brings development in contact with remote areas has the potential to expose archaeological resources to disturbance from construction or from vandalism. Historic sites, such as hunting, fishing, and whaling camps, or structures associated with settlements or the Distant Early Warning (DEW) Line (a system of radar stations) could be affected by increased cleanup activity in remote areas and increased vandalism. Prehistoric sites, though often not as visible as historic sites, also might be subjected to increased vandalism, as well (MMS 2007a, MMS 2009, BLM 2008a). As Bittner (1993) described in her summary of the 1989 EVOS, “Damage assessment revealed no contamination of the sites by oil, but considerable damage resulted from vandalism associated with cleanup activities, and lesser amounts were caused by the cleanup process itself" (MMS 2007a, 2009).

4.10.6.18 Land and Water Ownership, Use, and Management

4.10.6.18.1 Existing Analysis (BOEM 2011d)

Section 4.4.10.3.2 of the BOEM (2011e) analysis provides a discussion of the impacts of a catastrophic discharge event on land use, development patterns, and infrastructure in the Alaskan Arctic. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that a catastrophic discharge event could have both direct and indirect effects on land use, depending on the type, size, location, and duration of the incident. Impacts generally would be more intense in areas with little infrastructure in place to handle accidents and where a greater reliance is placed on coastal activities for subsistence (BOEM 2011d).

4.10.6.18.2 Additional Analysis for Land and Water Ownership, Use, and Management

Land and Water Ownership

Because the response efforts to a VLOS would not require any change in existing leasing rights, or the sale or transfer of any federal, state, or Native land or waters, no change in underlying land or water ownership would be anticipated in the Chukchi Sea. This includes federal waters (from 3 to 200 nm) and the federal lands National Petroleum Reserve-Alaska, Alaska Maritime National Wildlife Refuge, and Cape Krusenstern National Monument, state waters (shore to the three-mile limit), state lands and state selected lands, Native village lands and village selections and Native allotments, lands owned by the NSB and NAB, and municipal conveyed and selected lands.

Land and Water Use

A spill of this magnitude in the Chukchi Sea would impact some land uses. The presence of oil accumulation along the shoreline and in tidal zones could affect existing land uses by making it difficult to access land, creating a real or perceived change to the resources and values that support specific land uses, and discouraging pursuit of traditional land use in areas affected by a spill. Examples of these uses include subsistence, other traditional land uses, and recreation.

Industrial land may experience increased usage to support additional vessels, aircraft, vehicles and materials used in responding to a VLOS. This could require the construction or expansion of docks, warehouses, airstrips and/or storage facilities. It is unlikely that new permanent facilities would be constructed for spill response. Response support crews would need to be housed, affecting residential land uses. This could be accommodated through the construction of temporary worker camps, most likely in the vicinity of Prudhoe Bay or in the villages of Wainwright or Barrow. Depending on the location of industrial and commercial lands in the immediate vicinity of spill response activities, some temporary industrial land use may occur in new areas. Remote lands currently designated for natural resource protection might experience increased levels of human activity or disturbance for habitat restoration along shorelines where oil may accumulate. This would have similar effects to those discussed above, regarding access, damage to land and resource values, and interest in using the area. The duration of potential effects on land use would depend on the amount of oil that reaches shoreline and intertidal areas, the nature and duration of response activities, and the success in cleanup and restoration activities.

Land and Water Management

Current management plans within the EIS project area do not include contingencies for a VLOS. It is assumed that in the event of a VLOS, federal and state management plans that include coastal areas may require additional approvals for response and cleanup activities to accommodate heightened levels of human access for habitat restoration and oil cleanup efforts. Federal and state waters would be managed in the short term with an intense focus on response and clean-up of oil. Any management plan policies that are modified for a VLOS event would most likely be temporary, but could lead to plan updates to address any potential change in land and resource values, actions needed to promote recovery of affected resources, or address the potential for response activities in the unlikely event that they are needed.

Conclusion

The magnitude of impact would be low for land and water ownership because no change would be expected. The magnitude of impact would be high for land and water use for areas affected by a spill that have seen historical or current use for subsistence, other traditional land uses, and recreation, due to the potential change in resource/use values, and the level of activity associated with spill response and cleanup. The magnitude of impact would be medium for land and water management if management plans must result in new approvals to accommodate response efforts or a spill results in a change in resource or land values. The duration of impact would be long term because response efforts may extend up to several years, although the impact could be permanent if in the unlikely event construction of a new facility or infrastructure to accommodate spill response activities. The extent of impacts would be regional because the spill would affect large expanses of water and has the potential to come into contact with land along an extensive area of shoreline in and near the EIS project area. The context of impact would generally be common because the areas of land and water affected are extensively available, unless some special, rare, or unique characteristics associated with specific subsistence and recreation areas are affected. In summary, the effects of a VLOS would be major because of the possibility for high intensity and long term impact to land use and land management.

4.10.6.19 Transportation

4.10.6.19.1 Existing Analysis (BOEM 2011b and BOEM 2011d)

No specific analysis of the potential effects of a VLOS on transportation was provided in either the BOEM (2011b) or (2011e) discussions.

4.10.6.19.2 Additional Analysis for Transportation

The transportation systems among the Chukchi Sea communities would experience increased levels of air, vessel and surface traffic associated with containment, recovery, and cleanup activities for a VLOS that would involve hundreds of workers and vessels, aircraft, and onshore vehicles operating over an extensive area for one to two years. BOEM (2011b) predicted that in the event of a VLOS, offshore vessels such as skimmers, workboats, barges and icebreakers involved with cleanup would be used to remove oil from a spill area that occurs at sea and to drill a new well. Aircraft (fixed wing) would also likely be engaged in application of dispersants.

A VLOS may require up to 1,600 diesel-powered oil-skimming vessels, and other marine equipment such as ice breakers, over the course of time to confine and remove oil from the ocean surface (BOEM 2011b). The amount and type of vessels used during cleanup efforts could vary depending on seasonal and ice conditions:

> *In the event that response efforts continue into the winter season, small vessel traffic would come to a halt once the forming ice begins to cover the ocean surface. Larger skimming vessels could continue until conditions prevent oil from flowing into the skimmers. At this point, operations could shift to in-situ burning if sufficient thicknesses are encountered. The lack of daylight during winter months would increase the difficulties of response. As ice formation progresses, the focus of the response would shift to placing tracking devices in the forming ice sheet to follow the oil as it is encapsulated into the ice sheet. Once the ice sheet becomes solid and stable enough, recovery operations could resume by trenching through the ice to recover the oil using heavy equipment. This would most likely occur in areas closer to shore because the ice would be more stable. In late spring and early summer, as the ice sheet rots, larger ice-class vessels could*

> *move into the area and begin recovery or in-situ burning operations as the oil is released from the ice sheet. The ice would work as a natural containment boom keeping the oil from spreading rapidly. As the ice sheet decays, oil encapsulated in the ice would begin surfacing in melt pools at which time responders would have additional opportunities to conduct in-situ burn operations. Smaller vessels could eventually re-commence skimming operations in open leads and among ice flows, most likely in a free skimming mode (without boom) along the ice edge*.

Small boats and aircraft could also be involved with beach cleaning activities at oiled beaches (including booming) at marine and freshwater shorelines.

Aircraft could be used to apply dispersants used to decrease the size of the oil slick on the surface in the event of a VLOS. In addition, BOEM (2011b) noted that "during the response and cleanup process other aircraft may be needed for personnel and equipment transport, including helicopters, small piston-powered aircraft, and large commercial jets."

Aircraft used during spill response in the Chukchi Sea would likely be deployed from existing airport facilities including the airports of Barrow, Wainwright, Point Lay, Point Hope, Kivalina and Kotzebue, and other suitable airstrips (BOEM 2011b). Small vessels and surface vehicles would also be used during response operations at onshore areas.

As indicated in BOEM (2011b):

> *Aircraft and vessel operations would support many short-term efforts during the initial spill response as well as throughout the spill containment and treatments to minimize volume, spread, and environmental consequences. These include a wide variety of surveillance missions, placement of transmitter equipped buoys (to track spill edge in real time), media coverage, monitoring wildlife, dispersant application, treatments to shorelines and waters, as well as various activities associated with spill research, monitoring, and evaluation.*

Even after spill response and cleanup has occurred "aircraft and vessel operations would be supporting many longer term efforts for monitoring the recovery of resources, fate of oil and/or dispersants in the Arctic environment, and research and monitoring on the effectiveness of various cleanup and restoration practices" (BOEM 2011b). The effects and impacts of aircraft and vessels disturbance causes during response to a VLOS to seabirds, marine mammals and terrestrial mammals is described in Sections 4.10.6.10 through 4.10.6.12 and the affects to subsistence hunters is described in Section 4.10.6.15.

Local modes of transportation between communities by aircraft, vessels and surface means would be affected by a VLOS in nearshore and coastal areas. In the event of a VLOS, responders and additional response equipment would likely be transported to the airports of the Chukchi Sea communities. The Barrow airport could serve as a center for distributing responders and equipment to the smaller airports. As response efforts continue, the levels of air traffic to the areas affected in the Chukchi Sea would experience an increase in the numbers of flights arriving as additional response crews and supplies are transported to the affected areas. Air transportation within the state could also be indirectly affected as higher demand would occur for air travel to the spill area connecting from the Anchorage and Fairbanks airports. Increased levels of aircraft associated with spill response would affect local transportation systems for the duration of the response to a VLOS. Use of local airports associated with spill response activities (resupply, transport of spill response crews) could strain local transportation infrastructure.

Vessels and equipment associated with response would be present in increased numbers. It is likely that local tug/barge and small vessel traffic between communities would be affected during the spill due to the increased numbers of response and support vessels present in nearshore areas. Increased levels of response and support vessels associated with spill response would affect local transportation systems for the duration of the response to a VLOS. Local nearshore areas normally used for marine transportation between communities would experience and encounter vessels associated with spill response activities.

This could strain the local patterns of existing transportation. It is likely that in response to a VLOS there would be impairment of normal operations with deployment of response workers, vessels and equipment affecting the exiting levels of transportation along the coastline of the Chukchi Sea communities.

Surface transportation in the summer months could also be interrupted in the event of a VLOS that reaches the nearshore areas and coastlines. Local modes of surface transportation (e.g. off-road vehicles) used by residents during subsistence activities along the coasts may also become oiled if traveling within these areas.

Conclusion

The conclusions for impacts to transportation in the Chukchi Sea would be of high intensity (potentially year round), and long term in duration lasting one to two years or more during response and surveillance monitoring during recovery. The extent would be regional to statewide extent, and important in context. In summary, the impact of a VLOS on transportation would be moderate to major.

4.10.6.20 Recreation and Tourism

4.10.6.20.1 Existing Analysis (BOEM 2011d)

Section 4.4.12.3.2 of the BOEM (2011e) analysis provides a discussion of the impacts of a catastrophic discharge event on recreation and tourism in the Chukchi Sea planning area. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that effects from a catastrophic discharge event would likely include beach and coastal access restrictions, including restrictions on visitation, fishing, or hunting while cleanup is being conducted, and aesthetic impacts associated with the event itself and with cleanup activities. These impacts are expected to be temporary, with the magnitude dependent on the location and size of the event and the effectiveness of cleanup operations. Longer-term impacts may also be substantial if tourism were to suffer as a result of the real or perceived impacts of the event, or if there were substantial changes to tourism and recreation sectors in the region as a result of the event (BOEM 2011d).

4.10.6.20.2 Additional Analysis for Recreation and Tourism

Recreation and tourism occur at generally low levels of use in the Chukchi Sea. The effects of a VLOS for recreation and tourism will be described by setting and activities. It is important to distinguish between recreation and subsistence uses. The vast majority of fishing, hunting, and boating that occurs in the EIS project area are *subsistence*-based, managed completely apart from recreation-based activities, with separate rights and privileges (see Section 4.10.6.15, Subsistence for further discussion). This section discusses only recreation-based activities, a small portion of the human uses in the area.

The setting for recreation and tourism could be impacted by a VLOS, primarily the visitor experience of the recreation setting. If visitors recreating in the Chukchi Sea are expecting a fairly isolated and undeveloped recreation setting, the presence of response vessels, aircraft and support crews could alter the experience of the setting or the sense of place (Williams & Stewart 1998), as expectations of a pristine, isolated setting would not be met. The expectation for an isolated and undeveloped setting could be held by people traversing the area in personal pleasure boats or yachts, and recreationists using the coastal areas. Visual impacts are discussed in further detail in Section 4.10.6.21. The setting would also be adversely impacted by the physical presence of oil on the water and shoreline. The impact of the oil on the recreation setting would increase in effect as it spreads and reaches coastal areas. The appearance of water and coastline would be altered, presence or abundance and distribution of wildlife could change, and natural sounds could be supplanted by human-induced noise for spill response.

A VLOS could have a potential impact on the recreation setting including impacts on existence and bequest values (Schuster et al. 2005). Existence value refers to the knowledge that a particular resource exists and an emotional attachment to the resource, even if the place is never visited in person (Cordell et al. 2003, Rolston 1985) and bequest value refers to a desire to bequeath a natural resource to future generations (Cordell et al. 2003, Rolston 1985). A person who does not physically recreate in the Chukchi Sea could hold existence or bequest values related to the Arctic environment. A VLOS would alter the recreation setting from a natural setting to a setting impacted by oil and response vessels. The experience of the recreation setting would also likely be altered, including the experience of recreationists that hold existence and bequest values related to the Arctic environment.

The main activities that would be affected by a VLOS are offshore and coastal activities. Offshore wildlife viewing may be adversely impacted by the presence of the response efforts if wildlife avoids these vessels or industrial sites. If wildlife populations decrease as a result of the VLOS, that would also impact wildlife viewing through decreased sitings. Nearshore activities are generally engaged in by residents of local communities, and levels of activity are low; but those that exist would have noticeable impacts. Recreation activities could also be displaced; recreationists may avoid the affected areas, choosing instead to recreate someplace else to avoid the VLOS areas as publicity of the spill increases.

Conclusion

Based on the criteria given in Section 4.1.3, the intensity of the VLOS on recreation and tourism is expected to be high; the VLOS would noticeably alter recreation in the study area. Offshore and coastal settings would be altered by the amount of vessels, aircraft, and support for response. As the oil moves from the offshore setting to the coastal setting, recreation resources would be highly impacted from the oil. Most recreation in the area occurs in or near the water, and activities would be affected by the presence of the response teams, and the oil; particularly wildlife viewing, fishing and yachting. The recreation setting and activities would be altered for long-term duration, by the response teams and by the physical oil which could take over a year to clean or disperse, as well as impacts to existence and bequest values, which may last several years. Direct impacts to visitor setting and activities would be regional and could affect up to the entirety of the EIS project area. Indirect impacts to existence and bequest values would be considered state-wide based on the criteria because recreationists beyond the Chukchi Sea could hold existence and bequest values for the area.

The Alaska Maritime National Wildlife Refuge and Cape Krusenstern National Monument are within the EIS project area in the Chukchi Sea. Because these areas are federally designated and management includes public use, there is a perception of high recreation sensitivity in the area. Even though recreation opportunities across the Chukchi Sea are not scarce and not protected by legislation, the potential to impact recreation settings and activities in a national monument and public use of a national wildlife refuge, the context is considered important.

The impacts would be high intensity, long term duration, regional to statewide in extent, and important in context. In summary, the impact of a VLOS on recreation and tourism would be major.

4.10.6.21 Visual Resources

4.10.6.21.1 Existing Analysis (BOEM 2011b and 2011e)

No analysis of impacts specific to visual resources is presented in the BOEM (2011b) or BOEM (2011e) documents.

4.10.6.21.2 Additional Analysis for Visual Resources

A VLOS occurring in within the Chukchi Sea portion of the EIS project area has the potential to impact scenic quality and visual resources during Phases 2, 3, and 4 of the spill scenario. Potential impacts to scenic quality and visual resources are based on information presented in Section IV.D.2. (VLOS Scenario), Section IV.E.1 (OSRA Model [Oil Spill Trajectories]), and Section IV.E.2 (Water Quality) of the LS 193 FSEIS (BOEM 2011b). Direct effects could include views of the incident observed from local on-land or at-sea vantage points, or from images displayed in various forms of image-based media (e.g.

television, newspapers, and magazines). Indirect effects may include psychological/social distress from witnessing the incident first hand, or observing accounts of the incident through the same image-based media described above. The intensity, duration and extent of impacts will depend on the on the magnitude of the release (i.e. how much oil was released, and for how long) and the timing (seasonality) and location of the event. For example, a spill that occurred in closer proximity to the shoreline would have less time to weather before reaching nearshore and shoreline areas, thereby increasing potential for impacts to these areas. Oil released from a spill occurring during the fall season would have a greater likelihood of being sequestered under forming ice pack, and consequently may be transported across large geographic areas through moving ice. For the purposes of this analysis, potential impacts to scenic quality and visual resources are discussed by Phases 1 to 4 of the spill scenario. It is further assumed that the constituency of sensitive viewers would expand beyond the local population, tourist, and/or recreators in the area to include a broader public exposed to the VLOS via national (and international) media coverage. For this reason, this analysis assumes high visual sensitivity among all potential affected viewer groups.

Phase 1 (Initial Event)

The magnitude of impacts to scenic quality and visual resources is expected to be high during Phase 1 of the VLOS scenario. The explosion and resulting fire may be seen by individuals situated on marine vessels or those engaged in offshore subsistence activities. It is expected that air and marine traffic would be mobilized immediately to the location of the incident, resulting in a perceptible change in movement and activity in local communities (spill response and clean-up discussed further in Phase 4). Phase 1 impact to visual resources would be localized and temporary; resulting in short-term direct impacts to scenic quality and visual resources. Indirect effects, such as psychological/social distress are expected to occur among a broad public as a result of viewing images of the explosion and fire.

Phase 2 (Offshore Spill)/Phase 3 (Onshore Contact)

The magnitude of impacts to scenic quality and visual resources is expected to be high during Phase 2 and Phase 3 of the VLOS scenario. Direct impacts are expected to result from first-hand observation or media-based observation of images of oil on the water surface and in contact with onland areas. Indirect effects could include psychological/social distress from viewing oil on the water surface. The geographic extent and degree to which an offshore spill would affect on- and offshore locations outside of the EIS project area would depend on how far surface oil traveled (i.e. sequestration in moving ice, spreading through wind and wave action), and the amount that reached the shoreline. Although the duration of impacts under the VLOS scenario are expected to be short-term, potential direct and indirect impacts resulting from Phase 2 and 3 scenarios could be long-term depending on the persistence of oil, extent of affected area, and the degree to which seasonality influenced clean-up efforts.

Phase 4 (Spill Response and Cleanup)

The magnitude of impacts to scenic quality and visual resources is expected to be high during Phase 4. Direct impacts are expected to result from witnessing first-hand or through media outlets the perceptible change in activity level due to the presence of vessels, aircraft, skimmers, boomers, and actions associated with in-situ burning, animal rescue, introduction of dispersants, bioremediation, beach cleaning, and drilling of the relief well. Indirect effects could include psychological/social distress from viewing response efforts, again either first hand or through media outlets. The duration of impacts under the VLOS scenario 4 is expected to be short-term; long-term response efforts are discussed below (Phase 5).

Phase 5 (Long-Term Recovery)

The magnitude of impacts to scenic quality is expected to depend largely on the intensity, duration, and extent of Phases 2 and 3, and the effectiveness of efforts described in Phase 4. The magnitude of effects is expected to be highest in areas where oil is still visible on the surface of the water or on land, or where efforts to remediate water quality are underway. Indirect effects, such as psychological/social distress from witnessing (viewing) the spill and subsequent response is expected to attenuate in Phase 5 – although, the degree to which such indirect effects are reduced is again dependent on the visibility of oil and the level of response still underway. Such indirect effects may persist due to knowledge or fear of contamination, regardless of whether evidence of such contamination is visible to viewers. It is assumed that media coverage would not continue at levels experienced in Phases 1 to 4, thereby reducing direct and indirect effects to sensitive viewers located outside of Alaska.

Conclusion

In conclusion, major direct and indirect impacts to visual resources are expected to result from a VLOS scenario. Impacts would be of high intensity, short- to long-term in duration, regional to state-wide in geographic extent, and would affect an important resource.

4.10.6.22 Environmental Justice

4.10.6.22.1 Existing Analysis (BOEM 2011b and 2011e)

Section IV.E.18 of BOEM (2011b) describes potential impacts to environmental justice during the five phases of a possible VLOS in the Chukchi Sea. This information is incorporated herein by reference, and a summary of that information is provided here.

Environmental Justice impacts on Inupiat Natives could occur because of their reliance on subsistence foods, and oil-spill impacts would affect subsistence resources and harvest practices, sociocultural systems, and human health. Depending on the trajectory of the VLOS, the Inupiat communities of Barrow, Wainwright, Point Lay, and Point Hope, as well as the subsistence communities on the Russian Arctic Chukchi Sea coast, would all experience adverse impacts to varying degrees.

In the event of a VLOS in the Chukchi Sea, the Environmental Justice-related impacts described above would produce disproportionate, high, adverse effects in the Inupiat subsistence-oriented communities of Barrow, Wainwright, Point Lay, and Point Hope and in Russian subsistence communities along the Chukchi Sea coastline.

In addition, Section 4.4.14.3.2 of the BOEM (2011e) analysis provides some information about the impacts of a catastrophic discharge event on environmental justice in Alaska Arctic regions. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that many of the long-term impacts of a catastrophic discharge event on low-income and minority communities are unknown. Different cultural groups would likely possess varying capacities to cope with catastrophic events, with some low-income and/or minority groups more reliant on subsistence resources and/or less equipped to substitute contaminated or inaccessible subsistence resources with those purchased in the marketplace. Because lower income and/or minority communities may live near and be directly involved with catastrophic discharge event cleanup efforts, the vectors of exposure can be higher for them than for the general population, increasing the potential risks of long-term health effects (BOEM 2011d).

4.10.6.22.2 Conclusion

The impacts to subsistence foods and human health in the Iñupiat subsistence-oriented communities of Barrow, Wainwright, Point Lay, and Point Hope would be high intensity, long-term in duration, regional in extent, and unique in context. Therefore the summary impact level for environmental justice is major; there would be a disproportionate adverse effect to minority populations.

4.10.7 Beaufort Sea – Analysis of Impacts

The foundation for the analysis in Section 4.10.7 of this EIS is taken from the 2012-2017 OCS Oil and Gas Leasing Program Draft Programmatic EIS (BOEM 2011d), which contains the first post-DWH event scenario for the Beaufort Sea. Summaries of this information are provided in the applicable resource discussions below. As allowed for by CEQ regulations in §1502.21, NMFS has incorporated the information presented in the Draft Programmatic EIS (BOEM 2011d) into this EIS by reference.

Summaries of information from the former MMS (now BOEM) FEIS for the Beaufort Sea Planning Area Oil and Gas Lease Sales 186, 195, and 202 (MMS 2003) are also provided in this EIS where applicable. As allowed for by CEQ regulations in §1502.21, NMFS has incorporated the information from BOEM's FEIS into this document by reference. The specific sections from MMS (2003) that are referenced in this EIS are noted in the appropriate sections of this document.

Analysis beyond what was presented in BOEM (2011e) and MMS (2003) pertinent to this EIS is presented in each resource section. The information taken from BOEM (2011e) and MMS (2003) is identified as "Existing Analysis," and the analysis beyond what was presented in those documents is listed as "Additional Analysis."

4.10.7.1 Physical Oceanography

4.10.7.1.1 Existing Analysis (BOEM 2011d and MMS 2003)

Section 4.2.3.2 of the BOEM (2011e) analysis describes the effects of the movement and weathering of spilled oil on sea ice and currents in the Beaufort Sea planning area. This information is incorporated herein by reference.

Section IV.I.1 of MMS (2003) describes the behavior of spilled oil from a possible VLOS in the Beaufort Sea under various oceanographic conditions. This information is incorporated herein by reference, and a summary of that information is provided here.

4.10.7.1.2 Additional Analysis for Physical Oceanography

The direction and rate of movement of a VLOS originating in the narrow (15 to 40 km [9 to 25 mi]) Beaufort OCS would depend largely upon the wind direction in the spill area. Winds in the narrow area where exploration activities would occur are predominantly from the northeast and would facilitate wind driven transport of oil westward along the Beaufort Sea coast. Under such conditions, Ekman transport would tend to move spilled oil north, away from the shore. In contrast, westerly winds would tend to move oil closer to shore. Barrier islands would provide some protection to the mainland shoreline from a VLOS event originating outside of the barrier islands.

Phase 1 (Initial Event)

Impact producing factors associated with a well control incident, such as explosion, fire, and redistribution of sediment would have minor effects on physical ocean resources within the EIS project area. Uncontrolled combustion of petroleum hydrocarbons in the environment would result in an increase in water temperature in the immediate vicinity of the fire. It is difficult to quantify the increase in water temperature that would result from fire associated a well control incident, but it is likely that the geographic extent of changes in water temperature would be limited to areas immediately adjacent to the fire, and the duration of such thermal effects would be temporary. Redistribution of seafloor sediments would have minor impacts on the seafloor topography in the immediate vicinity of the well control incident. Although effects resulting from redistribution of seafloor sediment would likely be permanent, the intensity of the effects would be low and the geographic extent would be limited to the immediate vicinity (probably within 1 km) of the well control incident. Sinking of the drilling rig to the sea floor would effectively create an artificial reef, which would have permanent, local, low-intensity effects on the physical character of the EIS project area. If the rig were to sink in shallow water it could be considered a navigational hazard. Overall, effects of the initial well control incident on the physical character of the EIS project area would be minor.

Phase 2 (Offshore Oil)

Oil in the water from a VLOS event would affect the physical character of the sea surface in the EIS project area. An oil slick covering hundreds of square kilometers of ocean surface would influence ocean- atmosphere interactions including exchange of gasses across the air-water interface and the generation of wind driven waves in the affected area. The presence of an oil slick at the sea surface would impede normal gas exchange across the air-water interface, but the impacts of such effects would likely be surpassed by the release of large quantities of methane, ethane, propane and other hydrocarbon gasses into the water column. The natural gas mixture released into the water during a VLOS event would have temporary effects on the dissolved gas content of seawater in the affected area. The presence of an oil slick at the sea surface would likely lead to decreases in the magnitude of wind-driven waves in the affected area. Effects on waves resulting from a VLOS would be low intensity, local, and temporary. Such effects would decrease concomitant with clean-up or partitioning of the oil into environmental compartments other than the sea surface. Due to limited water depths on the Beaufort Sea shelf, most fractions of the released oil would float to the surface and effects on the physical character of pelagic and benthic zones are expected to be minor during this phase of the VLOS. However, effects of an oil slick on the viscosity of the sea surface would be high-intensity and regional. The sea surface could be considered an important physical resource within the EIS project area because of its critical role in myriad chemical, physical and biological processes. Due to the viscosity and stickiness of spilled oil, the overall effects of offshore oil on the physical character of the ocean would be major. In addition, an oil slick would effectively decrease the freezing point of the affected seawater, and may have non-negligible impacts on the formation of sea ice in affected areas.

Phase 3 (Onshore Contact)

Exposure to oil would affect the physical character of the shoreline for reasons similar to those described above. Spilled oil would adhere to the shoreline and affect the composition of beach substrates.

Phase 4 (Spill Response and Cleanup)

Spill cleanup operations could have adverse impacts on the physical character of the ocean and shoreline. Minor impacts due to differential shoreline erosion would be possible if the removal of contaminated substrates affects beach stability.

In situ burning of oil result in high-intensity effects on sea surface temperature, but these effects would be temporary and spatially limited to the area of *in situ* burning operations. The use of dispersants would effectively move the impacts associated with spilled oil from the sea surface into the water column. Dispersed oil in the pelagic environment would affect the density and viscosity of the water, but these effects would be low-intensity, and would decrease as the dispersed oil is weathered, diluted, and degraded.

Phase 5 (Long-term Recovery)

Long-term direct effects on the physical character of the ocean would be negligible. Oil is a mixture comprised mostly of volatile and hydrophobic compounds. As a result of these properties, oil has a strong tendency to associate with non-aqueous phase materials. Oil associated with solid phase particles may remain on beaches and in sediments on the sea floor for extended periods of time, but the long-term effects of weathered oil in the environment are expected to be related to the chemical properties and potential toxicity of certain hydrocarbon compounds.

Conclusion

The overall effects of the VLOS on the physical character of the ocean would initially be high-intensity due to the viscosity and stickiness of oil floating at the sea surface. The duration of these impacts would be limited by the properties of oil that cause it to associate with non-aqueous phase materials. If *in situ* burning is used as a response technique, high-intensity short term impacts would occur to the physical character of the sea surface. The overall effects of the VLOS on the physical character of the Beaufort Sea in the EIS project area would be high-intensity, temporary, and would affect an area of hundreds of square kilometers. Overall impacts to physical oceanography would be classified as moderate due to their high-intensity and temporary duration.

4.10.7.2 Geology

The geology of the continental shelf and OCS within the proposed action area is discussed in Section 3.1.3 of this EIS. For the purpose of this EIS, geological processes would not be altered by a VLOS; therefore geology as a resource is not carried forward for analysis in Chapter 4. In addition, naturally occurring phenomena like ice gouging and strudel scouring would not likely be affected by a VLOS, nor would these phenomena be expected to affect response to a VLOS.

4.10.7.3 Climate and Meteorology

4.10.7.3.1 Existing Analysis (BOEM 2011d)

Discussions on GHG emissions in the existing BOEM (2011e) analysis can be found in Sections 4.10.7.4 (Air Quality) of this EIS.

4.10.7.3.2 Additional Analysis for Climate and Meteorology

The VLOS scenario in the Beaufort Sea has the potential to impact climate change, especially during Phases 1 and 4 of the oil spill and cleanup scenario. These impacts are considered to be of the same nature and magnitude of those that could occur as a result of a VLOS in the Chukchi Sea (Section 4.10.6.3). The level of the impacts are expected to be of low magnitude, long-term duration, a minimum extent of state-wide, and unique in context. Therefore, the overall impact rating would be considered moderate.

4.10.7.4 Air Quality

4.10.7.4.1 Existing Analysis (BOEM 2011d)

Section 4.4.4.3.2 of the BOEM (2011e), provides an analysis of the impacts of a catastrophic discharge event on air quality in the Beaufort Sea planning area. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that evaporation of oil from a catastrophic discharge event, and emissions from spill response and cleanup activities including in situ burning, if used, have the potential to affect air quality in Arctic Alaska. The greatest impacts on air quality would occur during the initial explosion of gas and oil and during spill response and clean up, particularly if the event occurs during the winter. Impacts could continue for days during the initial event and could continue for months during spill response and clean up. Therefore, while the impacts may be large during these two phases, overall, the emissions from a catastrophic discharge event would be temporary and, over time, air quality in Arctic Alaska would return to pre-oil spill conditions (BOEM 2011d).

4.10.7.4.2 Additional Analysis for Air Quality

As described above, a VLOS has the potential to temporarily impact air quality in localized areas in the Beaufort Sea. However, the MMS 2003 information is based on a smaller potential VLOS; the magnitude, extent, and duration of effects on air quality would likely be larger for a larger spill, with higher initial emissions and more cleanup activities required. The potential VLOS-related air quality impacts are expected to be the same (similar levels of effect) in the Beaufort Sea as in the Chukchi Sea. Therefore, based on the more detailed information provided in Section 4.10.6.4, a VLOS has the potential to impact air quality, particularly during Phases 1 and 4 of the oil spill and cleanup scenario.

4.10.7.5 Acoustics

4.10.7.5.1 Existing Analysis (BOEM 2011d)

Section 4.4.5.4.2 of the BOEM (2011e) analysis provides a discussion of the impacts of a catastrophic discharge event on the acoustic environment in Arctic Alaska. This information is incorporated herein by reference, and a summary of the information is provided. The BOEM analysis concludes that the pressure wave and noise generated from an incident involving a loss of well control would affect marine mammals and could be large enough to harass or disturb them if they were close enough to the site of the event. In addition, accident response and support activities, including support aircraft and vessel activity, have the potential to cause noise impacts. These impacts would occur both at the site of the response activity and along the routes of support vessels and aircraft. The duration and magnitude of the impacts would depend on the volume, location, duration, and weather conditions during the catastrophic discharge event, and the response and cleanup activities (BOEM 2011d).

4.10.7.5.2 Additional Analysis for Acoustics

In the event of a VLOS, the acoustic environment could be changed by noise generating sources associated with the initial well control incident and with the subsequent cleanup effort. The impacts of a VLOS in the Beaufort Sea would be considered to be of the same nature and magnitude (minor to moderate) of those that could occur as a result of a VLOS in the Chukchi Sea, discussed in Section 4.10.6.5.

4.10.7.6 Water Quality

4.10.7.6.1 Existing Analysis (BOEM 2011d)

Section 4.4.3.3.2 of the BOEM (2011e) analysis provides a discussion of the impacts of a catastrophic discharge event on water quality in the Beaufort Sea planning area. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that a catastrophic discharge event in either coastal or marine waters could present sustained degradation of water quality from hydrocarbon contamination in exceedence of state and federal water and sediment quality criteria, and that these effects could be significant depending upon the duration and area impacted by the spill. Additional effects on water quality could occur from response and cleanup vessels, in situ burning of oil, dispersant use, discharges and seafloor disturbance from relief well drilling, and activities on shorelines associated with cleanup, booming, beach cleaning, and monitoring (BOEM 2011d).

4.10.7.6.2 Additional Analysis for Water Quality

The above analysis of effects of a VLOS on water quality in the Beaufort Sea (MMS 2003) is based on a potential VLOS flow rate of 15,000bbl per day over 15 days totaling 225,000bbl, of which 20 percent evaporates, leaving 180,000 bbl spilled on an artificial island and surrounding Beaufort Sea waters. The VLOS scenario analyzed for the Chukchi Sea uses a spill size of 2.2MMbbl, which would have similar effects on water quality in the Beaufort Sea analysis (MMS 2003). If a VLOS event were to originate outside the barrier islands in the Beaufort Sea, the islands could afford some level of protection to nearshore water quality in sensitive areas. If a VLOS event were to originate inside the barrier islands, the geographic extent of the affected area could be constrained to some extent by the effects of the islands on transport of spilled oil. However, sensitive areas inshore of the barrier islands would be likely to experience high-intensity effects on water quality in the event of an oil spill occurring inside of the islands.

A spill of 2.2 MMbbl in the Beaufort Sea would result in elevated concentrations of petroleum hydrocarbons and related compounds in the water. Those concentrations would exceed both state and federal water quality criteria over large areas and for extended periods of time. A VLOS in the Beaufort Sea would have high-intensity effects on water quality. The duration of such effects could be long-term, and the geographic extent of the effects could be either regional or state-wide depending on the specific launch area, meteorological conditions at the time of the spill, and effectiveness of the response effort. Chemical response techniques, such as the use of dispersants, could result in additional degradation of water quality, which may or may not offset the benefits of dispersant use. Although water is generally considered a common resource, a VLOS in the Beaufort Sea could impact water quality in sensitive areas that are protected by legislation. Overall, a VLOS would have major effects on water quality in the Beaufort Sea.

4.10.7.7 Environmental Contaminants and Ecosystem Functions

4.10.7.7.1 Existing Analysis (BOEM 2011d)

Section 4.4.6.2.4 of the BOEM (2011e) analysis provides some information about the impacts of a catastrophic discharge event on ecosystem functions in the Beaufort Sea planning area. This information is incorporated herein by reference, and a summary of the information is provided. The BOEM analysis states that sensitive benthic habitats could suffer long-term loss of ecological function because of both hydrocarbon toxicity and the subsequent cleanup activities. Hydrocarbons could persist at sublethal concentrations in sediments for decades, and sensitive habitats (i.e., kelp beds, intertidal zones; live-bottom and coral reef) damaged by a spill would likely recover slowly and possibly not recover at all. However, hydrocarbons would be broken down by natural processes, and most benthic habitats are likely to eventually recover. Pelagic habitats would eventually recover their habitat value as hydrocarbons broke down and were diluted. Recovery time would vary with local conditions and the degree of oiling. Overall, impacts on habitats from accidental hydrocarbon spills in open water could range from negligible to moderate, and impacts could be short term to long term; no permanent degradation of pelagic habitat would be expected (BOEM 2011d).

4.10.7.7.2 Additional Analysis for Environmental Contaminants and Ecosystem Functions

Impacts to ecosystem functions potentially resulting from a VLOS in the Beaufort Sea would be very similar to those described for the Chukchi Sea in Section 4.10.6.7 of this EIS, with several exceptions that are described below.

Potential locations for exploratory drilling activities are generally located closer to shore in the Beaufort Sea compared to the Chukchi Sea portion of the EIS project area. Due to the proximity of potential VLOS launch locations to sensitive nearshore habitats, a VLOS in the Beaufort Sea would have greater impacts on habitat functions relative to a similar event in the Chukchi Sea. Spawning and refuge habitats would be affected for most communities in the vicinity of the well control incident as discussed in other sections of this document. Impacts to coastal wetlands, tidal flats, and sheltered beaches would generally be greater than impacts to exposed gravel, cobbled beaches, or offshore areas (Gundlach and Hayes 1978). The effects of a VLOS on habitat functions in the Beaufort Sea would be high-intensity and regional scale. Overall impact of a VLOS on habitat functions in the Beaufort Sea would be major.

Response and clean-up activities could have intense effects on habitat functions in sensitive areas. For example, the use of hot water hydraulic washing to clean oiled shoreline could destabilize physical substrates causing adverse impacts to spawning and refuge habitats for coastal species.

Persistence of oil in sediments may have negative long-term effects on habitat functions within the affected area. Long-term effects on habitat functions would be limited to areas where oil may become trapped in sediments or other substrates, and shielded from weathering and degradation. Long-term effects on habitat functions would be local and medium intensity, but would have the potential to affect unique resources depending upon the location of the discharge and the efficacy of the response effort. Due to the prevalence of barrier islands in the Beaufort Sea portion of the EIS project area that shelter the coastline from wave action and weathering processes, it is probable that long- term adverse effects of a

VLOS on habitat functions would persist over greater geographic areas in the Beaufort Sea relative to the Chukchi Sea. In addition, presence of oil would be likely to affect production functions by inhibiting the germination and growth of many species in the Beaufort Sea area. However, robust primary producers such as Arctic Kelp (*Laminaria solidungula*), which dominates the Boulder Patch community in Stefansson Sound, would be likely to recover rapidly subsequent to clean-up. Thus, overall levels of photosynthesis and primary production would decrease temporarily, but would likely return to pre-VLOS levels within several years after the cessation of clean-up activity.

Conclusion

Effects of a VLOS on ecosystem functions in the Beaufort Sea would be high intensity, long-term, regional, and could affect unique resources. Overall, the effects of a VLOS on ecosystem functions in the Beaufort Sea would be considered major. However, with few exceptions, the ecosystem functions in the VLOS area would likely recover within several years of the cessation of clean-up activities. The functional properties of ecosystems described in this section, such as nutrient cycling and habitat functions, are more robust (i.e. resistant to stressors) than are species composition and other structural properties. As suggested by Peterson et al. (2003), a VLOS event would be likely to affect ecosystem structure over timescales of decades; ecosystem functions, from which humans derive value, would be likely to recover more quickly.

4.10.7.8 Lower Trophic Levels

4.10.7.8.1 Existing Analysis (BOEM 2011d and MMS 2003)

Section 4.4.7.5.3 of the BOEM (2011e) analysis provides a discussion of the impacts of a catastrophic discharge event on invertebrates and lower trophic levels in the Beaufort Sea. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that a catastrophic discharge event could affect a large number of benthic and pelagic invertebrates and their habitats. The location of the spill and the season in which the spill occurred would be important determinants of the impact magnitude of the spills. Hydrocarbon releases contacting the Stefansson Sound Boulder Patch community could have direct impacts on organisms inhabiting the area. The magnitude of impacts to the Boulder Patch would depend on the location and severity of the spill (BOEM 2011d).

Section IV.1.2.b of MMS (2003) describes potential impacts to lower trophic level organisms during a possible VLOS in the Beaufort Sea. This information is incorporated herein by reference, and a summary of that information is provided here.

Large-scale effects on marine plants from oil spills have been observed in the intertidal and subtidal zones of other regions. Because of the predominance of shorefast ice in the affected area, there is no resident marine flora in waters less than 6 feet deep; therefore, there would be no effects. The oil spill also is not expected to have any measurable effect on subtidal marine plants (such as those of the Boulder Patch kelp habitat), because they live below the zone where toxic concentrations of oil can reach them.

A very large oil spill probably would affect half of the planktonic organisms in about half of the sound, or a total of about one-quarter of the Stefansson Sound plankton. Because of their wide distribution, large numbers, and rapid rate of regeneration (12 hours), there would be only a temporary, local effect on the planktonic community. The recovery of the community would be complete within 1-2 weeks (the estimated flushing time for Stefansson Sound).

Some lower trophic-level organisms on the shorelines would be adversely affected. Use of dispersants on a spill near benthic kelp communities would mix the oil farther down into the water column and could affect the kelp community. However, the use of dispersants is not essential for spill response; their use would require further approval by the Coast Guard.

4.10.7.8.2 Additional Analysis for Lower Trophic Levels

The oil spill discussion in MMS (2003) analyzed the effects of an oil spill of 180,000 bbls, but for the purposes of this EIS, a VLOS of 2.2 MMbbls occurring over a 74 day period is considered for the Beaufort Sea. Although the impacts to lower trophic levels would be similar regardless of the size of the spill, the magnitude, duration, and extent would be substantially greater with a larger spill.

The existing leases in the Beaufort Sea are much closer to shore than those in the Chukchi Sea, with most leases within 56 km (35 mi) of the shore, and in shallower waters. A VLOS could therefore have a greater impact on nearshore habitats, although some impacts could be mitigated by the extensive barrier islands protecting the Beaufort Sea coastline. These islands may protect many of the bays and lagoons in the nearshore habitat from exposure to oiling. Although MMS (2003) determined that up to half of the coastline could be oiled in an 180,000 bbl spill, a larger spill could impact more coastline. No modeling was performed for the Beaufort Sea analysis, but prevailing winds are generally easterly through mid-July, and then shift to westerly in August. Over the course of a 74 day spill, there would likely be a net westerly movement, blowing the oil onshore and affecting any portion of the coastline.

As the lower trophic level organisms in the Chukchi and Beaufort seas are very similar, the extensive analysis performed by BOEM (2011) for the Chukchi Sea (Section 4.10.6 of this EIS) can be largely applied to the Beaufort Sea. The most likely impacts to lower trophic levels include:

- Mortality to all life stages resulting from pressure waves from an initial explosive event, toxicity to oil (acute and chronic), and coating with an oil layer;
- Impact to food web through bioaccumulation and biomagnification as a result of the close interactions between megafauna (i.e. whales, seals, walrus) and lower trophic organisms (Dunton et al. 2005, Grebmeier et al. 2006) (see Section 4.10.6.11 for more information regarding the effects of bioaccumulation and biomagnification on marine mammals);
- Longer recovery rates due to species traveling outside the original contamination site or being consumed later, thereby prolonging the recovery, as a result of drift or diapause (a forma of hibernation), respectively. This would delay recovery since these species surviving the initial incident, would store toxins and be consumed at a later date by higher trophic level organisms(MMS 2004, Jiang et al. 2010, Brodersen 1987); and
- Habitat loss due to oiling of ice or benthic substrate and the resultant decrease in primary productivity or mortality events.

The magnitude of these impacts is dependent on a variety of factors. The primary factors influencing the level of impact include:

- Duration and volume of the spill;
- Distribution and geographic coverage of surface oil slicks;
- Persistence and dispersion of oil in the water column (epontic, pelagic, or benthic);
- Chemical composition of the oil;
- Efficacy of chemical dispersants;
- Incorporation of spill into first year ice; and
- Weather patterns, including hours of daylight and UV intensity, presence or absence of ice, presence or absence of polynyas and reaches

Depending upon the factors discussed above, a VLOS in the Beaufort Sea could have a summary impact level of major, should the spill persist in the environment or affect unique resources. However, should the spill not last a long time or affect unique resources, the impacts to the lower trophic levels would be of low to medium magnitude, short-term duration, local to regional geographic extent, and common context.

In this case, the impact criteria listed above would lead to a summary impact level of moderate due to the shorter duration and regional impacts to common resources.

4.10.7.9 Fish and Essential Fish Habitat

4.10.7.9.1 Existing Analysis (BOEM 2011d and MMS 2003)

Section 4.4.7.3.3 of the BOEM (2011e), provides an analysis of the impacts of a catastrophic discharge event on fish in Arctic Alaska. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that a catastrophic discharge event could have population-level consequences on some fish populations if vital habitat areas were affected or if the spill occurred in spawning areas or juvenile feeding grounds when fish populations are highly concentrated (e.g., the Arctic cisco population concentrated near the Colville River). In such cases, catastrophic spills could cause substantial reductions in population levels for one or more years. However, no permanent impacts on fish populations are expected (BOEM 2011d).

Sections IV.1.2.c and IV.I.2.d of MMS (2003) describe potential impacts to fish and essential fish habitat during a possible VLOS in the Beaufort Sea. This information is incorporated herein by reference, and a summary of that information is provided here.

Fish

Fish distribution in the Beaufort Sea varies seasonally as many species move from offshore to nearshore environments. Therefore, a VLOS that reached the shore would have a much greater effect in summer and autumn when these fish species are nearshore feeding and spawning than in winter when many of these species are once again offshore. Based on the Oil-Spill-Risk Analysis model (Table IV.I-9a), the nearshore areas of highest chance of contact include Land Segments 31-37. If a 180,000-barrel oil spill occurred, these land segments would have a 0.5-8% chance of being contacted in 30 days. According to Tables IV.I-6a and IV.I-6b, a 180,000-barrel oil spill would contact about 300 kilometers of coastline, which is about seven times that estimated for the 4,600-barrel oil spill associated with Alternative I for Sales 186, 195, and 202. However, the combined probability of one or more spills occurring and contacting the nearshore area is very low (less than 0.5%). If it did occur, some marine and migratory fish might be harmed or killed. The number affected would depend on the size of the area affected, the concentration of petroleum present, the time of exposure, and the stage of fish development involved (eggs, larva, and juveniles are most sensitive). If lethal concentrations were encountered, or sublethal concentrations were encountered over a long-enough period, fish mortality would be likely to occur. However, mortality due to petroleum-related spills is seldom observed outside of the laboratory environment. This is because the zone of lethal toxicity is very small and short lived under a spill, and fishes in the immediate area typically avoid that zone. Mortality would be expected only in cases where fishes were somehow trapped in a lethal concentration and could not escape. Because this would be very unlikely outside of the laboratory environment, little to no mortality due to lethal concentrations would be expected.

If oil were to reach the shore and become buried in intertidal and/or subtidal sediments, it likely would be released back into the water column at a later time. However, the amounts of oil released in that manner are likely to be relatively small over time, and fish density in Beaufort Sea coastal waters also is relatively low most of the year. While a 180,000-barrel oil spill would be expected to affect about 300 kilometers of nearshore waters and coastline, it would be likely to have mostly sublethal effects (for example, changes in growth, feeding, fecundity, and temporary displacement) on marine and migratory fish. Juvenile fish (for example, arctic cod), which are common in the nearshore area during summer, or nearshore spawners (for example, capelin) are among those most likely to be adversely affected. Some fish in the immediate area of a spill may be killed; however, it is not expected to be a measurable effect on marine and migratory fish populations. Recovery of the number of fish harmed or killed would be expected within 10 years.

Oil-spill-cleanup activities, whether on ice or for oil entrained in the ice, are not expected to adversely affect fish populations. It is possible that a containment boom could trap some oil in a shoreline area and temporarily contaminate that area long enough to affect fishes or their food resources. In general however, reducing the amount of oil in the marine environment is expected to have a beneficial effect on fishes, because it reduces the possibility of hydrocarbons contacting them and their food resources. The extent of that benefit would depend on the actual reduction in the amount of oil contacting fish and their food resources, as compared to that of not reducing the amount of contact.

Essential Fish Habitat

Section 4.4.6.4.3 of the BOEM (2011e) analysis provides a discussion of the impacts of a catastrophic discharge event on EFH in Arctic Alaska. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that a catastrophic discharge event could cause long-term declines of fish species that rely on shallow coastal, intertidal, and freshwater areas. Spills occurring under ice could result in long-term degradation of EFH because of the cleanup difficulties; severity of effects of accidental hydrocarbon spills on EFH would depend on the size of the spill, its location, environmental factors, and the uniqueness of the affected EFH (BOEM 2011d).

4.10.7.9.2 Additional Analysis for Fish and Essential Fish Habitat

The most likely impacts to fish resulting from a VLOS are:

- Mortality to all life stages resulting from pressure waves from an initial explosive event, toxicity to oil (acute and chronic), and coating with an oil layer;
- Reduction of individual fitness and survival due to physiological contaminant effects. These effects can, in turn, affect swimming, feeding, reproductive and migratory behaviors and the physiologic adjustment for anadromous fish as they move between freshwater and saltwater environments; and
- Onshore and offshore habitat loss due to oiling, resulting in displacement and stress. Displacement could result in blocked or impeded access to spawning, rearing, feeding, and migratory habitats important for survival.

The magnitude of these impacts is dependent on a variety of factors. The primary factors influencing the level of impact include:

- Location and time of year of the oil spill;
- Life stage affected (egg, larvae, juvenile, adult) and life history (anadromous, migratory, reproductive behaviors and cycle, longevity);
- Species distribution and abundance;
- Species exposure and sensitivity to oil and gas (toxicology, swimming ability); and
- Habitat dependence (marine vs. freshwater, onshore vs. offshore, location of spawning habitat, depth).

Based on the five oil spill phases described in BOEM (2011), the greatest impacts in the Beaufort Sea could be felt during Phases 2 and 3, particularly in benthic and nearshore regions. The fish typically found in these areas are more susceptible to impacts from a VLOS due to their increased dependence on relatively limited habitat when compared to pelagic fish, or decreased swimming ability resulting in an inability to escape impacted areas. Most impacts to habitat could be short term in duration, with shoreline and substrate impacts lasting longer. The fish assemblages with an increased susceptibility include:

- Migratory and juvenile fish that use nearshore, shallow lagoons, estuaries, and bays;

- Benthic fish, which are typically poor swimmers; and
- Cryopelagic species such as Arctic cod, should the spill occur in winter or get entrained in seasonal pack ice.

In general, the leases in the Beaufort Sea are much closer to shore than those in the Chukchi Sea, with most less than 56 km (35 mi) from shore, and in shallower waters. A spill could therefore have an even greater impact on nearshore habitats, although it could be mitigated to some degree by the extensive barrier islands protecting the Beaufort Sea coastline. These islands may protect many of the bays and lagoons in the nearshore habitat to their landward side from exposure to oiling. Although MMS (2003) determined that up to half of the shoreline could be oiled in a 180,000 bbl spill, a larger spill could impact more shoreline. No modeling specific to the Beaufort Sea was performed, but prevailing winds are generally easterly through mid-July, and then shift to westerly from August onward. Over the course of a 74 day spill, there would likely be a net westerly movement, blowing the oil onshore. There is a possibility that any portion of the coast could be affected by a spill, but not the whole coast at one time.

The EFH described by NMFS in the Beaufort Sea is very similar to that in the Chukchi Sea, except that there is no opilio crab EFH in the Beaufort Sea. Therefore, it is likely that the types of effects to EFH would be very similar to those described in Section 4.10.6.9. The biggest concern for fish resources is not oil in the open ocean, but in nearshore waters and along the coast, where it can interfere with juveniles and spawning habitat. It can also be very disruptive in estuaries, lagoons, and bays, where many fish congregate and are not able to escape as easily as their pelagic counterparts can in the open ocean.

Most fish and EFH within the EIS project area are important resources that are widespread and abundant. However, the impacts from a VLOS could be of high intensity, long term duration, and occur over a broad, regional extent. Therefore, according to the criteria laid out in Section 4.1.3, the overall summary impact level of a VLOS could be moderate.

4.10.7.10 Marine and Coastal Birds

4.10.7.10.1 Existing Analysis (BOEM 2011d and MMS 2003)

Section 4.4.7.2.3 of the BOEM (2011e) analysis and Section IV.I.2 of MMS (2003) describe potential impacts to marine and coastal birds during a possible VLOS in the Beaufort Sea. This information is incorporated herein by reference, and a summary of that information is provided here.

A catastrophic discharge event is expected to cause spectacled eider mortality, if females with recently fledged young contact stranded oil in coastal habitats, or flocks of adult eiders or females with young feeding in lagoons and offshore waters are contacted by a spill sweeping over thousands of square kilometers. A winter spill released from the ice in spring could contact eiders concentrated in open water of river deltas. Substantial mortality that could result from such a large spill would represent a significant loss for the relatively small Arctic Coastal Plain spectacled eider population, requiring many generations for recovery. Recovery is not likely to occur while the regional population is in declining status. Any mortality, or decreased fitness or productivity from indirect effects such as decreased availability of food organisms or physiological effects from oil ingestion would be additive to the loss of oiled individuals. Although Fish and Wildlife Service survey data do not show a significant decline in the coastal plain spectacled eider population, the potential exists for a significant adverse effect from an oil spill on this regional population. Mortality of a few Steller's eiders also would represent a significant loss to its small regional population.

A 180,000-barrel oil spill in open water assumed for this analysis is expected to result in the loss of thousands of broodrearing and young waterfowl and shorebirds if they contact stranded oil along a substantial proportion of the affected shoreline. In lagoon habitats, observed high densities of long-tailed ducks suggest that on some occasions, tens of thousands of molting individuals could be contacted by a spill sweeping over thousands of square kilometers, representing a significant loss from the regional population. Likewise, contact of substantial numbers of postbreeding common eiders in the vicinity of barrier islands or Ross' gulls in the vicinity of Point Barrow, August through September could result in significant losses. Recovery is not expected to occur while specific populations are in declining status. A winter spill entering the environment after the ice melts in the spring could contact loons and other migrant waterfowl concentrated in open water near river deltas. Any mortality, or decreased fitness or productivity from indirect effects such as decreased availability of food organisms or physiological effects from oil ingestion would be additive to the losses of oiled individuals.

4.10.7.10.2 Additional Analysis for Marine and Coastal Birds

Direct and indirect exposure to oil is an impact producing factor that can affect marine and coastal birds. The increase from a 180,000 bbl oil spill to a 2.2MMbbls spill could cause adverse effects to marine and coastal birds that may be longer in duration and cover a larger area then those explained above in the MMS (2003) analysis. The level of effect is dependent upon the timing of the VLOS, the seasonal effects of currents and subsequent advection of oil, timing, and duration of the oil spill, presence or absence of fast or pack ice, location (within important areas or outside) and general weather patterns (wind and storm events). In accordance with criteria established in Section 4.1.3 of this EIS, if a VLOS occurs in critical habitat areas, the magnitude of impacts to marine and coastal birds could be medium to high, with displacement from the area, impacts to prey resources and habitat quality, and a likelihood of injury or mortality from either direct contact with or ingestion of oil and associated contaminants. The duration of the impacts could be long-term to permanent, because critical habitat areas could be abandoned or large portions of the population could be affected. The geographic extent could be state-wide due to migrating, molting and breeding bird populations. See Section 4.10.6.14 for more information about critical habitat areas. If the VLOS would occur outside critical habitat areas the effects could be the same except the duration could be temporary to long-term rather than long-term to permanent. The chance of recovery could be greater due to less birds likely being affected, compared to a higher concentration of birds that could be found in many important habitat areas at certain periods of time.

Population level effects are likely, given the high concentration of migrating, molting and breeding bird populations, a VLOS in the Beaufort Sea during the lifetime of this EIS could result in a major impact to marine and coastal birds. This is due to the potential adverse effects to population levels, habitat, molting and breeding areas, important habitat areas, toxicity to prey and individuals, and mortality of individuals.

4.10.7.11 Marine Mammals

4.10.7.11.1 Existing Analysis (BOEM 2011d and MMS 2003)

Section 4.4.7.1.3 of BOEM (2011e) provides an analysis of the impacts of a catastrophic discharge event on marine mammals in Arctic Alaska. The PEIS analyzes a catastrophic discharge event of 1.7 to 3.9 million bbl for the Beaufort Sea. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that a catastrophic discharge event would impact marine mammals from direct contact, inhalation, and ingestion (either directly or indirectly through the consumption of oiled forage or prey species). These effects would be significant, causing a multitude of acute and chronic effects. Additional effects on marine mammals would occur from water and air quality degradation associated with response and cleanup vessels, in situ burning of oil, dispersant use, discharges and seafloor disturbances from relief well drilling, and activities on shorelines associated with cleanup, booming, beach cleaning, and monitoring. A catastrophic discharge event has the potential to increase the area and duration of an oil spill, thereby increasing the potential for population-level effects, or at a minimum, an increase in the number of individuals killed. For example, a catastrophic discharge event contaminating ice leads or polynyas in the spring could have devastating effects, trapping bowhead whales where they may encounter fresh crude oil. Beluga whales that also use the spring lead system to migrate would also be susceptible to a spill that concentrates in these leads (BOEM 2011d).

Section IV.I.2.e(1) Bowhead Whales and IV.I.2.g Marine Mammals of MMS (2003) describes potential impacts to marine mammals during a possible VLOS in the Beaufort Sea. This information is incorporated herein by reference, and a summary of that information is provided here.

Bowhead Whales

It is likely that some bowhead whales would experience temporary, nonlethal effects, including one or more of the following symptoms:

- oiling their skin, causing irritation
- inhaling hydrocarbon vapors
- ingesting oil-contaminated prey
- fouling of their baleen
- losing their food source
- temporary displacement from some feeding areas

Some whales could die as a result of contact with spilled oil, particularly if there is prolonged exposure to freshly spilled oil, such as in a lead. The extent of the effects would depend on how many whales contacted oil, the duration of contact, and the age/degree of weathering of the spilled oil. The number of whales contacting spilled oil would depend on the location, size, timing, and duration of the spill and the whales' ability or inclination to avoid contact. If oil got into leads or ice-free areas frequented by migrating bowheads, a large portion of the population could be exposed to spilled oil. Under some circumstances, some whales could die as a result of contact with spilled oil. Prolonged exposure to freshly spilled oil could kill some whales, but the number likely would be small.

Based on conclusions from studies that have looked at the effects of oil spills on cetaceans, exposure to spilled oil is unlikely to have serious direct effects on baleen whales. Most individuals exposed to spilled oil are expected to experience temporary, nonlethal effects from oiling of the skin, inhaling hydrocarbon vapors, ingesting contaminated prey, fouling of their baleen, reduced food source, and displacement from feeding areas. Exposure of bowhead whales to spilled oil could result in lethal effects to some individuals.

Marine Mammals (Pinnipeds, Polar Bears, and Beluga and Gray Whales)

The effects from activities associated with Beaufort Sea oil and gas exploration and development are estimated to include the loss from [a large] oil spill (0.11 percent chance) of small numbers of pinnipeds (perhaps 300 ringed seals but probably fewer than 10-20 spotted and 30-50 bearded seals and small numbers [fewer than 100] walrus), polar bears (6-10 bears), and beluga and gray whales (fewer than 10), with populations recovering (recovery meaning the replacement of individuals killed as a consequence of exploration and development) within about 1 year.

The effect of a very large oil spill is expected to be fairly long term (1-2 generations, about 15 years) on pinnipeds and polar bears and short term (about 1 year) on beluga whales.

4.10.7.11.2 Additional Analysis for Marine Mammals

The introduction to Section 4.10.5 describes the approach used to extrapolate the estimated spill volume from a VLOS of 180,000 bbls discussed in MMS (2003) to 2.2 MMbbls considered in this EIS and in the following conclusions. With at least an order of magnitude increase in the volume of oil spilled in the current scenario, it can be assumed that the area impacted by such a spill and the volume persisting over time will greatly exceed that calculated by MMS (2003).

Cetaceans

Conclusions regarding potential effects of a VLOS on cetaceans in the Beaufort Sea will be addressed separately for each potentially affected species. Fin whales, humpback whales, minke whales, killer whales, harbor porpoise, and narwhals were omitted from the above MMS (2003) analysis and the following additional analyses due to their absence from or rarity in the Alaskan Beaufort Sea.

Bowhead Whale

Bowhead whales are vulnerable to oil spills in the Beaufort Sea while feeding during late summer and fall and during the westward migration across the region throughout the fall. If the spill occurs in the winter, or if oil persists in ice over winter, bowheads migrating through the lead system during the spring could be impacted.

If injury and/or mortality were to occur, it would most likely occur during the oil spill phase of a VLOS. Contact through the skin, eyes, or through inhalation and ingestion of fresh oil could result in temporary irritation or long-term endocrine or reproductive effects, depending on the duration of exposure. Multiple injuries or mortalities may result from exposure to aggregations, such as feeding aggregations, of bowhead whales during the summer or fall. The nearshore areas from Harrison Bay to Kaktovik are habitat areas of particular concern, as this is the region of highest concentration of active oil leases and an important late-summer and fall feeding, milling, and migration corridor for bowhead whales (Clarke et al. 2011b). Bowhead mothers and calves congregated in the nearshore waters of Camden Bay in disproportionate numbers in 2008 (Koski and Miller 2009) although this has not been seen in the last few years. The bowhead whale feeding “hot spot” that regularly forms during late summer and fall northeast of Point Barrow to Smith Bay is another area of high concentrations of bowhead whales that could be substantially impacted by a VLOS in the Beaufort Sea. This area is to the west of the majority of the federal leases but in close proximity to state leases in Smith Bay. Westerly winds late in the season may limit the initial movement of oil into this area, but easterly winds could do otherwise. In addition, oil persisting months to years after the initial spill either in sediments or sea ice, could have long-term ramifications on habitat quality and prey resources in these important fall feeding areas. Direct mortality of zooplankton may occur, and accumulation of toxins in the lipids of copepods could, through ingestion, bioaccumulate in bowhead whales. Bowhead whales that feed at or near the seafloor could continue to contact and ingest oil and dispersants that settled on and persist in seafloor sediments (see BOEM 2011 Section IV.E.7 in Section 4.10.6.11 of this EIS).

The entire population of Western Arctic bowhead whales passes through the Beaufort Sea at least twice each year while migrating from and to the Bering Sea and eastern Beaufort Sea and Amundson Gulf. The whales are dependent on lead systems during spring migration, which leaves them susceptible to oil entrained in sea ice that melts out the following spring. The fall migration corridor is less well defined, with some whales migrating near shore and others offshore. Those travelling farther offshore and not stopping to feed in the areas noted above may avoid contact with oil and associated clean-up activities. The remainder could encounter at least some portion of a VLOS were one to occur in the Beaufort Sea. Bowhead whales are exceedingly long-lived (150+ years [George et al. 1999]), increasing the chances of continued exposure to oil, contaminants, and clean-up activities that persist for years after an initial spill.

Based on criteria established in Section 4.1.3, the magnitude of the resulting impact from a VLOS in the Beaufort Sea could be high. The duration of effects could range from temporary (such as skin irritations or short-term displacement) to permanent (e.g. endocrine impairment or reduced reproduction) and would depend on the length of exposure and means of exposure, such as whether oil was directly ingested, the quantity ingested, and whether ingestion was indirect through prey consumption. Displacement from areas impacted by the spill due to the presence of oil and increased vessel activity is likely. If the area is an important feeding area, such as off Barrow, or along the migratory corridor, the effects may be of higher magnitude. The extent of impact could be state-wide, given the migratory nature of bowhead whales. Bowhead whales are a unique resource, as they are a centerpiece of the Iñupiat subsistence lifestyle and listed as endangered under the ESA. Population level effects are possible if a VLOS event coincided with and impacted a large feeding aggregation of bowhead whales during the open water season, particularly if calves were present. Mothers with young calves are also vulnerable to potential exposure to oil in the lead system during the spring migration. A VLOS could result in major impacts on bowhead whales.

Beluga Whale

Beluga whales from both the eastern Chukchi Sea and Beaufort Sea stocks are most vulnerable to a VLOS in the Beaufort Sea during spring and fall migrations. They are largely absent from the area during summer months. Suydam et al. (2005) found that use of the inshore waters within the Beaufort Sea OCS lease sale area was rare during that time. Most of the fall migration occurs offshore of the oil lease areas in the Beaufort Sea. The Beaufort Sea stock migrates westward in September from the eastern Beaufort Sea either far offshore of the Alaskan coastal shelf, on the shelf edge, or near the continental slope (Richard et al. 2001). Beluga whales regularly sighted during September-October surveys of the Alaska Beaufort Sea coast are distributed offshore along the shelf-break and slope areas, including in Barrow Canyon (Clarke et al. 2011b, 2011c). Under conditions of prevailing easterly winds, oil from a VLOS could disperse offshore where contact with belugas is possible. If prevailing dispersal is shoreward, most belugas could be outside of and avoid the areas of greatest impact. Oil concentrated in the spring lead system could impact the Beaufort stock as they migrate eastward during the spring through direct contact or ingestion of oil. Belugas could also be affected through secondary contamination of prey.

In accordance with criteria of Section 4.1.3 of this EIS, the magnitude of impacts on individual beluga whales could range from medium to high, depending on the extent of oil dispersal and level of injury or mortality resulting from contact. The duration of impacts could range from temporary skin irritations to permanent endocrine or reproductive failure if ingested, and the extent could be state-wide due to the migratory nature of belugas. Belugas are considered unique because of their importance as a subsistence resource. Lasting population level impacts could depend on the extent of the spill. The entire Beaufort Sea stock migrates through the Beaufort Sea twice annually and, if contact with a spill were unavoidable, a large portion of the stock could be impacted. A VLOS could have a major impact on beluga whales in the Beaufort Sea.

Gray Whale

Gray whales may be vulnerable to direct impacts from a VLOS in the Beaufort Sea if the spill extends sufficiently westward. Most summer feeding aggregations of gray whales are on the Chukchi Sea side of Point Barrow. Gray whales are observed feeding in late-summer and fall on the Beaufort Sea side of Point Barrow, although rarely east of Smith Bay (Clarke et al. 2011b, 2011c). MMS (2003) estimated a 0.5 to 6 percent chance that oil spilled in the Beaufort Sea lease area during the open water season would move sufficiently westward to contact the feeding area used by gray whales. Given that, small numbers of gray whales may encounter a VLOS, although larger aggregations will likely be outside of the impact area. Based on criteria of Section 4.1.3 of this EIS, the magnitude of impact from a VLOS on individual gray whales in the Beaufort Sea could be medium to high, depending on level of injury or mortality. Duration could range from temporary (minor skin irritations) to long-term (loss of habitat), and extend state-wide, given that gray whales migrate well beyond the Beaufort Sea to as far south as Mexico. The species is no longer listed as endangered, so it could be considered an important resource. A population level impact is unlikely, assuming oil from a VLOS in the Beaufort Sea remains within the Beaufort Sea. A VLOS in the Beaufort Sea could have a moderate to major impact on individual gray whales.

Ice Seals

The impact of a VLOS on ice seals in the Beaufort Sea may vary by habitat requirements, prey preferences, and seasonality of occurrence in the area, among other factors. Potential impacts are, therefore, discussed separately for each species. Ribbon seals are omitted from this section due to their rarity in the Beaufort Sea.

Bearded Seal

Bearded seals may occur in the Beaufort Sea year round and are commonly sighted throughout the Beaufort Sea shelf area (Clarke et al. 2011b, 2011c). They could, thus, be vulnerable to impacts from encountering fresh oil in open water and residual oil in sea ice, leads, and polynas, as well as associated VLOS clean-up activities. Direct contact with oil could result in large-scale injury or mortality events, particularly if it occurred in a polyna or lead system in which bearded seals aggregate. Bearded seals are benthic feeders and are restricted to shallow shelf areas for feeding. Damage to these areas and prey resources could cause long-term displacement and possible loss of fitness due to inadequate prey availability. Based on criteria of Section 4.1.3 of this EIS, impacts of a VLOS on bearded seals could be of medium to high intensity and of temporary to permanent duration, depending on extent of habitat loss, injury, or level of mortality. The geographic extent could be regional to state-wide, depending on how far bearded seals could be displaced or need to search for alternative habitat. Bearded seals are a unique resource in the Beaufort Sea due to their importance as a subsistence resource for coastal communities, as well as a recent proposal to list the species as threatened under the ESA. Population level impacts are possible if large portions of important benthic habitat are unavailable and if contact with a VLOS occurred in areas of high concentrations of seals, resulting in large-scale injury or mortality. A VLOS in the Beaufort Sea could have a major impact on bearded seals.

Ringed Seal

Ringed seals occur in the Beaufort Sea year round, where they are closely associated with sea ice. Ringed seals are the most commonly sighted pinniped during fall aerial surveys of the Beaufort Sea shelf and are broadly distributed across the area (Clarke et al. 2011b, 2011c). During the open water season, they spend more time in the water foraging, leaving them vulnerable to impacts of a VLOS during that time of the year. During winter and spring, they associate with shorefast ice where ice entrained oil may persist. The intensity, duration, and extent of impacts of a VLOS on ringed seals are similar to that anticipated for bearded seals (see above). Ringed seals are so are considered a unique resource because they are hunted for subsistence by Alaska Natives from communities along the coasts of the northern Bering, Chukchi, and Beaufort Seas. Population level impacts are possible if large portions of important habitat and prey are unavailable, and if contact with a VLOS occurred in areas of high concentrations of seals resulting in large scale injury or mortality. Based on criteria of Section 4.1.3 of this EIS, a VLOS in the Beaufort Sea could have a major impact on ringed seals.

Spotted Seal

Spotted seals may be vulnerable to impacts of a VLOS in the Beaufort Sea, where they are known to occur in nearshore areas and occasionally haul out. Spotted seals could be susceptible to impacts of floating oil in foraging areas in open water, oil that washes ashore in coastal areas, and the multitude of activities associated with clean-up, from boom deployment to vessels and airplanes. Displacement from important habitat areas is possible, as are direct impacts from contact with oil and dispersants. Based on criteria of Section 4.1.3 of this EIS, impacts of a VLOS on spotted seals could be of medium to high intensity and of temporary to permanent duration, depending on the extent of habitat loss, injury, or level of mortality. The geographic extent could be state-wide given the migratory behavior of spotted seals. Spotted seals are an important species for Alaskan subsistence hunters, so are considered a unique resource. Population level impacts are possible if large portions of important habitat are unavailable and if contact with a VLOS occurred in areas of high concentrations of seals. A VLOS in the Beaufort Sea could have a major impact on spotted seals.

Pacific Walrus

Pacific walrus are most susceptible to impacts of a VLOS during the summer months and can be affected at sea, on ice floes, or onshore. Walrus distribution in the Beaufort Sea is generally limited to waters north and east of Point Barrow, in the vicinity of Barrow Canyon, and only occasionally east of Smith Bay (Clarke et al. 2011b). There have been no large onshore aggregations of walrus in the Beaufort Sea as are seen along the Chukchi Sea coast. The likelihood of walrus contacting a VLOS in the Beaufort Sea is similar to that described above for gray whales. Assuming that impacts of a VLOS occurring in the Beaufort Sea remain in the Beaufort Sea, small numbers of walrus could be affected (e.g. of the 32 sightings (281 individuals) of walrus during BWASP surveys, 2006 to 2009, only three were east of Barrow Canyon [Clarke et al. 2011b, 2011c]). The larger aggregations in the Chukchi Sea will likely be outside of the impact area. Walrus that do encounter a VLOS could experience impacts associated with physical contact with the skin and membranes, inhalation of fumes, and impacts on benthic prey. Impacts of oil and dispersants on benthic prey resources (such as contamination or mortality) could have lasting impacts on prey and habitat availability for walrus in the Beaufort Sea. Based on criteria established in Section 4.1.3 of this EIS, impacts of a VLOS on individual Pacific walrus could be of medium to high intensity, duration could range from temporary displacement to long term injury or displacement from important habitat, and the geographic extent could be state-wide due to the migratory behavior of walrus. Walrus are an important subsistence species for several communities along the Bering and Chukchi Sea coasts of Alaska and the coast of Chukotka (Russia), so are considered a unique resource. Population level impacts are unlikely, unless oil disperses into the Chukchi Sea areas where large aggregations haul-out and feed. A VLOS in the Beaufort Sea could have major impacts on individual Pacific walrus.

Polar Bear

A VLOS in the Beaufort Sea could involve either the CBS or the SBS during the open-water season and the SBS stock at other times of the year, including during denning. Polar bears are vulnerable to impacts of a VLOS in the Beaufort Sea across a range of habitats and VLOS-related activities. They could directly contact oil in offshore areas during the summer open water period or the broken ice period during the fall, as it comes ashore on barrier islands and coastal regions, and experience disturbance impacts of clean-up activities originating from onshore localities. Polar bear occurrence onshore increased in recent years, likely in response to retreating ice conditions offshore (Schliebe et al. 2006). Polar bears are common in the fall near or onshore between Cape Halkett and Kaktovik (Clarke et al. 2011b, 2011c), the area that encompasses most of the active leases in the Beaufort Sea. Polar bears from the SBS stock den on both sea ice and in snow drifts on land, with an increasing percentage now denning on land (Fischbach et al. 2007). Primary terrestrial denning areas include barrier islands from Barrow to Kaktovik and coastal areas up to 25 miles inland, including ANWR to Peard Bay (Allen and Angliss 2010). Critical habitat was recently designated along the Beaufort Sea coastline that includes sea ice critical habitat, barrier islands critical habitat, and onshore denning critical habitat. Critical habitats could be impacted and suitability for use compromised by direct contamination from oil or chemical dispersants or by access being hindered by floating oil and subsequent clean-up activities (including disturbance caused by increased vessel and aircraft activity).

Based on criteria of Section 4.1.3 of this EIS, impacts of a VLOS on polar bears could be of medium to high intensity, particularly if the fur were sufficiently fouled to result in loss of insulation, if oil were ingested, or if displacement from critical habitats affected overall fitness. Duration of impacts could range from temporary displacement to permanent habitat loss, reproductive impairment, or even death. Contamination and toxic impacts from either directly consuming oil or through consuming marine mammal prey in which contaminants accumulated could be long-lasting. The geographic extent of impacts could be state-wide, given the migratory movements of bears and possible need to relocate if local habitats are severely altered. It is also possible that, if the oil discharge were widespread, denning areas on barrier islands could be impacted. Shore-based clean-up activities could lead to disturbance or displacement, including during den excavation in the fall or emergence from dens in the spring. Polar bears are considered unique due to their threatened status and importance as a subsistence resource. Population level impacts are possible and dependent on numbers of polar bears directly injured or killed, extent of habitat loss (including denning areas), and chronic long-term impacts on reproduction and survival. A VLOS could have major impacts on polar bears in the Beaufort Sea.

Kaktovik Time/Area Closure

The coastal area off Kaktovik provides habitat for a number of marine and anadromous fish, shorebirds and waterfowl, and marine mammals. MMS (2003) did not calculate the risk of a VLOS affecting Kaktovik in particular, but it did calculate the risk of oil reaching the coastline of the Arctic National Wildlife Refuge, which includes Kaktovik and lands eastward to Canada. The analysis stated that:

> *The coastline would be vulnerable to offshore spills mainly during the summer open-water period; during the rest of the year, the coastline probably would be buffered from offshore spills by the band of landfast ice. The Oil-Spill-Risk Analysis conditional probabilities for summer (Tables A.2-85 through A.2-90) indicate that the risk to the Refuge would be highest, of course, for any inshore spill in the eastern Alaskan Beaufort Sea. The specific probability that a spill from various offshore locations would contact the Refuge's coastline within 30 days is given in Table A.2-87. The table shows that the probability would be 38 percent or less from all hypothetical launch areas except one in Launch Area 18, which corresponds with the nearshore lease tracts in the eastern Alaskan Beaufort Sea. A summer spill in that area is estimated to have a 49 percent probability of contacting the Refuge's coastline within 30 days (Table A.2-87).*

Large numbers of bowhead whales move past Kaktovik from late August into October. Females with calves are common and some animals feed on concentrations of zooplankton. Several other marine mammal and bird species can be found near Kaktovik.

The primary reason this area is considered for time/area closure in this EIS is because of its importance to marine mammals and subsistence hunters from Kaktovik. The consequences of a 2.2 MMbbl VLOS impacting the waters in and around Kaktovik should be considered much greater than what was identified in the MMS (2003) 180,000 bbl VLOS analysis. No specific risk calculations were made for most of the biological components of the waters around Kaktovik but, because so many important species are migratory, impacts to them anywhere along the migration route would affect their status in this portion of the Beaufort Sea. Using more generalized analyses, the potential effects are likely to be of highest magnitude and duration on birds and marine mammals (see Sections 4.10.7.10 and 4.10.7.11). The effects on certain bird and marine mammal species, many of which are crucial for subsistence cultures, dominate the conclusion about the effects of a VLOS in this time/area closure. These effects are considered to be of high magnitude and intensity, long-term, and of state-wide geographic scope because they affect migrating birds and marine mammals. A VLOS could have major effects on the Kaktovik time/area closure according to the criteria established in Section 4.1.3.

Barrow Canyon and Adjacent Beaufort Shelf and Shelf Break Time/Area Closure

Barrow Canyon, a deep submarine canyon to the west of Point Barrow separates the shallow Beaufort and Chukchi sea shelves (Pickart and Stossmeiser 2008). The Alaskan Beaufort Sea shelf is approximately 80 km (50 mi) wide and extends approximately 500 km (311 mi) from Point Barrow to the Canadian border (Weingartner 2008). Bottom topography varies little along the shelf except for Barrow Canyon, which has steep walls and reaches depths of 200 to 250 m (656 to 820 ft). Outside and north of the barrier islands, water depths increase gradually to the shelf break approximately 64 km (40 mi) offshore (Shell 2011a). Neither MMS (2003) nor BOEM (2011) calculated the risks of a VLOS impacting Barrow Canyon and adjoining areas in particular.

Physical and oceanographic features of Barrow Canyon, coupled with favorable wind conditions promote the formation of an important recurring feeding area for bowhead whales near Point Barrow in late summer and fall. A strong shelf-break front forms along the southeastern edge of Barrow Canyon when shelf-break currents are directed onto the Beaufort shelf or along the edge of the canyon in response to weak winds. The front is absent when winds are moderate to strong from the east. The shelf-break front promotes the concentration and retention of euphausiids and copepods on the western Beaufort shelf and, consequently, a bowhead whale feeding "hotspot" (Okkonen et al. 2011).

Barrow Canyon is also an important habitat for beluga whales. During light to moderate ice years, beluga whale sightings are often highest in Barrow Canyon and offshore shelf break and slope areas (Clarke et al. 2011b, 2011c; Moore et al. 2000). Ringed, spotted, and bearded seals are also common year round, especially when ice is present. Many species of tundra-nesting seabirds, shorebirds, and waterfowl use the Barrow Canyon area, especially the nearshore areas, for feeding and staging during migration. These include ESA-listed Steller's and spectacled eiders and candidate species yellow-billed loon and Kittlitz's murrelet.

The primary reason Barrow Canyon and the adjacent seas are considered a time/area closure location in this EIS is because of their importance to marine mammals and subsistence hunters from Barrow and Wainwright. The risk of a 2.2 MMbbl VLOS impacting Barrow Canyon should be considered much greater than what was identified in the MMS (2003) 180,000 bbl VLOS analysis. No specific risk calculations were made for most of the biological components of the Barrow Canyon system but, because so many important species are migratory, impacts to them anywhere along the migration route would affect their status in Barrow Canyon. The potential effects are likely to be of highest magnitude and duration on birds and marine mammals (see Sections 4.10.7.10 and 4.10.7.11). The effects on certain bird and marine mammal species, many of which are crucial for subsistence cultures, dominate the conclusion about the effects of a VLOS on the Barrow Canyon and adjacent Beaufort Sea shelf and shelf break time/area closure, which is considered a unique resource because of its the combination of oceanographic features that concentrate biological resources and proximity to nearby subsistence cultures. These effects are considered to be of high magnitude and intensity, long-term, and of state-wide geographic scope because of impacts to migrating birds and marine mammals. A VLOS could have major effects on the Barrow Canyon and adjacent Beaufort Sea shelf and shelf break areas according to the criteria established in Section 4.1.3.

4.10.7.12 Terrestrial Mammals

4.10.7.12.1 Existing Analysis (BOEM 2011d and MMS 2003)

Section 4.4.7.1.3 of BOEM (2011e) provides an analysis of the impacts of a catastrophic discharge event on terrestrial mammals in Arctic Alaska. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that a catastrophic discharge event would result in sustained degradation of water quality, shoreline terrestrial habitats, and, to a lesser extent, air quality that could impact terrestrial mammals from direct contact, inhalation, and ingestion. These effects could be severe where persistent, heavy oil makes contact with important habitat and prey base, causing a multitude of acute and chronic effects (BOEM 2011d).

Section 4.1.2.h of MMS (2003) describes potential impacts to marine and coastal birds during a possible VLOS in the Beaufort Sea. This information is incorporated herein by reference, and a summary of that information is provided here.

The potential effect of a very large oil spill (180,000 barrels) on caribou, muskoxen, grizzly bears, and arctic foxes is likely to be limited to caribou groups occurring during the spring and during the insect relief periods in coastal waters near shorelines with extensive oil contamination. Although the oil spill is estimated to contact over 480 kilometers of shoreline and muskoxen, grizzly bears, and arctic foxes frequenting coastal areas from Pitt Point east to about the Canning River Delta, the majority of the coastline contamination would occur between Oliktok Point (Land Segment 36) east to about the Staines River delta (Land Segment 42) (Table IV.I-9c, LA12, 30 days). Caribou groups that belong to the Central Arctic, Teshekpuk Lake Herd, and Porcupine herds are the assemblages of caribou likely to encounter oil while in coastal waters or on the beaches.

Heavily oiled caribou might die from absorption and/or inhalation of toxic hydrocarbons. Several hundred caribou of the Central Arctic, Teshekpuk Lake, and Porcupine herds could die from the oil spill.

Small numbers of muskoxen, grizzly bears, and arctic foxes may encounter oil and be adversely affected. Potential losses would represent a short-term effect, with populations recovering within about one year.

The effects of a very large oil spill on caribou, muskoxen, grizzly bears, and arctic foxes are expected to be short term (recovery expected within about one year).

4.10.7.12.2 Additional Analysis for Terrestrial Mammals

There are approximately 30 species of terrestrial mammals within the vicinity of the EIS project area (Table 3.2-5). Among these species, it is expected that only barrenground caribou (*Rangifer tarandus granti*) may experience interactions with oil and gas exploration activities during critical periods of their life cycle; therefore, this analysis will focus solely on caribou. Descriptions of distribution, life cycle, and habitat characteristics of other species are not included in this EIS.

The oil spill discussion in MMS (2003) analyzed the effects of an oil spill of 180,000 bbl, and for the purposes of this EIS, a VLOS of 2.2 MMbbl occurring over a 74 day period is considered. Although the impacts to caribou would be similar regardless of the size of the spill, the magnitude, duration, and extent would be substantially greater with a larger spill.

The effects of a VLOS would be of medium intensity, temporary duration, local extent and common context because while there is a perceptible change to the caribou population, it is likely to be temporary, with a localized impact, and the caribou population can recover within one to two years even with a loss of several thousand animals (BOEM 2011b). For more information regarding the impact to subsistence or recreational hunting, see Sections 4.10.7.15 and 4.10.7.20, respectively. Utilizing the impact criteria listed in Section 4.1.3, a summary impact level of minor to moderate would result for caribou, depending on the magnitude and duration of the VLOS.

4.10.7.13 Time/Area Closures

A low probability, high impact VLOS could affect marine mammals and marine and coastal birds in time/area closure locations in the Beaufort Sea. Discussion of impacts to marine mammals in the waters off Kaktovik and Barrow Canyon and Adjacent Beaufort Shelf and Shelf Break can be found in Section 4.10.7.11 and impacts to marine and coastal birds can be found in Section 4.10.6.10.

4.10.7.14 Socioeconomics

4.10.7.14.1 Existing Analysis (BOEM 2011d)

Section 4.4.13.3.2 of BOEM (2011e) provides an analysis of the impacts of a catastrophic discharge event on sociocultural systems in the Alaska Arctic regions. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that a catastrophic discharge event could employ local villagers during the cleanup, it is likely that many additional workers would be necessary, placing stress on village facilities. An influx of outsiders is likely to result in some cultural conflict, stressing the local sociocultural systems. As is evident from the EVOS, such cleanup efforts can be disruptive socially, psychologically, and economically for an extended period of time (BOEM 2011d).

4.10.7.14.2 Additional Analysis for Socioeconomics

The MMS (2003) estimate of employment associated with oil spill clean-up activities was based on the most relevant historical experience of an oil spill in Alaskan waters, the EVOS of 1989. That spill was 240,000 bbls, while the Beaufort Sea VLOS described in this hypothetical VLOS scenario, would be 2.2 MMbbls. The socioeconomic effects described in MMS (2003) would be more intense due to the larger quantities of oil reaching the shore, the larger magnitude of the spill, and the longer duration of clean-up effort. The BOEM (2011) analysis described in Section 4.10.6.14 contains estimates that relate to an event in the Chukchi Sea, but are relevant to a scenario in the Beaufort Sea as well.

Public Revenue & Expenditures

Under a VLOS, there would be loss of future federal and state revenues due to a potential moratorium on future oil and gas production, or other disruptions. A Natural Resource Damage Assessment conducted by NOAA would determine compensation for natural resource service values. Local revenues would be generated in the communities staging clean-up response through the sale of goods and services to workers. NSB would receive property taxes if an enclave were developed to house the clean-up equipment and workers.

Employment & Personal Income

The MMS (2003) analysis provides an estimate for the number of workers needed for spill clean-up, but the VLOS scenario in the Beaufort Sea would be for a larger spill, thereby increasing the estimate for numbers of workers by an order of magnitude. The number of cleanup workers needed is unknown but the VLOS could induce some local employment.

The purchase of goods and services stemming from the disposable income of clean-up workers would have a positive, though short-term local economic impact. MMS (2003) and BOEM (2011) describe that after EVOS, numerous local residents quit their jobs to work on the cleanup, often accepting positions with considerably higher wages. This generated a sudden and substantial inflation in the local economy, a short to long-term economic impact. Economic impacts would be smaller for NSB than those that occurred during EVOS due to the likelihood that cleanup activities, including administrative personnel and spill-cleanup workers, would be located in Prudhoe Bay's existing enclave-support facilities (Cohen 1993:261 in BOEM 2011b).

Other major impacts related to the long-term disruption of the non-cash/subsistence economy are described in the Environmental Justice Section 4.10.6.22 and Public Health Section 4.10.6.16. The BOEM (2011b) analysis does not detail the level and extent of disaster funding to temporarily replace subsistence activity, but it mentions the redirection from subsistence activities to cash activities.

Demographic Characteristics

New oil spill clean-up employment opportunities described in MMS (2003) are not likely to cause a permanent demographic shift. The potential for outmigration due to the disruption of the subsistence activities is not analyzed in the BOEM (2011) analysis.

Social Organizations & Institutions

The influx of clean-up workers would create a long-term demand on institutions and social services in Barrow. Regional and local non-profit organizations that mediate between industry and subsistence users and social organizations would be impacted. BOMRE (2011) describes requests for temporary assistance from various institutions.

Private companies and regional corporations may be positively impacted in the short-term through the sale of goods and services to spill response companies.

Conclusion

Employment and local revenues associated with VLOS clean-up in the Beaufort Sea would be high intensity, long-term in duration, regional to national in extent, and unique and important in context. The impact to the non-monetary economy is discussed in detail in Section 4.10.7.15 (Subsistence), and are summarized as major negative impacts (classified as high intensity, long-term to permanent in duration (lasting more than five years), regional to statewide in extent because it would affect local and Alaskan residents, workers and businesses, and unique and important in context). Therefore, the summary impact level to socioeconomics would be major according to the direct and indirect impacts criteria established in Section 4.1.3.

4.10.7.15 Subsistence

4.10.7.15.1 Existing Analysis (BOEM 2011d)

Section 4.4.13.3.2 of BOEM (2011e) provides some information about the impacts of a catastrophic discharge event on subsistence harvest in the Alaska Arctic regions. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that as the result of a catastrophic discharge event, the economically, socially, and culturally important bowhead whale hunt could be disrupted, as could the beluga harvest. Animals could be directly oiled, or oil could contaminate the ice floes or onshore haulouts they use on their northern migration. Such animals could be more difficult to hunt because of the physical conditions. Animals could be spooked and/or wary, either because use of the spill itself or because of the hazing of marine mammals, which is a standard spill-response technique in order to encourage them to leave the area affected by a spill. Oiled animals are likely to be considered tainted by subsistence hunters and would not be harvested, as occurred after the EVOS. This would also apply to terrestrial animals, such as bears that scavenge oiled birds and animals along the shore, or caribou that seasonally spend time along the shore or on barrier islands seeking relief from insects. The loss of subsistence harvest resources, particularly marine mammals, would have significant effects on Alaska native culture and society (BOEM 2011d).

4.10.7.15.2 Additional Analysis for Subsistence Resources

Based on the criteria of Section 4.1.3 of this EIS, the intensity of the VLOS on subsistence resources and subsistence harvest in the Beaufort would be of high intensity and cause a year round change in subsistence use patterns. Subsistence harvests of marine mammals, fish, migratory birds, and caribou that occurs in or along the coastlines and lagoons would be affected by oiling and fouling and by the presence of the response equipment and personnel. Subsistence harvests could be altered long-term to permanent in duration. The perception that food is tainted and/or contaminated could be long-lasting or permanent among the Iñupiat communities of the Beaufort Sea (see Section 4.10.7.16, Public Health of this EIS). As observed after EVOS, the interruption of two to three years of training youth in subsistence harvest practices changed the balance of the subsistence economy for a period persisting well beyond the spill itself.

Impacts to subsistence harvests and sharing of resources would be regional to state-wide and may extend throughout the EIS project area and impact the non-wage regional economy of the communities of the Beaufort and Chukchi seas (Section 4.10.7.14, Socioeconomics of this EIS). Impacts from a VLOS to subsistence harvest of ESA protected bowhead whales and polar bears are considered unique in context. Impacts from a VLOS to subsistence harvest of beluga whales, seals, walrus, fish, birds, and caribou are considered important in context.

The impacts of a VLOS in the Beaufort Sea would be high intensity, long-term to permanent in duration, regional to statewide in extent, and affecting resources that are unique and important in context. In summary, the impact of a VLOS on subsistence harvest would be major.

4.10.7.16 Public Health

4.10.7.16.1 Existing Analysis (BOEM 2011d)

Section 4.3.2.4.2 of BOEM (2011e) provides some information about the impacts of a catastrophic discharge event on public health in the Alaska Arctic regions. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that major areas of concern related to a catastrophic discharge event would include impacts on subsistence resources, air quality, and oil spill cleanup (BOEM 2011d).

4.10.7.16.2 Additional Analysis for Public Health

The effects on public health associated with a VLOS in the Beaufort Sea are anticipated to be similar to those associated with a VLOS in the Chukchi Sea. The overall effects could range from moderate to major depending on the size, nature and location of the spill.

4.10.7.17 Cultural Resources

4.10.7.17.1 Existing Analysis (BOEM 2011d)

Section 4.4.15.3.2 of BOEM (2011e) provides some information about the impacts of a catastrophic discharge event on archaeological resources in Alaska Arctic regions. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that a catastrophic discharge event could result in extensive impacts on a large number of archaeological and historic resources. Due to the large area affected by a catastrophic event some resources such as coastal historic sites that are sensitive to prolonged contact with oil could be heavily impacted. Cleanup crews would be needed in a greater number of locations. This could allow oil to be in contact with resources for a significant amount of time before cleanup efforts could be applied, which could result in impacts to these resources. A greater threat to archaeological and historic resources during a catastrophic discharge event would result from the larger number of response crews being employed. A catastrophic discharge event would result in large impacts to numerous archaeological and historic resources from response activities (BOEM 2011d).

4.10.7.17.2 Additional Analysis for Cultural Resources

This section describes potential impacts to both offshore and onshore prehistoric and historic resources from a VLOS event in the Beaufort Sea.

Given the limited data related to historic and prehistoric resources in the Beaufort Sea area, it is difficult to determine how many historic properties might be located in areas affected by a VLOS event. The presence of oil and the various oil-spill response and cleanup activities could potentially impact both prehistoric and historic archaeological 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 Prehistoric and Historic Resources

In the event of a VLOS, submerged prehistoric and historic resources adjacent to a blowout could be damaged by the high volume of escaping gas, buried by large amounts of dispersed sediments, crushed by the sinking of the rig or platform, destroyed during relief well drilling, or contaminated by hydrocarbons (BOEM 2011b). Oil settling to the seafloor could contaminate organic materials associated with archaeological sites, resulting in erroneous dates from standard radiometric dating techniques (e.g. 14C-dating), and accelerate the deterioration of wooden shipwrecks and artifacts on the seafloor (BOEM 2011b). However, offshore resources are at greatest risk from bottom-disturbing activities, notably anchoring and anchor dragging. The potential to impact archaeological resources increases as the density of anchoring activities in these areas increases (BOEM 2011b). The anchoring of VLOS response and support vessels near a blowout site and in shallow water could result in damage to both known and undiscovered archaeological sites.

Onshore Prehistoric and Historic Resources

The greatest impacts on archaeological resources from a VLOS would be to onshore archaeological sites from oil-spill-cleanup activities. Cleanup activities could impact beached shipwrecks, or shipwrecks in shallow waters, and coastal historic and prehistoric archaeological sites. Any onshore activity (cleanup or otherwise) that brings development in contact with remote areas has the potential to expose archaeological resources to disturbance from construction or from vandalism. Historic sites, such as hunting, fishing, and whaling camps, or structures associated with settlements or the World War II and Cold War era Navy, Air Force, and Army facilities could be affected by increased cleanup activity in remote areas and increased vandalism. Prehistoric sites, though often not as visible as historic sites, also might be subjected to increased vandalism, as well (MMS 2007a, 2009; BLM, 2008). As Bittner (1993) described in her summary of the 1989 EVOS:

> *Damage assessment revealed no contamination of the sites by oil, but considerable damage resulted from vandalism associated with cleanup activities, and lesser amounts were caused by the cleanup process itself* (MMS 2007a, 2009).

4.10.7.18 Land and Water Ownership, Use, and Management

4.10.7.18.1 Existing Analysis (BOEM 2011d)

Section 4.4.10.3.2 of BOEM (2011e) provides an analysis of the impacts of a catastrophic discharge event on land use, development patterns, and infrastructure in the Alaskan Arctic. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that a catastrophic discharge event could have both direct and indirect effects on land use, depending on the type, size, location, and duration of the incident. Impacts generally would be more intense in areas with little infrastructure in place to handle accidents and where a greater reliance is placed on coastal activities for subsistence (BOEM 2011d). The Alaska Coastal Management Program was not reauthorized by the Alaska Legislature and is not in effect at this time.

4.10.7.18.2 Additional Analysis for Land and Water Ownership, Use, and Management

An oil spill that reaches the Beaufort Sea coastline has the potential to affect land use and management. In addition, activities associated with oil spill response and clean-up also have the potential to affect land use and management. The following analysis provides a discussion of these potential affects. Impacts to land and water ownership, use, and management related to a VLOS event in the Beaufort Sea would be similar to those occurring in the Chukchi Sea, the only difference being that existing leases in the Beaufort Sea lie closer to shore, making the likelihood of oil contacting the coastline more likely. Taking this into account, the impacts discussed in Section 4.10.6.18 for the Chukchi Sea are applicable to the Beaufort Sea as well.

Land and Water Ownership

Because the response efforts to a VLOS would not require any change in existing leasing rights, or the sale or transfer of any federal, state, or native land or waters, no change in underlying land or water ownership would be anticipated in the Beaufort Sea.

Land and Water Use

A spill of this magnitude in the Beaufort Sea would impact some land uses. Should an oil spill result in oil accumulating along the shoreline and in tidal zones, the presence of oil could affect existing land uses by making it difficult to access land, creating a real or perceived change the resources and values that support specific land uses, and discouraging pursuit of traditional land use in areas affected by a spill. Examples of these include subsistence, other traditional land uses, and recreation.

Industrial land may experience increased usage to support additional vessels, aircraft, vehicles and materials used in responding to a VLOS. This could require the construction or expansion of docks, warehouses, airstrips and/or storage facilities. It is unlikely that new permanent facilities would be constructed for spill response. Response support crews would need to be housed, affecting residential land uses. This could be accommodated through the construction of temporary worker camps, most likely in the vicinity of Prudhoe Bay or in the villages of Kaktovik, Nuiqsut and Barrow. Depending on the location of industrial and commercial lands in the immediate vicinity of spill response activities, some temporary industrial land use may occur in new areas. Remote lands currently designated for natural resource protection might experience increased levels of human activity or disturbance for habitat restoration along shorelines where oil may accumulate. This would have similar effects to those discussed above, regarding access, damage to land and resource values, and interest in using the area. The duration of potential effects on land use would depend on the amount of oil that reaches shoreline and intertidal areas, the nature and duration of response activities, and the success in cleanup and restoration activities.

For a discussion of the impacts from a VLOS event in the Beaufort Sea, see Section 4.10.7.15 (Subsistence) and Section 4.10.7.20 (Recreation).

Land and Water Management

Current management plans do not include contingencies for a VLOS. It is assumed that in the event of a VLOS, federal and state management plans that include coastal areas may require additional approvals for response and cleanup activities to accommodate heightened levels of human access for habitat restoration and oil cleanup efforts. Federal and state waters would be managed in the short term with an intense focus on response and clean-up of oil. Any management plan policies that are modified for a VLOS event would most likely be temporary, but could lead to plan updates to address any potential change in land and resource values, actions needed to promote recovery of affected resources, or address the potential for response activities in the unlikely event that they are needed.

Conclusion

Based on Table 4.4-2 and the analysis provided above, the impacts of land and water use caused by a VLOS are described as follows. The magnitude of impact would be low for land and water ownership because no change would be expected. The magnitude of impact would be high for land and water use for areas affected by a spill that have seen historical or current use for subsistence, other traditional land uses, and recreation, due to the potential change in resource/use values, and the level of activity associated with spill response and cleanup. The magnitude of impact would be medium for land and water management if management plans must result in new approvals to accommodate response efforts or a spill results in a change in resource or land values. The duration of impact would be long term because response efforts may extend up to several years, although the impact could be permanent if in the unlikely event construction of a new facility or infrastructure to accommodate spill response activities. The extent of impacts would be regional because the spill would affect large expanses of water and has the potential to come into contact with land along an extensive area of shoreline in and near the project area. The context of impact would generally be common because the areas of land and water affected are extensively available, unless some special, rare, or unique characteristics associated with specific subsistence and recreation areas are affected. In summary, the effects of a VLOS would be major due to the possibility for high intensity and long term impact to land use and land management.

4.10.7.19 Transportation

4.10.7.19.1 Existing Analysis (BOEM 2011d)

The BOEM (2011e) analysis did not specifically analyze impacts to transportation associated with an oil spill scenario.

4.10.7.19.2 Additional Analysis for Transportation

Setting

The transportation systems among the communities of Kaktovik, Nuiqsut and Barrow and the Prudhoe Bay area would experience increased levels of air, vessel and surface traffic associated with containment, recovery, and cleanup activities for a VLOS that would involve hundreds of workers and vessels, aircraft, and onshore vehicles operating over an extensive area for one to two years. In the event of a VLOS, vessels such as skimmers, workboats, barges and icebreakers involved with cleanup would be used to remove oil from a spill area that occurs at sea and to drill a new well. Aircraft (fixed wing) would also likely be engaged in application of dispersants. Equipment involved with clean up and response would vary based on seasonal conditions as described in Section 4.10.6.19. In the event that response efforts continue into the winter season, small vessel traffic would come to a halt once the forming ice begins to cover the ocean surface. Larger skimming vessels could continue until conditions prevent oil from flowing into the skimmers. Small boats and aircraft would also be involved with beach cleaning activities at oiled beaches (including booming) at marine and freshwater shorelines.

In addition aircraft could be used to apply dispersants used to decrease the size of the oil slick. Additional aircraft would also be used for transporting response personnel and equipment, including helicopters, small piston-powered aircraft, and large commercial jets affecting these communities. Aircraft could also be used to map the extent of an oil spill and for surveillance. Surface vehicles would also be used during response operations onshore.

Activities

Local modes of transportation between communities by aircraft, vessels and surface means would be affected by a VLOS in nearshore and coastal areas. Impacts to the transportation system along the Beaufort Sea coast would be similar as discussed for the Chukchi Sea (Section 4.10.6.19). In the event of a VLOS response, additional equipment would likely be delivered to the Prudhoe Bay area via surface transportation on the Dalton Highway. Air traffic to Deadhorse/Prudhoe Bay would increase from Anchorage and air traffic between the communities of Kaktovik, Nuiqsut and Barrow would increase in the event of a VLOS. The airport at Deadhorse/Prudhoe Bay could be a logistical center for distributing incoming responders and equipment to the airports at Barrow, Nuiqsut and Kaktovik. During the initial response phase the spill equipment that is already staged at local communities would be rapidly deployed via aircraft and support vessels. As response efforts continue the levels of air traffic to the areas affected of the Beaufort Sea would increase in the numbers of flights arriving as additional response crews and supplies are transported into the affected area. In the event of a VLOS air transportation within Alaska could also be indirectly affected as higher demand would occur for air travel to the spill area connecting from the Anchorage and Fairbanks airports. The increased levels of aircraft associated with spill response would affect local transportation systems for the duration of the response to a VLOS. Use of local airports associated with spill response activities (resupply, transport of spill response crews and equipment) could strain the local and regional air transportation infrastructure.

Vessels and equipment associated with response would be present in increased numbers in the nearshore areas. Prudhoe Bay and spill response facilities at West Dock near Prudhoe Bay would be expected to experience high levels of activity as potential areas where response vessels and equipment would be staged and refuel. It is likely that local tug/barge and small vessel traffic between communities would be affected during the spill due to the increased numbers of response and support vessels present in nearshore areas. Increased levels of response and support vessels associated with spill response would affect local transportation systems for the duration of the response to a VLOS. Local nearshore areas normally used for marine transportation between communities would experience and encounter vessels associated with spill response activities. This could strain the local patterns of existing marine transportation. It is likely that in response to a VLOS there would be impairment of normal operations with deployment of response workers, vessels and equipment affecting the exiting levels of transportation along the coastline of the Beaufort Sea communities. In addition skiffs and small vessels used locally in nearshore waters may be come oiled. Skiffs and small vessels used locally in nearshore waters may be come oiled.

Surface transportation in the summer months could also be interrupted in the event of a VLOS that reaches the nearshore areas and coastlines. Local modes of surface transportation, including four wheelers/off road vehicles, used by residents during subsistence activities along the coasts may also become oiled.

The effects and impacts of aircraft and vessels disturbance caused during response to a VLOS to seabirds, marine mammals and terrestrial mammals is described in Sections 4.10.7.10 through 4.10.7.12 and the affects to subsistence hunters is described in Section 4.10.7.15.

Conclusion

The conclusions for impacts to transportation in the Beaufort Sea would be of high intensity (potentially year round), and long term in duration lasting one to two years or more during response and surveillance monitoring during recovery. The extent would be regional to state-wide, and important in context. In summary, the impact of a VLOS on transportation would be moderate to major.

4.10.7.20 Recreation and Tourism

4.10.7.20.1 Existing Analysis (BOEM 2011d)

Section 4.4.12.3.2 of BOEM (2011e) provides an analysis of the impacts of a catastrophic discharge event on recreation and tourism in the Beaufort Sea planning area. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that effects from a catastrophic discharge event would likely include beach and coastal access restrictions, including restrictions on visitation, fishing, or hunting while cleanup is being conducted, and aesthetic impacts associated with the event itself and with cleanup activities. These impacts are expected to be temporary, with the magnitude dependent on the location and size of the event and the effectiveness of cleanup operations. Longer-term impacts may also be substantial if tourism were to suffer as a result of the real or perceived impacts of the event, or if there were substantial changes to tourism and recreation sectors in the region as a result of the event (BOEM 2011d).

4.10.7.20.2 Additional Analysis for Recreation and Tourism

Impacts to the recreation setting and activities in the Beaufort Sea would be similar as discussed for the Chukchi Sea (Section 4.10.6.20), except impacts to the setting of the Beaufort Sea would be magnified along the coast of the Arctic National Wildlife Refuge (ANWR) due to the sensitivity of visitors to that area. Visitors to ANWR are expecting an isolated and undeveloped setting here more than the rest of the Beaufort Sea because the area is managed to maintain wilderness characteristics and there is no oil and gas exploration or drilling activities in the coastal area. The area is perceived as an undeveloped setting for recreation with a high sensitivity to impacts to wilderness characteristics. Even though recreation opportunities across the Beaufort Sea are not scarce and not protected by legislation, the potential to impact recreation settings and activities in a National Wildlife Refuge that is managed to maintain wilderness characteristics, the context is considered unique.

Conclusion

The conclusions for impacts to recreation and tourism discussed earlier for the Chukchi Sea are also applicable to the Beaufort Sea. The impacts would be high intensity, long term duration, regional to state-wide extent, and unique in context. In summary, the impact of a VLOS on recreation and tourism would be major.

4.10.7.21 Visual Resources

4.10.7.21.1 Existing Analysis (BOEM 2011d)

No analysis of impacts specific to visual resources is presented in the BOEM (2011e) document.

4.10.7.21.2 Additional Analysis for Visual Resources

Based on the scenario described in the spectacled and Steller's Eider, and the Vegetation and Wetland Habitat sections of the MMS (2003) analysis, a VLOS event is expected to temporarily impact scenic quality and visual resources within the Beaufort Sea. The behavior, and hence visibility, of released oil is expected to change depending on the presence and condition of ice. The magnitude and extent of direct impacts expected to scenic quality and visual resources is also expected to change based on the presence and condition of ice. For example, a spill that occurred on solid ice is not expected to enter the water. In such a scenario, the magnitude of impacts to scenic quality and visual resources is expected to be high; however impacts are expected to be of short duration and local extent. In contrast, should a VLOS scenario occur during open water, the intensity of impacts is expected to remain high; however the extent of impacts could be of regional extent due to the lack of containment of oil by ice. Additional direct impacts are expected to result from the perceptible change in the level of marine vessel and air traffic due to response and clean-up efforts. In all cases, indirect effects, including psychological/social distress among viewers, is expected to occur from witnessing oil slicks on the surface of near- or on-shore areas either in person or through media outlets. As in the analysis of the Chukchi VLOS scenario, both local and off-site viewers in the Beaufort Sea are expected to be sensitive to potential affects to scenic quality and visual resources.

The scenario described above is based on an 180,000 bbl VLOS. The magnitude, extent, and duration of impacts to scenic quality and visual resources are expected to be larger for a larger spill, such as that described for a 2.2 MMbbl VLOS. Should a 2.2 MMbbl VLOS scenario occur in the Beaufort Sea, similar impacts are expected to result from Phases 1 and 5 of the oil spill and cleanup scenario as that described in Section 4.10.6.21. The greatest change would likely be observed in the magnitude, duration, and extent of impacts to shoreline and on-land areas.

Conclusion

In conclusion, major direct and indirect impacts to visual resources are expected to result from a VLOS scenario. Impacts would be of high intensity, short- to long-term in duration, regional to state-wide in geographic extent, and would affect an important resource.

4.10.7.22 Environmental Justice

4.10.7.22.1 Existing Analysis (BOEM 2011d)

Section 4.4.14.3.2 of BOEM (2011e) provides some information about the impacts of a catastrophic discharge event on environmental justice in Alaska Arctic communities. This information is incorporated herein by reference, and a summary of the information is provided. The analysis concludes that many of the long-term impacts of a catastrophic discharge event on low-income and minority communities are unknown. Different cultural groups would likely possess varying capacities to cope with catastrophic events, with some low-income and/or minority groups more reliant on subsistence resources and/or less equipped to substitute contaminated or inaccessible subsistence resources with those purchased in the marketplace. Because lower income and/or minority communities may live near and be directly involved with catastrophic discharge event cleanup efforts, the vectors of exposure can be higher for them than for the general population, increasing the potential risks of long-term health effects (BOEM 2011d).

4.10.7.22.2 Additional Analysis for Environmental Justice

The above text recognizes that Iñupiat Alaska Natives are the predominant residents of the affected area and a VLOS would affect subsistence resources and harvest practices, therefore having disproportionately high adverse effects.

For a description of the character and intensity of impacts to subsistence resources and harvests and human health, the reader should also refer to the Subsistence (Section 4.10.7.15) and Public Health (Section 4.10.7.16) discussions in this EIS.

MMS (2003) states that potential effects to subsistence resources and subsistence harvests could be mitigated to some extent. The BOEM (2011e) Environmental Justice analysis is more specific about mitigation techniques and limitations, but concludes that there are "significant and perhaps irrevocable adverse impacts."

Conclusion

The impacts to subsistence foods and human health in the Iñupiat subsistence-oriented communities of Kaktovik, Nuiqsut and Barrow would be high intensity, long-term in duration, regional in extent, and unique in context. Therefore the summary impact level for environmental justice is major; there would be a disproportionate adverse effect to minority populations.

4.11 Cumulative Effects

An EIS must include an analysis of the potential cumulative effects of a proposed action and its alternatives and consider those cumulative effects when determining environmental impacts. The analysis of cumulative effects in this EIS employs the definition of cumulative impacts found in the CEQ regulations (40 CFR 1508.7 and 1508.25(a)(2)):

> *Cumulative impact is the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.*
>
> *To determine the scope of environmental impact statements, agencies shall consider…cumulative actions, which when viewed with other proposed actions have cumulatively significant impacts and should therefore be discussed in the same impact statement.*

Cumulative effects are assessed by aggregating the potential direct and indirect effects of the proposed action with the impacts of past, present, and reasonably foreseeable future actions in the vicinity of the project. The ultimate goal of identifying potential cumulative effects is to provide for informed decisions that consider the total effects (direct, indirect, and cumulative) of the project alternatives. As suggested by the CEQ handbook *Considering Cumulative Effects Under the National Environmental Policy Act* (1997), the following basic types of cumulative effects are also considered:

- additive – the sum total impact resulting from more than one action;
- countervailing – adverse impacts that are offset by beneficial impacts; and
- synergistic – when the total impact is greater than the sum of the effects taken independently.

Cumulative effects may result from the incremental accumulation of similar effects or the synergistic interaction of different effects. Repeated actions may cause effects to build up over time, or different actions may produce effects that interact to produce cumulative impacts greater than (or less than) the sum of the effects of the individual actions.

As directed by CEQ's NEPA regulations (40 CFR 1502.16), direct and indirect impacts on specific physical, biological, and social resources are discussed in combination with varying levels of effects, ranging from negligible to major. The cumulative effects analysis focuses on impacts to long-term productivity and sustainability of valued ecosystem components.

4.11.1 Methodology for Identifying Cumulative Impacts

The methodology used for cumulative effects analysis in this EIS consists of the following steps:

- *Identify issues, characteristics, and trends within the affected environment that are relevant to assessing cumulative effects of the action alternatives.* Include discussions on lingering effects from past activities, and demonstrate how they have contributed to the baseline condition for each resource. This information is summarized in Chapter 3.
- *Describe the potential direct and indirect effects of oil and gas exploration activities.* This information is presented in detail in Sections 4.4 to 4.9 of this EIS.
- *Define the spatial (geographic) and temporal (time) frame for the analysis.* This timeframe may vary between resources depending on the historical data available and the relevance of past events to the current baseline.
- *Identify past, present, and reasonably foreseeable external actions such as other types of human activities and natural phenomena that could have additive or synergistic effects.* Summarize past and present actions, within the defined temporal and spatial timeframes, and also identify any reasonably foreseeable future actions (RFFAs) that could have additive, countervailing, or synergistic effects on identified resources.
- *Use specific methodology to screen all of the direct and indirect effects, when combined with the effects of external actions, to capture those synergistic and incremental effects that are potentially cumulative in nature.* Both adverse and beneficial effects of external factors are assessed and then evaluated in combination with the direct and indirect effects for each alternative on the various resources to determine if there are cumulative effects.
- *Evaluate the impact of the potential cumulative effects using the criteria established for direct and indirect effects, and assess the relative contribution of the action alternatives to cumulative effects.*
- *Discuss rationale for determining the impact rating, citing evidence from the peer-reviewed literature, and quantitative information where available.* The term "unknown" can be used where there is not enough information to determine an impact level, and the information cannot be readily obtained in a timely or cost effective manner. However, under CEQ guidelines, the effect of missing information on the decision to be made must be addressed in the EIS.

The advantages of this approach are that it closely follows CEQ guidance, employs an orderly and explicit procedure, and provides the reader with the information necessary to make an informed and independent judgment concerning the validity of the conclusions.

4.11.2 Past, Present, and Reasonably Foreseeable Future Actions

Relevant past and present actions are those that have influenced the current condition of the resource. For the purposes of this EIS, past and present actions include both human-controlled events, such as subsistence harvest and commercial whaling, and natural events, such as climate change. The past and present actions applicable to the cumulative effect analysis have been either presented in Chapter 3, or are discussed below. Additional past actions were identified using agency documentation, NEPA documentation, reports and resource studies, peer-reviewed literature, and best professional judgment. Table 4.11-1 lists a summary of relevant past and present actions.

Past, present, and RFFAs and activities considered for the cumulative effects analysis include: oil and gas exploration, development, and production activities; scientific research; mining exploration, development, and production; military facilities and training exercises; air and marine transportation; major community development projects; subsistence activities; recreation and tourism; and climate change. Commercial whaling in the late 19th century is also a past effect specific to bowhead whales that still influences population levels.

Recent environmental reports, lease sale documents, surveys, research plans, NEPA compliance documents, and other source documents have been evaluated to identify these actions. RFFAs were assessed to determine if they were speculative and would occur within the analytical timeframe of the EIS. Some specific assumptions include:

- Oil and gas exploration activities identified within this time frame cannot be foreseeably expected to result in discovery and production, primarily due to commercial uncertainty and regulatory timeframes.
- Potential oil and gas activities in the Canadian and Russian offshore Arctic were also researched and assessed if deemed applicable, given the potential to influence migratory marine mammal populations. Publically available information on the specific timing and nature of these activities is limited;
- Present oil and gas production activities are expected to continue at current levels, with the potential to contribute to cumulative effects through actions associated with both production and resupply;
- Mining activities occur primarily onshore but may involve air and marine support activities;
- Military activities with the potential to result in synergistic and additive effects include major construction or demolition projects and major training exercises;
- Community development activities with the potential to result in synergistic and additive effects include major construction projects such as the Kaktovik Airport and annual sealift resupply for fuel and commercial goods;
- Subsistence activities are evaluated primarily for their cumulative effect on populations of wildlife, such as fish and marine mammals.

Past, present and future actions for consideration in the cumulative impacts analysis are listed below. For the purposes of this EIS, present actions are those that are ongoing and have activities that contribute to potential cumulative effects. Future actions are those that are reasonably foreseeable within the next five to ten years. General categories of past, present and RFFAs are summarized in Table 4.11-1. For each of the general categories, a second set of detailed tables has been developed listing specific actions/activities that will be taken into consideration (Tables 4.11-2 through 4.11-10). Figures 4.1 and 4.2 show general locations of relevant past, present, and future actions for the Beaufort and Chukchi seas.

Table 4.11-1 General Categories of Relevant Past, Present, and Reasonably Foreseeable Future Actions

Category	Area	Type of Action
Oil and Gas Exploration, Development and Production	Offshore Waters[1] (Beaufort and Chukchi seas) Onshore North Slope (Beaufort Sea) Nearshore waters[2] (Beaufort Sea) Canadian Arctic Russian Chukchi Sea	Seismic surveys Coastal/nearshore ice roads Construction Maintenance Exploratory drilling Production Transportation (pipelines, aircraft, marine, ice roads)
Scientific Research	Nearshore waters (Beaufort and Chukchi seas) Offshore waters (Beaufort and Chukchi seas) Onshore North Slope	Oceanographic surveys Biological surveys Geophysical surveys
Mining	Western Brooks Range/foothills (Chukchi Sea) Red Dog/Red Dog Port (Chukchi Sea)	Coal mining Minerals mining

Category	Area	Type of Action
Military	Various coastal sites (Northwest Alaska, Gulf of Alaska, North Slope) Offshore waters (Beaufort and Chukchi seas)	DEW Line Sites USCG Icebreaker presence Aircraft overflights Submarine traffic
Transportation (separate from oil and gas, mining)	Marine (Beaufort and Chukchi seas) Onshore North Slope	Marine vessel traffic Roads and vehicular traffic Aircraft traffic Utility pipelines
Community Development Projects	North Slope Borough Northwest Arctic Borough	Village expansions Water and sewage projects Airport construction/improvements
Subsistence Activities	Kaktovik, Nuiqsut, Barrow, Wainwright, Point Lay, Point Hope, Kivalina, Kotzebue, and adjacent areas (offshore Beafort, Chukchi Seas, onshore)	Hunting (e.g. caribou, birds) Fishing Trapping Whaling Sealing Traveling
Recreation and Tourism	Arctic National Wildlife Refuge Various locations (Beaufort and Chukchi seas)	Wildlife viewing Sport/commercial hunting and fishing Recreation activities Cruise ships and commercial vessels
Commercial Whaling	Range of bowhead whales	Commercial harvest and mortality
Climate Change	Global	Changes in temperature, ice conditions, ocean circulation patterns, and other atmospheric, cryosperic, and coean processes
Persistent Contaminants	Offshore waters (Beaufort and Chukchi seas) Nearshore waters (Beaufort and Chukchi seas) Shoreline (Beaufort and Chukchi seas)	Accumulation of contaminants from multiple sources that have the potential for impact to wildlife (including benthos), and contamination of subsistence resources with human health implications

1 – Offshore waters are consideral federal waters for the purpose of this analysis

2 – Nearshore waters are consideral state waters for the purpose of this analysis

4.11.2.1 Oil and Gas Exploration, Development and Production

4.11.2.1.1 Existing Oil and Gas Production and Pipeline Facilities

Oil and gas development is the main agent of industrial-related change within the EIS project area. There are a number of other past, present, and ongoing oil and gas projects that contributed to past and present cumulative effects (Table 4.11-2). Among the cumulative effects issues associated with these activities are effects on marine mammals, subsistence, borough and state fiscal characteristics, and air and water quality. The majority of exploration activities and all of the production and transportation systems have occurred in the central Beaufort Sea portion of the EIS project area. Although oil from seepages was used as fuel by Iñupiat people prior to western contact, the first modern program of oil and gas exploration on the North Slope was conducted by the U.S. Navy and the United States Geological Survey (USGS) during the 1940s and 1950s. Federal leasing on the North Slope began in 1958 and led to several industry-sponsored exploration programs. The discovery of oil at Prudhoe Bay in 1968, followed by discoveries at Kuparuk, West Sak, and Milne Point in 1969, marked the beginning of commercial oil development in the region (NRC 2003). Completion of the Trans-Alaska Pipeline System (TAPS) in 1977 allowed year-round transport of North Slope oil to the marine terminal in Valdez and efficient export to market. Leasing of state and federal offshore continental shelf (OCS) areas began in 1979, and offshore discoveries were made at Endicott, Sag Delta, Point McIntyre, Niakuk, and Northstar (NRC 2003). The Point McIntyre and Niakuk pools, as well as the more recently discovered Liberty field, are located mostly in the offshore area; the Point McIntyre and Niakuk production facilities are located either onshore or on existing nearshore production facilities (MMS 2008). Several additional developments including Nikaitchuq, Northstar, and Oooguruk operate in nearshore areas of the Beaufort Sea. TAPS throughput peaked in 1988, at nearly 2.1 million barrels per day, but has since declined to about 630,000 barrels per day in 2011 (Alyeska 2011). Currently there are 35 fields and satellites producing oil on the North Slope and in nearshore areas of the Beaufort Sea, and additional discoveries are under development.

Table 4.11-2 Specific Past, Present, and Reasonably Foreseeable Future Actions Related to Oil and Gas Development and Production in the EIS Project Area

Category	Geographic Area/Unit	Action/Project	Activities	Timing Open Water	Timing Winter	Past	Present	Future
Oil/Gas Development Onshore Offshore	1- Beaufort Sea Coastal – Badami Unit	Badami	Production currently 1,500 bopd, pipeline to Endicott, additional exploration ongoing, winter sea ice road access		X	X	X	
	2 - Beaufort Sea Inland- Colville River Unit	Alpine (CD-1, CD-2), Fjiord (CD3), Nanuq (CD4)	Currently producing, pipeline to Kuparuk, overland annual ice road access, aircraft traffic		X	X	X	
		Alpine West (CD-5)	Permit application under review, construction could begin within 5 years, potential sealift activity and overland ice road access	X	X	X		X
	3 - Beaufort Sea Inland - Greater Mooses Tooth Unit (GMT) (NPR-A)	GMT 1 (aka Alpine Satellite CD-6)	Past exploration, future development and construction, including road and pipeline access		X	X		X
	4 - Beaufort Sea Nearshore - Duck Island Unit	Endicott, Eider, Sag Delta, Ivishak	Currently producing offshore production facility, pipeline and vehicle access to Prudhoe Bay via causeway			X	X	
		Liberty	Past exploration, future development and construction, onshore directional drilling of offshore field	X	X	X	X	X
	5 - Beaufort Sea Inland - Kuparuk River Unit	Kuparuk, Meltwater, Tabasco, Tarn, West Sak	Currently producing, pipeline and road access from Prudhoe Bay	X	X	X	X	
	6 - Beaufort Sea Coastal - Milne Point Unit	Milne Point, Kuparuk, Sag River, Schrader Bluff, Ugnu	Currently producing, access by road system from Prudhoe Bay	X	X	X	X	
	7 - Beaufort Sea Offshore – Northstar Unit	Northstar, Kuparuk	Currently producing offshore production facility, buried pipeline to onshore	X	X	X	X	
	8 - Beaufort Sea Coastal and Inland -Prudhoe Bay	Prudhoe Bay, Aurora, Borealis, Lisburne, Midnight Sun, N. Prudhoe Bay, Niakuk, Orion, Polaris, Point McIntyre, Raven, West Beach	Currently producing, pipeline and road access, central North Slope processing facilities, start of Trans-Alaska Pipeline	X	X	X	X	

Table 4.11-2 Specific Past, Present, and Reasonably Foreseeable Future Actions Related to Oil and Gas Development and Production in the EIS Project Area

Category	Geographic Area/Unit	Action/Project	Activities	Timing Open Water	Timing Winter	Past	Present	Future
	9 - Beaufort Sea Nearshore Oooguruk Unit	Oooguruk, Kuparuk, Nuiqsut	Currently producing offshore production facility, buried pipeline to onshore	X	X		X	
	10 - Beaufort Sea Nearshore, Coastal -Nikaitchuq Unit	Nikaitchuq, Ivisak, Scharder Bluff	Currently producing from onshore production facility at Oliktok Point, pipeline to Kuparuk; proposed drilling from constructed offshore artificial island at Spy Island, pipeline to shore	X	X		X	
	11 - Beaufort Sea Coastal - Point Thomson Unit	Point Thomson	exploratory drilling completed, future potential expanded gas cycling, onshore pipeline to Badami, barge, air, and ice road access	X	X	X	X	X
	Beaufort Sea nearshore, Coastal, and Inland – Prudhoe Bay	Alaska Producers Pipeline Project	Dredging and improvements to West Dock for pipeline and processing module delivery; large multi-year sealifts delivering processing modules and pipeline to West Dock; construction of large gas processing plant; Construction of large diameter gas pipeline	X	X			X

Table 4.11-2 (cont'd.) Past, Present, and Reasonably Foreseeable Future Actions Related to Oil and Gas Development and Production in the EIS Project Area

Category	Area	Action/Project	Past	Present	Future
Canadian Beaufort Sea Activities Related to Oil and Gas					
Oil & Gas Production	Mackenzie Delta	Norman Wells Oil Fields since 1942 (Deh Cho Area)	X	X	X
		Ikhil Gas Field (Beaufort Area)	X	X	X
Oil/Gas Development Onshore & offshore	Mackenzie Delta Mainland NWT	Sahtu Area	X		X
Oil/Gas Exploration (shallow hazards, site clearance, 2-D and 3-D seismic surveys, exploratory drilling)	Beaufort Sea	Seismic Activity 1965-1992; 2001-2002	X		
		Southern 1994	X		
		GXT Beaufort 2-D Marine Seismic Program 2010	X	X	X
		Canada Basin Seismic Reflection & Refraction Survey 2010		X	X
		Devon Exploration Drilling Program 2004 (no other drilling or seismic programs known at same time)	X		
		GXT Aerial Magnetic Survey 2008	X		
		BP Pokak 3D Seismic Program 2009	X	X	
		Imperial Oil Ajurak 3D Seismic Program Summer 2008	X		
		Fisheries & Oceans Canada Region-wide marine seismic survey 2006-2009	X		
	Arctic Islands	Canadian Polar Margin Seismic Reflection Survey 2009	X	X	
		Oil & Gas leases (current)	X	X	
	Mackenzie Delta offshore	Oil & Gas leases (current)	X	X	
Russian Chukchi Sea Activities Related to Oil and Gas					
Oil/Gas Exploration (shallow hazards, site clearance, 2D and 3D seismic surveys, exploratory drilling)	Chukchi Sea	Federal Program Subsoil Use 2006-2010 (future bidding sites) [5]	X		X
		Sakhalin Island	X		
	Arctic Seas	85,000 km 2D seismic data by 2010 and 278,000 km seismic data by 2020[5]		X	X

Sources: ExxonMobil Corporation 2009, MMS 2007, NMFS 2007, MMS 2010

4.11.2.1.2 Oil and Gas Exploration Activities

Oil and gas exploration activities have also occurred over the last 60 years throughout the EIS project area, but unless they lead to development of a project, are generally limited in time to a specific seasonal period over the course of one or two years, and are individually limited in geographic extent. As a result, the impacts from exploration activities tend to be limited in duration and occur in the immediate vicinity of exploration activities and transportation support routes. Exploration activities are similar to those discussed in Chapter 2 of this EIS, including seismic exploration (on land, over ice, open water) and exploratory drilling (onshore gravel pads and ice pads, offshore drillships and artificial islands). By far, the majority of onshore and offshore exploration activities have taken place in the Beaufort Sea and have occurred on a regular basis since the late 1960s, although some military programs date back to the 1940s. More limited and intermittent exploration activities have taken place in offshore areas of the Chukchi Sea since the 1980s. However, it should be noted that barge traffic to and from the Prudhoe Bay area passes through the Chukchi Sea in early summer, returning in late fall.

A small refined fuel spill (typically less than 48 bbls) from G&G refueling operations at sea or at docks could occur during exploration activities as well.

Oil and gas exploration has also occurred in the Canadian Arctic, specifically in the eastern Beaufort Sea, off the Mackenzie River Delta, Mackenzie Delta and in the Arctic Islands. Characteristics are similar to exploration activities in Alaska (shallow hazards, site clearance, 2D and 3D seismic surveys, exploratory drilling), except that the majority of support is provided by road access and coastal barges. Oil and gas exploration has also occurred in offshore areas the Russian Arctic and in areas around Sakhalin Island to the south of the Bering Straits. Sakhalin Island is located approximately 3,220 km (2,000 mi) from Kotzebue at a latitude approximately the same as British Columbia.

From the perspective of cumulative effects, multiple exploration activities that may occur over a large geographic area, with some level of activity going on from year to year, raise concerns about disturbance to fish and wildlife and response in behavior and distribution. The potential geographic extent of exploration activities, along with air and marine support, implies that sound producing activities are occurring across much of the range of many marine mammal species. In addition, the availability of fish and wildlife for subsistence harvest based on response to exploration activities and interference with subsistence hunting is also of concern to North Slope Natives.

There are currently no State of Alaska leases in the Chukchi Sea, and no onshore oil and gas production along the Chukchi Sea coast. The State of Alaska has scheduled lease sales that would offer exploration rights in certain regions including the Beaufort Sea nearshore areas. Activities in these areas are considered reasonably foreseeable, however, the exact locations and amount of acreage available for leasing are yet to be determined. The NSB plans to drill exploration and development wells in their East Barrow, South Barrow, and Walakpa gas fields during 2011-2012 (Petroleum News 2011a). In its most recent five-year plan, the State of Alaska does not intend to hold lease sales in the nearshore waters of the Chukchi Sea (ADNR 2013).

There are a number of onshore and nearshore exploration wells being proposed on State oil and gas leases in the Beaufort Sea region. State lease sales in this region, as well as BLM lease sales for the NPR-A, are proposed for 2012. However, these prospects are primarily onshore or inshore with little potential for affecting the proposed area.

Internationally but within the geographical scope of the proposed area, there are a number of past, present, and reasonably foreseeable future activities related to oil and gas exploration, development, and production located in Canadian and Russian waters. There is little information on specific plans, but the effects of Canadian and Russian activities are expected to be similar to those resulting from activities occurring in the Alaska Arctic OCS.

4.11.2.1.3 Large-Scale Future Oil and Gas Projects in Alaska

Activities related to natural gas development in the EIS project are reasonably foreseeable, assuming a market is found for the gas, and a gas pipeline is constructed to transport the gas (see discussion of the Alaska Pipeline Project below). Such activities may include the construction and installation of a gas pipeline to shore from existing offshore production facilities in the Beaufort Sea, and expansion of existing offshore and shore-based facilities to accommodate natural gas production.

The following project descriptions are five major oil and gas development projects proposed in the Beaufort Sea that are reasonably foreseeable within the next five years. Although the majority of project activities and facilities would take place on shore, there are marine components that would contribute to potential cumulative effects.

Alaska Pipeline Project

The schedule for this project has been delayed. The initial plans were altered, when on July 30, 2012, the Alaska Pipeline Project (APP) announced that it would conduct a non-binding public solicitation of interest in securing capacity on a potential new pipeline system to transport Alaska's North Slope gas in the fall of 2012. The solicitation of interest was conducted to identify parties potentially interested in making future capacity commitments on a pipeline system from the Alaska North Slope to a gas liquefaction (LNG) terminal at a tidewater location in south-central Alaska or to an interconnection point near the border of British Columbia and Alberta in Canada. APP's previous project plans, which were described in the 2011 DEIS are now on hold. APP received a two-year filing extension until fall 2014.

Point Thomson Project

ExxonMobil is proposing to produce gas and hydrocarbon liquids (condensate and oil) from the Thomson Sand reservoir and delineate other hydrocarbon resources in the Point Thomson area on the North Slope of Alaska. This project is located to the east of the existing Badami field, and west of ANWR. Produced fluids will be processed on site, with condensate and oil being transported by pipeline to existing common carrier pipelines at Badami that supply the Trans Alaska Pipeline System (TAPS). The primary activities that would contribute to cumulative effects include marine and air traffic associated with construction and operation, and an increased level of construction activity on the shoreline over a three-year period.

These project components include three production pads, process facilities, an infield road system, an export pipeline, infield gathering lines, and an airstrip.

The hydrocarbon reservoir lies mainly offshore. To avoid offshore development and potential adverse impacts on the marine environment, onshore drilling pads close to the shore have been selected to directionally drill into the offshore portions of the reservoir.

Offloading sealift modules without installing a solid fill causeway or dock would represent the primary marine component of the project.

Sealift by ocean-going barges direct to the Point Thomson location was selected as the option for moving heavy loads, such as process modules, to the site. Module transportation to the project site is scheduled for the summer of 2013 and would take place over three open water seasons (2013 through 2015). It is anticipated that the large ocean barges will be in place at the Point Thomson site for approximately 14 days, providing adequate time to dock and offload cargo. Once offloaded, the barges will leave the site. The method of barge access will be utilized for up to three construction seasons (2013 through 2015), with barges passing through the Chukchi Sea to and from offloading.

A bulkhead and five offshore mooring dolphins (pilings driven into the sea floor) are necessary for landing and securing the ocean barges, which require several feet of draft and cannot directly access the beach. The bulkhead (referred to as the high bulkhead) will be located above the Mean High Water (MHW) line on the beach. Mooring dolphins are needed to ensure an accurate alignment of the barges for offloading operations and will be left in place for future use. To better accommodate landing and offloading of the smaller coastal barges, an adjacent lower bulkhead (low bulkhead) will also be constructed above the MHW line on the beach, with an associated gravel ramp constructed to the Central Pad. Air traffic would be associated with construction and operations.

Alpine Unit CD-5 and CD-6 Projects

Permits applications for construction of Alpine CD-5 were submitted several years ago, but were delayed due to regulatory challenges resulting in denial of permits. These challenges were resolved in late 2011, with production now anticipated to begin in 2016. Construction of CD 5 and 6 would involve constructing a bridge across the Colville River to access the production pad; road connections to the Prudhoe Bay Kuparuk road system would be limited to seasonal ice roads. Barge support for construction would be based out of Prudhoe Bay, with modules and other construction material transported by gravel/ice roads. Air traffic would be associated with construction and operations. The primary areas of nexus with offshore exploratory activity would involve barge sealifts through the Chukchi and Beaufort seas, and offloading activity at West Dock.

Liberty Project

The Liberty Project is located on the eastern end of the Prudhoe Bay area in nearshore waters. It was initially conceived as an offshore production island, but has been redesigned as directional drilling from a location at the Endicott Satellite drilling island. Exploratory drilling was suspended in 2010. Development within the next five years is possible. Road access would be provided through the existing Prudhoe Bay road system; barge support for construction would be based out of Prudhoe Bay, with modules and other construction material transported by gravel roads. Air traffic would use the existing Prudhoe Bay air facilities. The primary areas of nexus with offshore exploratory activity would involve barge sealifts through the Chukchi and Beaufort seas, and offloading activity at West Dock.

Continuation of Badami Production

The Badami project is located approximately 20 miles east of Prudhoe Bay on the Beaufort Sea coast. It is connected by pipeline to Endicott, but there are no all-season road connections; Badami has a gravel causeway barge dock. The facility went into production around 2001, but was suspended in 2007 after production results were less than expected. In 2010, production was temporarily restarted. Additional winter exploratory drilling is currently being conducted; depending on results, production could be resumed on a continuing basis within a couple of years. Some improvements to the dock and other facilities may be needed. The primary areas of nexus with offshore exploratory activity would involve barge sealifts through the Chukchi and Beaufort seas, and offloading activity at Badami (Bradner 2011, Petroleum News 2011b).

4.11.2.2 Scientific Research

There are a number of scientific research programs that take place in offshore areas of the Beaufort and Chukchi seas. This section cannot be exhaustive in the listing of all studies funded by BOEM and other federal and industry partners in these waters. The following is a representative sample of the number and types of studies that have been and continue to be pursued in Alaskan Arctic waters. These activities involve vessel, air, and over-ice support which may contribute to cumulative effects through disturbance of marine mammals and impacts to subsistence harvest through marine vessel and aircraft traffic, and disturbance of bottom sediment through sampling. BOEM supports a variety of research programs aimed at understanding the Arctic OCS environment and associated ecosystems. BOEM Alaska OCS regional research in 2013 includes physical oceanography studies, habitat and ecology studies including mapping the distribution of marine mammals, shorebirds, fish, benthic, and epifaunal communities in the northern Chukchi Sea and central and eastern Beaufort Sea, studies designed to understand the rate and effects of climate change, modeling of weather and changing patterns of ice formation and loss, atmospheric effects from increased economic development, and effects of development and climate change on native subsistence and cultures. These studies include the Hanna Shoal Ecosystem Study and the Synthesis of Arctic Research study, both designed to attempt synthesizing past and future information being collected in the Alaskan Arctic. Included are marine mammal research studies such as the Bowhead Feeding Variability in the Western Alaska Beaufort Sea, as well as the Chukchi Offshore Monitoring in Drilling Area (COMIDA) program to establish an integrated knowledge of the Chukchi Sea ecosystem. These programs conduct studies to understand bowhead whale population and migration structures and include a range of biological, chemical, and physical processes. These include collections to establish baseline data sets for benthic infauna and epifauna, organic carbon and sediment grain size, radioisotopes for down core dating, trace metals in sediments, biota and suspended particles, as well as associated parameters. The program operates annually in the Chukchi Sea. In addition, the BOEM research vessel, the 36-foot Launch 1273, will be underway supporting research in the Beaufort Sea during the 2013 open water season. In the past, the ANIMIDA and (c)ANIMIDA Projects operated during the summers of 2004, 2005, 2006, and 2007. An explicit goal of the (c)ANIMIDA Project is to examine temporal and spatial changes in chemical and biological characteristics of the oil and gas exploration and development area of the Alaskan Beaufort Sea and to determine if any observed changes are related to the Northstar development and production operations. From 1997 through 2008, BOEM developed and conducted 31 projects directly related to improving equipment and processes for the prompt identification and removal of oil from harsh Arctic environments. Since 2000, the ANIMIDA project has been monitoring and attempting to understand the geographical extent of the Boulder Patch, a geographically isolated hard-bottom kelp community that exists in the Stefansson Sound south and east of the Prudhoe Bay and Liberty developments.

The NMFS National Marine Mammal Laboratory has contracted with the NSB to provide services related to the Bowhead Head Whale Feeding Ecology study (BOWFEST) through April 2013. The purpose of BOWFEST is to document patterns and variability in the timing and locations of bowhead whales feeding in the western Beaufort Sea and to estimate temporal and spatial patterns of habitat use by bowhead whales within the EIS project area. Local Iñupiat hunters conduct boat-based surveys of the study area to gather information on bowhead whale behavior and movement. The study is based around Barrow. In addition, the bowhead whale satellite tagging study operates annually in the Beaufort and Chukchi seas. The purpose of the project is to understand migration routes, migration timing, feeding areas, diving behavior, and time spent in areas within the spring and summer ranges of bowhead whales. Fifteen satellite tags were deployed on bowhead whales in Alaska and Canada in 2009. In August, eight bowhead whales were tagged near Barrow, Alaska, and three were tagged in Canada near Atkinson Point on the Tuktoyaktuk Peninsula. One gray whale was also tagged in Canada. Four more bowheads were tagged near Barrow in October 2009. The study has been operating since at least 2006, and between two and fifteen tags have been deployed on bowhead whales during each of those years.

The Russian-American Long-term Census of the Arctic (RUSALCA) is funded by NOAA and the NSF Arctic Observing Network Program (ARC-0855748) to understand and ultimately predict the effects of climate change in the northern Bering and Chukchi seas. To this end, the RUSALCA program collects information related to changes in physical and biogeochemical processes, and alteration of biomass and productivity of organisms and their associated marine food webs. The census involves a series of biophysical moorings in the western Bering Strait, CTD transects conducted across the Herald Shelf Valley, and a series of shipboard projects aimed at understanding biogeochemical processes that influence climate and ecosystem dynamics in the study area. RUSCLA appears to operate annually during the open water season and overlaps with the EIS project, in particular, in the Chukchi Sea near Cape Lisburne and Point Hope, and in the northern Beaufort Sea.

The Alaskan Ocean Observing system (AOOS) has various sensors and monitors deployed throughout the EIS project area to measure and record meteorological conditions and other environmental variables. AOOS also coordinates a seabird monitoring network in the proposed action area.

The Western Arctic Shelf Basin Interactions (SBI) project, sponsored by the NSF and the Office of Naval Research, was a multi-year, interdisciplinary program aimed at investigating the impact of global change on physical, biological and geochemical processes over the Chukchi and Beaufort Sea shelf basin region in the Western Arctic Ocean. The goal was to improve understanding of shelf-basin exchange, and to improve predictions of global change impacts in the Arctic. The SBI program includes both field and modeling studies (http://www.eol.ucar.edu/projects/sbi/). The project collected data during the 2002 to 2004 field seasons. In addition, NSF plans to conduct seismic surveys in northwest corner of U.S. EEZ, Chukchi Sea within the foreseeable future.

Finally, Chukchi baseline studies funded by ConocoPhillips Alaska, Inc (CPAI), Statoil, and Shell include physical oceanography, benthic, zooplankton, fish, acoustics, and ice studies in the Chukchi Sea.

Past, present, and reasonably foreseeable future actions related to scientific research in the EIS project area are summarized in Table 4.11-3.

4.11.2.3 Mining

Mining takes place in onshore areas of the Chukchi Sea portion of the EIS project area. While the majority of mining activities take place onshore, marine and air transportation could contribute to potential cumulative effects through the disturbance of marine mammals and impacts to the subsistence harvest. The world's largest known zinc resources are located in the western Brooks Range. As much as 25 million tons of high-grade zinc is estimated to be present near Red Dog Mine, approximately 40 mi from the southwest corner of the NPR-A (Schoen and Senner 2003). The Red Dog Mine port site may also become the port facility for a very large proposed coal mining operation adjacent to the Chukchi Sea. In addition, coal mining prospecting proposals for the Brooks Range have been submitted to ADNR, Division of Mining, Land and Water (DMLW) for approval. Past, present and reasonably foreseeable future activities related to mining activities within the EIS project area are summarized in Table 4.11-4.

4.11.2.4 Military

Military activity in the Arctic is thought to have increased in recent years, and it may be reasonable to expect that military activity will continue to increase in the foreseeable future. Military activities in the proposed action area include the transit of military vessels through area waters, as well as submarine activity, aircraft overflights, and related maneuvers. However, very little public information is available about future military activity in the region. Military vessel, submarine, and aircraft traffic could contribute to cumulative effects through the disturbance of marine mammals and effects to the subsistence harves, and the potential for marine fuel spills.

Table 4.11-3 Past, Present, and Reasonably Foreseeable Future Actions Related to Scientific Research in the EIS Project Area

Category	Area	Action / Project	Activities	Timing Open Water	Timing Winter	Past	Present	Future
Scientific Research (seismic, multi-beam sonar, transect surveys, oceanographic and biological sampling)	U.S. Beaufort and Chukchi Seas	Bowhead Head Whale Feeding Ecology study (BOWFEST) –.	Vessel traffic, includes acoustics, aerial surveys, water and benthic sampling	X		X	X	X
		Russian-American Long-term Census of the Arctic (RUSALCA) RUSALCA (http://www.arctic.noaa.gov/aro/russian-american/)	n/a	X	X			
		Chukchi Offshore Monitoring in Drilling Area (COMIDA) (*http://www.comidacab.org/*)	funded by MMS, regional area survey of benthic, seabird, marine mammals	X	X			
		Joint Chukchi baseline studies by CPAI, Statoil, Shell	includes physical ocean, benthic, zooplankton, fish, benthic, acoustics, and ice studies.	X				
		Bowhead whale satellite tagging study (http://www.wildlife.alaska.gov/index.cfm?adfg=marinemammals.bowhead)	n/a	X				
		Bowhead Whale Aerial Survey Project (BWASP)	surveys of the autumn migration of bowhead whales through the Alaskan Beaufort Sea and transect data on all other marine mammals sighted.	X				
		Various BOEM-funded studies (http://www..boem.gov/Studies/)	n/a	X	X			
		Western Arctic Shelf Basin Interactions project (Heath and						

Table 4.11-3 Past, Present, and Reasonably Foreseeable Future Actions Related to Scientific Research in the EIS Project Area

Category	Area	Action / Project	Activities	Timing Open Water	Timing Winter	Past	Present	Future
		Polar Star icebreakers / NSF).	vessel traffic	X	X			
		NSF Seismic Surveys	Vessel traffic, seismic surveys	X	X			
		Arctic Nearshore Impact Monitoring in Development Area III (ANIMIDA III) http://www.boem.gov/Environmental-Stewardship/Environmental-Studies/Alaska/Index.aspx	Vessel traffic, including water and benthic sampling	X				
	Canadian Beaufort Sea	National Research Council Escape, Evacuation & Rescue Systems and Ice Loading 2007	Vessel traffic	n/a	n/a	X		
		Oceans & Fisheries Canada (OFC) Arctic Fish Ecology and Assessment Research (AFEAR)	Vessel traffic	n/a	n/a		X	X
		OFC Arctic Marine Mammal Ecology and Assessment Research (AMMEA)	Vessel traffic	n/a	n/a		X	X
		OFC Arctic Stock Assessment (ex. movement of ringed seals, Beaufort belugas)	Vessel traffic	n/a	n/a		X	X
		OFC Arctic Environment and Contaminants Research	Vessel traffic	n/a	n/a		X	X

Table 4.11-4 Past, Present, and Reasonably Foreseeable Future Actions Related to Mining in the EIS Project Area

Category	Area	Action / Project	Activities	Timing Open Water	Timing Winter	Past	Present	Future
Mining	12 -Southwest Chukchi Sea Inland - Red Dog Mine	Red Dog Mine	Large inland zinc mine, ore trucked to port facility, aircraft traffic	X	X	X	X	X
	Southwest Chukchi Sea Coastal - Red Dog Port	Minerals Export	vessel traffic bringing in supplies, transshipping processed mineral product	X		X	X	X
	14 -Western Chukchi Sea Coastal – Western Arctic Coal Project	Coal exploration and development	Vessel traffic bringing in supplies	X				X

The Distant Early Warning Line, also known as the DEW Line, was a system of 63 radar stations located across the northern edge of the North American Continent, roughly along the 69th parallel. The radar stations were constructed between 1954 and 1957, and decommissioned during the 1990s. A runway operated by NSB (Kaktovik airport) presently active at the former Barter Island DEW Line site. The Bullen Point site is currently managed by the U.S. Air Force and has a gravel airstrip and a small radar system.

Submarines are valuable platforms for a wide variety of research activities including passive and active acoustic studies. Although the U.S. Navy (and other organizations) are likely to continue to use submarines within the proposed action area, detailed information about future military actions is not publicly available.

Past, present and reasonably foreseeable future activities related to military activities within the EIS project area are summarized in Table 4.11-5.

4.11.2.5 Transportation

In addition to marine and air transportation associated with the previously mentioned activities, there is frequent marine and air traffic associated with coastal communities on the North Slope and in Northwest Alaska. Marine and air transportation could contribute to potential cumulative effects through the disturbance of marine mammals and impacts to the subsistence harvest. It is reasonable to assume that trends associated with transportation to facilitate the maintenance and development of coastal communities will continue. In some specific cases, described below, transportation and associated infrastructure in the proposed activity area may increase as a result of increased commercial activity in the area. Past, present and reasonably foreseeable future activities related to transportation activities within the EIS project area are summarized in Table 4.11-6.

Vessel Traffic. Vessel traffic through the Bering Strait has risen steadily over recent years according to USCG estimates, and Russian efforts to promote a Northern Seas Route for shipping may lead to continued increases in vessel traffic adjacent to the western portion of the EIS project area. An analysis done by Shell Oil as part of a Revised Outer Continental Shelf Lease Exploration Plan for the Chukchi Sea (Shell 2011a) indicated that barge traffic passing through the Chukchi Sea during the month of July through October has increased from roughly 2000 miles of non-seismic vessel traffic in 2006 to roughly 11,500 miles of non-seismic vessel traffic in 2010. In comparison, the same analysis estimated that vessel miles associated with seismic surveys in 2006 were roughly 70,000 miles, compared to roughly 30,000 miles in 2010.

Vessel traffic within the EIS project area can currently be characterized as traffic to support oil and gas industries, barges or cargo vessels used to supply coastal villages, smaller vessels used for hunting and local transportation during the open water period, military vessel traffic, and recreational vessels such as cruise ships and a limited number of ocean-going sailboats. Barges and small cargo vessels are used to transport machinery, fuel, building materials and other commodities to coastal villages and industrial sites during the open water period. For example, villages along the Beaufort and Chukchi sea coasts are serviced by vessels from Crowley Alaska and or Northern Transportation Company. Additional vessel traffic supports the Arctic oil and gas industry, and some activity is the result of emergency-response drills in marine areas.

In addition, research vessels, including NSF and USCG icebreakers, also operate in the EIS project area. USCG anticipates a continued increase in vessel traffic in the Arctic. Changes in the distribution of sea ice, longer open-water periods, and increasing interest in studying and viewing Arctic wildlife and habitats may support an increase in research and recreational vessel traffic in the proposed action area regardless of oil and gas activity.

Table 4.11-5 Past, Present, and Reasonably Foreseeable Future Actions Related to Military in the EIS Project Area

Category	Area	Action / Project	Activities	Timing Open Water	Timing Winter	Past	Present	Future
Military	13 -Eastern Beaufort Sea Coastal -Barter Island [1]	Distant Early Warning[6] (DEW) Line Sites	Radar site still active, Aircraft traffic, Barge traffic	X	X	X	X	X
	13 -Central Beaufort Sea Coastal - Bullen Point SRRS[1]		Aircraft traffic, Barge traffic	X	X	X	X	X
	13 -Central Beaufort Sea Coastal -Flaxman Island SRRS[1]		Demolition complete			X		
	13 -Western Beaufort Sea Coastal -Point Barrow		Demolition complete but radar site still active, aircraft and barge traffic			X		
	13 -Eastern Chukchi Sea Coastal -Wainwright		Potential demolition, aircraft and barge traffic			X	X	
	13 -Central Chukchi Sea 13 -Coastal -Point Lay		Demolition complete			X		
	13 -Central Chukchi Seas Coastal - Cape Lisburne		Radar site still active, aircraft traffic, Barge traffic			X	X	X
	13 -Western Chukchi Sea Coastal -Kotzebue		Potential demolition, aircraft and barge traffic			X		
	submarines?	Arctic Submarine Laboratory has conducted various arctic activities since 1940 (http://www.csp.navy.mil/asl/Timeline.htm) locations unknown.	Vessel traffic, sonar impacts, ship strikes	X	X	X	X	X
	US Coast Guard icebreakers	*Healy* and *Polar Sea* icebreakers	Vessel traffic, potential ships strikes, icebreaking	X	X	X	X	X
	Overflights	North American Aerospace Defense Command (NORAD) Elmendorf AFB	Aircraft traffic	X	X	X	X	X

Table 4.11-6 Past, Present and Reasonably Foreseeable Future Actions Related to Transportation in the EIS Project Area

Category	Area	Action / Project	Activities	Timing Open Water	Timing Winter	Past	Present	Future
Transportation	Beaufort and Chukchi Seas - Coastal	Community Roads and Vehicular Traffic	Vehicle traffic	X	X	X	X	X
		Scheduled Air Transportation	Aircraft traffic	X	X	X	X	X
		Pipelines	Petroleum product offloading, transport, storage	X	X	X	X	X
	Beaufort and Chukchi Seas - Offshore	Marine Vessel Traffic	Vessel traffic	X		X	X	X
		Aircraft Traffic	Aircraft Traffic	X	X	X	X	X

Aircraft Traffic. Industry uses helicopters and fixed wing aircraft to support routine activities within the EIS project area. In addition, at least four companies operate passenger and air cargo services between North Slope communities and population centers, flying inland and along the coast. These may involve several scheduled flights daily using small propeller-driven aircraft. The majority of air travel and freight hauling between Arctic coastal communities involves small commuter-type aircraft, and government agencies and researchers often charter aircraft for travel and research purposes. These activities are expected to continue, and the level of aircraft traffic within the EIS project area may increase as a result of climate change and/or increased industrial activity and community development.

4.11.2.6 Community Development Projects

Community development projects in Arctic communities involve both major infrastructure projects, such as construction of airports and response centers, as well as smaller projects (e.g. construction of a new washeteria). These projects could result in construction noise in coastal areas, and could generate additional amounts of marine and aircraft traffic to support construction activities. Marine and air transportation could contribute to potential cumulative effects through the disturbance of marine mammals and impacts to the subsistence harvest. Keeping in mind that "it is not practical to analyze how the cumulative effects of a proposed action interact with the universe (CEQ 1997)," this section will focus only on past, present, and reasonably foreseeable community development projects that are truly meaningful within the context of the cumulative effects analysis.

Major community development projects that are foreseeable at the present time include the construction of a new airport at the village of Kaktovik, and potentially a new emergency response facility at Wainwright.

Past, present and reasonably foreseeable future activities related to community development project activities within the EIS project area are summarized in Table 4.11-7.

Table 4.11-7 Past, Present, and Reasonably Foreseeable Future Actions Related to Community Development Projects in the EIS Project Area

Category	Area	Action / Project	Past	Present	Future
U.S. Community Development/Capital Projects	Kaktovik	Marine and air, airport construction	X	X	X
	Nuiqsut	Marine and air traffic	X	X	X
	Barrow	Marine and air traffic	X	X	X
	Wainwright	Marine and air traffic, port construction	X	X	X
	Point Lay	Marine and air traffic	X	X	X
	Point Hope	Marine and air traffic	X	X	X
	Kivalina	Marine and air traffic	X	X	X
	Kotzebue	Marine and air traffic, small boat harbor	X	X	X
Canadian Community Development/Capital Projects	Aklavik, Yukon Territory	Marine and air traffic	X	X	X
	Inuvik, Northwest Territory (NWT)	Marine and air traffic	X	X	X

4.11.2.7 Subsistence

Subsistence activities occur in coastal and offshore portions of the EIS project area. Subsistence hunters primarily use boats and snowmachines for access. In addition to the harvest and mortality of marine mammals, boat and snowmachine traffic could lead to the disturbance of marine mammals as well. The types of subsistence uses and activities that were described in Chapter 3 are expected to continue into the future. Current and past hunting, gathering, fishing, trapping subsistence activities would be similar in the types of activities and areas utilized for the communities associated with the EIS project area in the future.

Past, present and reasonably foreseeable future activities related to subsistence activities within the EIS project area are summarized in Table 4.11-8.

4.11.2.8 Recreation and Tourism

Recreation and tourism activities are generally pursued by non-residents of the EIS project area. Marine and coastal vessel and air traffic could contribute to potential cumulative effects through the disturbance of marine mammals or impacts to the subsistence harvest. With the exception of adventure cruise ships that transit the Beaufort and Chukchi sea coasts in small numbers, much of the air sightseeing traffic is concentrated in ANWR. The types of recreation and tourism activities that were described in Chapter 3 are expected to continue into the future. Current and past sport hunting and fishing, or other recreation or tourism-related activities would be similar in the types of activities and areas utilized for the communities associated with the EIS project area in the future.

Past, present and reasonably foreseeable future activities related to recreation and tourism activities within the EIS project area are summarized in Table 4.11-9.

4.11.2.9 Climate Change

Climate change is an ongoing factor in the consideration of cumulative environmental effects on the Arctic region (NOAA 2011). It has been implicated in changing weather patterns, changes in the classification and seasonality of ice cover, and the timing and duration of phytoplankton blooms in the Beaufort Sea. Climate conditions in the EIS project area have been undergoing remarkable changes, particularly over the past 20 years (USGS 2011). Warmer air and water temperatures result in earlier spring snowmelt, decreased ice thickness during the winter, and accelerated rates of coastal erosion and permafrost degradation (USGS 2011). In addition, due to the changing extent and thickness of sea ice, resulting from changes in the temperature regime, there is more open water during the summer season. The lack of sea ice also leads to the creation of wind driven waves, which in turn contribute to coastal erosion. These changes have been attributed to rising CO_2 levels in the atmosphere and corresponding increases in CO_2 levels in the waters of the world's oceans. These changes have also led to the phenomenon of ocean acidification (IPCC 2007). This phenomenon is often called a sister problem to climate change, because they are both attributed to human activities that have resulted in increased CO_2 levels in the atmosphere. Ocean acidification in high latitude seas is happening at a more advanced rate compared to other areas of the ocean. The capacity of the Arctic Ocean to uptake CO_2 is expected to increase in response to increased levels as a result of climate change (Bates and Mathis 2009). This is due to the loss of sea ice that increases the open water surface area of the Arctic seas. Exposure of cooler surface water lowers the solubility (or saturation) of calcium carbonate within the water, which in turn leads to lower available levels of the minerals needed by shell-producing organisms (Fabry et al. 2009).

Climate change could affect the habitat, behavior, distribution, and populations of marine mammals, fish, and other wildlife within the EIS project area. Climate change could also affect the availability of, or access to, subsistence resources, particularly spring hunts for bowhead whales and other marine mammals. Climate change also affects the length of seasons that ice roads are operable, potentially leading to more reliance on marine access.

Past, present and reasonably foreseeable future activities related to climate change activities within the EIS project area are summarized in Table 4.11-10.

Table 4.11-8 Past, Present, and Reasonably Foreseeable Future Actions Related to Subsistence Activities in the EIS Project Area

Category	Area	Action / Project	Activities	Timing Open Water	Timing Winter	Past	Present	Future
Subsistence Activities (marine mammals)	Kaktovik, Nuiqsut, Barrow, Wainwright, Point Lay, Point Hope, Kivalina, Kotzebue and adjacent areas	Bowhead whale harvest	Vessel traffic in fall hunt, snow machine traffic in spring hunt	X	X	X	X	X
		Harvest of Beluga, walrus, seals	Vessel traffic for open water beluga, walrus, seal hunt; snow machine traffic in winter seal hunt	X	X	X	X	X
Subsistence Activities	Kaktovik, Nuiqsut, Barrow, Wainwright, Point Lay, Point Hope, Kivalina, Kotzebue and adjacent areas	Hunting, gathering, fishing, trapping, and associated activities.	Vessel traffic, snow machine traffic	X	X	X	X	X

Table 4.11-9 Past, Present, and Reasonably Foreseeable Future Actions Related to Recreation and Tourism in the EIS Project Area

Category	Area	Action / Project	Activities	Timing Open Water	Timing Winter	Past	Present	Future
Recreation/Tourism (wildlife watching, cruise ships)	Eastern Beaufort Sea Coastal and Inland -Arctic National Wildlife Refuge	River trips, wildlife viewing, hiking	Aircraft traffic, powered and non-powered vessel traffic	X		X	X	X
	Eastern Beaufort Sea Coastal and Inland - North Slope (Kaktovik)	Wildlife viewing	Aircraft traffic, vessel traffic	X		X	X	X
	Beaufort Sea Offshore and Nearshore	Cruise ships, ecotours	Vessel traffic	X			X	X
Recreational/Sport Hunting/Fishing	Chukchi Sea Offshore	Cruise ships, ecotours	Vessel traffic	X			X	X
	Eastern Beaufort Sea Coastal and Inland -Arctic National Wildlife Refuge	Hunting, Fishing	Aircraft traffic	X		X	X	X

Table 4.11-10 Past, Present, and Reasonably Foreseeable Future Actions Related to Climate Change in the EIS Project Area

Category	Area	Action / Project	Past	Present	Future
Climate Change	Global	Changes in atmospheric, cryosperic, and ocean processes	X	X	X

4.11.3 Alternative 1 – No Action

Under Alternative 1, 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 ancillary activity notices for activities in the Beaufort and Chukchi seas. There would be no potential for a VLOS under Alternative 1. As discussed in Section 4.4.1, there would be no direct or indirect effects to resources as a result of Alternative 1, other than to socioeconomics and land and water use, management, and ownership. Therefore, there would be no cumulative effects to resources outside of socioeconomics and land and water use, management, and ownership under Alternative 1.

Over the past several years, there has been a certain level of oil and gas exploration activity that has been permitted by NMFS and BOEM in the Beaufort and Chukchi seas. This level of activity is greater than what is associated with Alternative 1 (no activity permitted), but less than what is associated with Alternative 2. Therefore the impacts analyzed for Alternative 1 would be less than the status quo for oil and gas exploration activities in the Beaufort and Chukchi seas, and is within the range of activities evaluated in this EIS.

4.11.3.1 Socioeconomics

4.11.3.1.1 Summary of Direct and Indirect Effects

The magnitude of the direct and indirect socioeconomic effects from Alternative 1 is generally negative, due to potential lost opportunity for offshore oil and gas development. There would be no net change to the non-monetary (subsistence) economy. The potential impact to local employment and sales tax is low in magnitude because total personal income and local employment rates would not have increased by more than five percent. The duration of the local socioeconomic impacts would be temporary because it is not year-round, however, the activity would have occurred over a fixed number of years. The likelihood of exploration resulting in production cannot be predicted therefore the magnitude of potential unrealized revenue for state and federal governments is unknown. These potential negative economic impacts of the activity would be statewide and even national in extent. The context of the socioeconomic impacts, the people that would experience the potential for local employment and tax revenue, are unique in that Iñupiat communities would primarily be affected.

The summary impact level of direct and indirect effects from the No Action Alternative for Socioeconomics is moderate, not exceeding the significance threshold.

4.11.3.1.2 Past and Present Actions

As described in Chapter 3, oil and gas exploration, development, production, and transportation are major contributors to the economy of Alaska, the communities within NSB, and to a lesser degree for Northwest Arctic Borough.

Public Revenue & Expenditures

The predominant source of NSB revenue comes from property sold or leased by the oil industry (MMS 2008). The Northwest Arctic Borough generates a large portion of its revenue from payment in lieu of taxes from the Red Dog Mine and the remainder from state and federal government sources (EPA 2009c).

Approximately 90 percent of all state tax revenue is paid by the oil and gas industry, but the proposed action involves exploration activities on federal lands which generate no state revenue (ADCCED 2011a). Federal royalty revenue associated with offshore leases is a small portion of the total U.S. budget, but Federal spending in Alaska is first based on per capita (ADCCED 2011a). Onshore oil production has been declining, resulting in declining revenues to Borough and state governments.

Employment & Personal Income

The extraction of natural resources from remote rural Alaska produces only modest direct economic benefit in the form of jobs, household income, business purchases, and public revenue for most residents (Goldsmith 2007). North Slope oil field operations provide employment to over 5,000 people who are not residents of NSB (ADCCED 2011c). Direct employment in the oil and gas industry makes up just four percent of the total state employment (Fried 2011). Employment rates in NSB and Northwest Arctic Borough are much lower than state or national averages and have shown further decline in the period between 2000 and 2009 (U.S. Census 2009). However, indirect benefits of oil and gas development are substantial. The majority of employment in these areas is from state and local government, which receive operating revenues from taxes on oil and gas facilities and production. Over time, oil and gas exploration and production have decreased from historic levels; however, oil and gas and mining continue to contribute to local employment and income.

Demographic Characteristics

The middle range for the State of Alaska and EIS project area borough population growth projections are just under one percent annual increase per year; for the EIS project area regions annual growth is about 0.9 percent per year (ADLWD 2011d). The population for the State of Alaska in 2020 is projected to be 766,231; the North Slope Borough projected population for 2019 is 7,140; the Northwest Arctic Borough projected population for 2019 is 7,709; and Nome Census Area projected population for 2019 is 9,911 (ADLWD 2011d). North Slope Borough population has grown since it started to be tracked in the 1960 Census from 2,133 to 9,430 today (ADCCED 2011c).

In- and out-migration are more substantial and uncertain components of population change in Alaska than natural births and deaths. In certain years, net out-migration was strong enough to reverse the trend of annual growth.

Social Organizations & Institutions

Cultural values are reflected in 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. Social organizations and institutions will remain important in meeting community needs and preserving community culture, with regard to issues associated with resource development and trends in federal, state, and local revenue.

4.11.3.1.3 Reasonably Foreseeable Future Actions

There are numerous categories of reasonably foreseeable future actions that have an impact on public revenue and expenditures, employment and personal income, and social organizations and institutions. These include: onshore oil and gas exploration, development and production; mining exploration, development and production; military, transportation, community development projects, subsistence activities (as they affect the non-cash economy), and recreation and tourism. These categories of socioeconomic impact would likely to be not at a magnitude, like the discovery of oil in Prudhoe Bay (1968) and construction of TAPS or the oil price drop of 1985, to impact state and local revenue, employment, and demographic characteristics.

Public Revenue & Expenditures

If oil and gas production activities continue at current levels, the State of Alaska would continue to collect the majority of state tax revenue from the oil and gas industry, although this is expected to decline without major new discoveries, facility development and production. The vast majority of produced oil in Alaska depends on TAPS for transport to market and any OCS oil contribution would extend its commercial life. This would continue state and local royalty oil revenue that otherwise would end immediately upon a shutdown of TAPS.

Oil and gas revenue represented 90 percent of state tax revenue in 2009 during a period of high oil prices (ADCCED 2011a). For the EIS project area, the enacted FY 2012 State Capital Budget is $75.5 million divided between infrastructure ($67.1 million), education ($8.1 million), and ($0.3 million) public safety and health projects (OMB 2011). $52.5 million of this capital budget for the Arctic area comes from the federal government. Revenue generated for the NSB would follow similar trends, including declines in revenue without major new discoveries and subsequent development. Declines in state and borough revenue would be reflected in declines in capital project funding, levels of government services, and public sector employment.

Employment & Personal Income

Government bodies (boroughs, other municipal governments, and school districts) would remain the largest employer in the NSB and Northwest Arctic Borough (ADLWD 2005, NSB 2005). Foreseeable oil and gas and mining activity would contribute to maintaining current employment and income levels, but would not result in major increases. Increases in scientific research, military activity, transportation, and recreation and tourism would have a minor to negligible impact to local employment because current levels of these activities create very little direct employment. Expansion and continued development at Red Dog will contribute to the employment and income opportunities in Nome and Northwest Arctic Borough residents; however, a decline in oil and gas development on the North Slope would contribute to a decline in private and public sector employment and personal income.

Demographic Characteristics

Reasonably foreseeable future actions are likely to be of a scale and dispersed geographic nature to maintain current demographic levels and characteristics based on employment and revenue opportunities. As indicated previously, there is nothing foreseeable that would result in large-scale state or regional in-migration and change in demographic characteristics.

Social Organizations & Institutions

It is assumed social organizations and institutions will function at their current levels in the future, subject to available funding, which could be affected by any declines in federal, state, and borough revenue. Modest population growth would increase the demand on institutions and social services to some degree.

4.11.3.1.4 Contribution of Alternative to Cumulative Effects

The No Action Alternative is expected to contribute a low intensity, temporary adverse impact to the region due to the lost opportunity for revenue. Although there would be no impact to the local non-monetary economy, new local employment would also not be realized and there would be no OCS oil contribution to extend the commercial life of TAPS. Therefore the contribution to cumulative effects of socioeconomics would be negligible to minor.

If Alternative 1 results in the inability of a lessee to lawfully explore for oil and gas, the federal government could be required to buy back the leases from the lessees, which could cost tax payers several billions of dollars. A buy back of the leases would result in lost lease rentals to the federal government and delay/lose of any production, royalties, employment, and taxes from any petroleum that might have been produced.

4.11.3.1.5 Conclusion

The direct and indirect effects of Alternative 1 would be adverse and negligible to minor due to the lost opportunity for employment and generation of public revenue. The contribution to the socioeconomic cumulative effects would be adverse and negligible to minor.

4.11.3.2 Land and Water Ownership, Use, Management

4.11.3.2.1 Summary of Direct and Indirect Effects

Land and Water Ownership

Based on Table 4.4-2 and the analysis provided in Section 4.4.1.2, the impacts on land and water ownership under Alternative 1 would be high in magnitude, long term in duration, regional in extent, and important in context. In total, the direct and indirect impacts on land ownership are considered to be major, and result in changes of federal, state, and private development rights by effectively preventing exploration for oil and gas resources in compliance with federal regulations.

Land and Water Use

Based on Table 4.4-2 and the analysis provided in Section 4.4.1.2 the impacts on land and water use under Alternative 1 would be high in magnitude, long term in duration, important in context, and regional in extent, although some changes in land use could occur in support areas out of the region, in areas that provide support services such as Nome and Dutch Harbor. In total, the direct and indirect impacts on land use are considered to be major; they result in changes of federal, state, and private development rights by effectively preventing exploration for oil and gas resources in compliance with federal regulations. Refer to Sections 4.10.3.14 and 4.10.3.19 for impacts on subsistence and recreation.

Land and Water Management

Based on Table 4.4-2 and the analysis provided in Section 4.4.1.2, the impacts on land and water management under Alternative 1 would be high in magnitude, long term in duration, important in context, and regional in extent, although some changes in land use could occur in support areas out of the region. In total, the direct and indirect impacts on land and water management are considered to be major; they would result in changes of federal and state land and water management by effectively preventing exploration for oil and gas resources in compliance with federal regulations.

4.11.3.2.2 Past and Present Actions

Ownership patterns in Alaska were primarily influenced by Alaska statehood in 1959, ANCSA in 1971, North Slope oil development facilitated by the TransAlaska Pipeline in 1973, and ANILCA in 1980. Land management plans and lease sale documents were developed for public land at the federal and state level, while comprehensive plans, zoning, subdivision and other regulations were developed at the municipal level. In turn, physical land and water use generally reflects these policies and regulations. Specific land uses that have affected the EIS project area in the past include oil and gas leasing, development, production, and transportation; subsistence uses, discussed in Section 4.10.3.14; the development of Red Dog Mine, and land uses associated with local communities. Much of the current industrial, transportation, and commercial land and water uses have resulted directly and indirectly from the oil and gas industry. The level of impact of past and present actions would be moderate due to the wide-spread and long term effects of the onshore oil and gas and mining industries.

4.11.3.2.3 Reasonably Foreseeable Future Actions

Lease sales would be likely to continue on state and federal lands, but would not occur and affect ownership in offshore areas. Oil and gas production at existing facilities is expected to continue through the term of the EIS, and additional oil and gas development projects are foreseeable. These will have a continuing influence on land and water use on the North Slope.

Additional land could be required for mining if new or expanded coal and mineral mining operations occur at Red Dog Mine, the Brooks Range, or the Ambler Mining District. This would affect land and water use in the vicinity of specific projects, but would not likely result in changes on a regional scale.

Small community development projects take place, such as village expansions or infrastructure projects, which may require zoning changes. These land use changes would be incrementally small and geographically dispersed, and thus would not have combined effects creating cumulative impacts on land ownership, use, or management.

4.11.3.2.4 Contribution of Alternative to Cumulative Effects

Under Alternative 1, the direct and indirect effects on land ownership would be minor, and on land use and management would be major due to the inability to explore and develop offshore leases in state and federal waters in compliance with federal regulations. The incremental contribution of these impacts to those caused by other reasonably foreseeable future actions would be to place restrictions on the ability of private oil companies to explore and develop leases in federal and state waters that would not otherwise be present. Therefore, the contribution of Alternative 1 to cumulative effects on land use and management would be major.

4.11.3.2.5 Conclusion

Under Alternative 1, because direct, indirect and cumulative impacts are considered major and cumulative impacts are major, the overall level of impact for land ownership, use and management would be considered major.

4.11.4 Alternative 2 – Authorization for Level 1 Exploration Activity

4.11.4.1 Physical Oceanography

4.11.4.1.1 Summary of Direct and Indirect Effects

The effects of Alternative 2 on physical ocean resources would be medium intensity, temporary, local, and would affect common resources as defined in the impact criteria in Section 4.1 of this EIS. Changes in water depth from discharged material would have minor effects on the physical resource character of the EIS project area. Construction of artificial islands, which could occur in nearshore state waters of the Beaufort Sea at a rate of one island per year under Alternative 2, would result in medium-intensity, permanent, localized effects on nearshore currents in the waters adjacent to the artificial islands. Over the life of this EIS, those effects would be minor and would occur only if artificial islands are constructed to support exploratory drilling activities. The effects of Alternative 2 on sea ice would be medium-intensity, local, temporary, and would affect a resource that is common in the EIS project area. The overall effects of Alternative 2 on physical ocean resources in the EIS project area would be minor, particularly with the implementation of additional mitigation measures related to reducing or eliminating certain discharge streams.

4.11.4.1.2 Past and Present Actions

Oil and gas development is the main agent of industrial related change in the EIS project area. Past and present actions related to oil and gas development have affected physical ocean resources in the Beaufort and Chukchi seas. Present actions are considered those that will occur during the life of this EIS. Several artificial gravel islands have been constructed to support oil and gas activities, and these artificial gravel islands have effects on water depth and local circulation patterns within the EIS project area. For instance, the Endicott development, located approximately 16 km (10 mi) northeast of Prudhoe Bay in the Beaufort Sea, consists of two man-made gravel islands connected by a 2.5 km (1.6 miles) man-made gravel causeway. The construction and existence of such structures influence water depth and currents in the EIS project area. The effects are medium intensity, permanent, and localized in the waters adjacent to the artificial islands.

Several nearshore developments in the Beaufort Sea (see Table 4.10-2), including the Northstar development, are connected to the Trans-Alaska Pipeline System (TAPS) via subsea pipelines, which have low-intensity, permanent, local impacts on the physical character of the ocean.

Barging and docking facilities at Barrow and Prudhoe Bay also influence the physical character of the nearshore ocean within the EIS project area.

4.11.4.1.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions with the potential to impact physical ocean resources in the proposed EIS project area include dredging and screeding associated with sealift barging to support future oil and gas development in the region (see Section 4.10.2). Dredging, screeding, and construction of docking facilities associated with reasonably foreseeable future development would have minor impacts on the physical character of the ocean within the EIS project area.

Expansion of Red Dog Port could result in effects to nearshore physical ocean resources in the EIS project area. Such effects would likely be medium-intensity, permanent, and localized to the areas in the immediate vicinity of the Red Dog Port development.

Climate change has the potential to affect water temperatures, sea levels, stream and river discharge, and ice dynamics throughout the EIS project area. These changes could impact the physical character of the ocean in the EIS project area, and could influence the effects of naturally occurring phenomena (e.g. sea ice and storm conditions) on human safety. Due to the changing extent and thickness of sea ice resulting from changes in the temperature regime, there could be more open water during the summer season. The reduced coverage of sea ice would also lead to the creation of larger wind driven waves, which in turn could contribute to increased coastal erosion (USGS 2011). However, over the lifespan of this EIS climate-related changes to physical ocean resources in the EIS project area are expected to be negligible (see Section 4.5.1.1).

4.11.4.1.4 Contribution of Alternative to Cumulative Effects

Actions associated with Alternative 2 would cause localized minor impacts to physical ocean resources in the EIS project area. While some actions associated with Alternative 2, such as the construction of man-made gravel islands, would interact in a synergistic fashion with past, present, and reasonably foreseeable future actions to influence physical ocean resources in the EIS project area, the impacts resulting from such synergies would represent only a small fraction of foreseeable cumulative impact.

4.11.4.1.5 Conclusion

The incremental contribution of activities associated with Alternative 2 to cumulative effects on physical ocean resources in the EIS project area would be minor.

In the event of a VLOS, the overall effects on the physical character of the ocean in the EIS project area would be high-intensity, temporary (with the exception of potential for long-term contamination of sediments with entrained oil), and would affect an area of hundreds of square kilometers. There would be moderate additive effects on the physical character of the ocean resulting from a VLOS in either the Beaufort or Chukchi Sea.

4.11.4.2 Climate & Meteorology

4.11.4.2.1 Summary of Direct and Indirect Effects

As described in Section 4.5.1.2, direct impacts from Alternative 2 to climate are anticipated to be low magnitude, long-term duration, and could affect unique resources on a global scale. Overall, these impacts are assumed to be minor, due to their low contribution to GHG emissions on a state level. Indirect effects are estimated to have a low to medium magnitude, long-term duration, and could affect unique resources on a global scale. Indirect effects are considered minor to moderate, since the outcome of activities associated with Alternative 2 could lead to a greater continued increase in GHG emissions.

4.11.4.2.2 Past and Present Actions

Since pre-industrial times, global anthropogenic GHG emissions have been continually increasing. GHG emissions have increased by 70 percent from 1970 to 2004. The majority of these GHG emissions (77 percent) are CO_2. The amount of GHGs in the atmosphere is the cumulative result of past and present emissions (and removals) of GHGs from human and natural processes. Over time GHGs are removed from the atmosphere due to natural, chemical processes. The removal rate varies between the different GHGs and can also vary based on conditions such as gas concentration in the atmosphere, changes in vegetation coverage, temperature, or other background chemical conditions (Solomon et al. 2007). Carbon dioxide, methane, and nitrous oxide are considered long-lived GHGs and can remain in the atmosphere from a decade to centuries or more. Due to these properties, cumulative effects to climate change from GHG emissions are both additive and synergistic in nature. The effects are additive because the more GHGs that are emitted, the higher the GHG atmospheric concentrations, and consequently the higher the ability to warm the planet which leads to other climate change impacts (see Section 3.1.4.4 for specific examples). The effects are also synergistic because as the concentration of GHGs in the atmosphere increases, it also affects the ability for GHGs to be removed or absorbed by the atmosphere. Therefore, GHG atmospheric concentrations will continue to increase, and perhaps accelerate, because of the continued increase in emissions and the potential decrease in the removal rate of these gases from the atmosphere (Solomon et al. 2007). However, a January 2012 U.S. Energy Information Administration report indicates that with improved efficiency of energy use and a shift away from the most carbon-intensive fuels, CO_2 emissions related to U.S. energy projects could remain at least five percent below 2005 levels through 2040 (EIA 2012).

According to the IPCC, CO_2 is considered the most important GHG due to its dominant atmospheric concentration. Burning fossil fuels is the largest contributor to CO_2 emissions, accounting for approximately two-thirds of the total since 1750 (Solomon et al. 2007). Scientists have identified specific climate trends that are attributed to these human-caused GHG emissions, including increases in air temperature, decrease in snow and ice extent, sea level rise, and decrease in ice thickness, as described in Section 3.1.4.4 under Changes in the Arctic. The past GHG emissions are expected to lead to warming and climate change in the future, even if GHG emissions were to halt (Solomon et al. 2007).

4.11.4.2.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions that would cumulatively contribute to global climate change impacts include the continued use of fossil fuels. Fossil fuel are used in the EIS project area for activities associated with oil and gas exploration and production, community power generation and space heating, transportation, and subsistence activities. The continued exploration and development of oil and gas reserves would continue to provide a supply of fossil fuels, however, it is not likely that there will be any oil or gas production in the Beaufort or Chukchi seas during the life of this document. When burned, these fossil fuels would emit GHGs and add to the cumulative concentration of GHGs in the atmosphere.

If atmospheric concentrations of GHGs were to stabilize, future warming and other interrelated climate change impacts would still be expected to occur. Therefore, past, present, and future actions within the next five to ten years could continue to impact climate change for years to come. Estimates by the IPCC indicate that air temperatures could increase by approximately 1.1 to 6.4 deg. Celsius (3.0 to 11.5 deg. Fahrenheit) and sea levels could rise by approximately 0.2 to 0.6 m (0.7 to 2.0 ft) within the next century. However, dramatic changes would not be seen within the life of this EIS. A number of factors including population, energy use, amount of renewable energy use, and natural climatic influences are represented by the range in estimates (IPCC 2000).

4.11.4.2.4 Contribution of Alternative to Cumulative Effects

In general, GHG emissions from a single project do not have a large impact on climate change. However, once added with all other GHG emissions in the past and present, they combine to create a perceptible change to climate including specific changes to the Arctic climate that are discussed in Section 3.1.4.4. Due to the extended amount of time that GHGs remain in the atmosphere, any amount of GHG emissions can be reasonably expected to contribute to future climate change impacts. Activities that promote fossil fuel use or make them more accessible, such as oil and gas exploration activities, could result in sustained and even increased use of fossil fuels and GHG emissions in the future. As described in Section 4.5.1.2, potential indirect effects associated with Alternative 2 include this sustained and/or increased fossil fuels use. These indirect effects are expected to have a larger contribution to climate change cumulative impacts than the direct effects since they could add to the largest contributor to atmospheric GHG concentrations, CO_2 emissions from fossil fuel combustion, for years to come. There are many sources of fossils fuels throughout the world, so the contribution of this project by itself may not lead to an observable increase in GHG emissions on a global scale. However when viewed cumulatively, all projects involving and promoting the sustained or increased use of fossil fuels such as this project, would result in an observable increase in GHG emissions and global climate changes. These observable, global changes would be long-term and could affect unique resources as discussed in Section 4.5.1.2 under Project-Related Effects to Climate Change.

4.11.4.2.5 Conclusion

The direct and indirect use of fossil fuels associated with offshore exploration and drilling is relatively small. Due to the additive and synergistic nature of GHG emissions on climate change impacts, if offshore exploration activities were to make the use of fossil fuels more accessible, Alternative 2 could contribute to a moderate to major cumulative impact to climate change. However, it cannot be foreseen that exploration activities being analyzed in this EIS would result in the production of oil and gas within the timeframe being analyzed.

If a VLOS were to occur, as described in Section 4.10, the associated GHG emissions and radiative forcing from black carbon would also contribute to climate change. However, since these impacts are expected to be temporary and of lower intensity than the direct and indirect effects associated with Alternative 2, they are expected to result in minor additive effects to climate change.

4.11.4.3 Air Quality

4.11.4.3.1 Summary of Direct and Indirect Effects

Under Alternative 2, Level 1 Exploration Activity, potential air pollutant emissions are expected to be moderate. These emissions would be short in duration, extent, and content. The overall effect on air quality is expected to be moderate. Indirect effects of this alternative may include increased use of other resources, such as additional personnel travel and resource transport which may have an effect on air quality. These indirect effects are unknown, but are expected to be negligible to minor, and would occur at locations outside of the EIS project area.

4.11.4.3.2 Past and Present Actions

Of the action categories presented in Table 4.10-1, oil and gas exploration, development, and production is the primary source category for air emissions in the EIS project area. Past actions are unlikely to have any effect on current (or future) air quality; emissions of air pollutants are assumed to have ceased, and physical and chemical transport would have dissipated any impacts to air quality. Present actions related to exploration, development, or production have the potential to affect air quality in the area due to the use of combustion equipment. Any present activities in this category are expected to be permitted and have potential emissions that meet air quality standards. Oil and gas production activities generating air emissions are concentrated in the area between Prudhoe Bay and the Colville River to the west. Other actions with lesser effects on air quality in the EIS project area include: scientific research; military; transportation; community development projects; subsistence activities; recreation and tourism; and subsistence whaling. These actions may include the use of combustion sources. The actions that include onshore activities (such as transportation and community development projects) also have the potential to create air pollution from ground-disturbing sources.

Oil and gas exploration, development, and production is the primary source of air emissions in the EIS project area. As shown in Table 4.11-2, there are several present allowable exploration, development, and production activities. Each of these has potential activity in the immediate vicinity of the project EIS area, therefore effects of air quality could overlap with the direct effects from Alternative 2. The effects from these activities are expected to be minor to moderate in magnitude, potentially long-term (for development and production facilities), and localized in the areas surrounding the specific activities. Present transportation actions (barges and air traffic) could also overlap in the vicinity of the EIS project area. The effects from transportation activities are expected to be minor in magnitude, short term in duration, and localized in the areas surrounding the specific activities.

4.11.4.3.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions with the potential to impact air quality in the proposed EIS project area include the same categories as present actions; oil and gas exploration, development, and production would be the primary future source category for air emissions in the EIS project area. Any future actions would require permitting to demonstrate compliance with air quality standards. Actions that have lesser potential to affect air quality are similar to those described above for present actions.

4.11.4.3.4 Conclusion

Alternative 2 has the potential to contribute to cumulative effects on air quality when activities occur in the vicinity of other sources of air pollution, primarily oil and gas exploration, development, and production actions. Due to distance between activities, and the mobile and intermittent source activities, the cumulative effects are expected to be less than the sum of each, likely remaining moderate in magnitude. Because of the short time duration for activities, cumulative effects would be highly dependent on actual meteorological conditions at the time, and the relative location of Alternative 2 activities to any of the other air pollution generating actions. The largest cumulative effects would occur when sources are directly upwind or downwind of each other. However, due to dispersion, the cumulative effects would be less than additive (lower than the sum of the total maximum effects). There are no accumulative or synergistic effects associated with air quality. Due to the short duration of the Level 1 Exploration Activity, cumulative effects with transportation actions (also mobile and, therefore, short in duration at any one location) are expected to be unlikely, however, if occurring, would also have the potential to be moderate in magnitude.

As identified in Sections 4.10.6.4 and 4.10.7.4, in the event of a VLOS, the overall effects on air quality in the EIS project area would potentially be high in magnitude, but only temporary in duration and primarily located in the vicinity of the cleanup activities. There would be moderate additive effects on air quality resulting from a VLOS within either the Arctic OCS.

4.11.4.4 Acoustics

4.11.4.4.1 Summary of Direct and Indirect Effects

Direct injurious effects of noise on marine fauna are discussed in Sections 4.5 to 4 to 4.8. NMFS currently applies pulse SPL thresholds of 190 and 180 dB re 1 µPa (rms) as conservative criteria for evaluating onset of auditory system injury for pinnipeds and cetaceans respectively. The largest potential zones of auditory system injury are produced by deep-penetration 2-D and 3-D seismic surveys performed in the 15 to 42 m (50 to 130 ft) depth range (Section 4.5.1.4). These zones can reach almost 3 km in radius although they are typically 2.0 to 2.5 km (1.2 to 1.5 mi) (Section 4.5.1.4 and Table 4.5-11).

Seismic surveys performed in shallow coastal waters and shallow hazards surveys using smaller airgun arrays produce smaller zones of ensonification (Table 4.5-10), where the term *zone of ensonification* here refers generally to the spatial areas exposed to sound levels greater than disturbance or injury effects criteria. Auditory system injury from continuous noise produce by vessels and drilling rigs is not believed to be a risk (Southall et al. 2007).

NMFS's current criteria for marine mammal disturbance are pulse SPL of 160 dB re 1 μPa (rms) and continuous (non-pulsed) noise SPL of 120 dB re 1 μPa. Deep penetration 2 and 3-D seismic survey disturbance zones for offshore surveys typically have radii greater than 10 km (6 mi) (Table 4.5-10). Transiting vessels typically have smaller disturbance zone radii under 2 km (1.2 mi) (Section 4.5.1.). Vessels on DP produce higher sound levels and larger disturbance zone radii; a measurement of a Shell vessel on DP in the Chukchi Sea estimated the 120 dB re 1 μPa threshold occurred at 5.6 km (3.5 mi) range (Chorney et al. 2011). Limited measurements of noise from jack-up drill rigs are available but their disturbance zones are expected to be less than 1 km (0.6 mi) due to acoustic isolation of the noise-producing equipment from the water. Anchored drillships may produce relatively large disturbance zones nearly 10 km (6 mi) radius during high-noise activities in the Beaufort and Chukchi seas, although anchor setting by tugs could produce short bursts of higher noise with even larger resulting disturbance zones (Section 4.5.1.4). The overall impact rating for direct and indirect effects to the acoustic environment under Alternative 2 would be moderate.

4.11.4.4.2 Past and Present Actions

Existing vessel and barge traffic supplies goods to communities along the Beaufort and Chukchi coasts, including Canadian communities. Barge traffic also supplies equipment to existing oil and gas operations near Prudhoe Bay and Point Thomson. Oil and gas exploration programs in the Canadian Beaufort Sea require vessel traffic along the Beaufort and Chukchi coasts. These vessel transits produce relatively small acoustic footprints in vicinity of the transiting vessels and barges, similar to those from oil and gas exploration support vessels (see Section 4.5.1.4).

Seismic survey exploration activities have occurred both inside and outside (but nearby) the EIS project area. The seismic surveys performed in the EIS project area since 2006 are listed in Table 4.5-9. The collaborative United States Geological Survey (USGS) – Geological Survey of Canada (GSC) seismic survey program in the Canada Basin has been active for several years and is expected to continue. Oil and gas exploration programs by several companies have occurred in the Canadian Beaufort Sea in recent years and these remain active. Noise generated by these seismic surveys has exposed marine mammals that are protected under the MMPA. Noise from these external surveys has propagated over long distances into the Beaufort EIS project area where it is sometimes detectable above background levels; acoustic recorders deployed in the U.S. Beaufort Sea in 2007 recorded seismic survey noise from surveys performed off the Mackenzie Delta in Canadian waters with per-pulse SEL levels sometimes exceeding 120 dB re 1 μPa^2 sec (Blackwell et al. 2009). These measurements were made 100 to 300 km (60 to 180 miles) from the seismic survey locations. At these large distances the pulse rms levels are expected to be numerically similar to SEL values (though the measurement units are different). Higher seismic survey noise levels could be present in the eastern part of the Beaufort Sea EIS project area when Canadian surveys occur close to the U.S.-Canada border. Seismic survey noise from surveys in the Russian Chukchi Sea has not been identified on autonomous acoustic recorders deployed almost continuously since 2007 in the Alaskan Chukchi Sea (Martin et al. 2010). Several Russian seismic projects have been underway during this time period, but those have occurred far enough west that little survey noise has propagated into the Alaskan Chukchi Sea. This situation is likely to change if the Russian surveys move closer to the U.S.-Russia border.

Military activities in the EIS project area, including vessel, submarine and ice breaker transits may generate underwater noise; however, year-round acoustic monitoring in the Alaskan Chukchi Sea has not identified significant military noise sources (Martin et al. 2010).

4.11.4.4.3 Reasonably Foreseeable Future Actions

As discussed above, vessel and barge traffic for supply of coastal communities and existing and future oil and gas facilities will continue to generate anthropogenic noise along vessel transit routes. It is reasonable to expect that seismic surveys will continue in the Canada Basin and in the Canadian Beaufort Sea. These surveys could generate substantial nearfield sound levels that could impact nearby marine mammals, and they will also generate noise that propagates over long distances into the EIS project area.

4.11.4.4.4 Contribution of Alternative to Cumulative Effects

Cumulative exposures to noise from anthropogenic activities both inside and outside the EIS project area might lead to indirect and cumulative effects. At present the effects of low-level cumulative exposures on marine fauna are poorly understood. However, a recent report by an expert panel has suggested criteria for auditory system injury based on cumulative SEL from multiple impulsive sounds received over 24 hours (Southall et al. 2007). The approach includes frequency-weighting of the received noise signals according to functions based on the hearing sensitivity of five marine mammal groups. The M-weighting functions are illustrated in Figure 3.1-8. Proposed thresholds for auditory system injury under this approach are 198 dB re 1 $\mu Pa^2 s$ for cetaceans and 186 dB re 1 $\mu Pa^2 s$ cumulative M-weighted SEL. Cumulative M-weighted SEL have been computed for single survey line transects for seismic surveys in the Chukchi Sea (e.g. O'Neill et al. 2010). These results appear to indicate that, for single-line seismic surveys in the Chukchi Sea EIS project area, the Southall et al. criteria are more conservative than the current rms criteria for estimating effects on pinnipeds, and less conservative for estimating effects on cetaceans (meaning that injury zones computed using the SEL thresholds are greater for pinnipeds and smaller for cetaceans than the respective zones computed using the current rms thresholds). Alternate survey geometries might produce different results. NMFS is considering the Southall et al. report and its proposed cumulative SEL metric for possible inclusion in future criteria, but the rms thresholds discussed above remain the present criteria for defining marine mammal exclusion zones (based on auditory system injury) near seismic survey and other impulsive sources, and disturbance zones near both impulsive and non-inpulse noise sources.

While the assessment of cumulative effects is difficult, cumulative exposures to noise from multiple activities over time, sometimes referred to as aggregate exposure, can be estimated for certain species. Few analyses of this type have been attempted due to the inherent uncertainty of where and when animals have or will be exposed to anthropogenic noise. A recent study by University of California under a grant from BP America is underway to evaluate methods for estimating cumulative noise exposures (Fleishman and Streever 2011; Racca et al. 2011). A study test case considers seismic survey noise exposures of bowhead whales in the Beaufort Sea. This study involves, as a first step, using an acoustic model to predict the temporally and spatially varying noise levels produced by seismic survey exploration activities. The second step of the study, now in progress, passes simulated bowhead migration paths through the predicted noise field. The paths are computed by a specialized algorithm that incorporates information about bowheads' migration corridor, timing and behavior, and estimated avoidance reactions to seismic survey noise. A cumulative sound exposure metric is calculated by integrating the time-dependent sound level received by each simulated bowhead as it traverses the seismic survey area. Frequency weighting such as proposed by Southall et al. can be included in this approach.

A final cumulative effect that is worth noting is habituation. Animals that have previously been exposed to anthropogenic noise may be less inclined to avoid similar noise on subsequent exposures. Habituation to anthropogenic noise may cause animals to approach loud noise sources more closely than they otherwise would, and as a result become exposed to higher and perhaps injurious noise levels.

Alternative 2 includes multiple 2D and 3D seismic surveys and shallow hazards surveys. It is reasonable to expect that some of these surveys would be concurrent and individual marine mammals could be exposed at relatively close-range to more than one survey in a relatively short time (perhaps less than 24 hours). While the disturbance zones based on 160 dB re 1 μPa (rms) would be unlikely to overlap, animals could have difficulty navigating between these zones. If a cumulative SEL criterion for auditory system injury similar to that proposed by Southall et al. (2007) were adopted, it is likely that some animals would receive substantially more exposure than would occur if only a single survey were present.

The inclusion of ice-breaking and one on-ice winter seismic survey would not be expected to generate significant cumulative effects due to their temporal separation from most other anthropogenic activities. These operations would also occur at a time of year when fewer marine mammals are present, thereby reducing exposures.

4.11.4.4.5 Conclusion

Under Alternative 2, the presence of multiple seismic surveys could lead to greater exposures of marine mammals to disturbance noise levels than from a single survey if the surveys are concurrent and/or with limited spatial separation. This is a more noteworthy issue in the Beaufort Sea EIS project area than in the Chukchi Sea; marine mammal migration corridors are narrower in the Beaufort and pass more directly through the primary oil and gas exploration areas. Exposures to potentially injurious cumulative sound levels might also occur with higher likelihood in the Beaufort as marine mammals could be exposed to noise from more than one seismic survey within relatively short time periods. The potential for this type of cumulative effect is not presently accounted for by current NMFS criteria for auditory system injury that are based on per-pulse rms sound levels.

Impacts on the acoustic environment associated with VLOS response and cleanup would be medium-intensity, temporary, and regional. Due to the intensity, duration, and geographic extent associated with these impacts, the overall effects of spill response and cleanup on the acoustic environment in the EIS project area would contribute a moderate additive effect on acoustics.

In addition, impact producing factors associated with a VLOS could include the drilling of a relief well, which would result in effects on the acoustic environment similar to those described in Section 4.5.1.4 of this EIS.

4.11.4.5 Water Quality

4.11.4.5.1 Summary of Direct and Indirect Effects

Actions associated with Alternative 2 would have a variety of direct and indirect effects on water quality in the EIS project area. Discharges from exploratory drilling operations would increase the temperature and salinity of seawater in the immediate vicinity of the discharge. Ocean-bottom cable surveys, anchor handling activities, and discharges from exploratory drilling activities would affect turbidity and concentrations of total suspended solids in the immediate vicinity of the activities. Effects on water quality resulting from increases in salinity, temperature, turbidity and/or total suspended solids would be low-intensity, temporary, local, and would affect common resources as defined in the impact criteria in Section 4.1. Offshore exploratory drilling activities and associated shore-based and ice-based activities would influence concentrations of metals and organic contaminants in the water, which could affect water quality in the EIS project area. After mitigation, the effects of Alternative 2 on water quality are expected to be low-intensity, temporary, and local. Although applicable water quality criteria have not been established for some of the compounds present in discharged drilling fluids, the overall effects of Alternative 2 on water quality are expected to be minor.

4.11.4.5.2 Past and Present Actions

Over the past three decades, numerous onshore and offshore oil exploration and development projects have influenced water quality in the EIS project area (Brown et al. 2010; see Table 4.10-2). Activities that affect water quality include the construction of gravel islands and causeways, and discharges of materials (NRC 2003b). Due to past development and existing anthropogenic effects, existing water quality in the proposed action area cannot currently be considered “pristine” from a chemical perspective

(NRC 2003b, Brown et al. 2010). Certain organic pollutants tend to accumulate and persist in cold climates due to low mobility and slow degradation rates at low temperatures. Organic pollutants and other contaminants, such as heavy metals, have been deposited in the EIS project area as a result of both long-range transport processes and local activities.

NPDES-permitted discharges have included drill cuttings and used drilling fluids, cement slurry, drainage waters, and domestic wastewaters, which have been discharged after treatment according to the conditions and limitations of various NPDES permits. Discharges have generally been small, local, and infrequent, and the effects of discharges and spills on water quality have not accumulated (NRC 2003b). Water quality in the Beaufort and Chukchi seas is presently within the EPA criteria for the protection of marine life, and existing influences on water quality generally do not result in changes to ecosystem diversity or productivity, changes in the stability of biological communities, threats to human health, or loss of aesthetic, recreational, scientific, or economic values.

4.11.4.5.3 Reasonably Foreseeable Future Actions

Impacts to water quality in the EIS project area are expected to continue over the reasonably foreseeable future as a result of both long-range transport processes and local activities. It is reasonable to expect that NPDES permits including restrictions and monitoring requirements will be issued in the future. Discharges from existing industrial developments are expected to continue. Increases in marine vessel traffic (especially large vessels, such as cruise ships), military activities, and atmospheric deposition of pollutants could impact water quality in the Beaufort and Chukchi seas. Reasonably foreseeable increases in marine vessel traffic in the EIS project area would result in increased potential for introducing invasive species such as those contained in ballast water.

Changes in the acidity and alkalinity of the world's oceans are expected to continue and accelerate over the reasonably foreseeable future (USGS 2011). Concentrations of CO_2 dissolved in seawater are expected to increase as a result of increased concentrations of CO_2 in the atmosphere. Dissolution of CO_2 in seawater results in the formation of carbonic acid, which decreases the pH of the seawater causing ocean acidification. However, over the lifespan of this EIS, climate change and ocean acidification are expected to have negligible effects on water quality in the EIS project area.

4.11.4.5.4 Contribution of Alternative to Cumulative Effects

Actions associated with Alternative 2 would cause temporary local impacts to water quality such as increases in temperature, turbidity, and concentrations of pollutants. Some actions associated with Alternative 2, such as discharges of cooling water and waste material, would interact with past, present, and reasonably foreseeable future actions resulting in both additive and synergistic impacts to water quality. These interactions would be local and temporary and would represent only a negligible cumulative impact.

4.11.4.5.5 Conclusion

The incremental contribution of activities associated with Alternative 2 to cumulative effects on water quality in the EIS project area would be minor.

In the event of a VLOS, the cumulative effects on water quality in the EIS project area would be high-intensity, long-term, and would affect an area of hundreds of square kilometers. There would be major additive effects on water quality resulting from a VLOS in either the Beaufort or Chukchi Sea.

4.11.4.6 Environmental Contaminants and Ecosystem Functions

4.11.4.6.1 Summary of Direct and Indirect Effects

Direct and indirect impacts to ecosystem functions resulting from the implementation of Alternative 2 would be medium-intensity, temporary, and local. Regulation functions such as nutrient cycling and waste assimilation, which depend on biota and physical processes to facilitate storage and recycling of nutrients and breakdown or assimilation of contaminants, would be affected within the EIS project area, but the geographic extent of such impacts would be extremely limited. Habitat functions, particularly those related to benthic habitats, would be locally impacted as a result of activities and discharges associated with exploratory drilling. Production functions including primary productivity and subsequent transfers to higher trophic levels could potentially be impacted as a result of activities associated with Alternative 2, while the effects of Alternative 2 on information ecosystem functions would depend upon interrelationships between impacts to cultural resources, social resources, and aesthetic resources, which are addressed in other sections of this EIS. Overall direct and indirect effects of Alternative 2 on ecosystem functions are expected to be minor.

4.11.4.6.2 Past and Present Actions

A variety of past and present actions have affected the distribution of environmental contaminants in the EIS project area. Oil and gas exploration, development, and production have occurred in the area for several decades (see Table 4.10-2). Drilling operations generate waste muds and cuttings, produced water, and associated wastes, which typically contain a variety of organic pollutants and toxic metals (NRC 2003). Until recently, waste materials from the drilling of wells, including muds and cuttings, crude oil, spill materials, and other substances were disposed in open bermed areas called ‘reserve pits’ (NRC 2003). Historical practices within the EIS project area have also involved the disposal of muds and cuttings onto landfast ice in nearshore areas (Brown et al. 2010). Some materials from reserve pits have leached into the surrounding tundra, and the historical practice of applying reserve pit fluids to roads as a dust control measure has contaminated some terrestrial areas (NRC 2003). An agreement reached between industry and environmental groups has resulted in the remediation of most historical reserve pit sites, and injection of the contaminated materials into subsurface formations (NRC 2003). Current practices for the disposal of wastes generated from oil and gas exploration, development, and production activities usually involve injection wells used to dispose of wastes into subsurface formations thereby limiting the impact of present activities on the distribution of environmental contaminants within the EIS project area. Discharges from present developments have generally been small, local, and infrequent such that the effects from such discharges have not accumulated (NRC 2003). In addition to environmental contaminants originating from local sources, some organic pollutants and other contaminants are deposited in the EIS project area as a result of long-range transport processes. Oceanic currents and atmospheric transport processes currently contribute to the overall contaminant loads in the EIS project area and are considered in combination with actions that may lead to cumulative impacts.

Other past and present actions likely to influence ecosystem functions include vessel traffic and aircraft traffic within the EIS project area. Existing barging and docking facilities at Prudhoe Bay have the potential to influence ecosystem functions in the nearshore ocean within the EIS project area.

4.11.4.6.3 Reasonably Foreseeable Future Actions

As discussed in Section 4.4.1.4, anthropogenic materials are introduced to the Beaufort and Chukchi seas from a variety of sources, including influx from the Bering Sea, river runoff, coastal erosion, and atmospheric deposition, as well as from local and distant industrial activities (Woodgate and Aagaard 2005). Due to their hydrophobicity (non-polar molecular structure), persistence in the environment, and temperature-dependent volatility, certain contaminants originating from temperate environments would continue to contribute to the total contaminant loads of habitats and organisms in the Beaufort and Chukchi seas ecosystems. These impacts are likely to continue at varying rates and are considered in combination with actions that could lead to impacts in the cumulative case.

Future oil and gas development within the EIS project area would also contribute to cumulative impacts (see Table 4.10-2). Dredging, screeding, and construction of docking facilities associated with reasonably foreseeable future development would have minor impacts on ecosystem functions within the EIS project area.

Discharges from existing industrial developments are expected to continue. Increases in marine vessel traffic (especially large vessels, such as tug and barge fleets and cruise ships), military activities, and atmospheric deposition of pollutants could impact ecosystem functions in the Beaufort and Chukchi seas. The term "Sealift" refers to the annual supply of materials to the existing oilfields by tug and barge. During the next five years it is reasonably foreseeable that the size and number of Sealifts will increase as activities associated with the Alaska Pipeline Project and Point Thomson increase. Reasonably foreseeable increases in marine vessel traffic in the EIS project area would result in increased potential for introduction of invasive species such as those contained in ballast water.

Climate conditions in the EIS project area have been undergoing noticeable changes, particularly over the past 20 years (USGS 2011). Warmer air and water temperatures result in earlier spring snowmelt, decreased ice thickness during the winter, and accelerated rates of coastal erosion and permafrost degradation (USGS 2011). These changes and others are expected to continue over the reasonably foreseeable future and could aggregate with the effects of industrial activity to impact ecosystem functions. In addition to changes in air and water temperatures, changes in the acidity of the world's oceans are expected to continue and accelerate over the reasonably foreseeable future (USGS 2011). Ocean acidification may have substantial impacts on valued ecosystem components in the Beaufort and Chukchi seas, and must be considered in combination with actions that may lead to cumulative impacts in the proposed action area (USGS 2011).

4.11.4.6.4 Contribution of Alternative to Cumulative Effects

Actions associated with Alternative 2 would cause localized minor impacts to ecosystem functions within the EIS project area. Some actions associated with Alternative 2, such as discharges from exploratory drilling operations, would interact with past, present, and reasonably foreseeable future actions resulting in both additive and synergistic impacts to ecosystem functions. The impacts resulting from such interactions would represent only a small fraction of foreseeable cumulative impact, and the accumulation of impacts is unlikely to be substantial.

4.11.4.6.5 Conclusion

The incremental contribution of activities associated with Alternative 2 to cumulative effects on ecosystem functions in the EIS project area would be minor.

A VLOS would likely have substantial accumulating effects on ecosystem functions as a result of high-intensity, long-term impacts to multiple ecosystem components over large geographic areas. Structural properties of the EIS project area ecosystem could be permanently affected as a result of a VLOS, and effects on ecosystem functions would be classified as major due to their high-intensity, long-term duration, and regional geographic extent, as discussed in Sections 4.10.6.7 and 4.10.7.7. There would be major additive effects on ecosystem functions resulting from a VLOS in either the Beaufort or Chukchi Sea.

4.11.4.7 Lower Trophic Levels

4.11.4.7.1 Summary of Direct and Indirect Effects

As discussed under Direct and Indirect Effects in Section 4.5.2, oil and gas exploration activities under Alternative 2 incorporate the use of a variety of small and large support vessels and icebreakers. Included in these efforts are seismic airgun arrays, and associated gear such as hydrophones and sensor arrays on cables deployed in the water column and ocean bottom. Drilling rigs, helicopters, fixed-wing aircraft, and on-shore support facilities are also associated with exploration activities. All of these can directly and indirectly cause behavioral disturbance, injury and mortality, and/or habitat loss/alteration, which in turn would affect lower trophic level organisms in the EIS project area.

The effects discussed above would likely be low in intensity, temporary to long-term in duration, of local extent and would affect common resources; resulting in a summary impact level of minor. The only exception to these levels of impacts would be the introduction of an invasive species due to increased vessel traffic, which could be of medium intensity, long-term or permanent duration, of regional geographic extent, and affect common or important resources; thereby causing a summary impact of moderate.

4.11.4.7.2 Past and Present Actions

Lower trophic levels in the EIS project area have been exposed to activities that may have impacted them in the past and will continue in the reasonably foreseeable future. The biggest impact on lower trophic levels results from activities that disturb the ocean floor; other impacts result from the discharge of drilling muds and cuttings, or habitat loss. Past and present actions that contribute some of these disturbances include oil and gas development and exploration, and the introduction of persistent contaminants. Offshore exploratory drilling activities in the Arctic have historically used systems such as artificial islands, which directly impact the sea floor and have caused direct injury and mortality to lower trophic level organisms, and also cause habitat loss and disturbance. The discharge of drilling muds and cuttings also pose a threat to the benthic community's habitat; sediment and cuttings sink to the bottom and cause mortality and injury by burying benthic organisms. The Beaufort Sea is shallower and experiences less circulation than the Chukchi Sea, so discharges pose a greater threat to the benthos in these calmer waters. Mortality and injury is also be caused by the introduction of toxins and sediments into the water column due to drilling discharges. These toxins may pose a threat to pelagic and benthic organisms. Habitat loss can also result from oil and gas exploration activities that require ice breaking efforts, forcing organisms to relocate.

The effects from past and present actions on lower trophic levels tend to be localized to the modest areas near the activity, and so are geographically dispersed, as are exploration activities, in the EIS project area. For this reason, overall effects of past and present actions are minor.

4.11.4.7.3 Reasonably Foreseeable Future Actions

All of the same factors external to offshore oil and gas exploration in the Beaufort and Chukchi seas that have affected lower trophic levels in the past are likely to continue in the future. Offshore oil and gas exploration and development is likely to increase in Arctic waters of other countries (i.e. Russia and Norway) as the ice pack recedes and allows access to previously ice-covered areas. These activities would add to the risk of ocean floor disturbance that impact lower trophic habitat across large areas potentially reaching into the EIS project area. The continuation of offshore oil and gas exploration is expected to continue the accumulation of persistent contaminants from multiple sources and has the potential to affect lower trophic levels in the reasonably foreseeable future.

The influences of climate change on lower trophic levels are discussed in Section 3.2.1.3. In summary, the decrease of the extent of the Arctic ice pack impacts the epontic community, and subsequently, the pelagic and benthic communities (MMS 2007c). Warming ocean temperatures associated with climate change may increase zooplankton growth rates and generation times in the Beaufort and Chukchi seas.

The effects from oil and gas activity in the reasonable foreseeable future on lower trophic levels tend to be localized to the modest areas near the activity, and so are geographically dispersed, as are exploration activities, in the EIS project area. Although the effects of climate change will be long-term, the effects that would occur in the upcoming five years are not expected to considerably impact lower trophic levels. Therefore the overall impact from reasonably foreseeable future actions is minor.

4.11.4.7.4 Contribution of Alternative to Cumulative Effects

Under Alternative 2, the direct and indirect effects to lower trophic levels would be minor. The exploration activities authorized under Alternative 2 would add incrementally to the disturbance of lower trophic levels from increased sea floor disturbance. Discharge of drilling muds and small accidental spills would contribute a small amount to habitat change but such changes would be localized and very small. The resource would not be stressed to a point that would cause an irreversible impact. In the absence of a very large oil spill (see below), the exploration activities authorized under Alternative 2 would have moderate contributions to the cumulative effects from past, present, and reasonably foreseeable future actions on lower trophic levels.

4.11.4.7.5 Conclusion

Alternative 2 would have a minor contribution to cumulative effects on lower trophic organisms.

In the event of a VLOS, the impact could be expected to be major should the spill persist in the environment or affect unique resources. However, should the spill not last a long time or not affect unique resources, the impacts could lead to a summary impact level of moderate due to the shorter duration and regional impacts to common resources. In the event of a VLOS, there would be moderate additive effects on lower trophic levels in the EIS project area; there would be major additive effects should the spill persist in the environment or affect unique resources.

4.11.4.8 Fish and Essential Fish Habitat

4.11.4.8.1 Summary of Direct and Indirect Effects

The overall impact of Alternative 2 on fish resources and EFH is minor. Due to the very small scale of any potential effects relative to overall population levels and available habitat, and the temporary nature of the majority of the activities associated with Alternative 2, there would be no measurable effect on the resource.

Of the noise sources introduced by Alternative 2, most have been shown to have no long term impact on fish or fish resources. Because marine fish are widely dispersed and are largely unrestricted in their movements, noises associated with these activities are not expected to have a measurable effect on marine fish populations. All fish assemblages could potentially be exposed to noise, although pelagic and cryopelagic species are more likely to be affected, mainly through behavioral disturbance. However, the transient nature of the noise sources associated with seismic surveys, vessel traffic and icebreaking minimize the exposure to fish and fish resources, with standard ramp up procedures allowing further opportunity for mobile fish to escape the area of impact before any detrimental effects are felt. For more stationary noises associated with exploratory drilling, habituation provides a mechanism for fish to eliminate any effects from displacement. Therefore, the effect on juvenile and adult fish would be negligible. Based on the small footprint of the seismic surveys relative to the amount of habitat over the entire EIS project area, the effect would be minor, as a mechanism for population change exists, but no measurable change would result.

The opportunity for habitat loss or alteration resulting from Alternative 2 is very small. Direct effects to nearshore and offshore demersal fish and fish habitats from exploratory drilling, gravel island construction, icebreaking, and anchoring would be restricted to very limited areas, particularly when compared to the total area of benthic habitat available. Therefore, the adverse impacts are considered minor.

Of the activities described in Alternative 2, only those resulting in potential habitat loss or alteration are relevant to EFH. Effects to fish habitat from exploratory drilling, gravel island construction, and anchoring would be restricted to very limited areas, particularly when compared to the total area of benthic habitat available. Icebreaking would impact a small percentage of ice, which is essential for arctic cod. Salmon species spend much of their adult life at sea and therefore require feeding habitat. Saffron cod spend their entire lives in the marine environment and require spawning, rearing, or feeding habitat. Saffron cod also occurs in nearshore and estuarine environments (Wolotira 1985, Cohen et al. 1990). As with the analysis for marine fish, the opportunity for habitat loss or alteration resulting from

Alternative 2 is very small. Most impacts would be of such low intensity and of such small geographic extent that the effects would be considered minor.

4.11.4.8.2 Past and Present Actions

Past and present actions that have impacted or currently impact fish and EFH within the project EIS area include oil and gas development, transportation, military activity, scientific research, and subsistence activities. Primary issues of concern to fish and EFH include localized injury and mortality, impediments to fish passage and nearshore movement, and loss of habitat. Although the range of activities listed above have impacted fish resources, the scope of these impacts are difficult to quantify, but are considered to be negligible on a regional scale.

Oil and gas exploration and development activities have been occurring on the Arctic Coastal Plain since the 1960s. Much of the activity has been land-based, with fewer offshore elements. However, support for the North Slope development has relied on marine transportation, and continues to do so. Vessel traffic related to the oil and gas industry includes sealifts of large infrastructure pieces, barge deliveries, limited dredging, development (construction), and exploration activities (including seismic). Project-dependent traffic is infrequent and seasonally-dependent, occurring during the brief summer when the routes to the North Slope are ice-free. Exploration activities similar to those addressed in this EIS have also been ongoing within the EIS project area, but their limited scope is considered to have resulted in negligible impacts to fish. Seismic surveys are currently being undertaken in both Canadian and Russian Arctic waters, but are not considered to have any bearing on the fish resources with the EIS project area. Impacts from seismic surveys to fish resident in Canadian or Russian waters would be independent of the fish resources within the project EIS area; however, some species of fish, such as Arctic cisco, regularly migrate back and forth between the Canadian Beaufort Sea and U.S. Beaufort Sea. These type of migratory species could experience effects in both nations and therefore are not independent. The potential effects on fish from the oil and gas exploration and development activities listed here are the same as what is described in Section 4.4.2.2.

Arctic communities rely heavily on sea-going barges to transport consumer goods such as fuel and food to their remote locations. Barge traffic is slow-moving, infrequent, and seasonally dependent, resulting in no negligible impacts to fish.

Scientific research is ongoing within the EIS project area, and is driven by several factors. Although widespread and broadly focused, the cumulative impacts of these studies on fish resources are negligible, as the amount and scope of research is so limited.

Subsistence activities have been a vital part of northern life for as long as humans have lived in the region. Although subsistence patterns have changed over the years, and will likely continue to evolve in the future, it is not anticipated that any adverse impacts have occurred, or are occurring, to fish. Harvest of whitefish and salmon occurs across the coastal plain, but in small enough numbers to limit impacts. A detailed management regime has ensured that fish populations are maintained at viable levels, and fish resources are expected to be closely monitored into the future.

4.11.4.8.3 Reasonably Foreseeable Future Actions

Environmental changes associated with Arctic climate change have the greatest potential to impact fish resources within the EIS project area, and throughout the entire Arctic. Warming air and water has resulted in earlier spring snowmelt, decreased ice thickness, and permafrost degradation (USGS 2011). Studies have also documented a northern expansion of species. Pacific cod, walleye pollock, other groundfish are suspected to be expanding their range, based on the comparison of historical records. As the waters warm, productivity is likely to increase, thereby creating more favorable fish habitat throughout the Arctic.

This northward expansion of commercially viable species has renewed interest in a commercial fishery in the Arctic, which is currently not permitted in U.S. Arctic waters. The 2009 Arctic Fisheries Management Plan outlines the NPFMC's approach 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, but any decision would be highly dependent on climatic and financial factors.

The reduction in sea ice is anticipated to impact cryopelagic species such as Arctic cod. As the cryopelagic community is centered around sea ice, reduced sea ice result in habitat loss. Warming waters and decreases in ice cover also have the potential to alter prey and predator distributions and concentrations, thereby impacting fish.

Ocean acidification is a phenomenon associated with climate change that has recently begun to receive more scientific attention. Fish can be impacted by this phenomenon through several pathways including: reduction in calcifying prey organisms (e.g. pteropods for pink salmon); effects on calcium-carbonate structures in fish such as otoliths and some types of scales; alteration of carbonate based habitats that provide structural habitat; alteration of sound propagation causing increased exposure of fish to sound; effects on the olfactory sense leading to decreased ability of fish larvae to detect adult settling sites; and acidification acting synergistically with other climate change processes in influencing the risk of dispersal of non-native invasive species (BOEM 2011e).

With sea ice across the arctic gradually declining, vessel traffic is expected to increase throughout the region in coming years. However, even an exponential rise in vessel traffic would not be anticipated to have any measurable impact on fish, as the number of vessels would still be low enough to avoid.

Future mining activities are anticipated in the Arctic. Prospecting for zinc and coal in the western Brooks Range is on the horizon, but are unlikely to have any nexus with fish populations impacted by the activities proposed in this EIS. There would be no anticipated interactions with marine species.

Increased interest in the Arctic has resulted in an increase in scientific research, which could significantly increase the scientific understanding of fish resources within the EIS project area. This incremental increase in Arctic research activities will allow for an increasingly refined analysis of impacts on arctic resources, including fish, but will have a negligible impact on fish populations.

4.11.4.8.4 Contribution of Alternative to Cumulative Effects

Climate change is the only past, present, or reasonably foreseeable future action that is anticipated to have any measurable effects on fish and EFH within the EIS project area, and those effects are likely to be beneficial. As Arctic waters warm, productivity is likely to increase, thereby creating more favorable fish habitat throughout the region. The lack of measurable direct or indirect effects on fish and EFH resulting from the implementation of Alternative 2 would represent a negligible contribution to cumulative effects.

4.11.4.8.5 Conclusion

Most direct and indirect impacts resulting from Alternative 2 on fish and EFH would be of such low intensity and of such small geographic extent that the effects would be considered minor. The incremental contribution of activities associated with Alternative 2 to cumulative effects on fish would be negligible.

As described in Sections 4.106 and 4.10.7, in the event of a VLOS, there would be a moderate additive effect on fish and EFH within the EIS project area.

4.11.4.9 Marine and Coastal Birds

4.11.4.9.1 Summary of Direct and Indirect Effects

As discussed in Section 4.5.2.3, the effects of disturbance, injury/mortality, and changes in habitat for marine and coastal birds would likely be temporary or short-term, localized, and not likely to have population-level effects for any species. In summary, the impact of Alternative 2 on marine and coastal birds would be considered negligible to minor.

4.11.4.9.2 Past and Present Actions

Section 3.2.3 provides a brief description of the bird species that occur in the project area, including ESA-listed and candidate species, with references to conservation concerns from interactions with human activities and natural factors. The many marine species have been all exposed to a wide variety of marine vessel traffic and some species have been attracted to lights and collided with ship structures. Coastal species and nesting marine species may be affected by disturbance and loss of habitat from construction and some species, such as waterfowl, have been susceptible to collisions with power lines and communications structures. There have been no commercial or subsistence fishing operations in the Arctic seas large enough to affect their prey base or to threaten them with accidental entanglements but many species migrate through the Bering Sea, Gulf of Alaska, and other seas where there are large fisheries which may have adverse effects. Fixed-wing and helicopter traffic in nearshore areas has caused disturbance of marine and coastal birds. All species have been exposed to man-made and potentially toxic chemical compounds in the water and the food web that have been transported to the Arctic from around the world through the atmosphere, water currents, and migrating animals (AMAP 2010). Waterfowl and a few other species are also subject to subsistence hunting in various parts of their ranges, including the coastal communities adjacent to the Beaufort and Chukchi seas. Changes in sea-ice distribution, ocean acidification, and ocean dynamics due to climate change could have adverse effects on the some species and beneficial effects on others.

4.11.4.9.3 Reasonably Foreseeable Future Actions

All of the same factors external to offshore oil and gas exploration in the Beaufort and Chukchi seas that have affected marine and coastal birds in the past are likely to continue in the future. Offshore oil and gas exploration and development is likely to increase in Arctic waters of other countries (i.e. Russia and Norway) as the ice pack recedes and allows access to previously ice-covered areas. These activities would add to the risk of oil spills and other contamination that could affect the same species of marine birds as occur in Arctic Alaska. Large spills from other areas could also be transported into Alaska waters by currents and ice. On-shore oil and gas exploration and production activities are also expected to continue on the Alaskan North Slope, which would contribute to disturbance and habitat loss for coastal and nesting marine species. Reasonably foreseeable natural gas development projects (the Point Thomson production unit and the Alaska Pipeline Project) could affect marine and coastal birds through disturbance associated with marine vessel traffic and habitat loss from on-shore facility construction. Potentially toxic compounds will continue to be produced around the world and many will find their way to the Arctic with potentially adverse effects on all species. Hunting along migration paths and in Arctic breeding areas will likely continue to be the largest source of direct human-induced mortality on waterfowl. Climate change could affect marine and coastal bird habitats through changes in sea-ice distribution, water quality, seasonality and characteristics of tundra vegetation, and ocean acidification. Some habitat changes could be adverse for some species and beneficial for others.

4.11.4.9.4 Contribution of Alternative 2 to Cumulative Effects

The exploration activities authorized under Alternative 2 would add incrementally to the disturbance of birds from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Vessels and on-shore structures could also contribute to the risk of injurious or fatal collisions. Discharge of drilling muds and small accidental spills would contribute a small amount to habitat change but such changes would be localized and very small compared to the contribution from climate change. The exploration activities authorized under Alternative 2 would have negligible contributions to the cumulative effects from past, present, and reasonably foreseeable future actions on marine and coastal birds.

4.11.4.9.5 Conclusion

The direct and indirect effects of Alternative 2 on marine and coastal birds would be considered negligible to minor, given the temporary and localized nature of potential effects. Alternative 2 would have negligible contributions to the cumulative effects from past, present, and reasonably foreseeable future actions on marine and coastal birds.

There would be a remote chance of a VLOS occurring during exploratory drilling under Alternative 2 (Sections 4.10.6.10 and 4.10.7.10). The implications for birds would depend on the amount and distribution of the accidental spill and to how quickly and thoroughly it could be cleaned up, especially in relation to areas and times when birds are in dense congregations during migration and post-breeding molt. If a very large spill occurred in the Chukchi Sea and impacted the Ledyard Bay/Kasegaluk Lagoon area, the population of spectacled eiders could be severely impacted because of their concentration in this area during spring migration and post-breeding molt and the high risk of mortality from exposure to oil. Other species could also be severely impacted and many could have population-level effects if the spill coincided with their staging areas during spring or fall migration. Areas in the Beaufort Sea within the barrier islands would be particularly sensitive because they are high use areas for a variety of birds. Contamination of coastal and benthic habitats could persist for many years and have chronic effects on the health and reproductive success of birds. A very large oil spill could also contribute substantially to the cumulative effects of disturbance on birds because of the large number of marine vessels and aircraft that would be involved in any clean-up effort, which would likely extend for more than one year and involve a large area. If a VLOS were to occur, there would be a major additive effect to the cumulative effects on many species of marine and coastal birds.

4.11.4.10 Marine Mammals

4.11.4.10.1 Bowhead Whales

4.11.4.10.1.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 2 on bowhead whales are described in detail in Section 4.5.2.4.9 and are summarized here. Potential direct and indirect effects of oil and gas exploration activities on bowhead whales are primarily disturbance and behavioral changes from noise exposure and, possibly, injury or mortality from ship strikes, and habitat degradation. Oil and gas exploration activities authorized under Alternative 2 would likely cause varying degrees of disturbance to feeding, resting, or migrating bowhead whales. Disturbance could lead to displacement from and avoidance of areas of exploration activity to distances up to 20 to 30 km (12.4 to 18.6 mi) (Miller et al. 1999, Richardson et al. 1999), as well as changes in calling behavior (Blackwell et al. 2010b). The EIS project area encompasses a large portion of bowhead whale habitat between the Bering Strait and Canadian border, so leaving the area entirely to avoid impacts is not an option. Duration of disturbance is expected to be short-term; long term effects of disturbance are not well understood. Surveys utilizing ice breakers could cause avoidance and displacement over a larger radius with the additional noise input from the icebreaking activities, but the period of time over which this activity would overlap with bowhead whales is much shorter. Multiple exploration activities occurring simultaneously or overlaping to varying degrees temporally and/or spatially would increase the footprint of the cumulative activities and also potentially increase impacts to bowhead whales as a result. Although bowhead whales react to approaching vessels at greater distances than they react to most other activities, most observed disturbance reactions to vessels and aircraft appear to be short-term. The extent of disturbance effects will depend on the number of exploration activities and associated support vessels in an area, but, for individual sound sources, impacts are expected to be localized.

Incidence of injury and mortality due to ship strikes appears low, but could rise with increasing vessel traffic. Only three ship-strike injuries to bowhead whales were documented from 1976 to 1992 (George et al. 1994).

Potential impacts to bowhead whale habitat from oil and gas exploration activities permitted under Alternative 2 would mostly affect the area immediate adjacent to the site of impact, whether it be discharges, sediment disruption, or icebreaking. Most impacts would also be temporary, although longer-term and regional effects could occur through the process of bioaccumulation through the food chain.

Sub-lethal impacts on bowhead whale health (such as hearing impairment or increased stress) cannot currently be measured. There is no information on TTS or PTS thresholds specific to bowheads, and the likelihood of obtaining the information is low. Hearing and hearing damage can only be readily analyzed in smaller cetaceans, primarily in captivity, or through studying ears of dead whales. Because bowhead whales respond behaviorally to loud noise and generally move away from the sound source, they are less likely to suffer hearing loss from increased noise. However, and Richardson and Thomson (2002) note that bowhead whales are less responsive to seismic airguns when engaged in certain activities, such as feeding.

In terms of the impact criteria identified in Table 4.5-17, most effects of individual exploratory activities authorized under Alternative 2 are of medium intensity and temporary in duration. Potential long-term effects from repeated disturbance over time or over a broad geographic range are unknown. Individually, the various activities may elicit localized effects on bowhead whales, yet the area and extent of the population over which effects would be felt would increase with multiple activities occurring simultaneously or consecutively throughout much of the summer-fall range of this population. Since the EIS project area extends across most of the spring and fall migratory path of bowhead whales in U.S. waters, the combined oil and gas exploration activities could result in regional level effects on bowhead whales. Bowhead whales are listed as endangered and are an essential subsistence resource for Iñupiat and Yupik Eskimos of the Arctic coast, which places them in the context of being a unique resource. Evaluated collectively, and with consideration given to reduced adverse impacts through the imposition of the required standard mitigation measures, the overall effect of activities authorized under Alternative 2 on bowhead whales is likely to be moderate.

4.11.4.10.1.2 Past and Present Actions

Commercial whaling was the single greatest historical source of mortality for bowhead whales. An estimated 60 percent of the pre-whaling population was harvested by the late nineteenth century (Braham 1984). Commercial whaling for bowheads ended in the early twentieth century. Subsistence harvests are currently the primary source of mortality for bowhead whales, with an average of about 40 takes per year (Suydam et al. 2011). The subsistence harvest is well-managed and regulated through a quota system by the IWC (Section 3.3.2). In addition to direct injury or mortality from subsistence whaling, non-targeted bowheads in the vicinity of a struck whale may experience acoustic disturbance from motorized skiffs (especially during the fall hunt) and the explosive sounds of a whale bomb detonating when a whale is harpooned.

Offshore oil and gas exploration, development and production activities have occurred in State waters or on the OCS in the Beaufort and Chukchi seas since 1979. Seismic surveys have been conducted in the Chukchi and Beaufort seas since the late 1960s and early 1970s (MMS 2006a). Most of this activity has occurred in the Beaufort Sea (Table 4.11-2). The Western Arctic stock of bowhead whales has been exposed to these activities for several decades. These offshore activities and their known and potential effects on bowhead whales were discussed in Section 4.5.2.4.9, including ice management vessels, seismic sources, exploratory drilling, aircraft (fixed wing and helicopter) for crew transport and monitoring, and other associated vessels. What is currently known of effects–particularly relating to acoustic disturbance—was derived from studies of bowhead whales coincident to these past and presently occurring activities. Although bowhead whales appear to avoid or be temporarily displaced from an area of oil and gas activity by as much as 20 to 30 km (12.4 to 18.6 mi) (see Section 4.5.2.4.9 for details), there is no evidence of long-term population level effects on the health, status, or population recovery due to these past and present activities (MMS 2006a).

Bowhead whales are exposed to other marine vessel traffic including large ocean-going barges, industrial container ships, icebreakers and other vessels used for scientific and commercial purposes throughout their range, including many vessels used to supply on-shore oil and gas developments on the Prudhoe Bay area. In addition to acoustic disturbance from icebreaking and engine noise from vessel traffic, ship strikes are possible. However, only three ship-strike injuries of bowhead whales were documented from 1976 to 1992. The low number is likely due to relatively few vessels passing through most of the bowhead's range or because bowheads struck by ships do not survive and are, therefore, not accounted for (George et al. 1994).

Bowhead whales are also exposed to man-made and potentially toxic chemical compounds in the water and the food web that have been transported to the Arctic from around the world through the atmosphere, water currents, and migrating animals (AMAP 2010). Since bowhead whales feed on lower trophic level organisms (zooplankton), they are considered at lower risk of bioaccumulation of contaminants, such as persistent organic compounds, than higher level consumers. Levels of persistent organic compound concentrations in samples collected from bowhead whales in Alaska are low compared to other marine mammals (O'Hara and Becker 2003).

Bowhead whales may be sensitive to current and ongoing effects of climate change in the Arctic. It is not, however, currently possible to make reliable predictions of the effects of changes in weather, sea-surface temperatures, or sea ice extent on bowheads. Research and models suggest that, at least in the short term, reduced sea ice cover may actually increase prey availability for bowhead whales and result in improved body condition (Moore and Laidre 2006, George et al. 2006, cited in Allen and Angliss 2010). The loss of sea ice is also opening new habitat and the possibility of exchange between Atlantic and Pacific populations that were previously separated by sea ice. Satellite-tagged bowhead whales from Alaska and West Greenland recently entered the Northwest Passage from opposite directions and spent roughly ten days in the same general area. This is the first documented overlap of these two populations (Heide-Jørgensen et al. 2011).

Bowhead whales in the EIS project area, thus far, appear resilient to the level of human-caused mortality and disturbance that has occurred within their range since the end of commercial whaling (MMS 2006b). Since bowhead whales may live 150+ years (George et al. 1999), many individuals in this population may have already been exposed to numerous disturbance events during their lifetimes. The subsistence harvest levels (approximately 0.1 to 0.5 percent of the population per year [Philo et al. 1993b]) appear to be sustainable. With the Western Arctic stock of bowhead whales continuing to increase at an estimated 3.4 percent per year (George et al. 2004), there is no indication that the combined effects of past or present noise and disturbance-causing factors (e.g. oil and gas activities, shipping, subsistence hunting, and research activities), habitat alterating activities (e.g. gravel island construction, port construction), or pollutants has had any long-lasting physiological, or other adverse effect(s) on the population (MMS 2006b).

4.11.4.10.1.3 Reasonably Foreseeable Future Actions

The factors external to offshore oil and gas exploration in the Beaufort and Chukchi seas that affected bowhead whales in the past and present are likely to continue into the future. Subsistence hunting will likely continue to be the greatest source of mortality for bowhead whales. The oil and gas exploration activities likely to occur during the next five years are the subject of this EIS and their potential impacts on bowhead whales are described in Sections 4.5.2.4.9, 4.6.2.4.1, 4.7.2.4.1 and 4.8.2.4.1. Offshore oil and gas exploration and development is also likely to increase in Arctic waters of neighboring countries, such as Russia and Canada. Increased traffic and industrial activity in the Russian Chukchi Sea and Canadian Beaufort could affect bowhead whales at different stages of migration or during summer feeding in the eastern Beaufort Sea and Amundsen Gulf.

On-shore oil and gas exploration and production activities are also expected to continue on the Alaskan North Slope. Reasonably foreseeable future natural gas development projects (e.g. the Point Thomson production unit and the Alaska Pipeline Project) could affect bowhead whales during the open-water season marine transport of processing facilities and materials for the construction phases and development of nearshore structures.

Potentially toxic compounds may be accidentally discharged coincident to some of the above mentioned industrial activities, as well as continue to be produced around the world and potentially end up in the Arctic food web.

Continued Arctic warming trends and the resulting changes in sea ice conditions could impact bowhead whales in several ways, including prey productivity and shifting migratory patterns based on the presence of sea ice. Whether the short-term beneficial increases in prey productivity will continue in the long-term is unknown. Climate change would affect the entirety of the bowhead whales' range, although the nature and extent of habitat changes may differ by area.

Marine vessel traffic may increase with continued retreat of summer sea ice due to climate change. Increased commercial shipping, fishing, and tourism could occur. Increased vessel traffic in the Beaufort and Chukchi Seas could increase disturbance effects on feeding and migrating bowhead whales and lead to a higher incidence of ship strikes. Expansion of commercial fisheries into Arctic waters may also occur coincident to retreating ice extent and result in additional acoustic disturbance, incidental takes, or entanglement in fishing gear. Coast Guard activities and icebreaker traffic may also increase coincident to growth in shipping and exploration activities during longer ice-free periods. The influence of climate change on marine mammals is further discussed in Section 3.2.4.4.

4.11.4.10.1.4 Contribution of Alternative to Cumulative Effects

The direct and indirect effects of oil and gas exploration activities authorized under Alternative 2 are detailed in Section 4.5.2.4.9 and summarized above. The primary impacts of these activities derive from increased acoustic disturbance in several areas across the summer and fall range of the Western Arctic stock of bowhead whales. Since the EIS project area extends across most of the migratory path of bowhead whales in U.S. waters, the combined oil and gas exploration activities could result in regional level effects on bowhead whales and a minor to moderate additive contribution to cumulative acoustic effects. The spatial and temporal extent of disturbance depends on the spatial and temporal distribution of exploration activities relative to bowhead whale distribution and behavior (e.g. feeding, resting, or migrating). The geographic area and percent of the population over which effects would be felt would increase with multiple activities—including activities external to oil and gas exploration authorized under Alternative 2-- occurring simultaneously or consecutively throughout much of the summer-fall range of this population.

Although ship strikes are possible with increased vessel activity associated with oil and gas exploration, the likelihood of occurrence is relatively low. The contribution of this source of mortality to overall mortality levels for this stock of bowhead whales would be negligible compared to the annual level of mortality incurred through the subsistence harvest.

Exploration activities could contribute to habitat alterations through icebreaking efforts and discharge of drilling muds and contaminants. Most of these effects would be localized and short-term and, relative to the potential ecosystem-wide climate change effects of extensive sea ice loss and ocean acidification on habitat, seemingly minor. However, there is a great deal of uncertainty regarding future impacts of Arctic climate change and adequately assessing potential additive or synergistic effects of combined habitat impacts is not feasible.

The contribution of the direct and indirect impacts resulting from Alternative 2, when combined with the past, present, and reasonably foreseeable future actions would be minor to moderate, with most potential impacts due to acoustic disturbance that could, at least temporarily, disrupt or displace bowhead whales.

4.11.4.10.1.5 Conclusion

Under Alternative 2, the direct and indirect effects to bowhead whales would be moderate. Overall, Alternative 2 would have a minor to moderate contribution to cumulative effects on bowhead whales.

There would be a remote chance of a VLOS occurring during exploratory drilling under Alternative 2 (Sections 4.10.6.11 and 4.10.7.11). A very large oil spill would contribute substantially to cumulative effects of disturbance, injury and mortality, and habitat alterations. The duration of effects could range from temporary (such as skin irritations or short-term displacement) to permanent (e.g. endocrine impairment or reduced reproduction) and would depend on the length of exposure and means of exposure, such as whether oil was directly ingested, the quantity ingested, and whether ingestion was indirect through prey consumption. Displacement from areas impacted by the spill due to the presence of oil and increased vessel activity is likely. If the area is an important feeding area, such as off Barrow or Kaktovik, or along the migratory corridor, the effects may be of higher magnitude. The extent of impact could be state-wide, given the migratory nature of bowhead whales. Population level effects are possible if a very large oil spill coincided with and impacted large feeding aggregations of bowhead whales during the open water season, particularly if calves were present. If a VLOS were to occur, there would be a major additive effect to the cumulative effects on bowhead whales.

4.11.4.10.2 Beluga Whales

4.11.4.10.2.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 2 on beluga whales are described in Section 4.5.2.4.10 and are summarized here. The oil and gas exploration activities proposed in Alternative 2 could directly and indirectly affect beluga whales by causing noise disturbance, habitat degradation, and potential ship strikes. Beluga whales disturbed by oil and gas exploration activities may move away from important habitats. The scale of the avoidance depends on the number and relative proximity of the surveys. Numerous simultaneous seismic activities could cause avoidance over large distances. Potential habitat degradation from drill cuttings or drilling mud discharges would be localized and temporary; the impact level would be negligible. While the incidence of ship strikes is currently low, it could rise with increasing vessel traffic.

Direct and indirect effects on beluga whales from Alternative 2 would be low to medium intensity, short-term duration, local to regional extent, and would affect a unique resource. The summary impact level of Alternative 2 on beluga whales would be considered moderate.

4.11.4.10.2.2 Past and Present Actions

The historical baseline for beluga whales in Arctic Alaska is described in Section 3.2.4.2 and is summarized here. The primary source of human caused mortality in beluga whales has been and continues to be subsistence hunting. The annual subsistence take of Beaufort Sea stock belugas by Alaska Natives averaged 26 belugas during the five-year period from 2005-2009 (Allen and Angliss 2012b). The average annual subsistence take by Alaska Natives averaged 94 belugas from the eastern Chukchi stock during 2005-2009 (Allen and Angliss 2012b).

Beluga whales are exposed to marine vessel traffic including small skiffs and skin umiaqs operating close to shore, large ocean-going barges, industrial container ships, and icebreakers used for scientific and commercial purposes throughout their range. Fixed-wing and helicopter traffic in nearshore areas may cause temporary disturbance of belugas. Beluga whales are also exposed to man-made and potentially toxic chemical compounds in the water and the food web that have been transported to the Arctic from around the world through the atmosphere, water currents, and migrating animals (AMAP 2010). Since beluga whales feed on higher trophic level organisms they are considered at higher risk of bioaccumulation of contaminants, such as persistent organic compounds, than lower level consumers.

The best available abundance estimate for the Beaufort Sea stock is 39,258. The current population trend of the Beaufort Sea stock of beluga whales is unknown (Allen and Angliss 2010).

The most reliable estimate for the eastern Chukchi Sea stock continues to be 3,710 whales derived from 1989-91 surveys. There is currently no evidence that the eastern Chukchi Sea stock of beluga whales is declining (Allen and Angliss 2010).

Neither the Beaufort Sea stock nor the eastern Chukchi Sea stock is listed as depleted under the MMPA or threatened or endangered under the Endangered Species Act.

4.11.4.10.2.3 Reasonably Foreseeable Future Actions

The same factors external to offshore oil and gas exploration in the Beaufort and Chukchi seas that affected beluga whales in the past and present are likely to continue into the future. Subsistence hunting will likely continue to be the primary source of human-caused mortality for beluga whales. Marine vessel traffic is expected to increase with continued retreat of summer sea ice due to climate change. Increased commercial shipping, fishing, and tourism are likely as a result. Offshore oil and gas exploration and development is also likely to increase in Arctic waters of other countries, such as Russia and Canada. Coast Guard activities and icebreaker traffic may also increase coincident to growth in shipping and exploration activities.

On-shore oil and gas exploration and production activities are also expected to continue on the Alaskan North Slope. Reasonably foreseeable natural gas development projects (the Point Thomson production unit and the Alaska Pipeline Project) could affect beluga whales during construction phases that involve large sea lifts of processing facilities and material during the open-water season and development of nearshore structures. Potentially toxic compounds will continue to be produced around the world and many will find their way to the Arctic food web.

Continued Arctic warming trends and the resulting changes in sea ice conditions could impact beluga whales throughout the entirety of their range, although the nature and extent of habitat changes may differ by area.

4.11.4.10.2.4 Contribution of Alternative to Cumulative Effects

The oil and gas exploration activities authorized under Alternative 2 would add to the acoustic disturbance of beluga whales from marine vessels, seismic sources, and aircraft traffic in the Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be localized and temporary. Although ship strikes are possible with increased vessel activity associated with oil and gas exploration, the contribution to additional mortality would be negligible relative to the population level. Exploration activities could contribute to habitat alterations through icebreaking efforts and discharge of drilling muds. Effects would be localized and temporary. The contribution to habitat change would be negligible. The exploration activities authorized under Alternative 2 would therefore have minor to moderate additive contributions to the cumulative effects on beluga whales.

4.11.4.10.2.5 Conclusion

As stated above, most exploration activities authorized under Alternative 2 would result in minor to moderate contributions to cumulative effects on beluga whales.

There would be a small chance of a VLOS occurring during exploratory drilling under this alternative (Section 4.10.7.11). A VLOS would contribute substantially to cumulative effects of disturbance, injury and mortality, and habitat alterations. The duration of effects could range from temporary (such as skin irritations or short-term displacement) to permanent (e.g. endocrine impairment or reduced reproduction) and would depend on the length of exposure and means of exposure, such as whether oil was directly ingested, the quantity ingested, and whether ingestion was indirect through prey consumption. Displacement from areas impacted by the spill due to the presence of oil and increased vessel activity is likely. If the area is an important feeding area, such as the Shelf Break of the Beaufort Sea, or along the migratory corridor, the effects may be of higher magnitude. The extent of impact could be state-wide, given the migratory nature of beluga whales. Population level effects are possible if a very large oil spill coincided with and impacted large feeding aggregations of beluga whales during the open water season, particularly if calves were present. If a VLOS were to occur, there would be a major additive effect to the cumulative effects associated with Alternative 2 on beluga whales.

4.11.4.10.3 Other Cetaceans

4.11.4.10.3.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 2 on cetaceans are described in Section 4.5.2.4.11 and are summarized here. In general, potential direct and indirect effects on other cetaceans resulting from exploration activities in the Beaufort and Chukchi seas authorized under Alternative 2 are similar to those on bowhead whales and beluga whales. The primary direct and indirect effects on other cetaceans would result from noise exposure. Potential noise sources include 2D/3D seismic survey equipment (airgun arrays), CSEM electromagnetic signals, echosounder and sonar devices associated with site clearance and shallow hazards surveys, support, monitoring and receiving vessels associated with these surveys, icebreaking activities, on-ice vibroseis seismic surveys (Beaufort Sea only), exploratory drilling, and helicopter and fixed wing aircraft associated with the different programs.

Direct and indirect effects arising from ship strikes and habitat degradation are also possible. Potential habitat degradation from drill cuttings or drilling mud discharges would be localized and temporary; the impact level would be negligible. While the incidence of ship strikes is currently low, it could rise with increasing vessel traffic.

Direct and indirect effects on other cetaceans from Alternative 2 would be of low to medium intensity, of temporary or short-term duration, local to regional in extent, and would affect a unique resource. The summary impact level of Alternative 2 on other cetaceans would be considered minor.

4.11.4.10.3.2 Past and Present Actions

The historical baseline for cetaceans in Arctic Alaska is described in Section 3.2.4.2 and is summarized here. In the past, commercial whaling was the single greatest source of mortality for cetaceans, primarily mysticetes. Humpback, fin, and gray whales were all taken in large numbers up until the cessation of commercial whaling activities in the twentieth century. Commercial whaling for gray whales was banned after 1946, humpbacks were protected worldwide in 1965 and fin whales were commercially taken in the North Pacific until 1976 (Perry et al. 1999, Rice et al. 1984). Since then, subsistence hunting has provided the only whaling pressure to Arctic species. Bowhead whales are the primary target, with only sporadic and occasional takes of gray, humpback and minke whales by Alaskan and Russian Natives. A single humpback whale was taken in Norton Sound in 2006, but that is the only reliable record of a subsistence humpback whale take by Alaska Natives (Allen and Angliss 2010). During the period of 1950 to 1980, 47 gray whales were taken by Alaskan subsistence hunters from 12 villages (Marquette and Braham 1982). Only two gray whales were taken in the 1990s, both in 1995 (Angliss and Outlaw 2005). The annual subsistence take by Russian Natives was 122 during the five-year period from 1999 to 2003 (Angliss and Outlaw 2005). All subsistence takes are within the limits set by the International Whaling Commission (Angliss and Outlaw 2005). No other cetaceans within the EIS project area are affected by subsistence whaling.

All cetaceans are exposed to marine vessel traffic including small skiffs operating close to shore, large ocean-going barges, industrial container ships, and icebreakers used for scientific and commercial purposes throughout their range. Fixed-wing and helicopter traffic in nearshore areas may cause temporary disturbance. Gray whales and harbor porpoises, being the most abundant and regularly encountered of the non-beluga and -bowhead cetaceans throughout the EIS project area, are likely exposed to the most potential disturbance. Any disturbance is negligible.

Cetaceans are also exposed to man-made and potentially toxic chemical compounds in the water and the food web that have been transported to the Arctic from around the world through the atmosphere, water currents, and migrating animals (AMAP 2010). Most mysticetes, such as gray, humpback, and fin whales, feed primarily on amphipods, euphasiids, and other lower trophic level benthic organisms. However, toothed whales, such as harbor porpoise and narwhals, feed on higher trophic level organisms and are therefore considered at higher risk of bioaccumulation of contaminants, such as persistent organic compounds.

Cetaceans may be sensitive to current and ongoing effects of climate change in the Arctic. It is not, however, currently possible to make reliable predictions of the effects of changes in weather, sea-surface temperatures, or sea ice extent on any specific species. Research and models suggest that, at least in the short term, reduced sea ice cover may actually increase prey availability for bowhead whales and result in improved body condition (Moore and Laidre 2006, George et al. 2006, cited in Allen and Angliss 2010). This conclusion could be expected to hold true for other mysticetes, and likely for odontocetes as Arctic warming is thought to be resulting in the northern expansion of fish ranges and abundances. The loss of sea ice is also opening new habitat and the possibility of exchange between Atlantic and Pacific populations that were previously separated by sea ice.

4.11.4.10.3.3 Reasonably Foreseeable Future Actions

The same factors external to offshore oil and gas exploration in the Beaufort and Chukchi seas that affected cetaceans in the past and present are likely to continue into the future. Subsistence hunting will likely continue to be a source of mortality for gray whales. Marine vessel traffic is expected to increase with continued retreat of summer sea ice due to climate change. Increased commercial shipping, fishing, and tourism are likely, as a result. Offshore oil and gas exploration and development is also likely to increase in Arctic waters of other countries, such as Russia, Canada, and Norway. Marine military activity in the region is also on the rise, as both the U.S. Coast Guard and U.S. Navy have stated their interest in increasing their presence and response capabilities in the Arctic. As a result, Coast Guard activities and icebreaker traffic may also increase coincident to growth in shipping and exploration activities.

On-shore oil and gas exploration and production activities are also expected to continue on the Alaskan North Slope. Reasonably foreseeable natural gas development projects include the Point Thomson production unit and the Alaska Pipeline Project. These projects could affect cetaceans during their construction phases through increased vessel traffic in the form of sea lifts and barge transport during the open-water season and development of nearshore structures.

Continued Arctic warming and the resulting changes in sea ice conditions are likely to continue to impact cetaceans throughout the EIS project area. Whether the short-term beneficial increases in prey productivity will continue into the long-term is unknown. Any impacts are difficult to quantify. There is no indication of long-term adverse effects on the population from extensive seismic surveys and exploration drilling in previous decades.

4.11.4.10.3.4 Contribution of Alternative to Cumulative Effects

The oil and gas exploration activities authorized under Alternative 2 would add to the acoustic disturbance of other cetaceans from marine vessels, seismic sources, and aircraft traffic in the Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be localized and temporary. Although ship strikes are possible with increased vessel activity associated with oil and gas exploration, the contribution to additional mortality would be negligible relative to the population level. Exploration activities could contribute to habitat alterations through icebreaking efforts and discharge of drilling muds. Effects would be localized and temporary. The contribution to habitat change would be negligible.

None of the past, present, or reasonably foreseeable future actions described above are expected to have any substantial impact on cetacean populations within the EIS project area. Populations for most species are stable or increasing, and climate change is likely to add nominal beneficial impacts in the future. The exploration activities authorized under Alternative 2 would therefore have minor additive contributions to the cumulative effects on other cetaceans.

4.11.4.10.3.5 Conclusion

As stated above, most exploration activities authorized under Alternative 2 would result in minor contributions to cumulative effects on other cetaceans.

There would be a small chance of a VLOS occurring during exploratory drilling under this alternative (Section 4.10.7.11). A VLOS would contribute substantially to cumulative effects of disturbance, injury and mortality, and habitat alterations. Some species would be impacted more than others, depending on species abundance within the area affected by the spill, and the location and magnitude of the VLOS. Gray whales and harbor porpoises would be more likely to be impacted than other species in this group because of their higher relative abundance.

The duration of effects could range from temporary (such as skin irritations or short-term displacement) to permanent (e.g. endocrine impairment or reduced reproduction) and would depend on the length of exposure and means of exposure, such as whether oil was directly ingested, the quantity ingested, and whether ingestion was indirect through prey consumption. Displacement from areas impacted by a spill due to the presence of oil and increased vessel activity would be likely. If the area was an important feeding area, such as the Shelf Break of the Beaufort Sea, or along a migratory corridor, the effects would be of higher magnitude. Population level effects would not be likely given the sporadic and seasonal distribution of most cetaceans throughout the EIS project area. However, the extent could be regional, given the migratory nature of many cetaceans. If a VLOS were to occur, there would be a major additive effect to the cumulative effects associated with Alternative 2 on other cetaceans.

4.11.4.10.4 Ice Seals

4.11.4.10.4.1 Summary of Direct and Indirect Effects

There are four species of seals considered in this section that are often collectively called “ice seals”; ringed seal, spotted seal, ribbon seal, and bearded seal. The direct and indirect effects of Alternative 2 on ice seals are described in Section 4.5.2.4.12 and are summarized here. Ringed seals and bearded seals have been the most commonly encountered species of any marine mammals in past offshore oil and gas exploration activities in the Alaskan Beaufort and Chukchi seas and would likely be affected more frequently by exploration activities authorized under Alternative 2 than either ribbon or spotted seals. Data from observers on board seismic source vessels and monitoring vessels indicate that seals tend to avoid on-coming vessels and active seismic arrays but they do not appear to react strongly even as ships pass fairly close with active arrays. They also do not appear to react strongly to icebreaking or on-ice surveys, keeping their distance or moving away at some point to an alternate breathing hole or haulout, but the scope of these behavioral responses appears to be within their natural abilities and responses to their naturally dynamic environment. None of the behavioral reactions observed to date indicate that any of the ice seal species would be displaced from key areas or resources for more than a few minutes or hours and they would be unlikely to experience any measurable effects on their reproductive success or survival. Ice seals are protected under the MMPA, have unique ecological roles in the Arctic, and are important subsistence resources and are therefore considered to be unique resources. Given the standard mitigation measures that have been required in the past, the effects of exploration activities that could be authorized under Alternative 2 on ice seals would likely be low in magnitude, distributed over a wide geographic area, and temporary to short-term in duration. The effects of Alternative 2 would therefore be considered minor for all ice seal species according to the criteria established in Section 4.1.3.

4.11.4.10.4.2 Past and Present Actions

Each species of ice seal has a unique set of ecological and seasonal distribution characteristics that help determine their exposure to anthropogenic and natural forces within the EIS project area. These species are all highly dependent on sea ice for critical life functions and their seasonal distributions are heavily influenced by seasonal ice movement in Arctic waters. They are all exposed to marine vessel traffic ranging from small skiffs operated close to shore to large ocean-going barges, industrial container ships, and icebreakers used for scientific and commercial purposes. Vessel traffic associated with oil and gas development projects in the Prudhoe Bay area has made up a large percentage of total marine traffic in the past, with all of the large equipment and materials barges traversing the Beaufort and Chukchi seas in both directions between southern ports and Prudhoe Bay. Fixed-wing and helicopter traffic in nearshore areas has caused disturbance of seals on the ice and on shore-based haulouts. There have been no commercial or subsistence fishing operations in the Arctic seas large enough to affect their prey base, although large fisheries in the Bering Sea may affect the winter prey base of migrating seals. They are all exposed to man-made and potentially toxic chemical compounds in the water and the food web that have been transported to the Arctic from around the world through the atmosphere, water currents, and migrating animals (AMAP 2010). Each species is also subject to subsistence hunting in various parts of their ranges, primarily near coastal communities adjacent to the Beaufort and Chukchi seas but also in the Bering Sea during winter.

In 2010, NMFS determined that some of the DPS for ringed seals, spotted seals, and bearded seals should be listed as threatened under the ESA, primarily based on the likelihood of sea-ice habitat modification due to climate change and marine habitat modification due to ocean acidification. NMFS determined that ribbon seals did not warrant listing under the ESA in 2008.

4.11.4.10.4.3 Reasonably Foreseeable Future Actions

All of the same factors external to offshore oil and gas exploration in the Beaufort and Chukchi seas that have affected ice seals in the past are likely to continue in the future. Marine vessel traffic is expected to increase as the ice pack recedes due to climate change, primarily involving large international commercial ships. Offshore oil and gas exploration and development is also likely to increase in Arctic waters of other countries (i.e. Russia and Canada) as the ice pack recedes and allows access to previously ice-covered areas. On-shore oil and gas exploration and production activities are also expected to continue on the Alaskan North Slope, with many of them requiring large sea barges to transport equipment and material from southern ports to the Prudhoe Bay area. Reasonably foreseeable natural gas development projects (the Point Thomson production unit and the Alaska Pipeline Project) could affect ice seals during their construction phases which involve large sea lifts of processing facilities and material during the open-water season and development of nearshore structures. Potentially toxic compounds will continue to be produced around the world and many will find their way to the Arctic. Subsistence hunting will likely continue to be the largest source of direct human-induced mortality on ice seals. The greatest concern for ice seals in the reasonably foreseeable future is the continued Arctic warming trends and the resulting deterioration of sea ice conditions that are so important to these species. Most of the other factors that could affect ice seals would have more localized effects but climate change affects the entire ranges of these species and could adversely affect every life stage. It is not clear how or when this issue will be addressed or when the deterioration of ice seal habitat will be reversed.

4.11.4.10.4.4 Contribution of Alternative 2 to Cumulative Effects

The exploration activities authorized under Alternative 2 would add to the disturbance of ice seals from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be temporary and localized. Very small numbers of ringed seals could be exposed to exploration activities during the denning season (winter-spring) when females with young are more susceptible to disturbance. Exploration activities would contribute negligible risk of additional mortality to any species, which would continue to be dominated by subsistence harvest. Exploration activities could contribute to habitat change through on-ice surveys, icebreaking efforts, and discharge of drilling muds but these effects would be localized and temporary or short-term. This contribution to habitat change would be negligible compared to the potential for dramatic sea ice loss due to climate change and changes in ecosystems due to ocean acidification. The exploration activities authorized under Alternative 2 would therefore have negligible to minor contributions to the cumulative effects on the four species of ice seals considered.

4.11.4.10.4.5 Conclusion

The direct and indirect effects of Alternative 2 on pinnipeds would be considered minor. Alternative 2 would have negligible to minor contributions to the cumulative effects on the four species of ice seals.

There would be a small chance of a VLOS occurring during exploratory drilling under Alternative 2 (Section 4.10.7.11). The implications for ice seals would depend on the amount and distribution of the accidental spill, especially in relation to the ice pack, and how quickly and thoroughly it could be cleaned up. However, ice seals have the ability to purge their bodies of hydrocarbons through renal and biliary pathways and are not dependent on their fur to keep them warm so they are not as susceptible to spilled oil as are birds or polar bears. Although they can get lesions on their eyes and some internal organs from contacting crude oil, studies have indicated that many of the physiological effects self-correct if the duration of exposure is not too great (Engelhardt et al. 1977, Engelhardt 1982, Engelhardt 1983, Engelhardt 1985, Smith and Geraci 1975, Geraci and Smith 1976a, Geraci and Smith 1976b, St. Aubin 1990). A VLOS could contribute substantially to the cumulative effects of disturbance on ice seals because of the large number of marine vessels and aircraft that would be involved in any clean-up effort, which would likely extend for more than one year and involve a large area. It could also contribute to injury and mortality of seals, especially young animals and those with poor health, although the numbers of animals involved is unlikely to be very large given their physiological resistance to acute oil toxicity. The contribution to habitat effects could be long-term because of the potential for spilled oil to be captured in the food web and to persist on shore-based haulouts for greater than five years. If a VLOS were to occur, there would be a minor to moderate additive effect to the cumulative effects associated with Alternative 2 on the four species of ice seals considered in this EIS.

4.11.4.10.5 Walrus

4.11.4.10.5.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 2 on walrus are described in Section 4.5.2.4.13 and are summarized here. Walrus have been regularly encountered during vessel-based exploration activities in the past, primarily in late summer as the pack ice recedes, as recorded by PSOs on board seismic source vessels and monitoring vessels. These data indicate that walrus do not react strongly to vessels and active seismic arrays and their behavioral responses are often neutral rather than swimming away. They tend to dive into the water as icebreaking ships approach from some distance and are therefore not exposed to the loudest sounds generated by the ships. Mitigation measures required for walrus by USFWS LOAs since the early 1990s have reduced the risk of close encounters with seismic and other exploration vessels and have reduced the risk of accidental spills that may affect walrus or their prey. None of the data collected to date on walrus reactions to exploration activities indicate that they would be displaced from key areas or resources for more than a few minutes or hours. Careful avoidance of vessel and aircraft traffic around walrus haulouts on land would be important to minimize the risk of calf and juvenile mortality from stampedes. Walrus are protected under the MMPA, fulfill an important ecological role in the Arctic, and are important subsistence resources and are therefore considered to be a unique resource for NEPA purposes. For the level and type of exploration activities that would be authorized under Alternative 2, given the mitigation measures that would be required by USFWS LOAs and NMFS as considered in this EIS, the effects on Pacific walrus would likely be low in magnitude, distributed over a wide geographic area, and temporary in duration. The effects of Alternative 2 would therefore be considered minor for walrus according to the criteria established in Table 4.5-17.

4.11.4.10.5.2 Past and Present Actions

Pacific walrus are considered to be one population that ranges from Russia to Alaska in the Bering and Chukchi seas. Population trends have fluctuated substantially due to historic periods of heavy commercial and subsistence harvest alternating with conservation efforts. Joint U.S.-Russia surveys have been conducted since the 1970s but inconsistencies between methodologies, survey periods, and extent of area surveyed have yielded estimates of abundance that vary widely and the USFWS does not consider these surveys sufficient to establish the current population abundance or trend, although advances in thermal imaging and satellite telemetry could improve this situation (USFWS 2011c). In February 2011 the USFWS determined that Pacific walrus should be listed as either endangered or threatened under the ESA but higher priorities precluded the action and the species was put on the list of candidate species awaiting future action (USFWS 2011c). The listing action was determined to be warranted primarily based on the likelihood of sea-ice habitat modification due to climate change and marine habitat modification due to ocean acidification.

Pacific walrus are highly dependent on sea ice for critical life functions and their seasonal distribution is heavily influenced by seasonal ice movement in Arctic waters. They typically remain in close proximity to the pack ice as it recedes north in summer and south in the winter. Relatively few walrus have been exposed to the many exploration and shipping vessels traversing the Arctic seas in the past because these large ships tend to stay away from the ice edge if possible. However, the number of walrus encountered by vessels in the open water has increased in recent years, primarily in the fall when the ice pack recedes beyond the shelf break into water too deep for walrus to forage. The ice pack has been receding further north and sooner than it has in the past due to climate change. This change in the pack ice distribution has forced thousands of walrus to swim to shore-based haul outs along the Chukchi coast where they are more exposed to vessel and aircraft traffic (Clarke et al. 2011a, Fischbach et al. 2009). Use of shore-based haul outs may leave walrus, particularly calves and juveniles, vulnerable to disturbance related stampedes and trampling mortalities (Fischbach et al. 2009) and predation from similarly shore-bound polar bears.

Walrus have been displaced from pack ice and ice floes by icebreakers and other vessels used for scientific and commercial purposes. Low-flying fixed-wing and helicopter traffic over the ice and in nearshore areas has caused disturbance of walrus on the ice and on shore-based haul outs. There have been no commercial or subsistence fishing operations in the Arctic seas large enough to affect their prey base but large bottom trawl fisheries in the Bering Sea may affect the winter prey base of walrus. Like all Arctic-dwelling animals, walrus have been exposed to man-made and potentially toxic chemical compounds in the water and the food web that have been transported to the Arctic from around the world through the atmosphere, water currents, and migrating animals (AMAP 2010). Walrus are also subject to subsistence hunting in various parts of their range, primarily near coastal communities adjacent to the Bering and Chukchi seas in Alaska and Russia. The USFWS estimates that the most recent five-year average subsistence harvest in Alaska and Russia (2003 to 2007) is 4,960 to 5,457 walrus per year, including animals estimated to be struck and lost (Allen and Angliss 2011).

4.11.4.10.5.3 Reasonably Foreseeable Future Actions

All of the same factors external to offshore oil and gas exploration in the Beaufort and Chukchi seas that have affected walrus in the past are likely to continue in the future. Marine vessel traffic is expected to increase as the ice pack recedes due to climate change, primarily involving large international commercial ships. Offshore oil and gas exploration and development is also likely to increase in Arctic waters of other countries (i.e. Russia and Canada) as the ice pack recedes and allows access to previously ice-covered areas. On-shore oil and gas exploration and production activities are also expected to continue on the Alaskan North Slope. Although very few walrus would likely occur east of Barrow they could be exposed to vessels and barges passing through the Chukchi and Bering seas between southern ports and the Prudhoe Bay area. Reasonably foreseeable natural gas development projects (the Point Thomson production unit and the Alaska Pipeline Project) could affect walrus during their construction phases due to their use of large sea lifts for pre-built facilities and materials. Potentially toxic compounds will continue to be produced around the world and many will find their way to the Arctic, with unknown impacts on walrus and their habitat. Subsistence hunting will likely continue to be the largest source of direct human-induced mortality on walrus. The greatest concern for walrus in the reasonably foreseeable future is the continued Arctic warming trends and the resulting deterioration of sea ice conditions that are so important to this species. Most of the other factors that could affect walrus would have more localized effects but climate change affects the entire range of this species and could adversely affect every life stage.

4.11.4.10.5.4 Contribution of Alternative 2 to Cumulative Effects

The exploration activities authorized under Alternative 2 would add to the disturbance of walrus from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be temporary. Exploration activities would contribute negligible risk of additional mortality to walrus, which would continue to be dominated by subsistence harvest. Exploration activities could contribute to habitat change through on-ice surveys, icebreaking efforts, and discharge of drilling muds but these effects would be localized and temporary or short-term. This contribution to habitat change would be negligible compared to the potential for dramatic sea ice loss due to climate change and changes in ecosystems due to ocean acidification. The exploration activities authorized under Alternative 2 would therefore have negligible to minor contributions to the cumulative effects on Pacific walrus.

4.11.4.10.5.5 Conclusion

The direct and indirect effects of Alternative 2 on Pacific walrus would be considered minor. Alternative 2 would have negligible to minor contributions to the cumulative effects.

There would be a remote chance of a very large oil spill occurring during exploratory drilling under Alternative 2 (Section 4.10.7.11). The implications for walrus would depend on the amount and distribution of the accidental spill, especially in relation to the ice pack, and how quickly and thoroughly it could be cleaned up. Walrus are not dependent on their fur to keep them warm so they are not as susceptible to rapid lethal effects from spilled oil as are birds or polar bears. Ingestion of oil or oil contaminated prey items can cause tissue changes (Kooyman et al. 1976). It is not clear if walrus are able to metabolize small amounts of oil as has been demonstrated with ringed and bearded seals but they have a similar physiology so tissue damage may be temporary unless they are exposed to chronic contamination (Kooyman et al. 1976). Chronic exposure may result in mortality or long term sub-lethal effects that reduce fitness. A very large oil spill could contribute substantially to the cumulative effects of disturbance on walrus because of the large number of marine vessels and aircraft that would be involved in any clean-up effort, which would likely extend for more than one year and involve a large area. It could also contribute to injury and mortality of walrus if such disturbance causes stampedes of animals hauled out on land, especially young animals and those with poor health. The contribution to habitat effects could be long-term because of the potential for spilled oil to persist in benthic sediments, to be captured in the food web, and to persist on shore-based haulouts for greater than 5 years. Given the conservation concerns for the walrus population due to changing ice conditions, the additional mortality and disturbance caused by a very large oil spill that impacts the Chukchi Sea could have population-level effects. If a VLOS were to occur, there would be a moderate to major additive effect to the cumulative effects associated with Alternative 2 on Pacific walrus.

4.11.4.10.6 Polar Bears

4.11.4.10.6.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 2 on polar bears are described in Section 4.5.2.4.14 and are summarized here. Polar bears have been infrequently encountered during vessel-based exploration activities in the past, as recorded by PSOs on board source vessels and monitoring vessels. These sparse data indicate that polar bears do not react strongly to vessels and active seismic arrays and their behavioral responses are often neutral rather than running or swimming away. They also do not appear to react strongly to icebreaking or on-ice surveys. Some bears keep their distance or move away at some point but others may approach vehicles and equipment out of curiosity. The types of effects of most concern for polar bears during exploration activities involve the risk of bear-human encounters. Mitigation measures and polar bear safety/interaction plans required by USFWS LOAs since the early 1990s have reduced the risk of these encounters for both people and bears. None of the data collected to date on polar bear reactions to exploration activities indicate that polar bears would be displaced from key areas or resources for more than a few minutes or hours and they are unlikely to experience any measurable effects on their reproductive success or survival as a result. Polar bears are legally protected under the MMPA and ESA, have a unique ecological role in the Arctic, and are important to subsistence cultures and are therefore considered a unique resource. Given the mitigation measures that would be required by USFWS LOAs and NMFS as considered in this EIS, the effects of exploration activities that could be authorized under Alternative 2 on polar bears would likely be low in magnitude, distributed over a wide geographic area, and temporary in duration. The effects of Alternative 2 would therefore be considered minor for polar bears.

4.11.4.10.6.2 Past and Present Actions

There are two populations of polar bears in Alaska waters, the Southern Beaufort Sea stock and the Chukchi/Bering seas stock. Abundance levels and trend information on polar bears have been difficult to obtain due to their wide but sparse distribution and the logistical difficulties in conducting research over the shifting ice pack. The current best estimate is that the Southern Beaufort Sea stock has about 1,500 animals and is declining slowly (Allen and Angliss 2010, Hunter et al. 2007). There is currently no reliable population estimate or trend information for the Chukchi/Bering seas stock. In 2008, the USFWS determined that polar bears should be listed as threatened under the ESA throughout their range (73 FR 28212, May 15, 2008). This determination was based on declining sea ice habitat throughout the species range and the anticipated continued decline in the foreseeable future. Critical habitat, which was designated in 2010, included sea-ice habitat, terrestrial denning habitat, and barrier island habitat (75 FR 76086, December 7, 2010); however, this designation has recently been overturned by the courts.

Polar bears are highly dependent on sea-ice for critical life functions and their seasonal distribution is heavily influenced by the seasonal distribution of the ice seal species, which are their main prey, and by seasonal ice movement in Arctic waters. All polar bears except denning females typically roam across the pack ice as it recedes north in summer and south in the winter, although some bears spend time on barrier islands and the coast in the fall and winter to scavenge on whale carcasses. In the past, the majority of denning females in Alaska chose den sites on the pack ice (Amstrup and Gardner 1994) but more recent data indicate that the majority now choose den sites on land (Fishbach et al. 2007), a trend that appears related to thinning of the ice cap due to climate change (Durner et al. 2006). Another result of climate change is the increasingly delayed formation of sea-ice in the fall, forcing more bears to spend more time on land where they have difficulty catching prey and subsequently increasing the chance of human-bear interactions with increased mortality of bears killed in defense of life or property (Amstrup 2000b).

Polar bears have been subject to subsistence and sport hunting in many parts of their range but several treaties and inter-government agreements have been implemented to limit hunting mortality. Only subsistence hunting by Alaska Natives is allowed in Alaska. The 2003-2007 average Alaska harvest for the Southern Beaufort Sea stock was 33 bears per year and an additional 21 bears per year were taken from this stock in Canada (Allen and Angliss 2011). Harvest levels from the Chukchi/Bering stock are not as well known. An average of 65 bears per year are known to be harvested in Alaska and Russia but illegal harvests in Russia may account for an additional 150 to 250 bears per year (Allen and Angliss 2010).

Relatively few polar bears have been exposed to the many exploration and shipping vessels traversing the Arctic seas in the past because these large ships tend to stay away from the ice edge if possible. In the Beaufort Sea, polar bear sightings from exploration vessels are uncommon and most of these have been of polar bears on or near barrier islands in the fall (Savarese et al. 2010). In the Chukchi Sea, polar bear sightings from vessels have been relatively rare, with half the bears sighted in the water, and they generally do not react strongly to the presence of vessels (Haley et al. 2010b). Other temporary sources of disturbance in the past include icebreakers and low-flying fixed-wing and helicopter traffic.

Like all Arctic-dwelling animals, polar bears have been exposed to man-made and potentially toxic chemical compounds in the water and the food web that have been transported to the Arctic from around the world through the atmosphere, water currents, and migrating animals (AMAP 2010). As a top predator, polar bears could have high levels of potentially toxic compounds that bioaccumulate in the food chain, such as organochlorines and mercury (Braune et al. 2005, AMAP 2005).

4.11.4.10.6.3 Reasonably Foreseeable Future Actions

All of the same factors external to offshore oil and gas exploration in the Beaufort and Chukchi seas that have affected polar bears in the past are likely to continue in the future. The greatest concern for polar bears in the reasonably foreseeable future is the continued Arctic warming trends and the resulting deterioration of sea ice conditions that are necessary for this species and its prey. Most of the other factors that could affect polar bears would have more localized effects but climate change affects the entire range of this species and could adversely affect every life stage.

Marine vessel traffic is expected to increase as the ice pack recedes due to climate change, primarily involving large international commercial ships, which contributes to the risks of accidental fuel spills and other contamination. Offshore oil and gas exploration and development is also likely to increase in Arctic waters of other countries (i.e. Russia and Canada) as the ice pack recedes and allows access to previously ice-covered areas. These developments outside of Alaska could affect polar bears through oil spills transported in the ice pack or ocean currents. On-shore oil and gas exploration and production activities are also expected to continue on the Alaskan North Slope, although the impacts should be mitigated through LOAs issued by the USFWS. Reasonably foreseeable natural gas development projects (the Point Thomson production unit and the Alaska Pipeline Project) could affect polar bears through disturbance in denning and barrier island habitats, especially during construction, although these activities would also be mitigated through USFWS LOAs. Potentially toxic compounds will continue to be produced around the world and many will find their way to the Arctic, with unknown impacts on polar bears and their habitat. Hunting will likely continue to be the largest source of direct human-induced mortality on polar bears.

4.11.4.10.6.4 Contribution of Alternative 2 to Cumulative Effects

The exploration activities authorized under Alternative 2 would add to the disturbance of polar bears from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be temporary. Exploration activities would contribute negligible risk of injury or additional mortality to polar bears, which would continue to be dominated by subsistence harvest. Exploration activities could contribute to habitat change through on-ice surveys, icebreaking efforts, and discharge of drilling muds but these effects would be localized and temporary or short-term. This contribution to habitat change would be negligible compared to the potential for dramatic sea ice loss due to climate change and changes in ecosystems due to ocean acidification. The exploration activities authorized under Alternative 2 would therefore have a negligible to minor contribution to the cumulative effects on polar bears.

4.11.4.10.6.5 Conclusion

The direct and indirect effects of Alternative 2 on polar bears would be considered minor. Alternative 2 would have negligible to minor contributions to the cumulative effects.

There would be a remote chance of a VLOS occurring during exploratory drilling under Alternative 2 (Section 4.10.7.11). The implications for polar bears would depend on the amount and distribution of the accidental spill, especially in relation to the ice pack and to denning areas, and how quickly and thoroughly it could be cleaned up. Polar bears are susceptible to oil spill-induced injury and death through lost insulation value of their fur and ingestion of oil by grooming or contaminated prey (Hurst and Oritsland 1982, Neff 1990). Polar bears are curious about new things in their environment and may not avoid oil spill areas or contaminated prey or carcasses (St. Aubin 1990, Derocher and Stirling 1991). Marine mammal observers on clean-up crews may be effective at diverting curious bears from small spill areas but would likely be ineffective if the spill covers a large area or occurs during periods of darkness. A VLOS could contribute substantially to the cumulative effects of disturbance on polar bears because of the large number of marine vessels and aircraft that would be involved in any clean-up effort, which would likely extend for more than one year and involve a large area. The contribution to habitat effects could be long-term because of the potential for spilled oil to persist on coast lines and barrier islands for greater than five years.

Given the conservation concerns for polar bears due to changing ice conditions, the additional mortality and disturbance caused by a VLOS in either the Beaufort or Chukchi seas could have population-level effects. If such a spill were to occur, there would be a moderate to major additive effect to the cumulative effects associated with Alternative 2 on polar bears.

4.11.4.11 Terrestrial Mammals

4.11.4.11.1 Summary of Direct and Indirect Effects

The oil and gas exploration activities proposed in Alternative 2 could have direct and indirect effects on caribou, and possibly other terrestrial mammals from disturbances created by helicopters and fixed wing aircraft fly overs used for crew changes and other support of exploratory drilling programs in the Beaufort and Chukchi seas. Disturbances to caribou may also result from a general increase in human activities (air or ground) in the EIS project area, due to an overall increase in human population from support crews living in the North Slope area.

Disturbance to caribou may result in movements away from preferred habitats or away from preferred migration routes. Caribou respond to flyovers and nearby landings in a variety of ways depending on the degree of their habituation, weather conditions, sex and age composition of the herd, and the aircraft itself (Calef et al. 1976, Horejsi 1981). The type of aircraft, altitude, airspeed and frequency of flyovers all play a role on the caribou's reaction. Disturbance of caribou could also cause immediate physical injury or death to animals fleeing the disturbance, or could result in increased expenditures of energy or changes in the physiological condition of the animals, which reduces their rates of survival and reproduction. These reactions can result in long-term changes in behavior, especially the traditional use of calving areas and insect relief areas (Calef et al. 1976). An increase in human population within the EIS project area and the associated vehicle traffic from support crews or the population in general may result in an increase in the number of vehicle strikes causing injury or mortality to caribou. Increased hunting pressure from increased human populations in the EIS project area may also have short term effects on the caribou populations and an increase in the number of local sport hunters may compete with subsistence users.

4.11.4.11.2 Past and Present Actions

Numerous past and present actions have caused disturbances to the four caribou herds that may be affected by the implementation of Alternative 2. Although most of these probable disturbances may not be occurring within the EIS project area they have occurred in the past and continue to occur at several other locations within the migratory ranges of these North Slope caribou herds. Activities causing disturbance to caribou throughout their range contribute to the overall disturbance levels of these animals.

Past and present actions include North Slope oil and gas exploration, development, and production activities including the construction and operation of the Trans-Alaska Pipeline System, permanent roads and winter ice roads; construction of support facilities; and transportation activities involving surface vehicles, aircraft or marine traffic along the coast or within the barrier islands. The Central Arctic Herd's use of calving and midsummer habitats declined from the mid 1970's through the mid 1980's near oil field infrastructure on Alaska's Arctic Coastal Plain (Dau and Cameron 1986).

Caribou habitat has also experienced direct and indirect effects. Road construction, as well as pipeline construction, has not only destroyed some caribou habitat within the footprint of the road, but has also resulted in a reduction of habitat use within the adjacent areas. Cameron et al. (1992) found that calving caribou were displaced outward after construction of the Milne Point road system, resulting in underutilization of habitats adjacent to roads and overutilization elsewhere, effectively diminishing the capacity of the area to support caribou. Cameron et al. (2005) also reported that in the Kuparuk Development Area, west of Prudhoe Bay, abundance of calving caribou was less than expected within 4 km (2.5 mi) of roads and declined exponentially with road density. Currently there are thirty-five Alaska oil fields and satellite oil fields producing oil within the migratory ranges of the North Slope caribou herds, and additional discoveries are under development. There are also numerous oil and gas development activities occurring in Canada within the migratory range of the Porcupine Caribou Herd.

Mining is another example of past and present activities with direct and indirect effects on caribou, such as the development and operation of Red Dog Mine within the Northwest Arctic Caribou Herd range, which is the world's largest known zinc resource. As much as 25 million tons of high-grade zinc was estimated to be present near Red Dog Mine. Mining activities relative to caribou include the loss of habitat within the foot print of the mine and its support facilities and vehicle traffic between the mine and the coast.

Scientific research such as the continuation of ongoing and special biological surveys, and geophysical studies using both surface and aircraft transportation throughout the North Slope and Brooks Range can effect caribou. BOEM Alaska OCS region Oceanographic research in 2011 included physical oceanography studies, habitat and ecology studies including mapping the distribution of shorebirds. Many of these activities involve aircraft support with potential for caribou disturbances along the coast.

Military activity in the Arctic is thought to have increased in recent years. The Distant Early Warning Line, also known as the DEW-Line, was a system of 63 radar stations located across the northern edge of the North American Continent, roughly along the 69th parallel. Many of these coastal sites are associated with insect relief areas used by caribou. The radar stations were constructed between 1954 and 1957, and decommissioned during the 1990s. The Bullen Point site is currently managed by the U.S. Air Force and has a gravel airstrip and a small radar system.

Subsistence activities, such as routine travel to subsistence camps using aircraft, snow machines and boats along the coast or within the barrier islands cause some disturbance to caribou utilizing those areas. Sport hunting, as well as other recreational activities utilizing aircraft support also cause some level of disturbances to caribou throughout the seasonal ranges of these four caribou herds.

4.11.4.11.3 Reasonably Foreseeable Future Actions

There are numerous reasonably foreseeable future actions that may result in direct or indirect effects to caribou, through construction and operation of many projects, as well as the related activities of the associated human population expected to increase as a result. Oil and gas development in NPR-A will include the development of exploration and production facilities, road networks and support facilities. The Alaska Pipeline Project near Prudhoe Bay will include facilities to treat, transport and deliver gas from the North Slope of Alaska to markets in North America, which will include the installation and operation of a gas treatment plant at Prudhoe Bay with construction targeted for 2014. The Point Thompson project, located about 60 miles east of Prudhoe Bay will include the construction of three production pads, process facilities, an infield road system, an export pipeline, infield gathering lines and an airstrip.

Mining exploration, development, and production are expected in increase, which includes operations at the Red Dog Mine and the Red Dog Port within the migratory range of the Western Arctic Caribou Herd. The Red Dog Mine port site may also become the port facility for a very large proposed coal mining operation adjacent to the Chukchi Sea. In addition, coal mine prospecting proposals for the Brooks Range have been submitted to ADNR, Division of Mining, Land and Water (DMLW) for approval.

Military activity in the Arctic are expect to continue to increase in the foreseeable future. Activities may include training exercises and dismantling of DEW-Line sites (which may include demolition projects).

Routine travel and growth of transportation facilities is expected to continue within the North Slope. Industry uses helicopters and fixed wing aircraft to support routine activities. In addition, at least four companies operate air cargo services between North Slope communities and population centers. The majority of air travel and freight hauling between Arctic coastal communities involves small commuter-type aircraft, and government agencies and researchers often charter aircraft for travel and research purposes. These activities are expected to continue, and the level of aircraft traffic within the EIS project area may increase as a result of increased industrial activity. Activities associated with planned community development projects also have potential for direct and indirect effects on caribou. These include the Kaktovik airport project and ongoing water and sewage projects facilitated by the North Slope and Northwest Arctic boroughs.

Recreation and tourism will continue to increase, such as sport hunting, hiking, floating rivers, etc., particularly in the Arctic National Wildlife Refuge, as a result of elevated media exposure of the Refuge. Finally, subsistence hunting is a major source of mortality to caribou, and will continue in the future.

4.11.4.11.4 Contribution of Alternative to Cumulative Effects

The direct and indirect effects from Alternative 2 on caribou may be additive with some countervailing beneficial impacts, when considered in addition to the cumulative effects from other past, present and future activities identified above. Kutz et al. (2004) and Urban (2006) found that the construction of roads and gravel pads may provide caribou with additional insect-relief habitat, particularly when there is little or no road traffic present. However they also recognized that the construction of roads and pipelines could provide vectors by which invasive species, parasites, and new diseases could be introduced into the Arctic environment resulting in negative effects for caribou. Some studies of caribou responses to disturbances indicate that avoidance is not absolute and caribou may habituate to infrastructure and human activity (Haskell et al. 2006). Several studies have reported that ungulate populations in North America, including caribou have developed tolerance to aircraft, ground-vehicle traffic, and other human activities (Johnson and Todd 1977). Cronin et al. (2000) maintain that effects from onshore development and production have not resulted in negative population-level effects, and that the Central Arctic Herd has grown throughout the period of oil field development at a rate comparable to other herds in undeveloped areas (Lenart 2007).

Cow and calf groups appear to be the most sensitive to vehicle traffic, especially during the early summer months immediately after calving, and bulls appear to be least sensitive during that season. Minimizing traffic, especially within calving areas during the calving period, would reduce the potential for negative impacts on caribou (BOEM 2011b).

These findings suggest that caribou are able to habituate and adapt to some human activities, including vehicle traffic, aircraft operations and the construction and operation of oil and gas production facilities, but cow and calf groups are sensitive to these disturbances.

4.11.4.11.5 Conclusion

The incremental contribution of activities associated with Alternative 2 to cumulative effects on caribou would be negligible.

In the event of a VLOS, there would be a minor to moderate additive effect to the cumulative effects associated with Alternative 2 on caribou, depending on the magnitude and duration of the spill.

4.11.4.12 Time/Area Closures

The analysis of the cumulative effects associated with time/area closures can be found in Sections 4.11.4.10 (Marine Mammals), 4.11.4.9 (Marine and Coastal Birds) and 4.11.4.14 (Subsistence).

4.11.4.13 Socioeconomics

4.11.4.13.1 Summary of Direct and Indirect Effects

There would be no new Federal or State revenues generated under the implementation of Alternative 2 during the time period covered by this EIS because lease sales in federal and state waters have already been conducted and are the subject of proposed exploration activities. Some local revenues would be generated in communities that would stage crew or support services and that have a sales tax.

There would be a limited number of direct local North Slope employment opportunities associated with the standard mitigation measures for PSOs, Subsistence Advisors, Com Centers, and oil spill responders. There would be direct and indirect employment opportunities for Regional and Village Corporations that procure service contracts related to the above activities or support of crews and staging. In the communities of Barrow, Wainwright, Nome and Unalaska/Dutch Harbor (where crew changes occur or vessels are based), there could be short-term, seasonal demand on institutions and social services.

If a deflection or disturbance of subsistence resources occurs as a result of Alternative 2 (see the Subsistence Section), the activities of non-profit organizations could be impacted in order to coordinate adaptive strategies regarding potential economic and social implications of reduced harvest of subsistence resources. The Conflict Avoidance Agreement (CAA), Com Centers, and Plans of Cooperation (POC) are mechanisms currently used for communication, cooperation, and conflict avoidance between industry and local groups like the AEWC.

The magnitude of the socioeconomic impact is positive but low because total personal income and local employment rates are not increased by more than five percent. Revenues to the North Slope Borough would also not exceed five percent of their annual operating budgets. The duration of the socioeconomic impacts is temporary because it is not year-round. However, the activity is scheduled to occur over a fixed number of years. The positive economic impacts of the activity are statewide and even national in extent. The context of the socioeconomic impacts is unique because the people that would experience the flow of workers and research vessels are predominantly Iñupiat communities. The summary impact level for Socioeconomics under Alternative 2 is minor, not exceeding the significance threshold.

4.11.4.13.2 Past and Present Actions

The ongoing activities of the oil and gas industry are generally contained within the Prudhoe Bay industrial complex, between the Alpine Project to the west and Point Thomson Project to the east. The past and present actions that would contribute to the cumulative effects to socioeconomics under Alternative 2 are the same as those described for Alternative 1.

4.11.4.13.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions for Alternative 2 would be the same as those described for Alternative 1. This analysis assumes current levels of oil and gas production and on-shore exploration would continue, but does not assume that offshore exploration associated with Alternative 2 would result in future oil and gas production.

4.11.4.13.4 Contribution of Alternative to Cumulative Effects

The contribution of Alternative 2 to socioeconomic cumulative effects would be minor to negligible at a statewide and national level because the magnitude is low, the duration is temporary and the context is common. However, at a local level, the new direct employment, public revenue generation, and impact to social institutions would be greater and the Iñupiat community is a unique context, therefore the contribution would be minor.

4.11.4.13.5 Conclusion

The direct and indirect effects of Alternative 2 would be minor. The contribution to the cumulative effects of socioeconomics would be negligible to minor.

A VLOS in the Beaufort Sea or Chukchi Sea could result in short to long-term employment, potential new NSB revenues (property taxes for the construction of worker infrastructure) as well as potential lost revenue for NSB, state and federal revenues due to permitting delays, and exploration moratoria. Local and state agencies may also increase expenditures associated with the administration of oil spill response and social services related to the influx of new workers. The influx of workers would create a short to long-term demand on institutions and social services in NSB communities. Employment and local revenues associated with clean-up of a VLOS in the either the Beaufort or Chukchi Sea would be high intensity, long-term in duration, statewide to national in extent, and unique in context. The impact to the non-monetary economy is discussed in detail in Subsistence Section 4.10.6.15, but would be high intensity, long-term in duration, regional in extent, and important to unique in context. If a VLOS were to occur, there would be a major additive effect to the cumulative effects associated with Alternative 2 to socioeconomics.

4.11.4.14 Subsistence

4.11.4.14.1 Summary of Direct and Indirect Effects

Using the impact criteria identified in Table 4.2-25, the direct and indirect effect of oil and gas exploration activities on subsistence resources and harvests resulting from implementation of Alternative 2 would be of low intensity, temporary in duration, local to regional in extent, and the context would be common to unique. Protected resources (bowhead whales and polar bears are considered unique in context as these resources are protected by legislation (e.g. MMPA, ESA) or are considered an important subsistence resource (beluga whales). Therefore the summary impact level of Alternative 2 on subsistence resources and harvests would be considered to range from negligible to moderate depending upon the specific subsistence resource affected and source of disturbance (Section 4.5.3.2).

4.11.4.14.2 Past and Present Actions

Numerous past and present actions (Section 4.11.2) have likely caused disturbances to subsistence resources and hunting/harvest activities that may be affected by the implementation of Alternative 2. Although most of these probable disturbances may not be occurring within the EIS project area they have occurred in the past and would likely continue to occur at several other locations within mapped subsistence harvest areas (Figure 3.3-13). Past and present actions that cause disturbance to subsistence activities throughout the ranges of harvested resources contribute to the overall disturbance levels on resources and affect the success of subsistence hunting, harvests and rates of sharing between communities.

Past and present actions include North Slope oil and gas exploration, development, and production activities including the construction and operation of the Trans-Alaska Pipeline System, permanent roads and winter ice roads; construction of support facilities; and transportation activities involving surface vehicles, aircraft or marine traffic along the coast or within the barrier islands. Issues with user access and disturbance associated with these activities have caused real and perceived impacts to subsistence activities and harvest success. The habitat of subsistence resources has previously experienced direct and indirect effects which in turn have affected subsistence harvest. For instance road construction, as well as pipeline construction, has destroyed some caribou habitat within the footprint of the road, and has also resulted in a reduction of habitat use by this subsistence resource and limited harvest areas available within the adjacent areas (Section 4.11.4.11).

Mining is an example of past and present activities with direct and indirect effects on marine mammals and caribou, such as the development and operation of Red Dog Mine. This mine is located within the Northwest Arctic Caribou Herd range and barge traffic occurs through marine mammals harvest areas of Kivalina hunters. Subsistence users from Kivalina have noted a change in the seasonal pattern of harvest of beluga whales since the mine has been operational (Section 4.5.3.2). Mining activities relative to subsistence resources include the loss of habitat within the foot print of the mine and its support facilities and vehicle traffic between the mine and the coast and maritime shipping traffic.

Scientific research such as the continuation of ongoing and special biological surveys, and geophysical studies using both surface and aircraft transportation along the coast lines and throughout the North Slope can affect subsistence hunting and harvest activities. Past and present scientific research activities are described in Table 4.10-3. Many of these activities have included vessel, aircraft and over ice-support that potentially disturbs marine mammals and terrestrial resource subsistence hunting and harvest activities along the coast.

Military activity in the Arctic is thought to have increased in recent years. Vessel traffic through open water, aircraft overflights and related maneuvers have likely and will continue to contribute to cumulative effects on subsistence resources and their harvest by hunters.

Past and present subsistence activities, such as routine travel to subsistence camps using aircraft, snow machines and boats along the coast and small boat traffic within the barrier islands causes some disturbance to the subsistence resources and rates of harvest of the resources that are utilizing those areas. It is unlikely that past subsistence bowhead whaling led to adverse effects on a population level. Subsistence harvests are currently the primary source of mortality for bowhead whales, with an average of about 40 takes per year (Suydam et al. 2011). The subsistence harvest is well-managed and regulated through a quota system by the IWC (Section 3.3.2). There is no indication of long-term adverse effects on the population from the level of take through the subsistence harvest (approximately 0.1 to 0.5 percent of the population per year [Philo et al. 1993b]) appears to be sustainable.

Recreation, tourism and sport hunting, as well as other recreational activities utilizing aircraft support also cause some level of disturbances to subsistence activities such as caribou hunting, fishing, and migratory bird hunting throughout the project area.

Subsistence hunters have noted that climate change has affected the trends and methods of subsistence harvest of marine mammals (Section 3.3.2.6). Changes in ice conditions have influenced the spring bowhead whale hunt in the Beaufort and Chukchi seas communities. Wainwright, Point Hope and Point Lay have recently been conducting fall bowhead whale hunts to provide for their communities and meet allotted quotas when ice conditions have been considered less dangerous than in recent spring seasons when it has been considered too dangerous for crews to hunt (Comstock 2011).

4.11.4.14.3 Reasonably Foreseeable Future Actions

The same factors external to offshore oil and gas exploration in the Beaufort and Chukchi seas that have affected subsistence harvests in the past and present (Table 4.10-1) are likely to continue in the future. Subsistence hunting will likely continue to be the largest source of direct human-induced mortality on marine mammals. Marine vessel traffic is anticipated to increase and vessels would include those used for used for fishing and hunting, cruise ships, icebreakers, Coast Guard vessels, supply ships, tugs, and barges. The retreat of sea ice will make navigation easier during the longer open ice periods and increases in the levels of commercial shipping and tourism are expected to occur (Arctic Council 2009). The reduced sea ice extent will likely open up the Northwest and Northeast Passages for maritime shipping. Offshore oil and gas exploration, mineral exploration and development are also likely to increase in Arctic waters of other countries (i.e. Canada, Russia and Norway) as the ice pack recedes and allows access to previously ice-covered areas. Icebreakers from other nations are expected to become increasingly more present in the Arctic seas contributing the levels of noise introduced into the marine environment which in turn could impact subsistence resources and rates of harvest. The distribution of subsistence resources could change if the disturbance or alters resource distribution and/or migratory patterns.

Onshore oil and gas exploration and production activities are expected to continue on the Alaskan North Slope. Reasonably foreseeable natural gas development projects (the Point Thomson production unit and a large diameter natural gas pipeline) could affect subsistence resources and harvests during their construction phases which involve sea lifts of processing facilities infrastructure and materials during the open water season and development of nearshore structures. Access to subsistence resources and subsistence-hunting areas could change if the disturbance reduces the availability of subsistence resources for harvest or alters species distribution and or migratory patterns.

Potentially toxic compounds will continue to be produced around the world and many could find their way to the Arctic. There is the potential that some contaminants may accumulate in marine and terrestrial subsistence resources and in turn may have human health implications.

The greatest concern for subsistence resources in the reasonably foreseeable future is the continued trends of Arctic warming and the resulting deterioration of sea ice conditions that are important to subsistence resources and users. Climate change affects the entire range of subsistence resources and eventually could adversely affect harvest rates and success. Climate change could lead to changes in diversity, abundance, and distribution of traditional subsistence resources and harvest patterns and in turn lead to rapid and long-term impacts on the availability of some subsistence resources. Changing ice conditions are noted as a threat to indigenous lifestyles and subsistence practices. As ice conditions deteriorate, travel to hunting areas, and hunting itself become more hazardous due to more hunting in open water. Larger and more expensive vessels and motors may be required (Forbes 2011).

4.10.4.14.4 Contribution of Alternatives to Cumulative Effects

The activities authorized under Alternative 2 would add to the disturbance of subsistence resources from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be temporary and local. Of greatest concern would be potential effects on fall bowhead whale and other subsistence hunting activities associated with disturbance and behavioral responses. A low number of seals and polar bears could be disturbed during on-ice seismic surveys. Exploration activities would constitute a minor contribution to the disturbance of subsistence resources. Exploration activities could contribute to habitat change of subsistence resources through aircraft and vessel traffic, icebreaking efforts, on-ice surveys and discharge of drilling muds but these effects would be of low intensity, localized and temporary or short-term in duration, and affecting common to unique resources in context. This contribution to habitat change would be negligible when compared to the potential for dramatic sea ice loss due to climate change and changes in ecosystems and resource abundance due to ocean acidification. The exploration activities authorized under Alternative 2 would therefore have a negligible to moderate contribution to the cumulative effects on subsistence resources. Implementation of Alternative 2 would be considered additive to cumulative effects on subsistence resources.

4.11.4.14.5 Conclusion

Under Alternative 2, the direct and indirect effects to subsistence resources are considered low in intensity, temporary in duration, local to regional in extent and affect subsistence resources that range from common to unique in context. Implementation of Alternative 2 would be considered additive to cumulative effects on subsistence resources. The contribution of the direct and indirect impacts in consideration of the past, present, and reasonably foreseeable future actions would be negligible to moderate on subsistence, depending on the subsistence resources affected.

There would be a low probability of a VLOS occurring during exploratory drilling under Alternative 2. The implications for subsistence resources and harvests would depend on the amount and distribution of the accidental spill, especially in relation to the ice pack, and how quickly and thoroughly it could be cleaned up. A VLOS could contribute substantially to the cumulative effects of disturbance on marine mammals. This would be due to the large number of marine vessels and aircraft that would be involved in any clean-up effort, which would likely extend for more than one year and involve a large area. It could also contribute to injury and mortality of fish, marine and coastal birds and terrestrial resources which are important subsistence resources. If a VLOS were to occur, there would be a major additive effect to the cumulative effects associated with Alternative 2 to subsistence resources and harvests.

4.11.4.15 Public Health

4.11.4.15.1 Summary of Direct and Indirect Effects

As described in Section 4.5.3.3, both beneficial and adverse impacts on public health and safety could result from Alternative 2. Possible changes could occur to the numbers of people experiencing chronic disease and injury/trauma, primarily as a result of effects on traditional practices and subsistence activities. However, there is a very low likelihood of these health outcomes occurring, and effects are unlikely to be large enough cause a measurable change in health outcomes at a population level. The magnitude or intensity of effects is estimated to be low: above background conditions, but small and within both the natural variation and adaptive ability of the local population. If health changes do occur, the duration of changes may be permanent, and multiple communities could be affected.

4.11.4.15.2 Past and Present Actions

Over the last 50 to 100 years, as development and industrialization have increased, the population living in the EIS project area has experienced rapid modernization and acculturation, with significant changes in diet, housing, employment, and traditional culture. These changes have been accompanied by a shift in the burden of disease experienced by the population, as infectious disease and infant mortality have abated and chronic disease and cancer have become leading causes of death. This phenomenon, often known as the epidemiologic transition, is typical in any population as it develops, but is particularly acute in populations experiencing rapid modernization. Indigenous populations worldwide have seen particularly dramatic health changes over the last several decades as modernization has brought with it significant changes in diet, sociocultural systems and economic conditions. Circumpolar regions such as the EIS project area are particularly impacted.

Much of the change associated with this transition is for the better. For example, life expectancy increases, infant mortality decreases and age-specific mortality decreases. Rates of infectious diseases such as tuberculosis and vaccine-preventable illnesses also decline. Health care services, public health programs and municipal health infrastructure such as sanitation and water treatment also improve with development. Most population health indicators show that health in the EIS project area has significantly and steadily improved since the 1950s.

However, the epidemiologic transition also comes with some adverse health outcomes. The rates of chronic diseases such as cancer, cardiovascular disease and metabolic disorders rise. Health outcomes related to social conflict and stress also increase. In the EIS project area, as in most other circumpolar and indigenous populations, development has been commensurate with increases in alcohol and substance misuse, suicide, violence and other social dysfunction.

Much of this change in the burden of disease among the Iñupiat is a result of general development, economic growth and cultural change. The extent to which oil and gas development has contributed to it is unknown; however, there are well-documented causal pathways between oil and gas development activities and changes in both health determinants and outcomes, and local testimony supports the association of oil and gas with both positive and adverse health outcomes. Although the exact contribution of oil and gas development is unknown, its role as the primary driver of economic and industrial development in the region does support at least an indirect causal association.

However, the pattern of development and modernization that has taken place in the EIS project area has led to the creation of certain health areas that are of particular importance when considering cumulative effects. These include:

- **Injury and trauma.** The population living in the EIS project area experience high levels of injury and trauma, with high morbidity and mortality rates across most age groups. This is common in any rural or remote region and is particularly high in populations that engage in subsistence activities. These high rates of injury may be exacerbated by the way in which traditional subsistence activities have adapted to the presence of development – for example, hunters report that they need to travel farther to reach subsistence resources due to both a displacement of animals and to avoidance of industrialized areas.
- **Social pathologies such as alcohol and drug misuse, social dysfunction and violence.** Oil and gas development, with its large in-migrations of outside workers and influxes of money into the local economies, is associated with increased social pathology. In addition, the development of roads and seasonal access to the region increase opportunities to import alcohol.
- **Health disparities.** There already exist patterns of economic and health disparity within the EIS project area, with health outcomes and health determinants unevenly distributed within and across the population. Recent/present development, as well as future development has the potential to exacerbate these disparities both because of the uneven distribution of the "rewards" of development and because of uneven distribution of the risks.

4.11.4.15.3 Reasonably Foreseeable Future Actions

As described in Tables 4.10-1 through 4.10-7 and 4.10-9, there are a significant number of activities planned and/or approved in the EIS project area, including oil /gas exploration, development and production; scientific research activities; mining projects; military developments and activities; transportation plans; community development projects; and recreation and tourism activities. These future actions will continue to influence public health and safety. The common components of these future actions that are most likely to drive public health and safety outcomes are:

- A potential growth in population in the communities of the EIS project area;

- In-migration of workers not originally from the EIS project area;
- Economic changes at the level of both individual residents and the Native Corporations;
- Changes in the level or success of subsistence activities;
- Regional industrialization;
- Changes in/improvements to public infrastructure;
- Potential exposure to environmental contaminants;
- Changes in access to or use of the land; and
- Continued acculturation of the Iñupiat people and deterioration of sociocultural traditions.

As the reasonably foreseeable future actions continue the path and progress of development seen in past actions, it can be expected that the changes in public health and safety outcomes will follow the same trends that have been observed in recent years. These include:

- Improvements in general health indicators such as mortality and life expectancy;
- A shift in the burden of illness away from infectious disease and towards higher rates of chronic conditions;
- Changes in diet towards increased use of store-bought foods and associated changes in nutritional outcomes;
- Increasing disparities in health outcomes between the more-wealthy and the less-wealthy; and
- Increased rates of social ills including crime, violence, and alcohol and drug misuse.

Of particular significance for public health and safety is further increases in offshore oil and gas exploration, development and production following the demonstration of economically feasible opportunities. A ramp-up of offshore development has been posited by key informants to lead to potentially substantive changes in public health outcomes via three pathways: a) via displacement of marine mammals and the subsequent reduction of success and safety of subsistence hunting; b) via the potential for contamination and the fear of contamination through oil spills or routine discharge; and c) via substantially increased economic returns to the NSB, village corporations and individuals with resulting positive and negative health effects and disparities as outlined in Section 4.5.3.3.

4.11.4.15.4 Contribution of Alternative to Cumulative Effects

The effects on public health and safety resulting from Alternative 2 are likely to be low; and the direct contribution of the actions specified in Alternative 2 to cumulative effects on public health and safety should best be characterized as negligible. The pathways through which health effects would occur include diet and nutrition, contamination, safety, acculturative stress and economic impacts, as described in Section 4.5.3.3.

However, the health impacts of oil and gas development in the North Slope have been well documented in the past and insomuch as the activity in Alternative 2 will lead to further offshore oil and gas activity, there could be significant cumulative impacts in the future. These may also include health effects in other areas not anticipated through the direct and indirect effects of Alternative 2, such as increases in infectious disease and health outcomes related to air quality.

4.11.4.15.5 Conclusion

As described above, the contribution of the actions of Alternative 2 on public health and safety are likely to be negligible; however, the possibility of the exploration activity leading to further development raises the possibility of health consequences subsequent to this further activity.

As described in Sections 4.10.6.16 and 4.10.7.16, the magnitude of impacts from a VLOS would be medium to high, as some public health outcomes would be treatable and/or transient, but some may be irreversible. Some predicted public health effects would last for only a brief period and would be associated with the influx of workers during the Phase 4 clean-up period. However, health effects of a

VLOS resulting from changes in subsistence patterns would be likely to persist for many years. The geographic extent of the impact would vary depending on the size and location of the spill, but all EIS project area communities would be affected to some degree.

Alternative 2 therefore contributes to cumulative impacts on public health and safety via three mechanisms: a) the relatively small contribution of the direct and indirect impacts; b) acting as the gateway for additional future offshore oil and gas development; and c) and an unlikely but potentially large contribution from a VLOS. If a VLOS were to occur, there would be moderate to major additive effects to the cumulative effects associated with Alternative 2 to public health, depending on the size, nature, and location of the spill.

4.11.4.16 Cultural Resources

4.11.4.16.1 Summary of Direct and Indirect Effects

Direct and indirect impacts to cultural resources resulting from the implementation of Alternative 2 would be low-intensity and long-term in duration, but in a very localized area. Therefore, the summary impact level of direct and indirect effect from Alternative 2 for cultural resources is minor, not exceeding the significance threshold.

Direct effects to cultural resources include those activities that physically impact the condition or integrity of the resource. Specifically, construction of on-shore pipelines or staging areas could result in direct effects to surface or subsurface prehistoric or historic archaeological sites. Likewise, sea-floor based seismic activities and exploratory drilling could directly affect submerged prehistoric sites or historic vessels on the seafloor.

Indirect effects to offshore resources are unlikely, given that impacts would likely result during the exploratory phase of the project. Previously undiscovered resources, however, could be inadvertently damaged during this phase of the project. On-shore resources are more susceptible to indirect effects and can include inadvertent damage, looting caused by the introduction of increased access and local activity; and visual impacts to historic or traditional cultural properties.

4.11.4.16.2 Past and Present Actions

Past and present actions related to oil and gas exploration, development, production, and transportation are the main activities that have the potential to affect cultural resources in the EIS area. Currently there are 35 fields and satellites producing oil on the North Slope and in nearshore areas of the Beaufort Sea, and additional discoveries are under development. Specifically, these actions include North Slope oil and gas exploration, development, and production activities including the construction and operation of the Trans-Alaska Pipeline System, permanent roads and winter ice roads; construction of support facilities; and transportation activities involving surface vehicles, aircraft or marine traffic along the coast or within the barrier islands.

Mining is another example of past and present activities with direct and indirect effects on cultural resources, such as the development and operation of Red Dog Mine which is the world’s largest known zinc resource. As much as 25 million tons of high-grade zinc was estimated to be present near Red Dog Mine. Mining activities relative to cultural resources include ground-disturbing activities within the foot print of the mine and its support facilities and vehicle traffic between the mine and the coast.

Scientific research such as the continuation of ongoing and special biological surveys, and geophysical studies using both surface and aircraft transportation throughout the North Slope and Brooks Range can effect cultural resources with potential for ground disturbances along the coast.

Military activity in the Arctic, such as the development of the Distant Early Warning Line, also known as the DEW-Line, was a system of 63 radar stations located across the northern edge of the North American Continent, roughly along the 69th parallel. The radar stations were constructed between 1954 and 1957, and decommissioned during the 1990s. The Bullen Point site is currently managed by the U.S. Air Force and has a gravel airstrip and a small radar system.

Additionally, subsistence activities, such as routine travel to subsistence camps using aircraft, snow machines and boats along the coast or within the barrier islands cause some ground disturbance.

4.11.4.16.3 Reasonably Foreseeable Future Actions

There are numerous reasonably foreseeable future actions that may result in direct or indirect effects to cultural resources, through construction and operation of many projects, as well as the related activities of the associated human population expected to increase as a result. Oil and gas development will include the development of exploration and production facilities, road networks and support facilities.

The Alaska Pipeline Project near Prudhoe Bay will include facilities to treat, transport and deliver gas from the North Slope of Alaska to markets in North America, which will include the installation and operation of a gas treatment plant at Prudhoe Bay with construction targeted for 2014. The Point Thompson project, located about 60 miles east of Prudhoe Bay will include the construction of three production pads, process facilities, an infield road system, an export pipeline, infield gathering lines and an airstrip.

Mining exploration, development, and production are expected in increase, which includes operations at the Red Dog Mine and the Red Dog Port. The Red Dog Mine port site may also become the port facility for a very large proposed coal mining operation adjacent to the Chukchi Sea. In addition, coal mine prospecting proposals for the Brooks Range have been submitted to ADNR, Division of Mining, Land and Water (DMLW) for approval.

Military activity in the Arctic are expect to continue to increase in the foreseeable future. Activities may include training exercises and dismantling of DEW-Line sites (which may include demolition projects).

Routine travel and growth of transportation facilities is expected to continue within the North Slope. Activities associated with planned community development projects also have potential for direct and indirect effects on cultural resources. These include the Kaktovik airport project and ongoing water and sewage projects facilitated by the North Slope and Northwest Arctic boroughs.

Recreation and tourism will continue to increase, such as sport hunting, hiking, floating rivers, etc., particularly in the Arctic National Wildlife Refuge, as a result of elevated media exposure of the Refuge.

4.11.4.16.4 Contribution of Alternative to Cumulative Effects

The incremental contribution of activities associated with Alternative 2 to cumulative effects on cultural resources would be negligible.

4.11.4.16.5 Conclusion

Direct and indirect effects associated with Alternative 2 are considered to be minor. The incremental contribution of activities associated with Alternative 2 to cumulative effects on cultural resources would be negligible.

If a VLOS were to occur, there would be minor to moderate additive effects to the cumulative effects associated with Alternative 2 to cultural resources.

4.11.4.17 Land and Water Ownership, Use, Management

4.11.4.17.1 Summary of Direct and Indirect Effects

Land and Water Ownership

Based on Table 4.4-2, and the analysis provided in Section 4.5.3.5, the impacts on land and water ownership under Alternative 2 would be low in magnitude, temporary in duration, local in extent, and common in context. In total, the direct and indirect impacts on land ownership are considered to be negligible; they would result in no change of ownership or development rights.

Land and Water Use

Based on Table 4.4-2 and the analysis provided in Section 4.5.3.5, the impacts of land and water use caused by Alternative 2 would be high in magnitude where activity occurs in areas of little to no previous activity (such as Wainwright), and low in magnitude where activity occurs in areas where previous activity is common (Prudhoe Bay, Barrow, Nome, Dutch Harbor). Impacts would be temporary in duration, although the impact could be permanent if construction of a new facility or infrastructure to accommodate shipping traffic were built in Wainwright. The extent of impacts would be local and the context would be common. In summary, the direct and indirect effects of Alternative 2 on land and water use would be moderate.

Land and Water Management

Based on Table 4.4-2 and the analysis provided in Section 4.5.3.5, the impacts on land and water management caused by Alternative 2 would be low in magnitude temporary in duration, local in extent, and common in context. In total, the direct and indirect impacts of Alternative 2 on land and water management would be minor.

4.11.4.17.2 Past and Present Actions

Past and present actions affecting land and water ownership, use, and management within the EIS project area are discussed under Alternative 1, Section 4.4.1.2.

4.11.4.17.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting land and water ownership, use, and management within the EIS project area are discussed under Alternative 1, Section 4.4.1.2.

4.11.4.17.4 Contribution of Alternative to Cumulative Effects

The level of impact for land and water ownership under Alternative 2 would be negligible, and past, present, and reasonably foreseeable future actions are not expected to result in any changes in ownership. The level of impact on land and water use under Alternative 2 would be moderate, and duration would be short-term and seasonal in nature. With the possibility of some small changes in land use in the foreseeable future, the cumulative impact would remain moderate, as any additional changes in land use and water use would be incrementally small, short-term in duration and geographically dispersed. The level of impact on land management under Alternative 2 would be minor, and effects from past, present, and reasonably foreseeable future actions are negligible. Under Alternative 2, all changes would be incrementally small and geographically dispersed, and thus would not have combined effects creating cumulative impacts on land ownership, use, or management.

4.11.4.17.5 Conclusion

Under Alternative 2, the levels of direct, indirect and cumulative impacts for land and water ownership, use, and management would be negligible, moderate, and minor, respectively. Based on this, the overall level of impact is considered minor. The contribution of Alternative 2 to cumulative effects would be considered negligible.

If a VLOS were to occur, there would be major additive effects to the cumulative effects associated with Alternative 2 on land and water ownership, use, and management.

4.11.4.18 Transportation

4.11.4.18.1 Summary of Direct and Indirect Effects

Alternative 2 would increase the levels of air, roadway, and vessel traffic in the EIS project area. However, the increased traffic levels would be of low intensity, temporary, local in extent, and affecting resources considered common in context. As a result, the overall direct and indirect effects would be considered minor.

4.11.4.18.2 Past and Present Actions

Past and present actions such as: transportation of freight and local residents to, from, and between communities in the EIS project area; oil and gas exploration, drilling, and development; military development; mining; and tourism have included construction and expansion of local roads, airstrips, docks, seasonal ice roads, and the presence of vessels in the EIS project area. Coastal and marine vessel/barge traffic, fixed-wing and helicopter traffic, low-pressure tundra-travel, off road vehicles (four wheelers), snowmobile traffic, and vehicle traffic on local roadways have been generated as a result of these actions.

4.11.4.18.3 Reasonably Foreseeable Future Actions

It is reasonable to assume that trends associated with transportation to facilitate the maintenance and development of coastal communities, Red Dog Mine, and Prudhoe Bay area oil and gas facilities will continue. In some specific cases, described below, transportation and associated infrastructure in the proposed activity area may increase as a result of increased commercial activity in the area.

Aircraft Traffic: Existing air travel and freight hauling for local residents is likely to continue at approximately the same levels. Air traffic to support mining is expected to continue to be related to exploration because there are no new large mining projects in the EIS project area in the permitting process. Tourism air traffic will not likely change much because there are no reasonably foreseeable events that would draw large numbers of visitors to travel to or from the area using aircraft. Sport hunting and fishing demand for air travel will likely continue at approximately the same levels. Use of aircraft for scientific and search and rescue operations is likely to continue a present levels.

Oil and gas industry use of helicopters and fixed wing aircraft to support routine activities and exploration within the EIS project area is likely to increase as a result of increased interest in North Slope exploration. Air traffic would also increase if the Point Thomson Project or the Alaska Pipeline Project were constructed. These increases could cause congestion at the Deadhorse Airport during construction seasons.

Vehicle Traffic: None of the RFFAs propose to construct permanent roads to the communities in the EIS project area. Construction of ice roads could allow industry vehicles access to community roads, and likewise allow residents vehicular access to the highway system.

Vessel Traffic: Vessel traffic through the Bering Strait has risen steadily over recent years according to USCG estimates, and Russian efforts to promote a Northern Seas Route for shipping may lead to continued increases in vessel traffic adjacent to the western portion of the EIS project area.

In addition, research vessels, including NSF and USCG icebreakers, also operate in the EIS project area. USCG anticipates a continued increase in vessel traffic in the Arctic. Cruise ships and private sailboats sometimes transit through the proposed action area. Changes in the distribution of sea ice, longer open-water periods, and increasing interest in studying and viewing Arctic wildlife and habitats may support an increase in research and recreational vessel traffic in the proposed action area regardless of oil and gas activity.

Increased barge traffic would occur if the Point Thomson Project or the Alaska Pipeline Project were constructed during the time period covered under this EIS. Coastal barges would support these projects by delivering fuel, construction equipment, and materials and sea lift barges would deliver modules for processing and camp facilities. If realized, this would result in additional barge traffic transiting through the EIS project area but potential for congestion would only be expected near Prudhoe Bay docks and only during construction. Offshore oil and gas exploration drilling would also result in some additional tug and barge, support, icebreaker, and other vessel traffic (Petroleum News 2011a) that could contribute to congestion if they used Prudhoe Bay area docks.

4.11.4.18.4 Contribution of Alternative to Cumulative Effects

Alternative 2 would be expected to have minor direct and indirect impacts on transportation infrastructure. Alternative 2 could cause a minor increase in vessel activity in the area, potentially adding to the congestion that would be expected at Prudhoe Bay docks if large projects such as Point Thomson or the Alaska Pipeline Project were being constructed simultaneously. It is likely however that dock operators would schedule vessel callings to reduce potential for congestion and operate continuously to speed the servicing of vessels and barges. Barge traffic would cease in the winter and continue at a reduced frequency during the open water season when the proposed projects are in operation.

Likewise, Alternative 2 could result in increased air travel through the EIS project area. This could contribute to congestion at the Deadhorse Airport if major projects were also being constructed. Airlines would probably increase the number of flights during the busiest seasons and the flight volume would be within the overall capacity of the system. Following construction, there would be a modest long-term increase in flights to support operation of newly constructed projects.

Alternative 2 could cause minor temporary increases in local road traffic when aircraft or vessels use local community airstrips or docks. RFFAs are unlikely to increase local traffic to levels approaching a use that could interrupt service or cause congestion and the combined total local road traffic would not be expected to result in congestion.

4.11.4.18.5 Conclusion

In summary, no concerns related to adverse cumulative impacts have been identified. Some cumulative impacts may exist if Alternative 2 overlaps with large-scale development projects but those impacts would be of low intensity, temporary in duration affecting local areas of common resources, and are considered unlikely to have long-term impacts on regional transportation infrastructure.

A VLOS would be considered an additive adverse long term impact to cumulative impacts of transportation. Following a VLOS cumulative impacts to transportation in the Beaufort and Chukchi seas could be of high intensity (potentially year round), and long-term in duration lasting one to two years or more during response and surveillance monitoring during recovery. The extent would be regional to statewide extent, and important in context. If a VLOS were to occur, there would be moderate additive effect to the cumulative effects associated with Alternative 2 on transportation.

4.11.4.19 Recreation and Tourism

4.11.4.19.1 Summary of Direct and Indirect Effects

As discussed in Section 4.5.3.7, the direct impacts on recreation and tourism would be low intensity, temporary duration, local extent, and common in context. Indirect impacts would be the same levels as direct impacts, except that the geographic area would be broader, extending beyond the region to a state-wide level and potentially beyond. In summary, the direct and indirect impacts associated with Alternative 2 on recreation and tourism would be minor.

4.11.4.19.2 Past and Present Actions

Recreation and tourism occur at generally low levels of use in the EIS project area and are more common onshore (hiking, river float trips) than offshore (small cruise ships, kayaking). 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 4.5.3.2, Subsistence for further discussion). Past activities that have affected recreation include the discovery of oil and natural gas, and the resulting development of Deadhorse, industrial support facilities in the vicinity of Barrow, and the construction and operation of the Dalton Highway. The EIS project area became more accessible to recreationists, including minimal accommodations. Another past action that affected recreation and tourism use was the designation of the Arctic National Wildlife Refuge (ANWR). The designation brought attention to the area; it became a destination for recreation and tourism. All of these factors may have increased levels of recreation and tourism in the EIS project area. However, total recreation and tourism use in the EIS project area remains low, and impact would be minor.

4.11.4.19.3 Reasonably Foreseeable Future Actions

Most of the North Slope areas are underused for recreation and have the potential to support increased levels of recreation use in the future. The continuation of development for oil and natural gas drilling is highly likely. As development increases, the increase in noise and visibility, and simply the knowledge of the existence of industrial development is expected to impact the setting for recreation. Despite this, continued development may make the North Slope more accessible, and as a result bring more recreationists and tourists. As infrastructure improves and accommodations are increased in places like Deadhorse and Wainwright, there is a higher possibility that people would go to those places to recreate, or use those areas as a base to access recreation opportunities. Overall impact would be minor; recreation and tourism levels will not increase or decrease substantially in the foreseeable future.

4.11.4.19.4 Contribution of Alternative to Cumulative Effects

Under Alternative 2, the direct and indirect effects to recreation and tourism would be minor. The contribution of the direct and indirect impacts to the past, present, and reasonably foreseeable future actions would be minor; the additional demands on the recreation setting would be low, and the levels of activities are expected to remain low. Recreation and tourism would not be stressed to a point that would cause an irreversible impact. Therefore, the contribution of Alternative 2 to cumulative effects to recreation and tourism would be minor.

4.11.4.19.5 Conclusion

The direct and indirect impacts associated with Alternative 2 on recreation and tourism would be minor. Alternative 2 would have a minor contribution to cumulative effects on recreation and tourism.

In the event of a VLOS, offshore and coastal settings would be altered by the amount of vessels, aircraft, and support for response. The recreation setting in the EIS project that would be most affected would be near the water, and activities would be affected by the presence of the response teams and the oil; particularly wildlife viewing, fishing and yachting. If a VLOS were to occur, there would be major additive effect to the cumulative effects associated with Alternative 2 on recreation and tourism.

4.11.4.20 Visual Resources

4.11.4.20.1 Summary of Direct and Indirect Effects

Alternative 2 would include vessel-based surveys implemented in the Beaufort and Chukchi seas, and a single exploratory drilling program in both the Beaufort and Chukchi seas. Although the actions associated with this alternative could occur across the EIS project area, actions would primarily be seen from population centers located east of Barrow, extending to the Canadian border (including the ANWR). Due to the distances offshore, views of the proposed project in the Chukchi Sea would be restricted to those of industrial workers or commercial marine traffic occurring in offshore locations in the Chukchi and would not be detected by any sensitive viewer groups located in on-land or near-shore locations (see Section 3.3.9.7 for a description of viewer groups).

Seismic and hazard survey operations would not require a construction phase. Implementation of seismic and hazard surveys is expected to result in weak visual contrast where actions occur at close proximity (within 3 to 5 miles) to on-land and near-shore locations state waters of the Beaufort Sea. Visual contrast is expected to attenuate beyond 5 miles due to the scale of the vessels relative to the landscape and the transient nature of the proposed action.

The exploratory drilling program would include construction, operation, and decommissioning phases. Construction-related impacts may occur as part of exploratory drilling programs situated in state waters (located within 3 miles) of the Beaufort Sea. Construction-related actions would result in a temporary increase in marine barge, vehicle, and potentially air traffic around localized drill site(s). Such actions would contribute color, angular lines, and movement to the landscape; however, because oil and gas activity is underway in this area, change in visual resources and scenic quality as a result of construction of drill site(s) is not expected to create visual contrast or attract attention of the casual observer.

During the operational phase, the moderate to strong visual contrast may result from operation of drill sites, particularly where situated within five miles of viewers. Like vessel traffic, visual contrast of drilling facilities (i.e. ice islands) and lighting would be maximized where viewed from proximate locations and would attenuate with distance from the viewer. Project-related actions in the nearshore Beaufort Sea would be viewed by both highly sensitive viewers from the Alaska Native community of Nuiqsut and viewers located in the industrial centers of Deadhorse and Prudhoe Bay characterized as having low visual sensitivity.

Standard mitigation measures implemented as part of the proposed action would not alter the level of anticipated impacts to visual resources or scenic quality. Although Category D Mitigation Measures would limit exposure of sensitive viewers (individuals engaged in the culturally important activity of bowhead whaling) to vessel-based surveys during certain periods. However it would not change exposure to drill sites, as these structures would remain in place during shutdown periods unless the operator agrees to move off location during such shutdown periods.

In conclusion, implementation of Alternative 2 is expected to result in *short-term moderate effects* to scenic quality and visual resources. Potential impacts could be of low to medium intensity depending on specific location of drill sites. The geographic extent of potential impacts would be localized; however they would occur in an important ecosystem.

4.11.4.20.2 Past and Present Actions

Large scale oil and gas exploration is a major component of the landscape character of the West Beaufort Sea analysis unit, located on the North Slope. Oil and gas-related development has occurred in this area since the 1940's, with major onshore development in Prudhoe Bay and offshore exploration in the Beaufort and Chukchi seas underway by the 1970s. Development and production in the near shore Beaufort Sea began in the early 1980s. The TAPS was completed in 1977, providing a transport mechanism to move oil from the North Slope to Valdez, AK. Industrial development is primarily situated on the Beaufort Sea. Onshore and near-shore (within three miles) activity extends from the Colville River Unit west of Wainwright, east to the Badami Unit, and includes discrete industrial facilities connected by a network of roads, pipelines. Recent discoveries have led to at least six additional offshore operations in the Beaufort Sea; three of which are supported by on on-shore production facilities (MMS 2008). Currently, 35 fields and satellites producing oil are in operation on the North Slope and in near-shore areas of the Beaufort Sea.

Cultural modification is the most defining landscape characteristic separating the West Beaufort Sea analysis unit from other analysis units. This unit is characterized by ongoing oil and gas activity. Views of the EIS project area from native communities and industrial nodes along the shoreline of this unit would experience views of existing on- and offshore oil and gas activity. Viewers situated along the shoreline of the adjacent East Beaufort analysis unit may also experience views of on- and offshore oils and gas development. Developments may be long-term or temporary. 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 onland 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 approximately 75 miles offshore in the Chukchi Sea, these areas are not seen by viewer group's located on-land, and are rarely observed by non-industrial marine travelers.

4.11.4.20.3 Reasonably Foreseeable Future Actions

Several reasonably foreseeable future actions are planned for the EIS project area that may affect visual resources. Actions include:

- Natural gas-related development, including a pipeline, and expansion of near shore and shore-based natural gas production facilities.
- State of Alaska lease sales in the near-shore portions of the Beaufort Sea.
-
- Construction and operation of the Point Thompson Project located 60 miles east of Prudhoe Bay.

The reasonably foreseeable future actions listed above are expected to affect visual resources during both construction and operation phases. Actions would be seen from population centers located east of Barrow, extending to the Kaktovok, nearshore areas, and from the air. Construction-related impacts are expected to result from heightened activity due to increase in personnel, air and marine traffic, including sealifts, channel dredging, and modifications of an existing structure (i.e. Dock Head, airstrips). All projects would require installation of temporary work camps and access roads to support construction activities. Operations-related impacts are expected to result from the expanded footprint of industrial nodes – including associated light and movement -- particularly due to the operation of the Point Thomson Project in a geographically distinct area located 60 miles to the east. Reasonably foreseeable future actions are expected to have a major effect on visual resources as the cumulative actions would be high intensity, long-term, local in geographic extent, and affecting an important resource.

4.11.4.20.4 Contribution of Alternative to Cumulative Effects

Implementation of Alternative 2 would contribute to cumulative effects by increasing the industrial character of the area through introduction of an exploratory drilling structure and associated support vessels. Impacts are expected to be greatest if exploratory drilling is implemented in near-shore areas of the Beaufort Sea, between Harrison Bay and Kaktovik, where the majority of past, present, and reasonably foreseeable future actions are located. This area coincides with locations of sensitive viewers, including native communities or recreators using the ANWR. Transient views of seismic and shallow hazard survey vessels are not expected to contribute to the industrial character of the area, as views of vessels would be episodic. Proposed actions on the Chukchi Sea are, likewise, not expected to contribute to cumulative effects, as actions are separated geographically from reasonably foreseeable future actions.

4.11.4.20.5 Conclusion

Under Alternative 2, anticipated cumulative effects to visual resources are expected to be major. Impacts would be of high intensity, long-term in duration, regional in geographic extent and occurring in an important context.

If a VLOS were to occur, there would be major additive effect to the cumulative effects associated with Alternative 2 on visual resources, as the event would be high intensity, long-term or permanent, extended in scope, and would affect an important resource.

4.11.4.21 Environmental Justice

4.11.4.21.1 Summary of Direct and Indirect Effects

Impacts to Subsistence Foods and Human Health

Activities related to implementation of Alternative 2 would have a low intensity impact to the number of marine mammals harvested for subsistence use and access to marine mammals. Impacts would be of a temporary duration and would occur over a regional extent to unique Iñupiat communities.

Activities associated with Alternative 2 are expected to cause low intensity health outcomes (within normal human variation) due to potential exposure to contamination from subsistence foods. The changes in health would be long-term, persisting after the actions cease, and would be regional in extent. Alternative 2 may have an indirect effect of adding to the perception that subsistence foods are contaminated and alter confidence in their consumption. Subsistence foods and human health are unique resources, protected under the MMPA and Executive Order 12898. Thus, the direct and indirect effects of Alternative 2 to subsistence would be minor. Thus, the direct and indirect effects of Alternative 2 to public health would be minor.

4.11.4.21.2 Past and Present Actions

Impacts to the abundance and distribution or access to subsistence resources associated with past and present actions are described in Subsistence Section 4.11.4.14.

Impacts to subsistence foods and impacts to health indicators from past and present actions are described in the Public Health Section 4.11.4.15.

4.11.4.21.3 Reasonably Foreseeable Future Actions

Future industrial activities in the Arctic (including oil and gas exploration and production, mining, military activity, shipping) have the potential to impact the environmental justice indicators of subsistence and public health. Climate change can affect temperature, ice conditions and ocean circulation which can adversely impact abundance and distribution of subsistence resources. Therefore, climate change can have an indirect adverse impact on subsistence access and public health.

4.11.4.21.4 Contribution of Alternative to Cumulative Effects

The incremental contribution of Alternative 2 to the overall industrial activity in the area includes a potential: increase in contamination of subsistence foods; increased perception of contamination of subsistence foods; overall decrease in access or availability of subsistence resources; and decline in public health indicators. The contribution of Alternative 2 to subsistence cumulative effects would be minor because the impacts to subsistence resources and uses would be low intensity, temporary duration, regional in extent, and unique in context. The contribution of Alternative 2 to public health cumulative effects would be similar to subsistence except the duration would be long-term. Therefore, the contribution to cumulative effects of these environmental justice indicators would be minor.

4.11.4.21.5 Conclusion

The direct and indirect effects of Alternative 2 would be minor. The contribution to the cumulative effects of environmental justice indicators would be minor. Therefore, there would be a disproportionate impact to Alaska Natives in the EIS project area.

In the event of a VLOS in the Beaufort or Chukchi Sea, an indirect impact of the proposed action to issue G&G permits and ITAs for an exploratory drilling program, the allocation quota for bowhead whales would be reduced. The intensity of the VLOS on subsistence resources and subsistence harvest would be of high intensity and cause a year round change in subsistence use patterns. Subsistence harvests of marine mammals, fish, migratory birds and caribou would be affected by direct contact with oil and the presence of the response equipment and personnel. Subsistence harvests could be altered long-term to permanent in duration. The impacts of a VLOS in the Beaufort Sea would be high intensity, long-term to permanent in duration, regional to statewide in extent, and affecting resources that are unique and important in context. In summary, the impact of a VLOS on subsistence harvest would be major.

In addition to the long-term impacts on sociocultural systems, a VLOS could cause a large influx of outside workers that could spread infectious disease and strain the health care system in villages used as staging areas, and respiratory irritation or illness related to air quality. The greatest and most persistent impacts to public health would result from the stress, anxiety and changes to subsistence harvest patterns. Adverse public health effects would be medium to high in intensity because some are treatable and/or transient, but some effects may be irreversible. These health effects may be temporary to permanent lasting for a brief period or persisting for many years in two more communities in the EIS project area. In summary, the impact of a VLOS on public health would be moderate to major depending on the nature and location of the spill.

Therefore a VLOS would have disproportionate adverse additive impacts to Alaska Natives living in communities near the EIS project area.

4.11.5 Alternative 3 – Authorization for Level 2 Exploration Activity

4.11.5.1 Physical Oceanography

4.11.5.1.1 Summary of Direct and Indirect Effects

The effects of Alternative 3 on physical ocean resources would be medium-intensity, temporary, local, and would affect common resources as defined in the impact criteria in Section 4.1 of this EIS. Under Alternative 3, changes in water depth resulting from exploratory drilling programs would be the same in nature as those described for Alternative 2. Alternative 3 would allow additional drilling programs in the EIS project area, and as a result of the additional drilling programs, the intensity as well as the spatial extent of the impact could effectively be doubled. Relative to Alternative 2, water depth would be affected over a larger area. Construction of artificial islands, which could occur in nearshore state waters of the Beaufort Sea at a rate of two islands per year under Alternative 3, would result in medium-intensity, permanent/temporary (permanent if gravel, temporary if ice), localized effects on nearshore currents in the waters adjacent to the artificial islands. Relative to Alternative 2, sea ice would be affected over a larger area due to more extensive icebreaking activity and thermal inputs associated with exploratory drilling activities. Although common resources would be affected across increased spatial and temporal scales relative to Alternative 2, the overall effects of Alternative 3 on physical ocean resources in the EIS project area would be minor, particularly with the implementation of additional mitigation measures related to reducing or eliminating certain discharge streams.

4.11.5.1.2 Past and Present Actions

Past and present actions affecting physical ocean resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.1.

4.11.5.1.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting physical ocean resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.1.

4.11.5.1.4 Contribution of Alternative to Cumulative Effects

Actions associated with Alternative 3 would cause localized minor impacts to physical ocean resources in the EIS project area. While some actions associated with Alternative 3, such as the construction of man-made gravel islands, would interact in a synergistic fashion with past, present, and reasonably foreseeable future actions to influence physical ocean resources in the EIS project area, the impacts resulting from such synergies would represent only a small fraction of foreseeable cumulative impact.

4.11.5.1.5 Conclusion

The incremental contribution of activities associated with Alternative 3 to cumulative effects on physical ocean resources in the EIS project area would be minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with physical ocean resources were discussed under Alternative 2 (Section 4.11.4.1).

4.11.5.2 Climate & Meteorology

4.11.5.2.1 Summary of Direct and Indirect Effects

Alternative 3 would directly emit more GHGs than Alternative 2; however direct impacts to climate change are estimated to have the same level of impact (minor) due to their low magnitude and low contribution to GHG emissions on a state level. Due to uncertainties in the outcome of exploration activities, indirect effects associated with Alternative 3 are assumed to be the same as those for Alternative 2: minor to moderate.

4.11.5.2.2 Past and Present Actions

Past and present actions affecting climate change are discussed under Alternative 2, Section 4.11.4.2.

4.11.5.2.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting climate change are discussed under Alternative 2, Section 4.11.4.2.

4.11.5.2.4 Contribution of Alternative to Cumulative Effects

Alternative 3 would directly emit more GHGs than Alternative 2; therefore it would directly contribute more to cumulative climate change impacts than Alternative 2. Alternative 3 would result in approximately 82,308 tpy more CO_2e emissions than Alternative 2 (See Sections 4.5.1.2 and 4.6.1.2). Alone, this difference would not result in a noticeably larger cumulative effect than Alternative 2. However, when accounting for all past, present, and future projects with GHG emissions, even a minor contribution such as 82,308 tpy of CO_2e per project, can cumulatively result in a perceptible impact. Therefore, Alternative 3 could have a larger impact on cumulative impacts to climate change than Alternative 2. Indirect effects from Alternative 3 are expected to have the same contribution to cumulative effects as Alternative 2, resulting in observable, global changes that could be long-term and could affect unique resources.

4.11.5.2.5 Conclusion

Due to the additive and synergistic nature of GHG emissions on climate change impacts, Alternative 3 could contribute to a moderate to major cumulative impact to climate change.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with climate change were discussed under Alternative 2 (Section 4.11.4.2).

4.11.5.3 Air Quality

4.11.5.3.1 Summary of Direct and Indirect Effects

The air quality effects due to the worst-case activity under Alternative 3, Level 2 Exploration Activity, are expected to be the same as those predicted for Alternative 2. The emissions would be moderate in magnitude, and minor in duration, extent, and content. The total emissions from the Level 2 Exploration

Activity is greater than that for Level 1 Exploration Activity, however the overall direct effect on air quality is expected to be moderate. Indirect effects on air quality would remain at negligible to minor.

4.11.5.3.2 Past and Present Actions

Past and present actions affecting air quality within the EIS project area are discussed under Alternative 2, Section 4.11.4.3.

4.11.5.3.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting air quality within the EIS project area are discussed under Alternative 2, Section 4.11.4.3.

4.11.5.3.4 Contribution of Alternative to Cumulative Effects

As with Alternative 2, Alternative 3 has the potential to contribute to future cumulative effects on air quality if activities occur during the same time period(s) and vicinity of any of the actions identified above that have the potential to affect air quality. Because of the short time duration for activities, cumulative effects would be highly dependent on actual meteorological conditions at the time, and the relative location of sources. The cumulative effects would be negligible (lower than the sum of the total maximum effects). There are no accumulative or synergistic effects associated with air quality.

4.11.5.3.5 Conclusion

Alternative 3 has the potential to contribute to cumulative effects on air quality when activities occur in the vicinity of other sources of air pollution. Due to distance between activities, and the mobile and intermittent source activities, the cumulative effects are expected to be less than the sum of each, likely remaining moderate in magnitude.

The additive effects resulting from a VLOS within the seas Arctic OCS associated with air quality were discussed under Alternative 2 (Section 4.11.4.3).

4.11.5.4 Acoustics

4.11.5.4.1 Summary of Direct and Indirect Effects

The summary of direct and indirect effects provided in Section 4.11.4 (Alternative 2) is relevant also for Alternative 3. The overall impact rating for direct and indirect effects to the acoustic environment under Alternative 3 would be moderate.

4.11.5.4.2 Past and Present Actions

The past actions for Alternative 3 are the same as listed for Alternative 2 (Section 4.11.4.4). The present actions will consist of up to six deep penetration seismic surveys in the Beaufort Sea and up to five seismic surveys in the Chukchi Sea. This alternative also allows for up to five site clearance and high resolution shallow hazards surveys in Beaufort and five of these surveys in the Chukchi. Up to two drilling programs in each of the Beaufort and Chukchi seas and one on-ice seismic survey would be permitted.

4.11.5.4.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting acoustics within the EIS project area are discussed under Alternative 2, Section 4.11.4.4.

4.11.5.4.4 Contribution of Alternative to Cumulative Effects

This alternative permits the highest level of activity of all alternatives. The possibility of up to six deep-penetration seismic surveys and five site clearance and high resolution shallow hazards surveys with inclusion of two potential drilling operations in the Beaufort Sea open water season produces substantial total disturbance zone areas. Marine mammals could have difficulty navigating between the disturbance zones surrounding each of the surveys and drill operations if these activities were performed concurrently. The concurrent operation of multiple noise sources could lead to confusion by marine mammals at choosing a path to avoid regions of high noise. If cumulative SEL criteria for auditory system injury were considered, the total effects of exposures to multiple operations could be substantially greater than from individual activities. The large number of deep penetration seismic surveys would be the primary source of higher cumulative exposures.

Cumulative effects in the Chukchi Sea would be fewer than in the Beaufort Sea because the marine mammal migration corridors there are less concentrated. There would consequently be more opportunity for migrating marine mammals to choose paths between the surveys and drilling locations to avoid passing close to individual operations where noise levels are highest.

4.11.5.4.5 Conclusion

Cumulative effects from noise exposures to marine mammals under Alternative 3 are similar but larger than the effects described for Alternative 2 due to the greater number of noise-generating activities that would be permitted. The ability of marine mammals to avoid close approaches to seismic survey sources would be reduced when many sources were concurrently in operation with limited spatial separation. These animals would therefore be exposed to higher sound levels and higher cumulative sound levels than if fewer concurrent operations were present.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with acoustics were discussed under Alternative 2 (Section 4.11.4.4).

4.11.5.5 Water Quality

4.11.5.5.1 Summary of Direct and Indirect Effects

Impacts to water quality from Alternative 3 would be the same in nature as those described for Alternative 2 in Section 4.11.4.5. The only difference between the two alternatives is the level of activity. Alternative 3 would allow additional surveys and exploratory drilling programs in the EIS project area, and as a result of the additional drilling programs, the intensity as well as the spatial extent of the impacts may effectively be doubled. Relative to Alternative 2, water quality parameters may be affected over larger areas and over longer periods of time. However, the effects of Alternative 3 on water quality would be low intensity, temporary, and localized to areas in the immediate vicinity of the activities. Although common resources may be affected across increased spatial scales relative to Alternative 2, the overall effects of Alternative 3 on water quality are expected to be minor.

4.11.5.5.2 Past and Present Actions

Past and present actions affecting water quality within the EIS project area are discussed under Alternative 2, Section 4.11.4.5.

4.11.5.5.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting water quality within the EIS project area are discussed under Alternative 2, Section 4.11.4.5.

4.11.5.5.4 Contribution of Alternative to Cumulative Effects

Actions associated with Alternative 3 would cause temporary local impacts to water quality such as increases in temperature, turbidity, and concentrations of pollutants. Some actions associated with Alternative 3, such as discharges of cooling water and waste material, would interact with past, present, and reasonably foreseeable future actions resulting in both additive and synergistic impacts to water quality. These interactions would be local and temporary and would represent only a small fraction of foreseeable cumulative impact.

4.11.5.5.5 Conclusion

The incremental contribution of activities associated with Alternative 3 to cumulative effects on water quality in the EIS project area would be minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with water quality were discussed under Alternative 2 (Section 4.11.4.5).

4.11.5.6 Environmental Contaminants and Ecosystem Functions

4.11.5.6.1 Summary of Direct and Indirect Effects

Direct and indirect impacts to ecosystem functions resulting from the implementation of Alternative 3 would be medium-intensity, temporary, and local. Regulation functions such as nutrient cycling and waste assimilation, which depend on biota and physical processes to facilitate storage and recycling of nutrients and breakdown or assimilation of contaminants, would be affected within the EIS project area. While the geographic extent of such impacts would potentially be greater than that resulting from Alternative 2, the overall geographic extent of impacts to regulation functions would be limited. Habitat functions, particularly those related to benthic habitats, would be impacted as a result of discharges and other activities associated with exploratory drilling. Production functions including primary productivity and subsequent transfers to higher trophic levels could potentially be impacted as a result of activities associated with Alternative 3, while the effects of Alternative 3 on information ecosystem functions would depend upon interrelationships between impacts to cultural resources, social resources, and aesthetic resources, which are addressed in other sections of this EIS. Overall effects of Alternative 3 on ecosystem functions would be minor.

4.11.5.6.2 Past and Present Actions

Past and present actions affecting environmental contaminants and ecosystem functions within the EIS project area are discussed under Alternative 2, Section 4.11.4.6.

4.11.5.6.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting environmental contaminants and ecosystem functions within the EIS project area are discussed under Alternative 2, Section 4.11.4.6.

4.11.5.6.4 Contribution of Alternative to Cumulative Effects

Actions associated with Alternative 3 would cause localized minor impacts to environmental contaminants and ecosystem functions within the EIS project area. Some actions associated with Alternative 3, such as discharges from exploratory drilling operations, would interact with past, present, and reasonably foreseeable future actions resulting in both additive and synergistic impacts to ecosystem functions. Relative to Alternative 2, these interactions would potentially be distributed over a greater geographic area. The impacts resulting from such interactions would represent a relatively small fraction of foreseeable cumulative impact, and the accumulation of impacts is unlikely to be substantial over the lifespan of this EIS.

4.11.5.6.5 Conclusion

The incremental contribution of activities associated with Alternative 3 to cumulative effects on environmental contaminants and ecosystem functions in the EIS project area would be minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with environmental contaminants and ecosystem functions were discussed under Alternative 2 (Section 4.11.4.6).

4.11.5.7 Lower Trophic Levels

4.11.5.7.1 Summary of Direct and Indirect Effects

Alternative 3 is the same as Alternative 2 except with increased levels of activity. The impacts discussed in Section 4.11.4.7 for Alternative 2 are applicable for this alternative. The increased levels of activity would not generate different types of impacts to lower trophic levels. The conclusions for Alternative 2 are applicable to Alternative 3; therefore, the overall impact to lower trophic levels would be minor.

4.11.5.7.2 Past and Present Actions

Past and present actions affecting lower trophic levels within the EIS project area are discussed under Alternative 2, Section 4.11.4.7.

4.11.5.7.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting lower trophic levels within the EIS project area are discussed under Alternative 2, Section 4.11.4.7.

4.11.5.7.4 Contribution of Alternative to Cumulative Effects

Alternative 3 would have the same types of effects as Alternative 2 but the increased level of exploration activities under Alternative 3 would add incrementally to its contribution to cumulative effects on lower trophic levels. However, the conclusions about Alternative 3 would be similar to Alternative 2 discussed in Section 4.11.4.7 and the overall impact would be moderate. In the absence of a very large oil spill, the exploration activities authorized under Alternative 3 would have moderate contributions to the cumulative effects from past, present, and reasonably foreseeable future actions on lower trophic levels.

4.11.5.7.5 Conclusion

Alternative 3 could have a moderate contribution to cumulative effects on lower trophic organisms.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with lower trophic levels were discussed under Alternative 2 (Section 4.11.4.7).

4.11.5.8 Fish and Essential Fish Habitat

4.11.5.8.1 Summary of Direct and Indirect Effects

The overall impact of Alternative 3 on Fish Resources and EFH is minor. Despite a substantial increase in level of activity over Alternative 2, there would be no corresponding increase in the overall impact level. Due to the very small scale of any potential effects relative to overall population levels and available habitat, and the temporary nature of the majority of the activities associated with Alternative 3, there would be no measurable effect on the resource.

The direct and indirect effects on marine fish resulting from Alternative 3 would be very similar to those described under Alternative 2. Due to the uneven nature of the increases in activity levels by activity type, the increase in impacts to different fish assemblages would vary. The cryopelagic assemblage would have essentially no additional impacts, as the level for activities likely to affect that group (icebreaking and on-ice seismic surveys) would not change from Alternative 2. Demersal assemblages, on the other hand, would feel the additional effects from the increase in seismic survey levels and exploratory drilling, both in terms of habitat loss and the effects from noise. Pelagic assemblages would be impacted by the increase in surveys but less so by the increased drilling programs. However, in spite of the potential for different resource groups to experience uneven increases in level of effect, the overall impact would remain the same given the limited area affected compared to the distribution of fish populations. The impacts to marine fish would be considered minor.

The direct and indirect effects on migratory fish resulting from Alternative 3 would be very similar to those described under Alternative 2. Because anadromous fish are more likely to be impacted by the activity types than amphidromous fish, as discussed under Alternative 2, they are likely to experience a disproportionate increase in adverse impacts when the two groups are compared. However, as described in Alternative 2, those anadromous species known to inhabit the area where project activities would occur are not very abundant, and they are unlikely to be impacted. Therefore, the overall impact to the resource group would remain the same. The impacts to migratory fish would be considered negligible.

The direct and indirect effects on essential fish habitat resulting from Alternative 3 would be very similar to those described under Alternative 2, with an increase in effects due to the increase in oil and gas exploration activities. In particular, the increase in exploratory drilling programs would result in increased habitat loss and alteration, potentially to EFH for saffron cod and salmon. Since there would be no increase in icebreaking activities, EFH for Arctic cod would be impacted the least. The opportunity for habitat loss or alteration resulting from Alternative 3 is very small and only incrementally larger than for Alternative 2. Most impacts would be of such low intensity and of such small geographic extent that the effects would be considered minor.

4.11.5.8.2 Past and Present Actions

Past and present actions affecting fish and EFH within the EIS project area are discussed under Alternative 2, Section 4.11.4.8.

4.11.5.8.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting fish and EFH within the EIS project area are discussed under Alternative 2, Section 4.11.4.8.

4.11.5.8.4 Contribution of Alternative to Cumulative Effects

Climate change is the only past, present, or reasonably foreseeable future action that is anticipated to have any measurable effect on fish and EFH within the EIS project area, and those effects are likely to be beneficial. As Arctic waters warm, productivity is likely to increase, thereby creating more favorable fish habitat throughout the region. The lack of measurable effect on fish and EFH resulting from the implementation of Alternative 3 would not add to any cumulative effects.

4.11.5.8.5 Conclusion

Direct and indirect impacts resulting from Alternative 3 on fish and EFH would be of such low intensity and of such small geographic extent that the effects would be considered minor. The incremental contribution of activities associated with Alternative 3 to cumulative effects on fish would be minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with fish and EFH were discussed under Alternative 2 (Section 4.11.4.8).

4.11.5.9 Marine and Coastal Birds

4.11.5.9.1 Summary of Direct and Indirect Effects

As discussed in Section 4.6.2.3, the effects of disturbance, injury/mortality, and changes in habitat for marine and coastal birds would likely be temporary or short-term, localized, and not likely to have population-level effects for any species. In summary, the impact of Alternative 3 on marine and coastal birds would be considered negligible to minor.

4.11.5.9.2 Past and Present Actions

Past and present actions affecting marine and coastal birds within the EIS project area are discussed under Alternative 2, Section 4.11.4.9.

4.11.5.9.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting marine and coastal birds within the EIS project area are discussed under Alternative 2, Section 4.11.4.9.

4.11.5.9.4 Contribution of Alternative 3 to Cumulative Effects

Alternative 3 would have the same types of effects as Alternative 2 but the increased level of exploration activities under Alternative 3 would add incrementally to its contribution to cumulative effects on marine and coastal birds. However, the conclusions about Alternative 3 would be similar to Alternative 2 (4.11.4.9). The exploration activities authorized under Alternative 3 would have negligible contributions to the cumulative effects from past, present, and reasonably foreseeable future actions on marine and coastal birds.

4.11.5.9.5 Conclusion

The direct and indirect effects of Alternative 3 on marine and coastal birds would be considered negligible to minor. Alternative 3 would have negligible contributions to the cumulative effects from past, present, and reasonably foreseeable future actions on marine and coastal birds, as discussed under Alternative 2 (Section 4.11.4.9).

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with marine and coastal birds were discussed under Alternative 2 (Section 4.11.4.9).

4.11.5.10 Marine Mammals

4.11.5.10.1 Bowhead Whales

4.11.5.10.1.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 3 on bowhead whales are described in Section 4.6.2.4.1 and are summarized here. Impacts of individual activities associated with oil and gas exploration in the EIS project area under Alternative 3 are similar to Alternative 2. Despite a substantial increase in level of activity over Alternative 2, the overall impact level would be the same (See Section 4.11.4.10.1).

In terms of the impact criteria identified in Table 4.5-17, most effects of individual exploratory activities authorized under Alternative 3 are of medium intensity and temporary in duration. Potential long-term effects from repeated disturbance over time or over a broad geographic range are unknown. Individually, the various activities may elicit localized effects on bowhead whales, yet the area and extent of the population over which effects would be felt would increase with multiple activities occurring simultaneously or consecutively throughout much of the summer-fall range of this population. Since the EIS project area extends across most of the migratory path of bowhead whales in U.S. waters, the combined oil and gas exploration activities could result in regional level effects on bowhead whales. Bowhead whales are listed as endangered and are an essential subsistence resource for Iñupiat and Yupik Eskimos of the Arctic coast, which places them in the context of being a unique resource. Evaluated collectively, and with consideration given to reduced adverse impacts through the imposition of the required standard mitigation measures, the overall effect of activities authorized under Alternative 3 on bowhead whales is likely to be moderate.

4.11.5.10.1.2 Past and Present Actions

Past and present actions affecting bowhead whales within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.1.

4.11.5.10.1.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting bowhead whales within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.1.

4.11.5.10.1.4 Contribution of Alternative to Cumulative Effects

The contribution of the direct and indirect impacts resulting from Alternative 3, when combined with the past, present, and reasonably foreseeable future actions would be minor to moderate, the same as under Alternative 2 (Section 4.11.4.10.1), with most potential impacts due to acoustic disturbance that could, at least temporarily, disrupt or displace bowhead whales.

4.11.5.10.1.5 Conclusion

Under Alternative 3, the direct and indirect effects to bowhead whales would be moderate. Overall, Alternative 3 would have a minor to moderate contribution to cumulative effects on bowhead whales.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with bowhead whales were discussed under Alternative 2 (Section 4.11.4.10.1).

4.11.5.10.2 Beluga Whales

4.11.5.10.2.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 3 on beluga whales are described in Section 4.6.2.4.2 and are summarized here. The additional oil and gas exploration activities proposed in Alternative 3 could directly and indirectly affect beluga whales by causing noise disturbance, habitat degradation, and potential ship strikes. Beluga whales disturbed by oil and gas exploration activities may move away from important habitats. The scale of the avoidance depends on the number and relative proximity of the surveys. Numerous simultaneous seismic activities could cause avoidance over large distances. Potential habitat degradation from drill cuttings or drilling mud discharges would be localized and temporary; the impact level would be negligible. While the incidence of ship strikes is currently low, it could rise with increasing vessel traffic.

The direct and indirect effects on beluga whales from the exploration activities under Alternative 3 would be low to medium intensity, short-term duration, local to regional extent, and would affect a unique resource. The summary impact level of Alternative 3 on beluga whales would be considered moderate.

4.11.5.10.2.2 Past and Present Actions

Past and present actions affecting beluga whales in the EIS project area are discussed under Alternative 2, Section 4.11.4.10.2.

4.11.5.10.2.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions that would affect beluga whales in the EIS project area are discussed under Alternative 2, Section 4.11.4.10.2.

4.11.5.10.2.4 Contribution of Alternative to Cumulative Effects

The oil and gas exploration activities authorized under Alternative 3 would add to the acoustic disturbance of beluga whales from marine vessels, seismic sources, and aircraft traffic in the Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be localized and temporary. Although ship strikes are possible with increased vessel activity associated with oil and gas exploration, the contribution to additional mortality would be negligible relative to the population level. Exploration activities could contribute to habitat alterations through icebreaking efforts and discharge of drilling muds. Effects would be localized and temporary. The contribution to habitat change would be negligible since it would affect an extremely small proportion of habitat or prey base available to beluga whales. The exploration activities authorized under Alternative 3 would therefore have minor to moderate additive contributions to the cumulative effects on beluga whales.

4.11.5.10.2.5 Conclusion

As stated above, most exploration activities authorized under Alternative 3 would result in minor to moderate contributions to cumulative effects on beluga whales.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with beluga whales were discussed under Alternative 2 (Section 4.11.4.10.2).

4.11.5.10.3 Other Cetaceans

4.11.5.10.3.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 3 on cetaceans are described in Section 4.6.2.4.3 and are summarized here. Evaluated collectively, the overall impact of Alternative 3 on other cetaceans is minor. Despite a substantial increase in level of activity over Alternative 2, there would be no corresponding increase in impact level. Due to the very small scale of any potential effects relative to overall population levels and available habitat, and the temporary nature of the majority of the activities associated with Alternative 3, impacts on the resource would be low in intensity, of short duration, and limited extent. Long term impacts are unknown, but anticipated to be minor.

The primary direct and indirect effects on other cetaceans would result from noise exposure. Potential noise sources include 2D/3D seismic survey equipment (airgun arrays), CSEM electromagnetic signals, echosounder and sonar devices associated with site clearance and shallow hazards surveys, support, monitoring and receiving vessels associated with these surveys, icebreaking activities, on-ice vibroseis seismic surveys (Beaufort Sea only), exploratory drilling, and helicopter and fixed wing aircraft associated with the different programs.

Direct and indirect effects arising from ship strikes and habitat degradation are also possible. Potential habitat degradation from drill cuttings or drilling mud discharges would be localized and temporary; the impact level would be negligible. While the incidence of ship strikes is currently low, it could rise with increasing vessel traffic.

4.11.5.10.3.2 Past and Present Actions

Past and present actions affecting other cetaceans within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.3.

4.11.5.10.3.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting other cetaceans within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.3.

4.11.5.10.3.4 Contribution of Alternative to Cumulative Effects

The oil and gas exploration activities authorized under Alternative 3 would add to the acoustic disturbance of other cetaceans from marine vessels, seismic sources, and aircraft traffic in the Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be localized and temporary. Although ship strikes are possible with increased vessel activity associated with oil and gas exploration, the contribution to additional mortality would be negligible relative to the population level. Exploration activities could contribute to habitat alterations through icebreaking efforts and discharge of drilling muds. Effects would be localized and temporary. The contribution to habitat change would be negligible. Despite a substantial increase in level of activity over Alternative 2, there would be no corresponding increase in impact level.

None of the past, present, or reasonably foreseeable future actions described above are expected to have any substantial impact on cetacean populations within the EIS project area. Populations for most species are stable or increasing, and climate change is likely to add nominal beneficial impacts in the future. The exploration activities authorized under Alternative 3 would therefore have minor additive contributions to the cumulative effects on other cetaceans.

4.11.5.10.3.5 Conclusion

As stated above, most exploration activities authorized under Alternative 3 would result in minor contributions to cumulative effects on other cetaceans.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with other cetaceans were discussed under Alternative 2 (Section 4.11.4.10.3).

4.11.5.10.4 Ice Seals

4.11.5.10.4.1 Summary of Direct and Indirect Effects

There are four species of seals considered in this section that are often collectively called “ice seals”; ringed seal, spotted seal, ribbon seal, and bearded seal. The direct and indirect effects of Alternative 3 on ice seals are described in Section 4.6.2.4.4 and are summarized here. Ringed seals and bearded seals have been the most commonly encountered species of any marine mammals in past offshore oil and gas exploration activities in the Alaskan Beaufort and Chukchi seas and would likely be affected more frequently by exploration activities authorized under Alternative 3 than either ribbon or spotted seals. Data from observers on board seismic source vessels and monitoring vessels indicate that seals tend to avoid on-coming vessels and active seismic arrays but they do not appear to react strongly even as ships pass fairly close with active arrays. They also do not appear to react strongly to icebreaking or on-ice surveys, keeping their distance or moving away at some point to an alternate breathing hole or haulout, but the scope of these behavioral responses appears to be within their natural abilities and responses to their naturally dynamic environment. None of the behavioral reactions observed to date indicate that any of the ice seal species would be displaced from key areas or resources for more than a few minutes or hours and they would be unlikely to experience any measurable effects on their reproductive success or survival. Ice seals are legally protected, have unique ecological roles in the Arctic, and are important subsistence resources and are therefore considered to be unique resources. Given the standard mitigation measures that have been required in the past, the effects of exploration activities that could be authorized under Alternative 3 on ice seals would likely be low in magnitude, distributed over a wide geographic area, and temporary to short-term in duration. The effects of Alternative 3 would therefore be considered minor for all ice seal species according to the criteria established in Section 4.1.3.

4.11.5.10.4.2 Past and Present Actions

Past and present actions affecting pinnipeds within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.4.

4.11.5.10.4.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting pinnipeds within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.4.

4.11.5.10.4.4 Contribution of Alternative 3 to Cumulative Effects

The exploration activities authorized under Alternative 3 would add to the disturbance of ice seals from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be temporary. Very small numbers of ringed seals could be exposed to exploration activities during the denning season (winter-spring) when females with young are more susceptible to disturbance. Exploration activities would contribute negligible risk of additional mortality to any species, which would continue to be dominated by subsistence harvest. Exploration activities could contribute to habitat change through on-ice surveys, icebreaking efforts, and discharge of drilling muds but these effects would be localized and temporary or short-term. This contribution to habitat change would be negligible compared to the potential for dramatic sea ice loss due to climate change and changes in ecosystems due to ocean acidification. The exploration activities authorized under Alternative 3 would therefore have negligible to minor contributions to the cumulative effects on the four species of ice seals considered.

4.11.5.10.4.5 Conclusion

The direct and indirect effects of Alternative 3 on pinnipeds would be considered minor. Alternative 3 would have negligible to minor contributions to the cumulative effects on the four species of ice seals.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with pinnipeds were discussed under Alternative 2 (Section 4.11.4.10.4).

4.11.5.10.5 Walrus

4.11.5.10.5.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 3 on walrus are described in Section 4.6.2.4.5 and are summarized here. Walrus have been regularly encountered during vessel-based exploration activities in the past, primarily in late summer as the pack ice recedes, as recorded by PSOs on board seismic source vessels and monitoring vessels. These data indicate that walrus do not react strongly to vessels and active seismic arrays and their behavioral responses are often neutral rather than swimming away. They tend to dive into the water as icebreaking ships approach from some distance and are therefore not exposed to the loudest sounds generated by the ships. Mitigation measures required for walrus by USFWS LOAs since the early 1990s have reduced the risk of close encounters with seismic and other exploration vessels and have reduced the risk of accidental spills that may affect walrus or their prey. None of the data collected to date on walrus reactions to exploration activities indicate that they would be displaced from key areas or resources for more than a few minutes or hours. Careful avoidance of vessel and aircraft traffic around walrus haulouts on land would be important to minimize the risk of calf and juvenile mortality from stampedes. Walrus are legally protected, fulfill an important ecological role in the Arctic, and are important subsistence resources and are therefore considered to be a unique resource for NEPA purposes. Given the level and type of exploration activities that would be authorized under Alternative 3, and considering the mitigation measures that would be required by USFWS LOAs and NMFS in this EIS, the effects on walrus would likely be low in magnitude, distributed over a wide geographic area, and temporary in duration. The effects of Alternative 3 on Pacific walrus would therefore be considered minor.

4.11.5.10.5.2 Past and Present Actions

Past and present actions affecting Pacific walrus within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.5.

4.11.5.10.5.3 Reasonably Foreseeable Future Actions

Past and present actions affecting Pacific walrus within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.5.

4.11.5.10.5.4 Contribution of Alternative 3 to Cumulative Effects

The exploration activities authorized under Alternative 3 would add to the disturbance of walrus from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be temporary. Exploration activities would contribute negligible risk of additional mortality to walrus, which would continue to be dominated by subsistence harvest. Exploration activities could contribute to habitat change through on-ice surveys, icebreaking efforts, and discharge of drilling muds but these effects would be localized and temporary or short-term. This contribution to habitat change would be negligible compared to the potential for dramatic sea ice loss due to climate change and changes in ecosystems due to ocean acidification. The exploration activities authorized under Alternative 3 would therefore have negligible to minor contributions to the cumulative effects on Pacific walrus.

4.11.5.10.5.5 Conclusion

The direct and indirect effects of Alternative 3 on Pacific walrus would be considered minor. Alternative 3 would have negligible to minor contributions to the cumulative effects.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with Pacific walrus were discussed under Alternative 2 (Section 4.11.4.10.5).

4.11.5.10.6 Polar Bears

4.11.5.10.6.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 3 on polar bears are described in Section 4.6.2.4.6 and are summarized here. The types and levels of effects on polar bears are essentially the same under Alternative 3 as for Alternative 2**.** The primary difference for polar bears would be an incremental increase in disturbance from vessel and air traffic and an incremental increase in risk of habitat contamination**.** Polar bears have been infrequently encountered during vessel-based exploration activities in the past, as recorded by PSOs on board source vessels and monitoring vessels. These sparse data indicate that polar bears do not react strongly to vessels and active seismic arrays and their behavioral responses are often neutral rather than running or swimming away. The gradual introduction of alternative technologies for seismic surveys would make very little difference to polar bears because they are unlikely to be affected in any biologically meaningful way by seismic noise. They also do not appear to react strongly to icebreaking or on-ice surveys. Some bears keep their distance or move away at some point but others may approach vehicles and equipment out of curiosity. The types of effects of most concern for polar bears during exploration activities involve the risk of bear-human encounters. Mitigation measures and polar bear safety/interaction plans required by USFWS LOAs since the early 1990s have reduced the risk of these encounters for both people and bears. None of the data collected to date on polar bear reactions to exploration activities indicate that polar bears would be displaced from key areas or resources for more than a few minutes or hours and they are unlikely to experience any measurable effects on their reproductive success or survival as a result. Polar bears are legally protected, have a unique ecological role in the Arctic, and are important to subsistence cultures and are therefore considered a unique resource. Given the level and type of exploration activities that would be authorized under Alternative 3, and considering the mitigation measures that would be required by USFWS LOAs and NMFS in this EIS, the effects on polar bears would likely be low in magnitude, distributed over a wide geographic area, and temporary in duration. The effects of Alternative 3 on polar bears would therefore be considered minor.

4.11.5.10.6.2 Past and Present Actions

Past and present actions affecting polar bears within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.6.

4.11.5.10.6.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting polar bears within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.6.

4.11.5.10.6.4 Contribution of Alternative 3 to Cumulative Effects

The exploration activities authorized under Alternative 3 would add to the disturbance of polar bears from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be temporary. Exploration activities would contribute negligible risk of additional mortality to polar bears, which would continue to be dominated by subsistence harvest. Exploration activities could contribute to habitat change through on-ice surveys, icebreaking efforts, and discharge of drilling muds but these effects would be localized and temporary or short-term. This contribution to habitat change would be negligible compared to the potential for dramatic sea ice loss due to climate change and changes in ecosystems due to ocean acidification. The exploration activities authorized under Alternative 3 would therefore have negligible to minor contributions to the cumulative effects on polar bears.

4.11.5.10.6.5 Conclusion

The direct and indirect effects of Alternative 3 on polar bears would be considered minor. Alternative 3 would have negligible to minor contributions to the cumulative effects.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with polar bears were discussed under Alternative 2 (Section 4.11.4.10.6).

4.11.5.11 Terrestrial Mammals

4.11.5.11.1 Summary of Direct and Indirect Effects

Alternative 3 is the same as Alternative 2 except with increased levels of activity, with two exploratory drilling programs. The impacts discussed for Alternative 2 are applicable for this alternative. The increased levels of activity would not generate different types of impacts to terrestrial mammals. The conclusions for Alternative 2 are applicable to Alternative 3; and while the level of activity would increase, due to the relatively small area affected and short term, infrequent nature of crew changes, the overall impact to terrestrial mammals from aircraft activity would be minor.

4.11.5.11.2 Past and Present Actions

Past and present actions affecting caribou within the EIS project area are discussed under Alternative 2, Section 4.11.4.11.

4.11.5.11.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting caribou within the EIS project area are discussed under Alternative 2, Section 4.11.4.11.

4.11.5.11.4 Contribution of Alternative to Cumulative Effects

The contribution of this alternative to cumulative effects is the same as described under Alternative 2.

4.11.5.11.5 Conclusion

The incremental contribution of activities associated with Alternative 3 to cumulative effects on caribou would be negligible.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with caribou were discussed under Alternative 2 (Section 4.11.4.11).

4.11.5.12 Time/Area Closures

The analysis of the cumulative effects associated with the time/area closures can be found in Sections 4.11.5.10 (Marine Mammals), 4.11.5.9 (Marine and Coastal Birds) and 4.11.5.14 (Subsistence).

4.11.5.13 Socioeconomics

4.11.5.13.1 Summary of Direct and Indirect Effects

Direct and indirect effects associated with Alternative 3 are similar to those described in Alternative 2. Alternative 3 represents an increased level of oil and gas exploration therefore there would be an increased level of local revenue generated in staging communities; direct and indirect employment opportunities for Regional and Village Corporations that procure service contracts; and countervailing negative impacts to institutions and social services in the staging communities. The magnitude of the socioeconomic impact is positive but still low because total personal income, local employment rates, and borough revenues would also not increased by more than five percent.

Direct employment opportunities associated with the standard mitigation measures could increase or stay the same due as Alternative 2 to their duplicative nature. Also similar to Alternative 2, the duration of the socioeconomic impacts is temporary (not year-round) and scheduled to occur over a fixed number of years. The geographic extent of socioeconomic impacts is local, statewide, and even national. The context of the socioeconomic impacts is unique because the people that would experience the flow of workers and research vessels are predominantly Iñupiat communities. The summary impact level for Socioeconomics under Alternative 3 is minor, not exceeding the significance threshold.

4.11.5.13.2 Past and Present Actions

Past and present actions affecting socioeconomics within the EIS project area are discussed under Alternative 2, Section 4.11.4.13.

4.11.5.13.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting socioeconomics within the EIS project area are discussed under Alternative 2, Section 4.11.4.13. This analysis assumes current levels of oil and gas production and on-shore exploration would continue, but does not assume that offshore exploration associated with Alternative 3 would result in future oil and gas production.

4.11.5.13.4 Contribution of Alternative to Cumulative Effects

Actions associated with Alternative 3 would cause minor (positive) direct and indirect impacts to socioeconomics. They differ from Alternative 2 by a higher magnitude of direct employment and generation of local revenue, but with a potential increase in negative impacts on local institutions. The summary contribution of these impacts to the cumulative effectives of socioeconomics is negligible to minor at a statewide and national level and minor at the local level.

4.11.5.13.5 Conclusion

The direct and indirect effects of Alternative 3 would be minor. The contribution to cumulative effects of socioeconomics would be negligible to minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with socioeconomics were discussed under Alternative 2 (Section 4.11.4.13).

4.11.5.14 Subsistence

4.11.5.14.1 Summary of Direct and Indirect Effects

Using the impact criteria identified in Table 4.5-25, the direct and indirect effect of oil and gas exploration activities on subsistence resources and harvests resulting from implementation of Alternative 3 would be of low intensity, temporary in duration, local to regional in extent, and the context would be common to unique. Protected resources (bowhead whales and polar bears are considered unique in context as these resources are protected by legislation (e.g. MMPA, ESA) or are considered an important subsistence resource (beluga whales). Even with the increase in the number of activities/programs that could potentially occur under Alternative 3, the impacts to subsistence resources and harvest are anticipated to be similar in type, generally of similar intensity, and comparable duration, but occurring in more locations. Therefore the summary impact level of Alternative 3 on subsistence resources and harvests would be considered to range from negligible to moderate depending upon the specific subsistence resource affected and source of disturbance (Section 4.6.3.2).

4.11.5.14.2 Past and Present Actions

Past and present actions affecting subsistence resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.14.

4.11.5.14.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting subsistence resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.14.

4.11.5.14.4 Contribution of Alternatives to Cumulative Effects

The activities authorized under Alternative 3 would add to the disturbance of subsistence resources from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be temporary and local. A low number of seals and polar bears could be disturbed during on-ice seismic surveys. Exploration activities would constitute a minor contribution to the disturbance of subsistence resources. Exploration activities could contribute to habitat change of subsistence resources through aircraft and vessel traffic, icebreaking efforts, on-ice surveys and discharge of drilling muds but these effects would be of low intensity, localized to regional in extent, temporary in duration, and affect subsistence resources that are common to unique in context. This contribution to habitat change would be negligible when compared to the potential for dramatic sea ice loss due to climate change and changes in ecosystems and resource abundance due to ocean acidification. The exploration activities authorized under Alternative 3 would occur at a higher level of activity in comparison to those proposed under Alternative 2. The contribution of Alternative 3 would have a negligible to moderate contribution to the cumulative effects on subsistence resources.

4.11.5.14.5 Conclusion

Under Alternative 3, the direct and indirect effects to subsistence resources as a result of the increased levels of activity associated with this alternative are considered low in intensity, temporary in duration, local to regional in extent and affect subsistence resources that range from common to unique in context. The contribution of the direct and indirect impacts in consideration of the past, present, and reasonably foreseeable future actions would be negligible to moderate on subsistence.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with subsistence resources were discussed under Alternative 2 (Section 4.11.4.14).

4.11.5.15 Public Health

4.11.5.15.1 Summary of Direct and Indirect Effects

As described in Section 4.6.3.3, anticipated direct and indirect effects on public health and safety as a result of Alternative 3 are expected to be similar to those expected under Alternative 2.

4.11.5.15.2 Past and Present Actions

The effects of past and present actions on public health and safety are the same as those described in Section 4.11.3.15.

4.11.5.15.3 Reasonably Foreseeable Future Actions

The effects of reasonably foreseeable future actions on public health and safety are the same as those described in Section 4.11.3.15.

4.11.5.15.4 Contribution of Alternative to Cumulative Effects

The contribution of Alternative 3 to cumulative effects on public health and safety are the same as those for Alternative 2, described in Section 4.11.4.15.

4.11.5.15.5 Conclusion

Similar to the contribution of Alternative 2 described in Section 4.11.4.15, Alternative 3 contributes to cumulative impacts on public health and safety via the relatively small contribution of the direct and indirect impacts.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with public health and safety were discussed under Alternative 2 (Section 4.11.4.15).

4.11.5.16 Cultural Resources

4.11.5.16.1 Summary of Direct and Indirect Effects

Alternative 3 is the same as Alternative 2 except with increased levels of activity, with two exploratory drilling programs. The impacts discussed for Alternative 2 are applicable for this alternative. The increased levels of activity would not generate different types of impacts to cultural resources. The conclusions for Alternative 2 are applicable to Alternative 3; and while the level of activity would increase, due to the relatively small area affected and short term, infrequent nature of crew changes, the overall impact to cultural resources from increased levels of \activity would be minor.

4.11.5.16.2 Past and Present Actions

Past and present actions affecting cultural resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.16.

4.11.5.16.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting cultural resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.16.

4.11.5.16.4 Contribution of Alternative to Cumulative Effects

The contribution of this alternative to cumulative effects is the same as described under Alternative 2.

4.11.5.16.5 Conclusion

The incremental contribution of activities associated with Alternative 3 to cumulative effects on cultural resources would be negligible.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with cultural resources were discussed under Alternative 2 (Section 4.11.4.16).

4.11.5.17 Land and Water Ownership, Use, Management

4.11.5.17.1 Summary of Direct and Indirect Effects

As discussed in Section 4.11.4.17, the direct and indirect impacts on land and water ownership would be low magnitude, temporary duration, local extent, and common in context. The direct and indirect impacts on land and water use would have a high magnitude, be temporary in duration, local and common. The direct and indirect impacts to land and water management would be low intensity, temporary in nature, local, and common. In summary, the impacts of Alternative 3 on land and water ownership, use, and management would be negligible, moderate, and minor, respectively.

4.11.5.17.2 Past and Present Actions

Past and present actions affecting land and water ownership, use, and management within the EIS project area are discussed under Alternative 2, Section 4.11.4.17.

4.11.5.17.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting land and water ownership, use, and management within the EIS project area are discussed under Alternative 2, Section 4.11.4.17.

4.11.5.17.4 Contribution of Alternative to Cumulative Effects

Alternative 3 is the same as Alternative 2 except with increased levels of activity. The cumulative effects discussed in Section 4.11.4.17 for Alternative 2 are applicable for this alternative. The increased levels of activity would not generate different types of impacts to land or water ownership, use, and management. The conclusions for Alternative 2 are applicable to Alternative 3; all changes would be incrementally small, short-term in duration, and geographically dispersed, and thus would not have combined effects creating cumulative impacts on land ownership, use, or management and would be considered minor.

4.11.5.17.5 Conclusion

Under Alternative 3, the levels of direct, indirect and cumulative impacts for land and water ownership, use, and management are negligible, moderate, and minor, respectively. Based on this, the overall level of impact of Alternative 3 is considered minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with land and water ownership, use, and management were discussed under Alternative 2 (Section 4.11.4.17).

4.11.5.18 Transportation

4.11.5.18.1 Summary of Direct and Indirect Effects

Increased levels of marine vessel traffic in Alternative 3 associated with the seismic survey and exploratory drilling programs would be expected to primarily occur in offshore areas where local marine transportation does not occur. Industry vessels would likely encounter local marine traffic when littering to designated nearshore marine facilities (which are limited). The impact of increased vessel presence would be low in intensity, temporary in duration, limited in geographic extent to a local area, and common to potentially unique context (in respect to protected marine mammal resources). The summary impact from increases in vessel traffic would be considered minor.

4.11.5.18.2 Past and Present Actions

Past and present actions affecting transportation within the EIS project area are discussed under Alternative 2, Section 4.11.4.18.

4.11.5.18.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting transportation within the EIS project area are discussed under Alternative 2, Section 4.11.4.18.

4.11.5.18.4 Contribution of Alternative to Cumulative Effects

The contribution of impacts from Alternative 3 would be similar but of slightly higher intensity than described for Alternative 2 in Section 4.11.4.18.

4.11.5.18.5 Conclusion

In summary, no concerns related to adverse cumulative impacts have been identified. Some cumulative impacts may exist if Alternative 3 overlaps with another large-scale development project but those impacts would be of low intensity, temporary in duration affecting local areas of common resources, and are considered unlikely to have long-term impacts on regional transportation infrastructure.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with transportation were discussed under Alternative 2 (Section 4.11.4.18).

4.11.5.19 Recreation and Tourism

4.11.5.19.1 Summary of Direct and Indirect Effects

As discussed in Section 4.6.3.7, the direct impacts on recreation and tourism would be low intensity, temporary duration, local extent, and common in context. Indirect impacts would be the same levels as direct impacts, except that the geographic area would be broader, extending beyond the region to a state-wide level and potentially beyond. In summary, the impact of Alternative 3 on recreation and tourism would be minor.

4.11.5.19.2 Past and Present Actions

Past and present actions affecting recreation and tourism within the EIS project area are discussed under Alternative 2, Section 4.11.4.19.

4.11.5.19.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting recreation and tourism within the EIS project area are discussed under Alternative 2, Section 4.11.4.19.

4.11.5.19.4 Contribution of Alternative to Cumulative Effects

Alternative 3 is the same as Alternative 2 except with increased levels of activity. The cumulative effects discussed in Section 4.10.4.19 for Alternative 2 are applicable for this alternative. The increased levels of activity would not generate different types of impacts to recreation and tourism. The conclusions for Alternative 2 are applicable to Alternative 3; the contribution of Alternative 3 to cumulative effects to recreation and tourism would be minor.

4.11.5.19.5 Conclusion

Alternative 3 would have a minor contribution to cumulative effects on recreation and tourism.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with recreation and tourism were discussed under Alternative 2 (Section 4.11.4.19).

4.11.5.20 Visual Resources

4.11.5.20.1 Summary of Direct and Indirect Effects

Implementation of Alternative 3 would be similar to that describe in Section 4.11.4.20, however there would be an increase in the level of permitted activity and a consequent potential increase in impacts to visual resources. The proposed action is expected to result in short-term moderate effects to scenic quality and visual resources similar to that described in Alternative 2. Because of the greater number of support vessels used in the two exploratory drilling programs proposed under Alternative 3, this action could be high intensity if both programs are implemented in close proximity to each other. Potential impacts could be of low to medium intensity depending if programs are geographically separated. In either case, actions would be temporary, localized and occur in an important context.

Standard mitigation measures implemented as part of the proposed action would not alter the level of anticipated impacts to visual resources or scenic quality. Although Category D Mitigation Measures would limit exposure of sensitive viewers (individuals engaged in the culturally important activity of bowhead whaling) to vessel-based surveys during certain periods. However it would not change exposure to drill sites, as these structures would remain in place during shutdown periods unless the operator agrees to move off location during such shutdown periods.

4.11.5.20.2 Past and Present Actions

Past and present actions associated with visual resources are presented under Alternative 2 (Section 4.11.4.20).

4.11.5.20.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions associated with visual resources are presented under Alternative 2 (Section 4.11.4.20).

4.11.5.20.4 Contribution of Alternative to Cumulative Effects

Implementation of Alternative 3 would increase the level of permitted activity (i.e. three versus two 2D/3D seismic surveys; two versus one exploratory drilling program). Actions could occur at any location within the EIS project area; however, like Alternative 2, actions associated with implementation of Alternative 3 would result in the greatest impact to visual resources if sited in near-shore areas between Harrison Bay and Kaktovik, where the majority of past, present, and reasonably foreseeable future actions are located. The location would also coincide with locations of sensitive viewers, such as residents of native communities or recreators using the ANWR. If actions associated with Alternative 3 are concentrated in areas where the majority of past, present, and reasonably foreseeable future actions are located, Alternative 3 would contribute to the industrialized landscape character of the area. Transient views of seismic and shallow hazard survey vessels are not expected to contribute to the industrial character of the area, as views of vessels would be episodic.

4.11.5.20.5 Conclusion

Under Alternative 3, anticipated cumulative effects to visual resources are expected to be major. Impacts would be of high intensity, long-term in duration, regional in geographic extent and occurring in an important context.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with visual resources were discussed under Alternative 2 (Section 4.11.4.20).

4.11.5.21 Environmental Justice

4.11.5.21.1 Summary of Direct and Indirect Effects

Direct and indirect effects to subsistence and public health associated with Alternative 3 would be minor, similar to those described in Alternative 2. The level of activity associated with Alternative 3 is greater than Alternative 2, but the effects do not change the summary impact level for these environmental justice indicators.

4.11.5.21.2 Past and Present Actions

Past and present actions associated with environmental justice are presented under Alternative 2 (Section 4.11.4.21).

4.11.5.21.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions associated with environmental justice are presented under Alternative 2 (Section 4.11.4.21).Future industrial activities and climate change would have an adverse impact on subsistence resources and uses and public health.

4.11.5.21.4 Contribution of Alternative to Cumulative Effects

The incremental contribution of Alternative 3 to the overall industrial activity in the area would be similar that that described for Alternative 2. Therefore, the contribution of Alternative 3 to environmental justice indicator cumulative effects would be minor.

4.11.5.21.5 Conclusion

The direct and indirect effects of Alternative 3 would be minor. The contribution to the cumulative effect of environmental justice indicators would be minor. Therefore, there would be a disproportionate impact to Alaska Native communities in the EIS project area.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with environmental justice were discussed under Alternative 2 (Section 4.11.4.21). A VLOS would have disproportionate adverse impacts to Alaska Native communities in the EIS project area.

4.11.6 Alternative 4 – Authorization for Level 3 Exploration Activity

4.11.6.1 Physical Oceanography

4.11.6.1.1 Summary of Direct and Indirect Effects

The effects of Alternative 4 on physical ocean resources would be medium-intensity, temporary, local, and would affect common resources as defined in the impact criteria in Section 4.1 of this EIS. Under Alternative 4, changes in water depth resulting from exploratory drilling programs would be the same in nature as those described for Alternative 3. Alternative 4 would allow additional drilling programs in the EIS project area, and as a result of the additional drilling programs, the intensity as well as the spatial extent of the impact could effectively be doubled. Relative to Alternative 3, water depth would be affected over a larger area. Construction of artificial islands, which could occur in nearshore state waters of the Beaufort Sea at a rate of two islands per year under Alternative 3, would result in medium-intensity, permanent/temporary (permanent if gravel, temporary if ice), localized effects on nearshore currents in the waters adjacent to the artificial islands. Relative to Alternative 3, sea ice would be affected over a larger area due to more extensive icebreaking activity and thermal inputs associated with exploratory drilling activities. Although common resources would be affected across increased spatial and temporal scales relative to Alternative 3, the overall effects of Alternative 4 on physical ocean resources in the EIS project area would be minor, particularly with the implementation of additional mitigation measures related to reducing or eliminating certain discharge streams.

4.11.6.1.2 Past and Present Actions

Past and present actions affecting physical ocean resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.1.

4.11.6.1.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting physical ocean resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.1.

4.11.6.1.4 Contribution of Alternative to Cumulative Effects

Actions associated with Alternative 4 would cause localized minor impacts to physical ocean resources in the EIS project area. While some actions associated with Alternative 4, such as the construction of man-made gravel islands, would interact in a synergistic fashion with past, present, and reasonably foreseeable future actions to influence physical ocean resources in the EIS project area, the impacts resulting from such synergies would represent only a small fraction of foreseeable cumulative impact.

4.11.6.1.5 Conclusion

The incremental contribution of activities associated with Alternative 4 to cumulative effects on physical ocean resources in the EIS project area would be minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with physical ocean resources were discussed under Alternative 2 (Section 4.11.4.1).

4.11.6.2 Climate & Meteorology

4.10.5.2.1 Summary of Direct and Indirect Effects

Alternative 4 would directly emit more GHGs than Alternative 3; however direct impacts to climate change are estimated to have the same level of impact (minor) due to their low magnitude and low contribution to GHG emissions on a state level. Due to uncertainties in the outcome of exploration activities, indirect effects associated with Alternative 4 are assumed to be the same as those for Alternative 3, which would be minor to moderate.

4.11.6.2.2 Past and Present Actions

Past and present actions affecting climate change are discussed under Alternative 2, Section 4.11.4.2.

4.11.6.2.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting climate change are discussed under Alternative 2, Section 4.11.4.2.

4.11.6.2.4 Contribution of Alternative to Cumulative Effects

Alternative 4 would directly emit more GHGs than Alternative 3; therefore it would directly contribute more to cumulative climate change impacts than Alternative 3. Alternative 4 would result in approximately 82,308 tpy more CO_2e emissions than Alternative 3 (See Sections 4.5.1.2 and 4.6.1.2). Alone, this difference would not result in a noticeably larger cumulative effect than Alternative 3. However, when accounting for all past, present, and future projects with GHG emissions, even a minor contribution such as 82,308 tpy of CO_2e per project, can cumulatively result in a perceptible impact. Therefore, Alternative 4 could have a larger impact on cumulative impacts to climate change than Alternative 3. Indirect effects from Alternative 4 are expected to have the same contribution to cumulative effects as Alternative 3, resulting in observable, global changes that could be long-term and could affect unique resources.

4.11.6.2.5 Conclusion

Due to the additive and synergistic nature of GHG emissions on climate change impacts, Alternative 4 could contribute to a moderate to major cumulative impact to climate change.

The additive effects resulting from a VLOS within the seas Arctic OCS associated with climate change were discussed under Alternative 2 (Section 4.11.4.2).

4.11.6.3 Air Quality

4.11.6.3.1 Summary of Direct and Indirect Effects

The air quality effects due to the worst-case activity under Alternative 4, Level 3 Exploration Activity, are expected to be the same as those predicted for Alternative 3. The emissions would be moderate in magnitude, and minor in duration, extent, and content. The total emissions from the Level 3 Exploration Activity is greater than that for Level 2 Exploration Activity, however the overall direct effect on air quality is expected to be moderate. Indirect effects on air quality would remain at negligible to minor.

4.11.6.3.2 Past and Present Actions

Past and present actions affecting air quality within the EIS project area are discussed under Alternative 2, Section 4.11.4.3.

4.11.6.3.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting air quality within the EIS project area are discussed under Alternative 2, Section 4.11.4.3.

4.11.6.3.4 Contribution of Alternative to Cumulative Effects

As with Alternative 3, Alternative 4 has the potential to contribute to future cumulative effects on air quality if activities occur during the same time period(s) and vicinity of any of the actions identified above that have the potential to affect air quality. Because of the short time duration for activities, cumulative effects would be highly dependent on actual meteorological conditions at the time, and the relative location of sources. The cumulative effects would be negligible (lower than the sum of the total maximum effects). There are no accumulative or synergistic effects associated with air quality.

4.11.6.3.5 Conclusion

Alternative 4 has the potential to contribute to cumulative effects on air quality when activities occur in the vicinity of other sources of air pollution. Due to distance between activities, and the mobile and intermittent source activities, the cumulative effects are expected to be less than the sum of each, likely remaining moderate in magnitude.

The additive effects resulting from a VLOS within the seas Arctic OCS associated with air quality were discussed under Alternative 2 (Section 4.11.4.3).

4.11.6.4 Acoustics

4.11.6.4.1 Summary of Direct and Indirect Effects

The summary of direct and indirect effects provided in Section 4.11.4 (Alternative 2) is relevant also for Alternative 4. The overall impact rating for direct and indirect effects to the acoustic environment under Alternative 4 would be moderate.

4.11.6.4.2 Past and Present Actions

The past actions for Alternative 4 are the same as listed for Alternative 2 (Section 4.11.4.4). The present actions will consist of up to six deep penetration seismic surveys in the Beaufort Sea and up to five seismic surveys in the Chukchi Sea. This alternative also allows for up to five site clearance and high resolution shallow hazards surveys in Beaufort and five of these surveys in the Chukchi. Up to four drilling programs in each of the Beaufort and Chukchi seas and one on-ice seismic survey would be permitted in the Beaufort Sea only.

4.11.6.4.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting acoustics within the EIS project area are discussed under Alternative 2, Section 4.11.4.4.

4.11.6.4.4 Contribution of Alternative to Cumulative Effects

This alternative permits the highest level of activity of all alternatives. The possibility of up to six deep-penetration seismic surveys and five site clearance and high resolution shallow hazards surveys with inclusion of two potential drilling operations in the Beaufort Sea open water season produces substantial total disturbance zone areas. Marine mammals could have difficulty navigating between the disturbance zones surrounding each of the surveys and drill operations if these activities were performed concurrently. The concurrent operation of multiple noise sources could lead to confusion by marine mammals at choosing a path to avoid regions of high noise. If cumulative SEL criteria for auditory system injury were considered, the total effects of exposures to multiple operations could be substantially greater than from individual activities. The large number of deep penetration seismic surveys would be the primary source of higher cumulative exposures.

Cumulative effects in the Chukchi Sea would be fewer than in the Beaufort Sea because the surveys will have greater spatial separation and marine mammal migration corridors there are less concentrated. There would consequently be more opportunity for migrating marine mammals to choose paths between the surveys and drilling locations to avoid passing close to individual operations where noise levels are highest.

4.11.6.4.5 Conclusion

Cumulative effects from noise exposures to marine mammals under Alternative 4 are similar but slightly larger than the effects described for Alternative 3 due to the greater number of noise-generating activities that would be permitted. The ability of marine mammals to avoid close approaches to seismic survey sources would be reduced when many sources were concurrently in operation with limited spatial separation. These animals would therefore be exposed to higher sound levels and higher cumulative sound levels than if fewer concurrent operations were present.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with acoustics were discussed under Alternative 2 (Section 4.11.4.4).

4.11.6.5 Water Quality

4.11.6.5.1 Summary of Direct and Indirect Effects

Impacts to water quality from Alternative 4 would be the same in nature as those described for Alternative 2 in Section 4.11.4.5. The only difference between the two alternatives is the level of activity. Alternative 4 would allow additional surveys and exploratory drilling programs in the EIS project area, and as a result of the additional drilling programs, the intensity as well as the spatial extent of the impacts may effectively be doubled. Relative to Alternative 2, water quality parameters may be affected over larger areas and over longer periods of time. However, the effects of Alternative 4 on water quality would be low intensity, temporary, and localized to areas in the immediate vicinity of the activities. Although common resources may be affected across increased spatial scales relative to Alternative 2, the overall effects of Alternative 4 on water quality are expected to be minor.

4.11.6.5.2 Past and Present Actions

Past and present actions affecting water quality within the EIS project area are discussed under Alternative 2, Section 4.11.4.5.

4.11.6.5.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting water quality within the EIS project area are discussed under Alternative 2, Section 4.11.4.5.

4.11.6.5.4 Contribution of Alternative to Cumulative Effects

Actions associated with Alternative 4 would cause temporary local impacts to water quality such as increases in temperature, turbidity, and concentrations of pollutants. Some actions associated with Alternative 4, such as discharges of cooling water and waste material, would interact with past, present, and reasonably foreseeable future actions resulting in both additive and synergistic impacts to water quality. These interactions would be local and temporary and would represent only a small fraction of foreseeable cumulative impact.

4.11.6.5.5 Conclusion

The incremental contribution of activities associated with Alternative 4 to cumulative effects on water quality in the EIS project area would be minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with water quality were discussed under Alternative 2 (Section 4.11.4.5).

4.11.6.6 Environmental Contaminants and Ecosystem Functions

4.11.6.6.1 Summary of Direct and Indirect Effects

Direct and indirect impacts to ecosystem functions resulting from the implementation of Alternative 4 would be medium-intensity, temporary, and local. Regulation functions such as nutrient cycling and waste assimilation, which depend on biota and physical processes to facilitate storage and recycling of nutrients and breakdown or assimilation of contaminants, would be affected within the EIS project area. While the geographic extent of such impacts would potentially be greater than that resulting from Alternative 3, the overall geographic extent of impacts to regulation functions would be limited. Habitat functions, particularly those related to benthic habitats, would be impacted as a result of discharges and other activities associated with exploratory drilling. Production functions including primary productivity and subsequent transfers to higher trophic levels could potentially be impacted as a result of activities associated with Alternative 4, while the effects of Alternative 4 on information ecosystem functions would depend upon interrelationships between impacts to cultural resources, social resources, and aesthetic resources, which are addressed in other sections of this EIS. Overall effects of Alternative 4 on ecosystem functions would be minor.

4.11.6.6.2 Past and Present Actions

Past and present actions affecting environmental contaminants and ecosystem functions within the EIS project area are discussed under Alternative 2, Section 4.11.4.6.

4.11.6.6.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting environmental contaminants and ecosystem functions within the EIS project area are discussed under Alternative 2, Section 4.11.4.6.

4.11.6.6.4 Contribution of Alternative to Cumulative Effects

Actions associated with Alternative 4 would cause localized minor impacts to environmental contaminants and ecosystem functions within the EIS project area. Some actions associated with Alternative 4, such as discharges from exploratory drilling operations, would interact with past, present, and reasonably foreseeable future actions resulting in both additive and synergistic impacts to ecosystem functions. Relative to Alternative 3, these interactions would potentially be distributed over a greater geographic area. The impacts resulting from such interactions would represent a relatively small fraction of foreseeable cumulative impact, and the accumulation of impacts is unlikely to be substantial over the lifespan of this EIS.

4.11.6.6.5 Conclusion

The incremental contribution of activities associated with Alternative 4 to cumulative effects on environmental contaminants and ecosystem functions in the EIS project area would be minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with environmental contaminants and ecosystem functions were discussed under Alternative 2 (Section 4.11.4.6).

4.11.6.7 Lower Trophic Levels

4.11.6.7.1 Summary of Direct and Indirect Effects

Alternative 4 is the same as Alternative 3 except with increased levels of activity. The impacts discussed in Section 4.11.4.7 for Alternative 2 are applicable for this alternative. The increased levels of activity would not generate different types of impacts to lower trophic levels. The conclusions for Alternative 2 are applicable to Alternative 4; therefore, the overall impact to lower trophic levels would be minor.

4.11.6.7.2 Past and Present Actions

Past and present actions affecting lower trophic levels within the EIS project area are discussed under Alternative 2, Section 4.11.4.7.

4.11.6.7.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting lower trophic levels within the EIS project area are discussed under Alternative 2, Section 4.11.4.7.

4.11.6.7.4 Contribution of Alternative to Cumulative Effects

Alternative 4 would have the same types of effects as Alternative 3 but the increased level of exploration drilling activities under Alternative 4 would add incrementally to its contribution to cumulative effects on lower trophic levels. However, the conclusions about Alternative 4 would be similar to Alternative 3 discussed in Section 4.11.5.7 and the overall impact would be moderate. In the absence of a very large oil spill, the exploration activities authorized under Alternative 4 would have moderate contributions to the cumulative effects from past, present, and reasonably foreseeable future actions on lower trophic levels.

4.11.6.7.5 Conclusion

Alternative 4 could have a moderate contribution to cumulative effects on lower trophic organisms.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with lower trophic levels were discussed under Alternative 2 (Section 4.11.4.7).

4.11.6.8 Fish and Essential Fish Habitat

4.11.6.8.1 Summary of Direct and Indirect Effects

The overall impact of Alternative 4 on Fish Resources and EFH is minor. Despite a substantial increase in level of activity over Alternative 2, there would be no corresponding increase in the overall impact level. Due to the very small scale of any potential effects relative to overall population levels and available habitat, and the temporary nature of the majority of the activities associated with Alternative 4, there would be no measurable effect on the resource.

The direct and indirect effects on marine fish resulting from Alternative 4 would be very similar to those described under Alternative 2. Due to the uneven nature of the increases in activity levels by activity type, the increase in impacts to different fish assemblages would vary. The cryopelagic assemblage would have essentially no additional impacts, as the level for activities likely to affect that group (icebreaking and on-ice seismic surveys) would not change from Alternative 2. Demersal assemblages, on the other hand, would feel the additional effects from the increase in seismic survey levels and exploratory drilling, both in terms of habitat loss and the effects from noise. Pelagic assemblages would be impacted by the increase in surveys but less so by the increased drilling programs. However, in spite of the potential for different resource groups to experience uneven increases in level of effect, the overall impact would remain the same given the limited area affected compared to the distribution of fish populations. The impacts to marine fish would be considered minor.

The direct and indirect effects on migratory fish resulting from Alternative 4 would be very similar to those described under Alternative 2. Because anadromous fish are more likely to be impacted by the activity types than amphidromous fish, as discussed under Alternative 2, they are likely to experience a disproportionate increase in adverse impacts when the two groups are compared. However, as described in Alternative 2, those anadromous species known to inhabit the area where project activities would occur are not very abundant, and they are unlikely to be impacted. Therefore, the overall impact to the resource group would remain the same. The impacts to migratory fish would be considered negligible.

The direct and indirect effects on essential fish habitat resulting from Alternative 4 would be very similar to those described under Alternative 2, with an increase in effects due to the increase in oil and gas exploration activities. In particular, the increase in exploratory drilling programs would result in increased habitat loss and alteration, potentially to EFH for saffron cod and salmon. Since there would be no increase in icebreaking activities, EFH for Arctic cod would be impacted the least. The opportunity for habitat loss or alteration resulting from Alternative 4 is small and only incrementally larger than for Alternative 3. Most impacts would be of such low intensity and of such small geographic extent that the effects would be considered minor.

4.11.6.8.2 Past and Present Actions

Past and present actions affecting fish and EFH within the EIS project area are discussed under Alternative 2, Section 4.11.4.8.

4.11.6.8.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting fish and EFH within the EIS project area are discussed under Alternative 2, Section 4.11.4.8.

4.11.6.8.4 Contribution of Alternative to Cumulative Effects

Climate change is the only past, present, or reasonably foreseeable future action that is anticipated to have any measurable effect on fish and EFH within the EIS project area, and those effects are likely to be beneficial. As Arctic waters warm, productivity is likely to increase, thereby creating more favorable fish habitat throughout the region. The lack of measurable effect on fish and EFH resulting from the implementation of Alternative 4 would not add to any cumulative effects.

4.11.6.8.5 Conclusion

Direct and indirect impacts resulting from Alternative 4 on fish and EFH would be of such low intensity and of such small geographic extent that the effects would be considered minor. The incremental contribution of activities associated with Alternative 4 to cumulative effects on fish would be minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with fish and EFH were discussed under Alternative 2 (Section 4.11.4.8).

4.11.6.9 Marine and Coastal Birds

4.11.6.9.1 Summary of Direct and Indirect Effects

As discussed in Section 4.6.2.3, the effects of disturbance, injury/mortality, and changes in habitat for marine and coastal birds would likely be temporary or short-term, localized, and not likely to have population-level effects for any species. In summary, the impact of Alternative 4 on marine and coastal birds would be considered negligible to minor.

4.11.6.9.2 Past and Present Actions

Past and present actions affecting marine and coastal birds within the EIS project area are discussed under Alternative 2, Section 4.11.4.9.

4.11.6.9.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting marine and coastal birds within the EIS project area are discussed under Alternative 2, Section 4.11.4.9.

4.11.6.9.4 Contribution of Alternative 4 to Cumulative Effects

Alternative 4 would have the same types of effects as Alternative 2 but the increased level of exploration activities under Alternative 4 would add incrementally to its contribution to cumulative effects on marine and coastal birds. However, the conclusions about Alternative 4 would be similar to Alternative 3 (4.11.5.9). The exploration activities authorized under Alternative 4 would have negligible contributions to the cumulative effects from past, present, and reasonably foreseeable future actions on marine and coastal birds.

4.11.6.9.5 Conclusion

The direct and indirect effects of Alternative 4 on marine and coastal birds would be considered negligible to minor. Alternative 4 would have negligible contributions to the cumulative effects from past, present, and reasonably foreseeable future actions on marine and coastal birds, as discussed under Alternative 2 (Section 4.11.4.9).

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with marine and coastal birds were discussed under Alternative 2 (Section 4.11.4.9).

4.11.6.10 Marine Mammals

4.11.6.10.1 Bowhead Whales

4.11.6.10.1.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 4 on bowhead whales are described in Section 4.7.2.4.1 and are summarized here. Impacts of individual activities associated with oil and gas exploration in the EIS project area under Alternative 4 are similar to Alternative 3. Despite a substantial increase in level of activity over Alternative 2, the overall impact level would be the same (See Section 4.11.4.10.1).

In terms of the impact criteria identified in Table 4.5-17, most effects of individual exploratory activities authorized under Alternative 4 are of medium intensity and temporary in duration. Potential long-term effects from repeated disturbance over time or over a broad geographic range are unknown. Individually, the various activities may elicit localized effects on bowhead whales, yet the area and extent of the population over which effects would be felt would increase with multiple activities occurring simultaneously or consecutively throughout much of the summer-fall range of this population. Since the EIS project area extends across most of the migratory path of bowhead whales in U.S. waters, the combined oil and gas exploration activities could result in regional level effects on bowhead whales.

Bowhead whales are listed as endangered and are an essential subsistence resource for Iñupiat and Yupik Eskimos of the Arctic coast, which places them in the context of being a unique resource. Evaluated collectively, and with consideration given to reduced adverse impacts through the imposition of the required standard mitigation measures, the overall effect of activities authorized under Alternative 4 on bowhead whales is likely to be moderate to major.

4.11.6.10.1.2 Past and Present Actions

Past and present actions affecting bowhead whales within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.1.

4.11.6.10.1.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting bowhead whales within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.1.

4.11.6.10.1.4 Contribution of Alternative to Cumulative Effects

The contribution of the direct and indirect impacts resulting from Alternative 4, when combined with the past, present, and reasonably foreseeable future actions would be moderate, with most potential impacts due to acoustic disturbance that could, at least temporarily, disrupt or displace bowhead whales.

4.11.6.10.1.5 Conclusion

Under Alternative 4, the direct and indirect effects to bowhead whales would be moderate to major. Overall, Alternative 4 would have a moderate contribution to cumulative effects on bowhead whales.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with bowhead whales were discussed under Alternative 2 (Section 4.11.4.10.1).

4.11.6.10.2 Beluga Whales

4.11.6.10.2.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 4 on beluga whales are described in Section 4.7.2.4.2 and are summarized here. The additional oil and gas exploration activities proposed in Alternative 4 could directly and indirectly affect beluga whales by causing noise disturbance, habitat degradation, and potential ship strikes. Beluga whales disturbed by oil and gas exploration activities may move away from important habitats. The scale of the avoidance depends on the number and relative proximity of the surveys. Numerous simultaneous seismic activities could cause avoidance over large distances. Potential habitat degradation from drill cuttings or drilling mud discharges would be localized and temporary; the impact level would be negligible. While the incidence of ship strikes is currently low, it could rise with increasing vessel traffic.

The direct and indirect effects on beluga whales from the exploration activities under Alternative 4 would be low to medium intensity, short-term duration, local to regional extent, and would affect a unique resource. The summary impact level of Alternative 4 on beluga whales would be considered moderate.

4.11.6.10.2.2 Past and Present Actions

Past and present actions affecting beluga whales in the EIS project area are discussed under Alternative 2, Section 4.11.4.10.2.

4.11.6.10.2.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions that would affect beluga whales in the EIS project area are discussed under Alternative 2, Section 4.11.4.10.2.

4.11.6.10.2.4 Contribution of Alternative to Cumulative Effects

The oil and gas exploration activities authorized under Alternative 4 would add to the acoustic disturbance of beluga whales from marine vessels, seismic sources, and aircraft traffic in the Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be localized and temporary. Although ship strikes are possible with increased vessel activity associated with oil and gas exploration, the contribution to additional mortality would be negligible relative to the population level. Exploration activities could contribute to habitat alterations through icebreaking efforts and discharge of drilling muds. Effects would be localized and temporary. The contribution to habitat change would be negligible since it would affect an extremely small proportion of habitat or prey base available to beluga whales. The exploration activities authorized under Alternative 4 would therefore have minor to moderate additive contributions to the cumulative effects on beluga whales.

4.11.6.10.2.5 Conclusion

As stated above, most exploration activities authorized under Alternative 4 would result in minor to moderate contributions to cumulative effects on beluga whales.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with beluga whales were discussed under Alternative 2 (Section 4.11.4.10.2).

4.11.6.10.3 Other Cetaceans

4.11.6.10.3.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 4 on cetaceans are described in Section 4.7.2.4.3 and are summarized here. Evaluated collectively, the overall impact of Alternative 4 on other cetaceans is minor to moderate. Despite a doubling in the level of exploratory drilling activity over Alternative 3, there would be no corresponding increase in impact level. Due to the very small scale of any potential effects relative to overall population levels and available habitat, and the temporary nature of the majority of the activities associated with Alternative 4, impacts on the resource would be low in intensity, of short duration, and limited extent. Long term impacts are unknown, but anticipated to be minor.

The primary direct and indirect effects on other cetaceans would result from noise exposure. Potential noise sources include 2D/3D seismic survey equipment (airgun arrays), CSEM electromagnetic signals, echosounder and sonar devices associated with site clearance and shallow hazards surveys, support, monitoring and receiving vessels associated with these surveys, icebreaking activities, on-ice vibroseis seismic surveys (Beaufort Sea only), exploratory drilling, and helicopter and fixed wing aircraft associated with the different programs.

Direct and indirect effects arising from ship strikes and habitat degradation are also possible. Potential habitat degradation from drill cuttings or drilling mud discharges would be localized and temporary; the impact level would be negligible. While the incidence of ship strikes is currently low, it could rise with increasing vessel traffic.

4.11.6510.3.2 Past and Present Actions

Past and present actions affecting other cetaceans within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.3.

4.11.6.10.3.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting other cetaceans within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.3.

4.11.6.10.3.4 Contribution of Alternative to Cumulative Effects

The oil and gas exploration activities authorized under Alternative 4 would add to the acoustic disturbance of other cetaceans from marine vessels, seismic sources, and aircraft traffic in the Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be localized and temporary. Although ship strikes are possible with increased vessel activity associated with oil and gas exploration, the contribution to additional mortality would be negligible relative to the population level. Exploration activities could contribute to habitat alterations through icebreaking efforts and discharge of drilling muds. Effects would be localized and temporary. The contribution to habitat change would be negligible. Despite a doubling in the level of exploratory drilling activity over Alternative 3, there would be no corresponding increase in impact level.

None of the past, present, or reasonably foreseeable future actions described above are expected to have any substantial impact on cetacean populations within the EIS project area. Populations for most species are stable or increasing, and climate change is likely to add nominal beneficial impacts in the future. The exploration activities authorized under Alternative 4 would therefore have minor additive contributions to the cumulative effects on other cetaceans.

4.11.6.10.3.5 Conclusion

As stated above, most exploration activities authorized under Alternative 4 would result in minor contributions to cumulative effects on other cetaceans.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with other cetaceans were discussed under Alternative 2 (Section 4.11.4.10.3).

4.11.6.10.4 Ice Seals

4.11.6.10.4.1 Summary of Direct and Indirect Effects

There are four species of seals considered in this section that are often collectively called “ice seals”; ringed seal, spotted seal, ribbon seal, and bearded seal. The direct and indirect effects of Alternative 4 on ice seals are described in Section 4.7.2.4.4 and are summarized here. Ringed seals and bearded seals have been the most commonly encountered species of any marine mammals in past offshore oil and gas exploration activities in the Alaskan Beaufort and Chukchi seas and would likely be affected more frequently by exploration activities authorized under Alternative 4 than either ribbon or spotted seals. Data from observers on board seismic source vessels and monitoring vessels indicate that seals tend to avoid on-coming vessels and active seismic arrays but they do not appear to react strongly even as ships pass fairly close with active arrays. They also do not appear to react strongly to icebreaking or on-ice surveys, keeping their distance or moving away at some point to an alternate breathing hole or haulout, but the scope of these behavioral responses appears to be within their natural abilities and responses to their naturally dynamic environment. None of the behavioral reactions observed to date indicate that any of the ice seal species would be displaced from key areas or resources for more than a few minutes or hours and they would be unlikely to experience any measurable effects on their reproductive success or survival. Ice seals are legally protected, have unique ecological roles in the Arctic, and are important subsistence resources and are therefore considered to be unique resources. Given the standard mitigation measures that have been required in the past, the effects of exploration activities that could be authorized under Alternative 4 on ice seals would likely be low in magnitude, distributed over a wide geographic area, and temporary to short-term in duration. The effects of Alternative 3 would therefore be considered minor to moderate for all ice seal species according to the criteria established in Section 4.1.3.

4.11.6.10.4.2 Past and Present Actions

Past and present actions affecting pinnipeds within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.4.

4.11.6.10.4.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting pinnipeds within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.4.

4.11.6.10.4.4 Contribution of Alternative 4 to Cumulative Effects

The exploration activities authorized under Alternative 4 would add to the disturbance of ice seals from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be temporary. Very small numbers of ringed seals could be exposed to exploration activities during the denning season (winter-spring) when females with young are more susceptible to disturbance. Exploration activities would contribute negligible risk of additional mortality to any species, which would continue to be dominated by subsistence harvest. Exploration activities could contribute to habitat change through on-ice surveys, icebreaking efforts, and discharge of drilling muds but these effects would be localized and temporary or short-term. This contribution to habitat change would be negligible compared to the potential for dramatic sea ice loss due to climate change and changes in ecosystems due to ocean acidification. The exploration activities authorized under Alternative 4 would therefore have minor contributions to the cumulative effects on the four species of ice seals considered.

4.11.6.10.4.5 Conclusion

The direct and indirect effects of Alternative 4 on pinnipeds would be considered minor to moderate. Alternative 4 would have minor contributions to the cumulative effects on the four species of ice seals.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with pinnipeds were discussed under Alternative 2 (Section 4.11.4.10.4).

4.11.6.10.5 Walrus

4.11.6.10.5.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 4 on walrus are described in Section 4.7.2.4.5 and are summarized here. Walrus have been regularly encountered during vessel-based exploration activities in the past, primarily in late summer as the pack ice recedes, as recorded by PSOs on board seismic source vessels and monitoring vessels. These data indicate that walrus do not react strongly to vessels and active seismic arrays and their behavioral responses are often neutral rather than swimming away. They tend to dive into the water as icebreaking ships approach from some distance and are therefore not exposed to the loudest sounds generated by the ships. Mitigation measures required for walrus by USFWS LOAs since the early 1990s have reduced the risk of close encounters with seismic and other exploration vessels and have reduced the risk of accidental spills that may affect walrus or their prey. None of the data collected to date on walrus reactions to exploration activities indicate that they would be displaced from key areas or resources for more than a few minutes or hours. Careful avoidance of vessel and aircraft traffic around walrus haulouts on land would be important to minimize the risk of calf and juvenile mortality from stampedes. Walrus are legally protected, fulfill an important ecological role in the Arctic, and are important subsistence resources and are therefore considered to be a unique resource for NEPA purposes. Given the level and type of exploration activities that would be authorized under Alternative **4**, and considering the mitigation measures that would be required by USFWS LOAs and NMFS in this EIS, the effects on walrus would likely be low in magnitude, distributed over a wide geographic area, and temporary in duration. The effects of Alternative **4** on Pacific walrus would therefore be considered minor.

4.11.6.10.5.2 Past and Present Actions

Past and present actions affecting Pacific walrus within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.5.

4.11.6.10.5.3 Reasonably Foreseeable Future Actions

Past and present actions affecting Pacific walrus within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.5.

4.11.6.10.5.4 Contribution of Alternative 4 to Cumulative Effects

The exploration activities authorized under Alternative 4 would add to the disturbance of walrus from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be temporary. Exploration activities would contribute negligible risk of additional mortality to walrus, which would continue to be dominated by subsistence harvest. Exploration activities could contribute to habitat change through on-ice surveys, icebreaking efforts, and discharge of drilling muds but these effects would be localized and temporary or short-term. This contribution to habitat change would be negligible compared to the potential for dramatic sea ice loss due to climate change and changes in ecosystems due to ocean acidification. The exploration activities authorized under Alternative 4 would therefore have negligible to minor contributions to the cumulative effects on Pacific walrus.

4.11.6.10.5.5 Conclusion

The direct and indirect effects of Alternative 4 on Pacific walrus would be considered minor. Alternative 4 would have negligible to minor contributions to the cumulative effects.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with Pacific walrus were discussed under Alternative 2 (Section 4.11.4.10.5).

4.11.6.10.6 Polar Bears

4.11.6.10.6.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 4 on polar bears are described in Section 4.7.2.4.6 and are summarized here. The types and levels of effects on polar bears are essentially the same under Alternative **4** as for Alternative **3.** The primary difference for polar bears would be an incremental increase in disturbance from vessel and air traffic and an incremental increase in risk of habitat contamination**.** Polar bears have been infrequently encountered during vessel-based exploration activities in the past, as recorded by PSOs on board source vessels and monitoring vessels. These sparse data indicate that polar bears do not react strongly to vessels and active seismic arrays and their behavioral responses are often neutral rather than running or swimming away. The gradual introduction of alternative technologies for seismic surveys would make very little difference to polar bears because they are unlikely to be affected in any biologically meaningful way by seismic noise. They also do not appear to react strongly to icebreaking or on-ice surveys. Some bears keep their distance or move away at some point but others may approach vehicles and equipment out of curiosity. The types of effects of most concern for polar bears during exploration activities involve the risk of bear-human encounters. Mitigation measures and polar bear safety/interaction plans required by USFWS LOAs since the early 1990s have reduced the risk of these encounters for both people and bears. None of the data collected to date on polar bear reactions to exploration activities indicate that polar bears would be displaced from key areas or resources for more than a few minutes or hours and they are unlikely to experience any measurable effects on their reproductive success or survival as a result. Polar bears are legally protected, have a unique ecological role in the Arctic, and are important to subsistence cultures and are therefore considered a unique resource. Given the level and type of exploration activities that would be authorized under Alternative **4**, and considering the mitigation measures that would be required by USFWS LOAs and NMFS in this EIS, the effects on polar bears would likely be low in magnitude, distributed over a wide geographic area, and temporary in duration. The effects of Alternative 3 on polar bears would therefore be considered minor.

4.11.6.10.6.2 Past and Present Actions

Past and present actions affecting polar bears within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.6.

4.11.6.10.6.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting polar bears within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.6.

4.11.6.10.6.4 Contribution of Alternative 3 to Cumulative Effects

The exploration activities authorized under Alternative 4 would add to the disturbance of polar bears from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be temporary. Exploration activities would contribute negligible risk of additional mortality to polar bears, which would continue to be dominated by subsistence harvest. Exploration activities could contribute to habitat change through on-ice surveys, icebreaking efforts, and discharge of drilling muds but these effects would be localized and temporary or short-term. This contribution to habitat change would be negligible compared to the potential for dramatic sea ice loss due to climate change and changes in ecosystems due to ocean acidification. The exploration activities authorized under Alternative 4 would therefore have negligible to minor contributions to the cumulative effects on polar bears.

4.11.6.10.6.5 Conclusion

The direct and indirect effects of Alternative 4 on polar bears would be considered minor. Alternative 4 would have negligible to minor contributions to the cumulative effects.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with polar bears were discussed under Alternative 2 (Section 4.11.4.10.6).

4.11.6.11 Terrestrial Mammals

4.11.6.11.1 Summary of Direct and Indirect Effects

Alternative 4 is the same as Alternative 3 except with increased level of exploratory drilling activity (a total of four programs in each sea instead of two programs in each sea). The impacts discussed for Alternative 3 are applicable for this alternative. The increased levels of activity would not generate different types of impacts to terrestrial mammals. The conclusions for Alternative 3 are applicable to Alternative 4; and while the level of activity would increase, due to the relatively small area affected and short term, infrequent nature of crew changes, the overall impact to terrestrial mammals from aircraft activity would be minor.

4.11.6.11.2 Past and Present Actions

Past and present actions affecting caribou within the EIS project area are discussed under Alternative 2, Section 4.11.4.11.

4.11.6.11.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting caribou within the EIS project area are discussed under Alternative 2, Section 4.11.4.11.

4.11.6.11.4 Contribution of Alternative to Cumulative Effects

The contribution of this alternative to cumulative effects is the same as described under Alternative 2.

4.11.6.11.5 Conclusion

The incremental contribution of activities associated with Alternative 4 to cumulative effects on caribou would be negligible.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with caribou were discussed under Alternative 2 (Section 4.11.4.11).

4.11.6.12 Time/Area Closure Locations

The analysis of the cumulative effects associated with time/area closures can be found in Sections 4.11.5.10 (Marine Mammals), 4.11.5.9 (Marine and Coastal Birds) and 4.11.5.14 (Subsistence).

4.11.6.13 Socioeconomics

4.11.6.13.1 Summary of Direct and Indirect Effects

Direct and indirect effects associated with Alternative 4 are similar to those described in Alternative 3. Alternative 4 represents an increased level of oil and gas exploration therefore there would be an increased level of local revenue generated in staging communities; direct and indirect employment opportunities for Regional and Village Corporations that procure service contracts; and countervailing negative impacts to institutions and social services in the staging communities. The magnitude of the socioeconomic impact is positive but still low because total personal income, local employment rates, and borough revenues would also not increased by more than five percent.

Direct employment opportunities associated with the standard mitigation measures could increase or stay the same as Alternative 3 due to their duplicative nature. Also similar to Alternative 3, the duration of the socioeconomic impacts is temporary (not year-round) and scheduled to occur over a fixed number of years. The geographic extent of socioeconomic impacts is local, statewide, and even national. The context of the socioeconomic impacts is unique because the people that would experience the flow of workers and research vessels are predominantly Iñupiat communities. The summary impact level for Socioeconomics under Alternative 4 is minor, not exceeding the significance threshold.

4.11.6.13.2 Past and Present Actions

Past and present actions affecting socioeconomics within the EIS project area are discussed under Alternative 2, Section 4.11.4.13.

4.11.6.13.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting socioeconomics within the EIS project area are discussed under Alternative 2, Section 4.11.4.13. This analysis assumes current levels of oil and gas production and on-shore exploration would continue, but does not assume that offshore exploration associated with Alternative 3 would result in future oil and gas production.

4.11.6.13.4 Contribution of Alternative to Cumulative Effects

Actions associated with Alternative 4 would cause minor (positive) direct and indirect impacts to socioeconomics. They differ from Alternative 3 by a higher magnitude of direct employment and generation of local revenue, but with a potential increase in negative impacts on local institutions. The summary contribution of these impacts to the cumulative effectives of socioeconomics is negligible to minor at a statewide and national level and minor at the local level.

4.11.6.13.5 Conclusion

The direct and indirect effects of Alternative 4 would be minor. The contribution to cumulative effects of socioeconomics would be negligible to minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with socioeconomics were discussed under Alternative 2 (Section 4.11.4.13).

4.11.6.14 Subsistence

4.11.6.14.1 Summary of Direct and Indirect Effects

Using the impact criteria identified in Table 4.5-25, the direct and indirect effect of oil and gas exploration activities on subsistence resources and harvests resulting from implementation of Alternative 4 would be of low intensity, temporary in duration, local to regional in extent, and the context would be common to unique. Protected resources (bowhead whales and polar bears are considered unique in context as these resources are protected by legislation (e.g. MMPA, ESA) or are considered an important subsistence resource (beluga whales). Even with the increase in the number of activities/programs that could potentially occur under Alternative 4, the impacts to subsistence resources and harvest are anticipated to be similar in type, generally of similar intensity, and comparable duration, but occurring in more locations. Therefore the summary impact level of Alternative 4 on subsistence resources and harvests would be considered to range from negligible to moderate depending upon the specific subsistence resource affected and source of disturbance (Section 4.7.3.2).

4.11.6.14.2 Past and Present Actions

Past and present actions affecting subsistence resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.14.

4.11.6.14.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting subsistence resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.14.

4.11.6.14.4 Contribution of Alternatives to Cumulative Effects

The activities authorized under Alternative 4 would add to the disturbance of subsistence resources from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be temporary and local. A low number of seals and polar bears could be disturbed during on-ice seismic surveys. Exploration activities would constitute a minor contribution to the disturbance of subsistence resources. Exploration activities could contribute to habitat change of subsistence resources through aircraft and vessel traffic, icebreaking efforts, on-ice surveys and discharge of drilling muds but these effects would be of low intensity, localized to regional in extent, temporary in duration, and affect subsistence resources that are common to unique in context. This contribution to habitat change would be negligible when compared to the potential for dramatic sea ice loss due to climate change and changes in ecosystems and resource abundance due to ocean acidification. The exploration activities authorized under Alternative 4 would occur at a higher level of activity in comparison to those proposed under Alternative 3. The contribution of Alternative 4 would have a negligible to moderate contribution to the cumulative effects on subsistence resources.

4.11.6.14.5 Conclusion

Under Alternative 4, the direct and indirect effects to subsistence resources as a result of the increased levels of activity associated with this alternative are considered low in intensity, temporary in duration, local to regional in extent and affect subsistence resources that range from common to unique in context.

The contribution of the direct and indirect impacts in consideration of the past, present, and reasonably foreseeable future actions would be negligible to moderate on subsistence.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with subsistence resources were discussed under Alternative 2 (Section 4.11.4.14).

4.11.6.15 Public Health

4.11.6.15.1 Summary of Direct and Indirect Effects

As described in Section 4.7.3.3, anticipated direct and indirect effects on public health and safety as a result of Alternative 4 are expected to be similar to those expected under Alternative 3.

4.11.6.15.2 Past and Present Actions

The effects of past and present actions on public health and safety are the same as those described in Section 4.11.4.15.

4.11.6.15.3 Reasonably Foreseeable Future Actions

The effects of reasonably foreseeable future actions on public health and safety are the same as those described in Section 4.11.4.15.

4.11.6.15.4 Contribution of Alternative to Cumulative Effects

The contribution of Alternative 4 to cumulative effects on public health and safety are the same as those for Alternative 2, described in Section 4.11.4.15.

4.11.6.15.5 Conclusion

Similar to the contribution of Alternative 2 described in Section 4.11.4.15, Alternative 4 contributes to cumulative impacts on public health and safety via the relatively small contribution of the direct and indirect impacts.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with public health and safety were discussed under Alternative 2 (Section 4.11.4.15).

4.11.6.16 Cultural Resources

4.11.6.16.1 Summary of Direct and Indirect Effects

Alternative 4 is the same as Alternative 3 except with increased level of exploratory drilling activity, with two additional programs in each sea per season. The impacts discussed for Alternative 3 are applicable for this alternative. The increased levels of activity would not generate different types of impacts to cultural resources. The conclusions for Alternative 3 are applicable to Alternative 4; and while the level of activity would increase, due to the relatively small area affected and short term, infrequent nature of crew changes, the overall impact to cultural resources from increased levels of activity would be minor.

4.11.6.16.2 Past and Present Actions

Past and present actions affecting cultural resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.16.

4.11.6.16.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting cultural resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.16.

4.11.6.16.4 Contribution of Alternative to Cumulative Effects

The contribution of this alternative to cumulative effects is the same as described under Alternative 2.

4.11.6.16.5 Conclusion

The incremental contribution of activities associated with Alternative 4 to cumulative effects on cultural resources would be negligible.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with cultural resources were discussed under Alternative 2 (Section 4.11.4.16).

4.11.6.17 Land and Water Ownership, Use, Management

4.11.6.17.1 Summary of Direct and Indirect Effects

As discussed in Section 4.11.4.17, the direct and indirect impacts on land and water ownership would be low magnitude, temporary duration, local extent, and common in context. The direct and indirect impacts on land and water use would have a high magnitude, be temporary in duration, local and common. The direct and indirect impacts to land and water management would be low intensity, temporary in nature, local, and common. In summary, the impacts of Alternative 4 on land and water ownership, use, and management would be negligible, moderate, and minor, respectively.

4.11.6.17.2 Past and Present Actions

Past and present actions affecting land and water ownership, use, and management within the EIS project area are discussed under Alternative 2, Section 4.11.4.17.

4.11.6.17.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting land and water ownership, use, and management within the EIS project area are discussed under Alternative 2, Section 4.11.4.17.

4.11.6.17.4 Contribution of Alternative to Cumulative Effects

Alternative 4 is the same as Alternative 3 except with increased levels of activity. The cumulative effects discussed in Section 4.11.4.17 for Alternative 2 are applicable for this alternative. The increased levels of activity would not generate different types of impacts to land or water ownership, use, and management. The conclusions for Alternative 2 are applicable to Alternative 4; all changes would be incrementally small, short-term in duration, and geographically dispersed, and thus would not have combined effects creating cumulative impacts on land ownership, use, or management and would be considered minor.

4.11.5.17.5 Conclusion

Under Alternative 4, the levels of direct, indirect and cumulative impacts for land and water ownership, use, and management are negligible, moderate, and minor, respectively. Based on this, the overall level of impact of Alternative 4 is considered minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with land and water ownership, use, and management were discussed under Alternative 2 (Section 4.11.4.17).

4.11.6.18 Transportation

4.11.6.18.1 Summary of Direct and Indirect Effects

Increased levels of marine vessel traffic in Alternative 4 associated with the seismic survey and exploratory drilling programs would be expected to primarily occur in offshore areas where local marine transportation does not occur. Industry vessels would likely encounter local marine traffic when littering to designated nearshore marine facilities (which are limited). The impact of increased vessel presence would be low in intensity, temporary in duration, limited in geographic extent to a local area, and common to potentially unique context (in respect to protected marine mammal resources). The summary impact from increases in vessel traffic would be considered minor.

4.11.6.18.2 Past and Present Actions

Past and present actions affecting transportation within the EIS project area are discussed under Alternative 2, Section 4.11.4.18.

4.11.6.18.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting transportation within the EIS project area are discussed under Alternative 2, Section 4.11.4.18.

4.11.6.18.4 Contribution of Alternative to Cumulative Effects

The contribution of impacts from Alternative 4 would be similar but of slightly higher intensity than described for Alternative 2 in Section 4.11.4.18.

4.11.6.18.5 Conclusion

In summary, no concerns related to adverse cumulative impacts have been identified. Some cumulative impacts may exist if Alternative 4 overlaps with another large-scale development project but those impacts would be of low intensity, temporary in duration affecting local areas of common resources, and are considered unlikely to have long-term impacts on regional transportation infrastructure.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with transportation were discussed under Alternative 2 (Section 4.11.4.18).

4.11.6.19 Recreation and Tourism

4.11.6.19.1 Summary of Direct and Indirect Effects

As discussed in Section 4.6.3.7, the direct impacts on recreation and tourism would be low intensity, temporary duration, local extent, and common in context. Indirect impacts would be the same levels as direct impacts, except that the geographic area would be broader, extending beyond the region to a state-wide level and potentially beyond. In summary, the impact of Alternative 4 on recreation and tourism would be minor.

4.11.6.19.2 Past and Present Actions

Past and present actions affecting recreation and tourism within the EIS project area are discussed under Alternative 2, Section 4.11.4.19.

4.11.6.19.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting recreation and tourism within the EIS project area are discussed under Alternative 2, Section 4.11.4.19.

4.11.6.19.4 Contribution of Alternative to Cumulative Effects

Alternative 4 is the same as Alternative 3 except with increased levels of exploratory drilling activity. The cumulative effects discussed in Section 4.11.4.19 for Alternative 2 are applicable for this alternative. The increased levels of activity would not generate different types of impacts to recreation and tourism. The conclusions for Alternative 2 are applicable to Alternative 4; the contribution of Alternative 4 to cumulative effects to recreation and tourism would be minor.

4.11.6.19.5 Conclusion

Alternative 4 would have a minor contribution to cumulative effects on recreation and tourism.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with recreation and tourism were discussed under Alternative 2 (Section 4.11.4.19).

4.11.6.20 Visual Resources

4.11.6.20.1 Summary of Direct and Indirect Effects

Implementation of Alternative 4 would be similar to that describe in Section 4.10.4.20, however there would be an increase in the level of permitted activity and a consequent potential increase in impacts to visual resources. The proposed action is expected to result in short-term moderate effects to scenic quality and visual resources similar to that described in Alternative 2. Because of the greater number of support vessels used in the two exploratory drilling programs proposed under Alternative 4, this action could be high intensity if both programs are implemented in close proximity to each other. Potential impacts could be of low to medium intensity depending if programs are geographically separated. In either case, actions would be temporary, localized and occur in an important context.

Standard mitigation measures implemented as part of the proposed action would not alter the level of anticipated impacts to visual resources or scenic quality. Although Category D Mitigation Measures would limit exposure of sensitive viewers (individuals engaged in the culturally important activity of bowhead whaling) to vessel-based surveys during certain periods. However it would not change exposure to drill sites, as these structures would remain in place during shutdown periods unless the operator agrees to move off location during such shutdown periods.

4.11.6.20.2 Past and Present Actions

Past and present actions associated with visual resources are presented under Alternative 2 (Section 4.11.4.20).

4.11.6.20.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions associated with visual resources are presented under Alternative 2 (Section 4.11.4.20).

4.11.6.20.4 Contribution of Alternative to Cumulative Effects

Implementation of Alternative 4 would increase the level of permitted activity (i.e. four versus two exploratory drilling programs per sea each year). Actions could occur at any location within the EIS project area; however, like Alternative 3, actions associated with implementation of Alternative 4 would result in the greatest impact to visual resources if sited in near-shore areas between Harrison Bay and Kaktovik, where the majority of past, present, and reasonably foreseeable future actions are located. The location would also coincide with locations of sensitive viewers, such as residents of native communities or recreators using the ANWR. If actions associated with Alternative 4 are concentrated in areas where the majority of past, present, and reasonably foreseeable future actions are located, Alternative 4 would contribute to the industrialized landscape character of the area. Transient views of seismic and shallow hazard survey vessels are not expected to contribute to the industrial character of the area, as views of vessels would be episodic.

4.11.6.20.5 Conclusion

Under Alternative 3, anticipated cumulative effects to visual resources are expected to be major. Impacts would be of high intensity, long-term in duration, regional in geographic extent and occurring in an important context.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with visual resources were discussed under Alternative 2 (Section 4.11.4.20).

4.11.6.21 Environmental Justice

4.11.6.21.1 Summary of Direct and Indirect Effects

Direct and indirect effects to subsistence and public health associated with Alternative 4 would be minor, similar to those described in Alternative 2. The level of activity associated with Alternative 4 is greater than Alternative 2, but the effects do not change the summary impact level for these environmental justice indicators.

4.11.6.21.2 Past and Present Actions

Past and present actions associated with environmental justice are presented under Alternative 2 (Section 4.11.4.21).

4.11.6.21.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions associated with environmental justice are presented under Alternative 2 (Section 4.11.4.21).Future industrial activities and climate change would have an adverse impact on subsistence resources and uses and public health.

4.11.6.21.4 Contribution of Alternative to Cumulative Effects

The incremental contribution of Alternative 4 to the overall industrial activity in the area would be similar that that described for Alternative 2. Therefore, the contribution of Alternative 4 to environmental justice indicator cumulative effects would be minor.

4.11.6.21.5 Conclusion

The direct and indirect effects of Alternative 4 would be minor. The contribution to the cumulative effect of environmental justice indicators would be minor. Therefore, there would be a disproportionate impact to Alaska Native communities in the EIS project area.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with visual resources were discussed under Alternative 2 (Section 4.11.4.20). A VLOS would have disproportionate adverse impacts to Alaska Native communities in the EIS project area.

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

4.11.7.1 Physical Oceanography

4.11.7.1.1 Summary of Direct and Indirect Effects

The effects of Alternative 5 on physical ocean resources would be substantially the same as those described for Alternative 4. The required time/area closures in Alternative 5 would not substantially change the effects of the alternative on physical ocean resources in the EIS project area. The effects of Alternative 5 on physical ocean resources would be medium-intensity, temporary, local, and would affect common resources as defined in the impact criteria in Section 4.1 of this EIS. The direct and indirect effects of Alternative 5 on physical ocean resources in the proposed action area would be minor.

4.11.7.1.2 Past and Present Actions

Past and present actions affecting physical ocean resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.1.

4.11.7.1.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting physical ocean resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.1.

4.11.7.1.4 Contribution of Alternative to Cumulative Effects

Actions associated with Alternative 5 would cause localized minor impacts to physical ocean resources in the EIS project area. While some actions associated with Alternative 5, such as the construction of man-made gravel islands, would interact with past, present, and reasonably foreseeable future actions to influence physical ocean resources in the EIS project area, resulting in a minor contribution to cumulative impacts.

4.11.7.1.5 Conclusion

The direct and indirect effects of Alternative 5 on physical ocean resources in the EIS project area would be minor. The incremental contribution of activities associated with Alternative 5 to cumulative effects on physical ocean resources in the EIS project area would be minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with physical ocean resources were discussed under Alternative 2 (Section 4.11.4.1).

4.11.7.2 Climate & Meteorology

4.11.7.2.1 Summary of Direct and Indirect Effects

Alternative 5 involves the same exploration activities as proposed in Alternative 4, except with the inclusion of time/area closures. Assuming that the same level of activity would occur and work around time/area closures, the estimated amount of GHG emissions associated with Alternative 5 are the same as those for Alternative 4. Therefore the impact levels are expected to be the same as Alternative 4, which are minor direct impacts and minor to moderate indirect impacts.

4.11.7.2.2 Past and Present Actions

Past and present actions affecting climate change within the EIS project area are discussed under Alternative 2, Section 4.11.4.2.

4.11.7.2.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting climate change within the EIS project area are discussed under Alternative 2, Section 4.11.4.2.

4.11.7.2.4 Contribution of Alternative to Cumulative Effects

Alternative 5 would emit approximately the same amount of GHGs as Alternative 4; therefore its direct impacts would contribute more to cumulative climate change impacts than Alternative 2. As with Alternatives 2 and 3, the indirect effects from Alternative 5 would contribute more to cumulative impacts than the direct effects. The magnitude of indirect effects cannot be quantified and is considered to be the same as for Alternatives 2 and 3. Indirect effects from Alternative 5 are expected to result in changes that could be long-term and could affect unique resources.

4.11.7.2.5 Conclusion

Alternative 5 could contribute to a moderate to major cumulative impact to climate change, to the same as Alternative 4.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with climate change were discussed under Alternative 2 (Section 4.11.4.2).

4.11.7.3 Air Quality

4.11.7.3.1 Summary of Direct and Indirect Effects

The air quality effects due to the worst-case activity under Alternative 5, Level 3 Exploration Activity, are expected to be the same as those for Alternative 4. The overall direct effect on air quality is expected to be moderate, and indirect effects would be moderate.

4.11.7.3.2 Past and Present Actions

Past and present actions affecting air quality within the EIS project area are discussed under Alternative 2, Section 4.11.4.3.

4.11.7.3.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting air quality within the EIS project area are discussed under Alternative 2, Section 4.11.4.3.

4.11.7.3.4 Contribution of Alternative to Cumulative Effects

The potential cumulative effects on air quality for Alternative 5 are the same as those for Alternative 4. These are expected to be moderate, with worst-case effect being less than additive.

4.11.7.3.5 Conclusion

Alternative 5 has the potential to contribute to cumulative effects on air quality when activities occur in the vicinity of other sources of air pollution. Due to distance between activities, and the mobile and intermittent source activities, the cumulative effects are expected to be less than the sum of each, likely remaining moderate in magnitude.

The additive effects resulting from a VLOS within the seas Arctic OCS associated with air quality were discussed under Alternative 2 (Section 4.11.4.3).

4.11.7.4 Acoustics

4.11.7.4.1 Summary of Direct and Indirect Effects

The summary of direct and indirect effects provided in Section 4.11.4 (Alternative 2) is relevant also for Alternative 5.

4.11.7.4.2 Past and Present Actions

Past and present actions affecting acoustics within the EIS project area are discussed under Alternative 2, Section 4.11.4.4.

4.11.7.4.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting acoustics within the EIS project area are discussed under Alternative 2, Section 4.11.4.4. The inclusion of time/area closures may cause greater seismic survey activity levels during non-closure times unless scheduling of individual activities can be performed as part of the closure decisions.

4.11.7.4.4 Contribution of Alternative to Cumulative Effects

The contributions to cumulative effects for Alternative 5 should be substantially less than from Alternative 4 if the closures were scheduled to avoid peak marine mammal migration times. This approach should work relatively well to avoid bowhead migrations that are low in the Beaufort Sea EIS project area prior to mid-September. The number of individual exposures, and hence the total exposures will be reduced. However, the shorter available working season is likely to lead to increased activity during the open periods. Animals that are present during those open periods may have higher activity levels to contend with than if closures were not implemented. Those animals may therefore be exposed to higher sound levels and possibly injurious levels. While the total number of disturbance exposures should decrease, there could be higher chance of injurious exposures for marine mammals present during non-closed periods due to reduced ability to avoid close approaches with seismic survey sources.

4.11.7.4.5 Conclusion

Use of closures as proposed in Alternative 4 should be effective for reducing total exposures to sound levels that could disturb marine mammals. Implementing closures may however lead to compressed periods of higher activity during the reduced open periods. Animals present during those open periods could be exposed to high noise levels that could lead to injuries. Scheduling of individual activities might be considered as part of the closure scheduling to mitigate this possible outcome.

The additive effects resulting from a VLOS within the seas Arctic OCS associated with acoustics were discussed under Alternative 2 (Section 4.11.4.4).

4.11.7.5 Water Quality

4.11.7.5.1 Summary of Direct and Indirect Effects

Impacts to water quality from Alternative 5 are expected to be very similar to those described above for Alternative 4. The only difference between Alternative 4 and Alternative 5 is the addition of required time/area closures. The level of activity would be the same for Alternatives 4 and 5, but the times and locations of the activity could be different. Time/area closures established under Alternative 5 as additional mitigation measures could reduce the likelihood of adverse impacts to water quality in sensitive areas during certain times. The effects of Alternative 5 on water quality are expected to be low intensity, temporary, local, and would affect common resources as defined in the impact criteria in Section 4.1. The overall effects of Alternative 5 on water quality are expected to be minor.

4.11.7.5.2 Past and Present Actions

Past and present actions affecting water quality within the EIS project area are discussed under Alternative 2, Section 4.11.4.5.

4.11.7.5.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting water quality within the EIS project area are discussed under Alternative 2, Section 4.11.4.5.

4.11.7.5.4 Contribution of Alternative to Cumulative Effects

Additional time/area closures would reduce the potential for incremental degradation of water quality in sensitive areas. Actions associated with Alternative 5 would cause temporary local impacts to water quality such as increases in temperature, turbidity, and concentrations of pollutants. Some actions associated with Alternative 5, such as discharges of cooling water and waste material, would interact with past, present, and reasonably foreseeable future actions resulting in both additive and synergistic impacts to water quality. These interactions would be local and temporary and would represent only a small fraction of foreseeable cumulative impact.

4.11.7.5.5 Conclusion

The incremental contribution of activities associated with Alternative 5 to cumulative effects on water quality in the EIS project area would be minor. The additional time/area closures required under Alternative 5 would reduce the potential for cumulative adverse water quality impacts to occur in sensitive areas.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with water quality were discussed under Alternative 2 (Section 4.11.4.5).

4.11.7.6 Environmental Contaminants and Ecosystem Functions

4.11.7.6.1 Summary of Direct and Indirect Effects

Additional mitigation measures related to time/area closures under Alternative 5 would potentially result in decreased impacts to environmental contaminants and ecosystem functions relative to Alternative43. The time area closures proposed under Alternative 4 would limit impacts to certain coastal areas and convergence zones during particular times and therefore have the potential to reduce adverse impacts to all categories of ecosystem functions.

Regulation functions such as nutrient cycling and waste assimilation, which depend on biota and physical processes to facilitate storage and recycling of nutrients and breakdown or assimilation of contaminants, would be affected over a limited geographic extent within the EIS project area. Habitat functions, particularly those related to benthic habitats, would be impacted as a result of discharges and other activities associated with exploratory drilling. However, time/area closures associated with Alternative 5 would limit the potential for adverse impacts to certain important habitats. Production functions including primary productivity and subsequent transfers to higher trophic levels could potentially be impacted as a result of activities associated with Alternative 5, while the effects of Alternative 4 on information ecosystem functions would depend upon interrelationships between impacts to cultural resources, social resources, and aesthetic resources, which are addressed in other sections of this EIS. Direct and indirect impacts to ecosystem functions resulting from the implementation of Alternative 5 would be medium-intensity, temporary, and local. Overall effects of Alternative 5 on environmental contaminants and ecosystem functions would be minor.

4.11.7.6.2 Past and Present Actions

Past and present actions affecting environmental contaminants and ecosystem functions within the EIS project area are discussed under Alternative 2, Section 4.11.4.6.

4.11.7.6.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting environmental contaminants and ecosystem functions within the EIS project area are discussed under Alternative 2, Section 4.11.4.6.

4.11.7.6.4 Contribution of Alternative to Cumulative Effects

Actions associated with Alternative 5 would cause localized minor impacts to environmental contaminants and ecosystem functions within the EIS project area. Some actions associated with Alternative 5, such as discharges from exploratory drilling operations, would interact with past, present, and reasonably foreseeable future actions resulting in both additive and synergistic impacts to ecosystem functions. The impacts resulting from such interactions would represent a relatively small fraction of foreseeable cumulative impact, and the accumulation of impacts is unlikely to be substantial. Time/area closures associated with Alternative 5 would limit the potential for aggregation of adverse impacts to occur in sensitive areas.

4.11.7.6.5 Conclusion

The incremental contribution of activities associated with Alternative 5 to cumulative effects on environmental contaminants and ecosystem functions in the EIS project area would be minor. The additional time/area closures required under Alternative 5 would reduce the potential for cumulative adverse impacts to all categories of environmental contaminants and ecosystem functions in sensitive areas.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with environmental contaminants and ecosystem functions were discussed under Alternative 2 (Section 4.11.4.6).

4.11.7.7 Lower Trophic Levels

4.11.7.7.1 Summary of Direct and Indirect Effects

Activity levels in Alternative 5 are the same as in Alternative 4, and there are additional mitigation measures for seasonal closures for certain areas. These mitigated closures do not affect lower trophic levels in the EIS project area, so the impacts discussed for Alternative 4 are the same for Alternative 5, therefore, the overall impact to lower trophic levels would be minor.

4.11.7.7.2 Past and Present Actions

Past and present actions affecting lower trophic levels within the EIS project area are discussed under Alternative 2, Section 4.11.4.7.

4.11.7.7.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting lower trophic levels within the EIS project area are discussed under Alternative 2, Section 4.11.4.7.

4.11.7.7.4 Contribution of Alternative to Cumulative Effects

Alternative 5 would have the same types of effects as Alternative 2 with the addition of certain time/area closures. Therefore, the conclusions about Alternative 5 would be similar to Alternative 2 discussed in Section 4.11.4.7 and the overall impact would be moderate. In the absence of a very large oil spill, the exploration activities authorized under Alternative 4 would have moderate contributions to the cumulative effects from past, present, and reasonably foreseeable future actions on lower trophic levels.

4.11.6.7.5 Conclusion

Alternative 5 could have a moderate contribution to cumulative effects on lower trophic organisms.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with lower trophic levels were discussed under Alternative 2 (Section 4.11.4.7).

4.11.7.8 Fish and Essential Fish Habitat

4.11.7.8.1 Summary of Direct and Indirect Effects

The effect of the time/area closures outlined in Alternative 5 on Fish Resources and EFH would be a reduction in the overall impact. Although the overall impact is considered to be negligible based on Alternative 4 alone, any further reduction in impacts resulting from the time/area closures would be beneficial. The already low impact levels would be decreased by each of the individual closures, and any combination would reduce the impacts further. Implementing all of the time/area closures would substantially decrease all effects on fish resources by protecting the most important fish habitats where the highest fish densities are found. Due to the substantial decrease to the already very small scale of any potential effects relative to overall population levels and available habitat, there would be no measurable effect on the resource.

4.11.7.8.2 Past and Present Actions

Past and present actions affecting fish and EFH within the EIS project area are discussed under Alternative 2, Section 4.11.4.8.

4.11.7.8.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting fish and EFH within the EIS project area are discussed under Alternative 2, Section 4.11.4.8.

4.11.7.8.4 Contribution of Alternative to Cumulative Effects

Climate change is the only past, present, or reasonably foreseeable future action that is anticipated to have any measurable effect on fish and EFH within the EIS project area, and those effects are likely to be beneficial. As Arctic waters warm, productivity is likely to increase, thereby creating more favorable fish habitat throughout the region. The lack of measurable effect on fish and EFH resulting from the implementation of Alternative 5 would not add to any cumulative effects.

4.11.7.8.5 Conclusion

Direct and indirect effects associated with Alternative 5 on fish and EFH would be minor. The overall contribution of Alternative 5 to cumulative effects on fish and EFH would be minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with fish and EFH were discussed under Alternative 2 (Section 4.11.4.8).

4.11.7.9 Marine and Coastal Birds

4.11.7.9.1 Summary of Direct and Indirect Effects

As discussed in Section 4.7.2.3, the effects of disturbance, injury/mortality, and changes in habitat for marine and coastal birds would likely be temporary or short-term, localized, and not likely to have population-level effects for any species. In summary, the impact of Alternative 5 on marine and coastal birds would be considered negligible.

4.11.7.9.2 Past and Present Actions

Past and present actions affecting marine and coastal birds within the EIS project area are discussed under Alternative 2, Section 4.11.4.9.

4.11.7.9.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting marine and coastal birds within the EIS project area are discussed under Alternative 2, Section 4.11.4.9.

4.11.7.9.4 Contribution of Alternative 4 to Cumulative Effects

Alternative 5 would have the same types and level of exploration activities as Alternative 4 with the addition of certain time/area closures. The most important of these closure areas for birds, Ledyard Bay, would be the same as exists under Alternative 4 due to USFWS requirements to protect spectacled eiders. The other closure areas would be important to certain species, such as Barrow Canyon for Ross's gull in the fall, but these closures would generally be less effective at reducing adverse effects on birds as they would be to protect marine mammals or subsistence hunting. The effects of Alternative 5 would therefore be essentially the same as for Alternative 4. The exploration activities authorized under Alternative 5 would have negligible contributions to the cumulative effects from past, present, and reasonably foreseeable future actions on marine and coastal birds.

4.11.7.9.5 Conclusion

Direct and indirect effects associated with Alternative 5 on marine and coastal birds would be negligible. The overall contribution of Alternative 5 to cumulative effects on marine and coastal birds would be negligible.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with marine and coastal birds were discussed under Alternative 2 (Section 4.11.4.9).

4.11.7.10 Marine Mammals

4.11.7.10.1 Bowhead Whales

4.11.7.10.1.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 5 on bowhead whales are described in Section 4.8.2.4.1. Impacts of activities associated with oil and gas exploration in the EIS project area under Alternative 5 are similar to Alternative 4 (See Section 4.11.6.10.1).

Effects of disturbance on bowhead whales would be reduced in the closure areas during time periods specified in Alternative 5. Overall exploration effort may not be reduced, but, rather, redistributed and possibly concentrated in other areas. 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 includes large portions of the Beaufort and Chukchi seas not included in the Time/Area closures. Although the Time/Area closures specified in Alternative 5 could mitigate adverse impacts in particular times and locations, the overall impact on bowhead whales of oil and gas exploration activities allowed under this alternative would be considered moderate.

4.11.7.10.1.2 Past and Present Actions

Past and present actions affecting bowhead whales within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.1.

4.11.7.10.1.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting bowhead whales within the EIS project area are discussed under Alternative 2, Section 4.10.4.11.1.

4.11.7.10.1.4 Contribution of Alternative to Cumulative Effects

The contribution of the direct and indirect impacts resulting from Alternative 5, when combined with the past, present, and reasonably foreseeable future actions would be similar to Alternative 4 (Section 4.11.6.10.1), with most potential impacts due to acoustic disturbance that could, at least temporarily, disrupt or displace bowhead whales. The time/area closures required under this alternative would mitigate potential adverse impacts during the specified times and within the specified locations. However, bowhead whales are not restricted to these specified areas and may be exposed to impacts by exploration activities operating outside of these closure areas. Because the closures would alleviate, but not eliminate, impacts, the contribution of activities authorized under Alternative 5 to cumulative effects on bowhead whales would be minor.

4.11.7.10.1.5 Conclusion

Under Alternative 5, the direct and indirect effects to bowhead whales would be moderate. Overall, Alternative 5 would have a minor contribution to cumulative effects on bowhead whales.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with bowhead whales were discussed under Alternative 2 (Section 4.11.4.10.1).

4.11.7.10.2 Beluga Whales

4.11.7.10.2.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 5 on beluga whales are described in Section 4.8.2.4.2 and are summarized here. The additional oil and gas exploration activities proposed in Alternative 5 could directly and indirectly affect beluga whales by causing noise disturbance, habitat degradation, and potential ship strikes. Beluga whales disturbed by oil and gas exploration activities may move away from important habitats. The scale of the avoidance depends on the number and relative proximity of the surveys. Numerous simultaneous seismic activities could cause avoidance over large distances. Potential habitat degradation from drill cuttings or drilling mud discharges would be localized and temporary; the impact level would be negligible. While the incidence of ship strikes is currently low, it could rise with increasing vessel traffic.

The time/area closures would reduce the effects of disturbance on beluga whales in the closed areas during the time periods specified. The closures of Kasegaluk Lagoon, Ledyard Bay, and the Shelf Break of the Beaufort Sea would be especially beneficial to beluga whales. Exploration activities could, however, occur during different time periods within these areas. In addition, industry may relocate exploration activities to other, possibly adjacent, areas until the closure areas are available. Overall, exploration effort may not be reduced, but, rather, redistributed and possibly concentrated in other areas. Time/area closures that mitigate adverse impacts on concentrations of beluga whales could reduce impacts to a lower intensity, shorter duration and more localized areas than would result in the absence of closures. However, beluga whale habitat use in the EIS project area is dynamic and widespread. Considering the migration corridors, it includes large portions of the Beaufort and Chukchi seas not included in the time/area closures that could coincide with oil and gas exploration activities throughout the region. Although the time/area closures specified in Alternative 5 could reduce or avoid adverse impacts in particular times and locations, the overall impact of Alternative 5 on beluga whales would be considered minor to moderate.

4.11.7.10.2.2 Past and Present Actions

Past and present actions affecting beluga whales in the EIS project area are discussed under Alternative 2, Section 4.11.4.10.2.

4.11.7.10.2.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions that would affect beluga whales in the EIS project area are discussed under Alternative 2, Section 4.11.4.10.2.

4.11.7.10.2.4 Contribution of Alternative to Cumulative Effects

The oil and gas exploration activities authorized under Alternative 5 would add to the acoustic disturbance of beluga whales from marine vessels, seismic sources, and aircraft traffic in the Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be localized and temporary. Although ship strikes are possible with increased vessel activity associated with oil and gas exploration, the contribution to additional mortality would be negligible relative to the population level. Exploration activities could contribute to habitat alterations through icebreaking efforts and discharge of drilling muds. Effects would be localized and temporary. The contribution to habitat change would be negligible since it would affect an extremely small proportion of habitat or prey base available to beluga whales. The exploration activities authorized under Alternative 5 would therefore have moderate additive contributions to the cumulative effects on beluga whales.

4.11.7.10.2.5 Conclusion

As stated above, most exploration activities authorized under Alternative 5 would result in minor to moderate contributions to cumulative effects on beluga whales.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with beluga whales were discussed under Alternative 2 (Section 4.11.4.10.2).

4.11.7.10.3 Other Cetaceans

4.11.7.10.3.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 5 on cetaceans are described in Section 4.8.2.4.3 and are summarized here. Evaluated collectively, the overall impact of Alternative 4 on other cetaceans is minor to moderate. Although the time/area closures specified in Alternative 5 could mitigate adverse impacts in particular times and locations, the overall impact on other cetaceans of oil and gas exploration activities allowed under this alternative would be similar to Alternative 4. Due to the very small scale of any potential effects relative to overall population levels and available habitat, and the temporary nature of the majority of the activities associated with Alternative 5, impacts on the resource would be low in intensity, of short duration, and limited extent. Long term impacts are unknown, but anticipated to be minor.

Effects on other cetaceans from open-water exploration activities would be reduced in the closure areas during time periods specified in Alternative 5. 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. Overall exploration effort may not be reduced, but, rather, redistributed and possibly concentrated in other areas. Time/Area closures that mitigate adverse impacts on concentrations of cetaceans within the closures, 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, cetacean habitat use in the EIS project area is dynamic and, when migration corridors are considered, includes large portions of the Beaufort and Chukchi seas not included in the time/area closures that could coincide with oil and gas exploration activities throughout the region. These measures are most likely to impact gray whales and less likely to impact the remaining cetaceans in the resource group, due to species distribution.

4.11.7.10.3.2 Past and Present Actions

Past and present actions affecting other cetaceans within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.3.

4.11.7.10.3.2 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting other cetaceans within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.3.

4.11.7.10.3.3 Contribution of Alternative to Cumulative Effects

The oil and gas exploration activities authorized under Alternative 5 would add to the acoustic disturbance of other cetaceans from marine vessels, seismic sources, and aircraft traffic in the Beaufort and Chukchi seas. Although the time/area closures specified in Alternative 5 could mitigate adverse impacts in particular times and locations, the overall impact on other cetaceans of oil and gas exploration activities allowed under this alternative would be similar to Alternative 4. Most of this disturbance would occur during the open-water season and would be localized and temporary. Although ship strikes are possible with increased vessel activity associated with oil and gas exploration, the contribution to additional mortality would be negligible relative to the population level. Exploration activities could contribute to habitat alterations through icebreaking efforts and discharge of drilling muds. Effects would be localized and temporary. The contribution to habitat change would be negligible.

None of the past, present, or reasonably foreseeable future actions described above are expected to have any substantial impact on cetacean populations within the EIS project area. Populations for most species are stable or increasing, and climate change is likely to add nominal beneficial impacts in the future. The exploration activities authorized under Alternative 5 would therefore have minor additive contributions to the cumulative effects on other cetaceans.

4.11.7.10.3.4 Conclusion

As stated above, most exploration activities authorized under Alternative 5 would result in minor contributions to cumulative effects on other cetaceans.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with other cetaceans were discussed under Alternative 2 (Section 4.11.4.10.3).

4.11.7.10.4 Ice Seals

4.11.7.10.4.1 Summary of Direct and Indirect Effects

There are four species of seals considered in this section that are often collectively called "ice seals"; ringed seal, spotted seal, ribbon seal, and bearded seal. The direct and indirect effects of Alternative 5 on ice seals are described in Section 4.8.2.4.4 and are summarized here. Ringed seals and bearded seals have been the most commonly encountered species of any marine mammals in past offshore oil and gas exploration activities in the Alaskan Beaufort and Chukchi seas and would likely be affected more frequently by exploration activities authorized under Alternative 5 than either ribbon or spotted seals. Data from observers on board seismic source vessels and monitoring vessels indicate that seals tend to avoid on-coming vessels and active seismic arrays but they do not appear to react strongly even as ships pass fairly close with active arrays. They also do not appear to react strongly to icebreaking or on-ice surveys, keeping their distance or moving away at some point to an alternate breathing hole or haulout, but the scope of these behavioral responses appears to be within their natural abilities and responses to their naturally dynamic environment. None of the behavioral reactions observed to date indicate that any of the ice seal species would be displaced from key areas or resources for more than a few minutes or hours and they would be unlikely to experience any measurable effects on their reproductive success or survival. Ice seals are legally protected, have unique ecological roles in the Arctic, and are important subsistence resources and are therefore considered to be unique resources. Given the standard mitigation measures that have been required in the past, the effects of exploration activities that could be authorized under Alternative 5 on ice seals would likely be low in magnitude, distributed over a wide geographic area, and temporary to short-term in duration. The effects of Alternative 4 would therefore be considered minor for all ice seal species according to the criteria established in Section 4.1.3.

4.11.7.10.4.2 Past and Present Actions

Past and present actions affecting pinnipeds within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.4.

4.11.7.10.4.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting pinnipeds within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.4.

4.11.7.10.4.4 Contribution of Alternative 5 to Cumulative Effects

The exploration activities authorized under Alternative 5 would add to the disturbance of ice seals from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be temporary. Very small numbers of ringed seals could be exposed to exploration activities during the denning season (winter-spring) when females with young are more susceptible to disturbance. Exploration activities would contribute negligible risk of additional mortality to any species, which would continue to be dominated by subsistence harvest. Exploration activities could contribute to habitat change through on-ice surveys, icebreaking efforts, and discharge of drilling muds but these effects would be localized and temporary or short-term. This contribution to habitat change would be negligible compared to the potential for dramatic sea ice loss due to climate change and changes in ecosystems due to ocean acidification. The exploration activities authorized under Alternative 5 would therefore have negligible to minor contributions to the cumulative effects on the four species of ice seals considered.

4.11.7.10.4.5 Conclusion

The direct and indirect effects of Alternative 5 on pinnipeds would be considered minor. Alternative 5 would have negligible to minor contributions to the cumulative effects on the four species of ice seals.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with pinnipeds were discussed under Alternative 2 (Section 4.11.4.10.4).

4.11.7.10.5 Walrus

4.11.7.10.5.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 5 on walrus are described in Section 4.8.2.4.5 and are summarized here. The types and levels of effects on walrus are essentially the same under Alternative 5 as for Alternative 4 (Section 4.7.2.4.5). The primary difference for walrus would be a change in the timing of vessel traffic and impacts on benthic habitat in the Hanna Shoal area, which would be subject to a closure period in the fall. The closure period would reduce the potential for disturbance of walrus by vessels in that time period but would not change overall exploration efforts so the potential for disturbance in the Chukchi Sea would be similar to Alternative 4. Walrus have been regularly encountered during vessel-based exploration activities in the past, primarily in late summer as the pack ice recedes, as recorded by PSOs on board seismic source vessels and monitoring vessels. These data indicate that walrus do not react strongly to vessels and active seismic arrays and their behavioral responses are often neutral rather than swimming away. They tend to dive into the water as icebreaking ships approach from some distance and are therefore not exposed to the loudest sounds generated by the ships. The gradual introduction of alternative technologies for seismic surveys would make very little difference to walrus because they are unlikely to be affected in any biologically meaningful way by seismic noise. Mitigation measures required for walrus by USFWS LOAs since the early 1990s have reduced the risk of close encounters with seismic and other exploration vessels and have reduced the risk of accidental spills that may affect walrus or their prey. None of the data collected to date on walrus reactions to exploration activities indicate that they would be displaced from key areas or resources for more than a few minutes or hours. Careful avoidance of vessel and aircraft traffic around walrus haulouts on land would be important to minimize the risk of mortality from stampedes. Walrus are legally protected, fulfill an important ecological role in the Arctic, and are important subsistence resources and are therefore considered to be a unique resource for NEPA purposes. Given the level and type of exploration activities that would be authorized under Alternative 5, and considering the mitigation measures that would be required by USFWS LOAs and NMFS in this EIS, the effects on walrus would likely be low in magnitude, distributed over a wide geographic area, and temporary in duration. The effects of Alternative 5 on Pacific walrus would therefore be considered minor.

4.11.7.10.5.2 Past and Present Actions

Past and present actions affecting Pacific walrus within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.5.

4.11.7.10.5.2 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting Pacific walrus within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.5.

4.11.7.10.5.3 Contribution of Alternative 5 to Cumulative Effects

The exploration activities authorized under Alternative 5 would add to the disturbance of walrus from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be temporary. Exploration activities would contribute negligible risk of additional mortality to walrus, which would continue to be dominated by subsistence harvest. Exploration activities could contribute to habitat change through on-ice surveys, icebreaking efforts, and discharge of drilling muds but these effects would be localized and temporary or short-term. This contribution to habitat change would be negligible compared to the potential for dramatic sea ice loss due to climate change and changes in ecosystems due to ocean acidification. The exploration activities authorized under Alternative 5 would therefore have minor to negligible contributions to the cumulative effects on Pacific walrus.

4.11.7.10.5.4 Conclusion

The direct and indirect effects of Alternative 5 on Pacific walrus would be considered minor. Alternative 5 would have negligible to minor contributions to the cumulative effects on Pacific walrus.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with Pacific walrus were discussed under Alternative 2 (Section 4.11.4.10.5).

4.11.7.10.6 Polar Bears

4.11.7.10.6.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 5 on polar bears are described in Section 4.8.2.4.6 and are summarized here. The types and levels of effects on polar bears are essentially the same under Alternative 5 as for Alternative 4 (Section 4.7.2.4.6). The time/area closure periods specified in Alternative 5 involve open-water environments where bears are rare so the potential for disturbance and other effects in the Arctic seas would be essentially the same as under Alternative 4. Polar bears have been infrequently encountered during vessel-based exploration activities in the past, as recorded by PSOs on board source vessels and monitoring vessels. These sparse data indicate that polar bears do not react strongly to vessels and active seismic arrays and their behavioral responses are often neutral rather than running or swimming away. The gradual introduction of alternative technologies for seismic surveys would make very little difference to polar bears because they are unlikely to be affected in any biologically meaningful way by seismic noise. They also do not appear to react strongly to icebreaking or on-ice surveys. Some bears keep their distance or move away at some point but others may approach vehicles and equipment out of curiosity. The types of effects of most concern for polar bears during exploration activities involve the risk of bear-human encounters. Mitigation measures and polar bear safety/interaction plans required by USFWS LOAs since the early 1990s have reduced the risk of these encounters for both people and bears. None of the data collected to date on polar bear reactions to exploration activities indicate that polar bears would be displaced from key areas or resources for more than a few minutes or hours and they are unlikely to experience any measurable effects on their reproductive success or survival as a result. Polar bears are legally protected, have a unique ecological role in the Arctic, and are important to subsistence cultures and are therefore considered a unique resource. Given the level and type of exploration activities that would be authorized under Alternative 5, and considering the mitigation measures that would be required by USFWS LOAs and NMFS in this EIS, the effects on polar bears would likely be low in magnitude, distributed over a wide geographic area, and temporary in duration. The effects of Alternative 5 on polar bears would therefore be considered minor.

4.11.7.10.6.2 Past and Present Actions

Past and present actions affecting polar bears within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.6.

4.11.7.10.6.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting polar bears within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.6.

4.11.7.10.6.4 Contribution of Alternative 5 to Cumulative Effects

The exploration activities authorized under Alternative 5 would add to the disturbance of polar bears from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be temporary. Exploration activities would contribute negligible risk of additional mortality to polar bears, which would continue to be dominated by subsistence harvest. Exploration activities could contribute to habitat change through on-ice surveys, icebreaking efforts, and discharge of drilling muds but these effects would be localized and temporary or short-term. This contribution to habitat change would be negligible compared to the potential for dramatic sea ice loss due to climate change and changes in ecosystems due to ocean acidification. The exploration activities authorized under Alternative 5 would therefore have negligible to minor contributions to the cumulative effects on polar bears.

4.11.7.10.6.5 Conclusion

The direct and indirect effects of Alternative 5 on polar bears would be considered minor. Alternative 5 would have negligible to minor contributions to the cumulative effects on polar bears.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with polar bears were discussed under Alternative 2 (Section 4.11.4.10.6).

4.11.7.11 Terrestrial Mammals

4.11.7.11.1 Summary of Direct and Indirect Effects

Activity levels in Alternative 5 are the same as in Alternative 4, with the added requirement for time/area closures for certain areas. These required closures under Alternative 5 do not affect terrestrial mammals in the EIS project area, so the impacts discussed for Alternative 4 are the same for Alternative 5; the summary level direct and indirect impact to terrestrial mammals would be minor.

4.11.7.11.2 Past and Present Actions

Past and present actions affecting caribou within the EIS project area are discussed under Alternative 2, Section 4.11.4.11.

4.11.7.11.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting caribou within the EIS project area are discussed under Alternative 2, Section 4.11.4.11.

4.11.7.11.4 Contribution of Alternative to Cumulative Effects

The contribution of this alternative to cumulative effects is the same as described under Alternative 2.

4.11.7.11.5 Conclusion

Direct and indirect impacts resulting from Alternative 5 on caribou would be minor. The incremental contribution of activities associated with Alternative 5 to cumulative effects on caribou would be negligible.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with caribou were discussed under Alternative 2 (Section 4.11.4.11).

4.11.7.12 Time/Area Closures

The analysis of the cumulative effects associated with time/area closure locations can be found in Sections 4.11.7.10 (Marine Mammals), 4.11.7.9 (Marine and Coastal Birds) and 4.11.7.14 (Subsistence).

4.11.7.13 Socioeconomics

4.11.7.13.1 Summary of Direct and Indirect Effects

Direct and indirect effects associated with Alternative 5 are minor, similar to those described for Alternative 2. To the extent that time/area closures in all closure areas provide additional benefits to marine mammals and reduce net impacts on subsistence activities, there would be some potential socioeconomic benefits to the non-cash economy. Time/area closures may result in productivity costs to lease holders and reduced personal income for local hires in PSO and Com Center positions due to reductions in the duration of these positions.

4.11.7.13.2 Past and Present Actions

Past and present actions affecting socioeconomics within the EIS project area are discussed under Alternative 2, Section 4.11.4.13.

4.11.7.13.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting socioeconomics within the EIS project area are discussed under Alternative 2, Section 4.11.4.13.

4.11.7.13.4 Contribution of Alternative to Cumulative Effects

The contribution of Alternative 5 to socioeconomic cumulative effects would be minor and positive. They differ from Alternative 2 by a low magnitude of lost productivity for lease holders and loss in magnitude in the new personal income sources. The mitigation measures associated with Alternative 5 would have a net benefit to subsistence resources and activities and therefore would have a countervailing positive impact to the non-cash economy. The summary contribution of these impacts to the cumulative effectives of socioeconomics is negligible to minor at a statewide and national level and minor at the local level.

4.11.7.13.5 Conclusion

The direct and indirect effects of Alternative 5 would be positive and minor. The contribution to cumulative effects of socioeconomics would be minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with socioeconomics were discussed under Alternative 2 (Section 4.11.4.13).

4.11.7.14 Subsistence

4.11.7.14.1 Summary of Direct and Indirect Effects

Using the impact criteria identified in Table 4.5-25, the direct and indirect effect of oil and gas exploration activities on subsistence resources and harvests resulting from implementation of Alternative 5 would be of low intensity, temporary in duration, local in extent, and the context would be common to unique. Protected resources (bowhead whales and polar bears are considered unique in context as these resources are protected by legislation (e.g. MMPA, ESA) or are considered an important subsistence resource (beluga whales). The impacts of implementing Alternative 5 could be considered beneficial to subsistence harvests and users as the time and area closures would be applied in all circumstances instead of being considered as additional mitigation measures. Direct and indirect impacts to subsistence harvest and subsistence resources are likely to be similar or less than those of Alternative 2 as discussed in Section 4.5.3.2 and Section 4.11.4.14. The summary impact to subsistence is therefore considered to range from negligible to minor depending upon the specific subsistence resource affected and source of disturbance (Section 4.5.3.2 and Section 4.8.3.2).

4.11.7.14.2 Past and Present Actions

Past and present actions affecting subsistence resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.14.

4.11.7.14.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting subsistence resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.14.

4.11.7.14.4 Contribution of Alternatives to Cumulative Effects

The activities authorized under Alternative 5 would add to the disturbance of subsistence resources from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be temporary and local. A low number of seals and polar bears could be disturbed during on-ice seismic surveys. Exploration activities would constitute a minor contribution to the disturbance of subsistence resources. Exploration activities could contribute to habitat change of subsistence resources through aircraft and vessel traffic, icebreaking efforts, on-ice surveys and discharge of drilling muds but these effects would be of low intensity, localized to regional in extent, temporary in duration, and affect subsistence resources that are common to unique in context. This contribution to habitat change would be negligible when compared to the potential for dramatic sea ice loss due to climate change and changes in ecosystems and resource abundance due to ocean acidification. The exploration activities authorized under Alternative 5 would occur at a higher level of activity in comparison to those proposed under Alternative 2 but the time and area closures that would be applied under this alternative in all circumstances are considered beneficial to subsistence harvests and users. The exploration activities authorized under Alternative 5 would have a negligible to minor contribution to the cumulative effects on subsistence resources. Implementation of Alternative 5 would be considered additive to cumulative effects on subsistence resources.

4.11.7.14.5 Conclusion

Under Alternative 5, the direct and indirect effects to subsistence resources are considered low in intensity, temporary in duration, local in extent and affect subsistence resources that range from common to unique in context. Implementation of Alternative 5 while beneficial in implementing time and area closures would be additive to cumulative effects on subsistence resources. The contribution of the direct and indirect impacts in consideration of the past, present, and reasonably foreseeable future actions would be negligible to minor on subsistence.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with subsistence resources were discussed under Alternative 2 (Section 4.11.4.14).

4.11.7.15 Public Health

4.11.7.15.1 Summary of Direct and Indirect Effects

As described in Section 4.8.3.3, anticipated direct and indirect effects on public health and safety as a result of Alternative 5 are expected to be similar to those expected under Alternative 2. To the extent the time/area closures described for Alternative 4 improve the likelihood of maintaining a strong subsistence harvest, there will also be resulting benefits to public health. Similarly, insofar as time and area closures minimize dispersion of marine mammals and allow hunters to complete their hunts with less travel time, the potential impact to safety should be reduced. However, these benefits do not affect the overall impact criteria rating, as the anticipated results to public health are already negligible.

4.11.7.15.2 Past and Present Actions

The effects of past and present actions on public health and safety are the same as those described in Section 4.11.3.15.

4.11.7.15.3 Reasonably Foreseeable Future Actions

The effects of reasonably foreseeable future actions on public health and safety are the same as those described in Section 4.11.3.15.

4.11.7.15.4 Contribution of Alternative to Cumulative Effects

The contribution of Alternative 5 to cumulative effects on public health and safety are the same as those for Alternative 2, described in Section 4.11.4.15.

4.11.7.15.5 Conclusion

Similar to the contribution of Alternative 2 described in Section 4.11.4.15, Alternative 5 contributes to cumulative impacts on public health and safety via the relatively small contribution of the direct and indirect impacts.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with public health and safety were discussed under Alternative 2 (Section 4.11.4.15).

4.11.7.16 Cultural Resources

4.11.7.16.1 Summary of Direct and Indirect Effects

Activity levels in Alternative 5 are the same as in Alternative 4, with the added requirement for seasonal closures for certain areas. These required closures under Alternative 5 do not affect cultural resources in the EIS project area, so the impacts discussed for Alternative 4 are the same for Alternative 5; the overall impact to cultural resources would be minor.

4.11.7.16.2 Past and Present Actions

Past and present actions affecting cultural resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.16.

4.11.7.16.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting cultural resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.16.

4.11.7.16.4 Contribution of Alternative to Cumulative Effects

The contribution of this alternative to cumulative effects is the same as described under Alternative 2.

4.11.7.16.5 Conclusion

The incremental contribution of activities associated with Alternative 5 to cumulative effects on cultural resources would be negligible.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with cultural resources were discussed under Alternative 2 (Section 4.11.4.16).

4.11.7.17 Land and Water Ownership, Use, Management

4.11.7.17.1 Summary of Direct and Indirect Effects

As discussed in Section 4.8.3.5, the direct and indirect impacts on land and water ownership would be low magnitude, temporary duration, local extent, and common in context. The direct and indirect impacts on land and water use would have a high magnitude, be temporary in duration, local and common. The direct and indirect impacts to land and water management would be low intensity, temporary in nature, local, and common. In summary, the impacts of Alternative 5 on land and water ownership, use, and management would be negligible, moderate, and minor, respectively.

4.11.7.17.2 Past and Present Actions

Past and present actions affecting land and water ownership, use, and management within the EIS project area are discussed under Alternative 2, Section 4.11.4.17.

4.11.7.17.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting land and water ownership, use, and management within the EIS project area are discussed under Alternative 2, Section 4.11.4.17.

4.11.7.17.4 Contribution of Alternative to Cumulative Effects

Alternative 5 is the same as Alternative 2 except with increased levels of activity and some specific time/area closures for exploration activities in federal marine waters. The cumulative effects discussed in Section 4.11.4.17 for Alternative 2 are applicable for this alternative. The increased levels of activity would not generate different types of impacts to land or water ownership, use, and management. The conclusions for Alternative 2 are applicable to Alternative 5; the contribution of Alternative 5 to cumulative effects to land and water ownership, use, and management would be negligible, moderate, and minor, respectively.

4.11.7.17.5 Conclusion

Under Alternative 5, the levels of direct, indirect and cumulative impact on land and water ownership, use, and management are negligible, moderate, and minor, respectively. Based on this, the overall level of impact of Alternative 5 is considered minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with land and water ownership, use, and management were discussed under Alternative 2 (Section 4.11.4.17).

4.11.7.18 Transportation

4.11.7.18.1 Summary of Direct and Indirect Effects

Impacts to transportation from Alternative 5 are expected to be very similar to those described above for Alternative 4. The only difference between Alternative 4 and Alternative 5 is the addition of required time/area closures. The level of activity would be the same for Alternatives 4 and 5, but the times and locations of the activity could be different. Any direct impact to regional marine transportation would be low in intensity, temporary in duration, and limited in geographic extent to a local area and common in context and considered minor.

4.11.7.18.2 Past and Present Actions

Past and present actions affecting transportation within the EIS project area are discussed under Alternative 2, Section 4.11.4.18.

4.11.7.18.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting transportation within the EIS project area are discussed under Alternative 2, Section 4.11.4.18.

4.11.7.18.4 Contribution of Alternative to Cumulative Effects

The contribution of impacts from Alternative 4 would be similar as those described for Alternative 3 in Section 4.11.5.18.

4.11.7.18.5 Conclusion

In summary, no concerns related to adverse cumulative impacts have been identified. Some cumulative impacts may exist if Alternative 5 overlaps with another large-scale development project but those impacts would be of low intensity, temporary in duration affecting local areas of common resources and are considered unlikely to have long-term impacts on regional transportation infrastructure.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with transportation were discussed under Alternative 2 (Section 4.11.4.18).

4.11.7.19 Recreation and Tourism

4.11.7.19.1 Summary of Direct and Indirect Effects

The direct impacts would be low intensity, temporary duration, local extent, and common in context. Indirect impacts would be the same levels as direct impacts, except that the geographic area would be broader, extending beyond the region to a state-wide level and potentially beyond. In summary, the impact of Alternative 5 on recreation and tourism would be minor.

4.11.7.19.2 Past and Present Actions

Past and present actions affecting recreation and tourism within the EIS project area are discussed under Alternative 2, Section 4.11.4.19.

4.11.7.19.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting recreation and tourism within the EIS project area are discussed under Alternative 2, Section 4.11.4.19.

4.11.7.19.4 Contribution of Alternative to Cumulative Effects

To the extent that the required time/area closures contemplated in Alternative 5 provide benefit to marine mammals, they would be beneficial to tourism based on wildlife viewing, and similar to the benefits of other standard and additional mitigation measures. The potential cumulative effects discussed in Sections 4.11.4.19 and 4.11.5.19 for Alternatives 2 and 3 are the same for Alternative 5; the overall impact to recreation and tourism would be minor.

4.11.7.19.5 Conclusion

Alternative 5 would have a minor contribution to cumulative effects on recreation and tourism.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with recreation and tourism were discussed under Alternative 2 (Section 4.11.4.19).

4.11.7.20 Visual Resources

4.11.7.20.1 Summary of Direct and Indirect Effects

Direct and indirect effects of past and present actions are identical to those described in Section 4.11.6.20, Alternative 4.

4.11.7.20.2 Past and Present Actions

Past and present actions affecting visual resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.20.

4.11.7.20.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting visual resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.20.

4.11.7.20.4 Contribution of Alternative to Cumulative Effects

The contribution of Alternative 5 to cumulative effects would be identical to that described for Alternative 4.

4.11.7.20.5 Conclusion

Under Alternative 5, anticipated cumulative effects to visual resources are expected to be major. Impacts would be of high intensity, long-term in duration, regional in geographic extent and occurring in an important context.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with visual resources were discussed under Alternative 2 (Section 4.11.4.20).

4.11.7.21 Environmental Justice

4.11.7.21.1 Summary of Direct and Indirect Effects

Direct and indirect effects to subsistence and public health associated with Alternative 5 would be minor, similar to those described for Alternative 2. To the extent that time/area closures in all closure areas provide additional benefits to marine mammals and reduce net impacts on subsistence activities, the impacts to subsistence and public health would be lessened, however, these benefits to do not affect the summary impact level of minor.

4.11.7.21.2 Past and Present Actions

The past and present actions that would contribute to the cumulative effects of environmental justice under Alternative 5 are the same as those described for Alternative 1 in Section 4.11.3.21.

4.11.7.21.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions for Alternative 5 would be the same as those described for Alternative 2 in Section 4.11.4.21. Future industrial activities and climate change would have an adverse impact on subsistence resources and uses and public health.

4.11.7.21.4 Contribution of Alternative to Cumulative Effects

The incremental contribution of Alternative 5 to the overall industrial activity in the area would be similar that that described for Alternative 2. Therefore, the contribution of Alternative 5 to environmental justice indicator cumulative effects would be minor.

4.11.7.21.5 Conclusion

The direct and indirect effects of Alternative 5 would be minor. The contribution to the cumulative effect of environmental justice indicators would be minor. Therefore, there would be a disproportionate impact to Alaska Native communities in the EIS project area.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with environmental justice were discussed under Alternative 2 (Section 4.11.4.21). A VLOS would have disproportionate adverse impacts to Alaska Natives living in the communities near the EIS project area.

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

4.11.8.1 Physical Oceanography

4.11.8.1.1 Summary of Direct and Indirect Effects

The effects of Alternative 6 on physical ocean resources would be substantially the same as those described for Alternative 4. The additional mitigation measures included in Alternative 6 would not substantially change the effects of the alternative on physical ocean resources in the EIS project area. The effects of Alternative 6 on physical ocean resources would be medium-intensity, temporary, local, and would affect common resources as defined in the impact criteria in Section 4.1 of this EIS. The effects Alternative 6 on physical ocean resources in the EIS project area would be minor.

4.11.8.1.2 Past and Present Actions

Past and present actions affecting physical ocean resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.1.

4.11.8.1.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting physical ocean resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.1.

4.11.8.1.4 Contribution of Alternative to Cumulative Effects

Actions associated with Alternative 6 would cause localized minor impacts to physical ocean resources in the EIS project area. While some actions associated with Alternative 6, such as the construction of man-made gravel islands, would interact in a synergistic fashion with past, present, and reasonably foreseeable future actions to influence physical ocean resources in the EIS project area, the impacts resulting from such synergies would represent only a small fraction of foreseeable cumulative impact.

4.11.8.1.5 Conclusion

The incremental contribution of activities associated with Alternative 6 to cumulative effects on physical ocean resources in the EIS project area would be minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with physical ocean resources were discussed under Alternative 2 (Section 4.11.4.1).

4.11.8.2 Climate & Meteorology

4.11.8.2.1 Summary of Direct and Indirect Effects

Alternative 6 involves the same exploration activities as proposed in Alternatives 4 and 5, with the potential inclusion of alternative technologies. The estimated amount of GHG emissions associated with Alternative 6 is the same as those for Alternatives 4 and 5. Therefore the impact levels are expected to be the same as Alternatives 4 and 5, which are minor direct impacts and minor to moderate indirect impacts.

4.11.8.2.2 Past and Present Actions

Past and present actions affecting climate change within the EIS project area are discussed under Alternative 2, Section 4.11.4.2.

4.11.8.2.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting climate change within the EIS project area are discussed under Alternative 2, Section 4.11.4.2.

4.11.8.2.4 Contribution of Alternative to Cumulative Effects

Alternative 6 would emit approximately the same amount of GHGs as Alternatives 4 and 5; therefore its direct impacts would contribute more to cumulative climate change impacts than Alternative 2. As with Alternatives 2 through 5, the indirect effects would contribute more to cumulative impacts than the direct effects. The magnitude of indirect effects cannot be quantified and is considered to be the same as for Alternatives 2 through 5. Therefore indirect effects from Alternative 6 are expected to result in changes that could be long-term and could affect unique resources.

4.11.8.2.5 Conclusion

Alternative 6 could contribute to a moderate to major cumulative impact to climate change, the same as with Alternatives 2 through 5.

The additive effects resulting from a VLOS within the seas Arctic OCS associated with climate change were discussed under Alternative 2 (Section 4.11.4.2).

4.11.8.3 Air Quality

4.118.3.1 Summary of Direct and Indirect Effects

The air quality effects due to the worst-case activity under Alternative 6, Level 3 Exploration Activity, are expected to be the same as those for Alternatives 4 and 5. The overall direct effect on air quality is expected to be moderate, and indirect effects would be negligible to minor.

4.11.8.3.2 Past and Present Actions

Past and present actions affecting air quality within the EIS project area are discussed under Alternative 2, Section 4.11.4.3.

4.11.8.3.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting air quality within the EIS project area are discussed under Alternative 2, Section 4.11.4.3.

4.11.8.3.4 Contribution of Alternative to Cumulative Effects

The potential cumulative effects on air quality for Alternative 6 are the same as those for Alternative 4, with a moderate contribution to cumulative effects from Alternative 6.

4.11.8.3.5 Conclusion

Alternative 6 has the potential to contribute to cumulative effects on air quality when activities occur in the vicinity of other sources of air pollution. Due to distance between activities, and the mobile and intermittent source activities, the cumulative effects are expected to be less than the sum of each, likely remaining moderate in magnitude.

The additive effects resulting from a VLOS within the seas Arctic OCS associated with air quality were discussed under Alternative 2 (Section 4.11.4.3).

4.11.8.4 Acoustics

4.11.8.4.1 Summary of Direct and Indirect Effects

The summary of direct and indirect effects provided in Section 4.11.4 (Alternative 2) is relevant also for Alternative 6. Alternative 6 suggests replacement of some impulsive airgun sources with alternate sources to reduce the emitted impulsive levels. Several alternative source types are described in Section 2.3.5.

4.11.8.4.2 Past and Present Actions

Past and present actions affecting acoustics within the EIS project area are discussed under Alternative 2, Section 4.11.4.4.

4.11.8.4.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting acoustics within the EIS project area are discussed under Alternative 2, Section 4.11.4.4.

4.11.8.4.4 Contribution of Alternative to Cumulative Effects

The contribution to cumulative effects from use of alternate technologies is difficult to assess. Simple reductions in pulse rms levels will reduce the number of auditory system injury takes and disturbance takes under the present NMFS criteria for these effects. Some of the proposed sources, such as marine vibrators, operate by extending the time period over which acoustic energy is transmitted into the water. These extended-duration sources operate at lower rms pressure levels but may produce similar SEL. These sources would not show as much improvement when evaluated against SEL-based criteria such as those proposed by Southall et al. (2007). Another important issue associated with extending the transmission time of impulsive sounds is that the source signals become less impulsive and could be reclassified as continuous noise. In that case they could be evaluated against the continuous noise disturbance threshold of 120 dB re 1 μPa instead of the impulsive threshold 160 dB re 1 μPa (rms). The above points illustrate outstanding issues with regard to developing relevant criteria upon which to base acoustic effects assessments. If this alternative is successful then further reductions of seismic survey sound levels might be achieved as improvements to the alternate technologies are made. These improvements could lead to reduced exposures and effects.

4.11.8.4.5 Conclusion

The use of alternate sources under Alternative 6 has potential to substantially reduce the size of effects zones for seismic surveys. There are potential drawbacks for modified sources that increase the duration of source signals, including the smaller reduction of SEL and the possibility the signals may be reclassified as continuous noise – thereby becoming subject to evaluation against a much lower disturbance threshold criterion. Still, these issues can be overcome if accounted for in the development of the alternate source systems.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with acoustics were discussed under Alternative 2 (Section 4.11.4.4).

4.11.8.5 Water Quality

4.11.8.5.1 Summary of Direct and Indirect Effects

Impacts to water quality resulting from Alternative 6 are expected to be very similar to those described for Alternative 4 in Section 4.11.6.5. Alternative 6 includes mitigation measures that focus on the use of alternative technologies to replace or augment traditional airgun-based seismic exploration techniques. See Chapter 2 for descriptions of the mitigation measures included under Alternative 6. These mitigation measures are not expected to affect the level of water quality impacts. The effects of Alternative 6 on water quality are expected to be low intensity, temporary, local, and would affect common resources as defined in the impact criteria in Section 4.1 of this EIS. The overall effects of Alternative 6 on water quality are expected to be minor.

4.11.8.5.2 Past and Present Actions

Past and present actions affecting water quality within the EIS project area are discussed under Alternative 2, Section 4.11.4.5.

4.11.8.5.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting water quality within the EIS project area are discussed under Alternative 2, Section 4.11.4.5.

4.11.8.5.4 Contribution of Alternative to Cumulative Effects

Use of alternative technologies would not influence the contribution of exploration activities to cumulative effects on water quality. Actions associated with Alternative 5 would cause temporary local impacts to water quality such as increases in temperature, turbidity, and concentrations of pollutants. Some actions associated with Alternative 6, such as discharges of cooling water and waste material, would interact with past, present, and reasonably foreseeable future actions resulting in both additive and synergistic impacts to water quality. These interactions would be local and temporary and would represent only a small fraction of foreseeable cumulative impact.

4.11.8.5.5 Conclusion

The incremental contribution of activities associated with Alternative 6 to cumulative effects on water quality in the EIS project area would be minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with water quality were discussed under Alternative 2 (Section 4.11.4.5).

4.11.8.6 Environmental Contaminants and Ecosystem Functions

4.11.8.6.1 Summary of Direct and Indirect Effects

Direct and indirect impacts to environmental contaminants and ecosystem functions resulting from the implementation of Alternative 6 would be medium-intensity, temporary, and local. Regulation functions such as nutrient cycling and waste assimilation, which depend on biota and physical processes to facilitate storage and recycling of nutrients and breakdown or assimilation of contaminants, would be affected within the EIS project area. Habitat functions, particularly those related to benthic habitats, would be impacted as a result of discharges and other activities associated with exploratory drilling. Production functions including primary productivity and subsequent transfers to higher trophic levels could potentially be impacted as a result of activities associated with Alternative 6, while the effects of Alternative 6 on information ecosystem functions would depend upon interrelationships between impacts to cultural resources, social resources, and aesthetic resources, which are addressed in other sections of this EIS. Overall effects of Alternative 6 on ecosystem functions would be minor.

4.11.8.6.2 Past and Present Actions

Past and present actions affecting environmental contaminants and ecosystem functions within the EIS project area are discussed under Alternative 2, Section 4.11.4.6.

4.11.8.6.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting environmental contaminants and ecosystem functions within the EIS project area are discussed under Alternative 2, Section 4.11.4.6.

4.11.8.6.4 Contribution of Alternative to Cumulative Effects

Actions associated with Alternative 6 would cause localized minor impacts to environmental contaminants and ecosystem functions within the EIS project area. Some actions associated with Alternative 6, such as discharges from exploratory drilling operations, would interact with past, present, and reasonably foreseeable future actions resulting in both additive and synergistic impacts to ecosystem functions. The impacts resulting from such interactions would represent a relatively small fraction of foreseeable cumulative impact, and the accumulation of impacts is unlikely to be substantial. The use of alternative technologies associated with Alternative 6 could potentially decrease the accumulation of adverse impacts to habitat, production, and information functions within the EIS project area.

4.11.8.6.5 Conclusion

The incremental contribution of activities associated with Alternative 6 to cumulative effects on environmental contaminants and ecosystem functions in the EIS project area would be minor. Use of alternative technologies could potentially decrease the accumulation of adverse impacts to certain habitat functions within the EIS project area.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with environmental contaminants and ecosystem functions were discussed under Alternative 2 (Section 4.11.4.6).

4.11.8.7 Lower Trophic Levels

4.11.8.7.1 Summary of Direct and Indirect Effects

Activity levels in Alternative 6 are the same as in Alternative 4, with the addition of required measures that focus on alternative technologies for seismic exploration. This requirement does not affect lower trophic levels in the EIS project area, so the impacts discussed previously for Alternatives 2, 3, 4, and 5 are the same for Alternative 6; the overall impact to lower trophic levels would be minor.

4.11.8.7.2 Past and Present Actions

Past and present actions affecting lower trophic levels within the EIS project area are discussed under Alternative 2, Section 4.11.4.7.

4.11.8.7.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting lower trophic levels within the EIS project area are discussed under Alternative 2, Section 4.11.4.7.

4.11.8.7.4 Contribution of Alternative to Cumulative Effects

Alternative 6 would have the same types of effects as Alternative 2 with the addition of certain time/area closures. Therefore, the conclusions about Alternative 6 would be similar to Alternative 2 discussed in Section 4.10.4.7 and the overall impact would be moderate. The exploration activities authorized under Alternative 6 would have moderate contributions to the cumulative effects from past, present, and reasonably foreseeable future actions on lower trophic levels.

4.11.8.7.5 Conclusion

Alternative 6 could have a minor contribution to cumulative effects on lower trophic organisms.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with lower trophic levels were discussed under Alternative 2 (Section 4.11.4.7).

4.11.8.8 Fish and Essential Fish Habitat

4.11.8.8.1 Summary of Direct and Indirect Effects

The effect of the alternative technologies outlined in Alternative 6 on fish resources and EFH are difficult to determine with any certainty but are anticipated to result in a reduction in the overall impact. Although the overall impact is considered to be minor based on Alternative 4 alone, replacement of airgun arrays with alternative technologies could potentially reduce adverse effects on fish. However, the limited number of airgun arrays that could be replaced by any of these technologies is fairly limited, thereby resulting in minimal reductions of overall impact levels. Therefore, there would be no measurable effect on the resource, and overall impact is considered to be minor.

4.11.8.8.2 Past and Present Actions

Past and present actions affecting fish and EFH within the EIS project area are discussed under Alternative 2, Section 4.11.4.8.

4.11.8.8.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting fish and EFH within the EIS project area are discussed under Alternative 2, Section 4.11.4.8.

4.11.8.8.4 Contribution of Alternative to Cumulative Effects

Climate change is the only past, present, or reasonably foreseeable future action that is anticipated to have any measurable effect on fish and EFH within the EIS project area, and those effects are likely to be beneficial. As Arctic waters warm, productivity is likely to increase, thereby creating more favorable fish habitat throughout the region. The lack of measurable effect on fish and EFH resulting from the implementation of Alternative 6 would not add to any cumulative effects.

4.11.8.8.5 Conclusion

Direct and indirect effects associated with Alternative 6 on fish and EFH would be minor. The overall contribution of Alternative 6 to cumulative effects on fish and EFH would be negligible.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with fish and EFH were discussed under Alternative 2 (Section 4.11.4.8).

4.11.8.9 Marine and Coastal Birds

4.11.8.9.1 Summary of Direct and Indirect Effects

As discussed in Section 4.9.2.3, the effects of disturbance, injury/mortality, and changes in habitat for marine and coastal birds would likely be temporary or short-term, localized, and not likely to have population-level effects for any species. In summary, the impact of Alternative 6 on marine and coastal birds would be considered negligible.

4.11.8.9.2 Past and Present Actions

Past and present actions affecting marine and coastal birds within the EIS project area are discussed under Alternative 2, Section 4.11.4.9.

4.11.8.9.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting marine and coastal birds within the EIS project area are discussed under Alternative 2, Section 4.11.4.9.

4.11.8.9.4 Contribution of Alternative 6 to Cumulative Effects

Alternative 6 would have the same types and level of exploration activities as Alternative 4 with the gradual introduction of alternative seismic technologies. However, the potential reduction in sound levels during seismic surveys would not make much difference to birds so the effects are essentially the same as described for Alternative 4. In the absence of a very large oil spill (see below), the exploration activities authorized under Alternative 6 would have negligible contributions to the cumulative effects from past, present, and reasonably foreseeable future actions on marine and coastal birds.

4.11.8.9.5 Conclusion

Direct and indirect effects associated with Alternative 6 on marine and coastal birds would be negligible. The overall contribution of Alternative 6 to cumulative effects on marine and coastal birds would be negligible.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with marine and coastal birds were discussed under Alternative 2 (Section 4.11.4.9).

4.11.8.10 Marine Mammals

4.11.8.10.1 Bowhead Whales

4.11.8.10.1.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 6 on bowhead whales are described in Section 4.9.2.4.1. Impacts of activities associated with oil and gas exploration in the EIS project area under Alternative 5 are similar to Alternative 4 (See Section 4.11.6.10.1).

Mitigating capabilities and effects of alternative technologies introduced under Alternative 6 on bowhead whales are difficult to determine, but could reduce adverse impacts associated with the use of airgun arrays. The overall reduction would likely be minimal. The gradual introduction of these alternative technologies could, ultimately, reduce the amount of seismic noise introduced into the marine environment. 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. Effects of existing technology on bowhead whales would be mostly of medium intensity and temporary duration and range from localized to regional in extent. 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. Bowhead whales are considered a unique resource, since they are listed as endangered and are an essential subsistence resource for Iñupiat and Yupik Eskimos of the Arctic coast. Despite possible localized mitigating capabilities of using alternative technologies in lieu of limited numbers of airgun arrays, the overall impact of Alternative 6 on bowhead whales is considered to be moderate to major.

4.11.8.10.1.2 Past and Present Actions

Past and present actions affecting bowhead whales within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.1.

4.11.8.10.1.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting bowhead whales within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.1.

4.11.8.10.1.4 Contribution of Alternative to Cumulative Effects

The contribution of the direct and indirect impacts resulting from Alternative 6, when combined with the past, present, and reasonably foreseeable future actions would, in many respects, be similar to Alternative 4 (Section 4.11.6.10.1). Since most potential impacts are due to acoustic disturbance that could, at least temporarily, disrupt or displace bowhead whales, the use of alternative technologies has the potential to reduce, but not eliminate, such effects. These technologies would gradually be introduced, would not completely replace airguns, and many are still in development with uncertain efficacy, so a thorough assessment of their effectiveness is not currently possible. Therefore, the contribution of activities authorized under Alternative 6 to cumulative effects on bowhead whales would be considered moderate.

4.11.8.10.1.5 Conclusion

Under Alternative 6, the direct and indirect effects to bowhead whales would be moderate. Alternative 6 would have a minor to moderate contribution to cumulative effects on bowhead whales.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with bowhead whales were discussed under Alternative 2 (Section 4.11.4.10.1).

4.11.8.10.2 Beluga Whales

4.11.8.10.2.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 6 on beluga whales are described in Section 4.9.2.4.2 and are summarized here. The additional oil and gas exploration activities proposed in Alternative 6 could directly and indirectly affect beluga whales by causing noise disturbance, habitat degradation, and potential ship strikes. Beluga whales disturbed by oil and gas exploration activities may move away from important habitats. The scale of the avoidance depends on the number and relative proximity of the surveys. Numerous simultaneous seismic activities could cause avoidance over large distances. Potential habitat degradation from drill cuttings or drilling mud discharges would be localized and temporary; the impact level would be negligible. While the incidence of ship strikes is currently low, it could rise with increasing vessel traffic.

The use of alternative technologies under Alternative 6 may reduce adverse impacts to beluga whales associated with the use of airgun arrays. Alternative technologies could reduce the extent of impacts to localized areas on a small scale. It is difficult to quantify the amount of impact reduction likely to occur due to the uncertainty in assessing potential behavioral reactions. Therefore there is no evidence to support a change in the expected impact intensity level. Despite possible localized impact reductions from using alternative technologies instead of airgun arrays, the overall impact of Alternative 6 on beluga whales is considered moderate.

The direct and indirect effects on beluga whales from the exploration activities under Alternative 5 would be low to medium intensity, short-term duration, local to regional extent, and would affect a unique resource. The summary impact level of Alternative 6 on beluga whales would be considered moderate.

4.11.8.10.2.2 Past and Present Actions

Past and present actions affecting beluga whales in the EIS project area are discussed under Alternative 2, Section 4.11.4.10.2.

4.11.8.10.2.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions that would affect beluga whales in the EIS project area are discussed under Alternative 2, Section 4.11.4.10.2.

4.11.8.10.2.4 Contribution of Alternative to Cumulative Effects

The oil and gas exploration activities authorized under Alternative 6 would add to the acoustic disturbance of beluga whales from marine vessels, seismic sources, and aircraft traffic in the Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be localized and temporary. Although ship strikes are possible with increased vessel activity associated with oil and gas exploration, the contribution to additional mortality would be negligible relative to the population level. Exploration activities could contribute to habitat alterations through icebreaking efforts and discharge of drilling muds. Effects would be localized and temporary. The contribution to habitat change would be negligible since it would affect an extremely small proportion of habitat or prey base available to beluga whales. The exploration activities authorized under Alternative 6 would therefore have moderate additive contributions to the cumulative effects on beluga whales.

4.11.8.10.2.5 Conclusion

As stated above, most exploration activities authorized under Alternative 6 would result in minor to moderate contributions to cumulative effects on beluga whales.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with beluga whales were discussed under Alternative 2 (Section 4.11.4.10.2).

4.11.8.10.3 Other Cetaceans

4.11.8.10.3.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 6 on cetaceans are described in Section 4.9.2.4.3 and are summarized here. Evaluated collectively, the overall impact of Alternative 6 on other cetaceans is minor to moderate. Although the introduction of alternative technologies specified in Alternative 6 could incrementally mitigate adverse impacts into the future, the overall impact on other cetaceans of oil and gas exploration activities allowed under this alternative would be similar to Alternative 4. Due to the very small scale of any potential effects relative to overall population levels and available habitat, and the temporary nature of the majority of the activities associated with Alternative 6, impacts on the resource would be low in intensity, of short duration, and limited extent. Long term impacts are unknown, but anticipated to be minor.

Mitigating capabilities and effects of alternative technologies introduced under Alternative 6 on the cetaceans are difficult to determine, but could reduce adverse impacts associated with the use of airgun arrays. The overall reduction would likely be minimal. The gradual introduction of these alternative technologies could, ultimately, reduce the amount of seismic noise introduced into the marine environment. New alternative technologies may extend the transmission time of impulsive sounds and source signals could become less impulsive and could be reclassified as continuous noise that would be unlikely to affect fish. 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 survey equipment.

4.11.8.10.3.2 Past and Present Actions

Past and present actions affecting other cetaceans within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.3.

4.11.8.10.3.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting other cetaceans within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.3.

4.11.8.10.3.4 Contribution of Alternative to Cumulative Effects

The oil and gas exploration activities authorized under Alternative 6 would add to the acoustic disturbance of other cetaceans from marine vessels, seismic sources, and aircraft traffic in the Beaufort and Chukchi seas. Although the introduction of the Alternative Technologies specified in Alternative 6 could incrementally mitigate adverse impacts into the future, the overall impact on other cetaceans of oil and gas exploration activities allowed under this alternative would be similar to Alternative 4. Most of this disturbance would occur during the open-water season and would be localized and temporary. Although ship strikes are possible with increased vessel activity associated with oil and gas exploration, the contribution to additional mortality would be negligible relative to the population level. Exploration activities could contribute to habitat alterations through icebreaking efforts and discharge of drilling muds. Effects would be localized and temporary. The contribution to habitat change would be negligible. The exploration activities authorized under Alternative 6 would therefore have minor additive contributions to the cumulative effects on other cetaceans.

4.11.8.10.3.5 Conclusion

As stated above, most exploration activities authorized under Alternative 6 would result in minor contributions to cumulative effects on other cetaceans.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with other cetaceans were discussed under Alternative 2 (Section 4.11.4.10.2).

4.11.8.10.4 Ice Seals

4.11.8.10.4.1 Summary of Direct and Indirect Effects

There are four species of seals considered in this section that are often collectively called "ice seals"; ringed seal, spotted seal, ribbon seal, and bearded seal. The direct and indirect effects of Alternative 6 on ice seals are described in Section 4.9.2.4.4 and are summarized here. Ringed seals and bearded seals have been the most commonly encountered species of any marine mammals in past offshore oil and gas exploration activities in the Alaskan Beaufort and Chukchi seas and would likely be affected more frequently by exploration activities authorized under Alternative 6 than either ribbon or spotted seals. Data from observers on board seismic source vessels and monitoring vessels indicate that seals tend to avoid on-coming vessels and active seismic arrays but they do not appear to react strongly even as ships pass fairly close with active arrays. They also do not appear to react strongly to icebreaking or on-ice surveys, keeping their distance or moving away at some point to an alternate breathing hole or haulout, but the scope of these behavioral responses appears to be within their natural abilities and responses to their naturally dynamic environment. None of the behavioral reactions observed to date indicate that any of the ice seal species would be displaced from key areas or resources for more than a few minutes or hours and they would be unlikely to experience any measurable effects on their reproductive success or survival. Ice seals are legally protected, have unique ecological roles in the Arctic, and are important subsistence resources and are therefore considered to be unique resources. Given the standard mitigation measures that have been required in the past, the effects of exploration activities that could be authorized under Alternative 6 on ice seals would likely be low in magnitude, distributed over a wide geographic area, and temporary to short-term in duration. The effects of Alternative 6 would therefore be considered minor to moderate for all ice seal species according to the criteria established in Section 4.1.3.

4.11.8.10.4.2 Past and Present Actions

Past and present actions affecting pinnipeds within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.4.

4.11.8.10.4.2 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting pinnipeds within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.4.

4.11.8.10.4.3 Contribution of Alternative 6 to Cumulative Effects

The exploration activities authorized under Alternative 6 would add to the disturbance of ice seals from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be temporary. Very small numbers of ringed seals could be exposed to exploration activities during the denning season (winter-spring) when females with young are more susceptible to disturbance. Exploration activities would contribute negligible risk of additional mortality to any species, which would continue to be dominated by subsistence harvest. Exploration activities could contribute to habitat change through on-ice surveys, icebreaking efforts, and discharge of drilling muds but these effects would be localized and temporary or short-term. This contribution to habitat change would be negligible compared to the potential for dramatic sea ice loss due to climate change and changes in ecosystems due to ocean acidification. The exploration activities authorized under Alternative 6 would therefore have minor contributions to the cumulative effects on the four species of ice seals considered.

4.11.8.10.4.4 Conclusion

Direct and indirect effects associated with Alternative 6 on pinnipeds would be minor to moderate. The overall contribution of Alternative 6 to cumulative effects on pinnipeds would be minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with pinnipeds were discussed under Alternative 2 (Section 4.11.4.10.4).

4.11.8.10.5 Walrus

4.11.8.10.5.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 6 on walrus are described in Section 4.9.2.4.5 and are summarized here. The types and levels of effects on Pacific walrus are essentially the same under Alternative 6 as for Alternative 4 (Section 4.7.2.4.5). Walrus have been regularly encountered during vessel-based exploration activities in the past, primarily in late summer as the pack ice recedes, as recorded by PSOs on board seismic source vessels and monitoring vessels. These data indicate that walrus do not react strongly to vessels and active seismic arrays and their behavioral responses are often neutral rather than swimming away. They tend to dive into the water as icebreaking ships approach from some distance and are therefore not exposed to the loudest sounds generated by the ships. The gradual introduction of alternative technologies for seismic surveys would make very little difference to walrus because they are unlikely to be affected in any biologically meaningful way by seismic noise. Mitigation measures required for walrus by USFWS LOAs since the early 1990s have reduced the risk of close encounters with seismic and other exploration vessels and have reduced the risk of accidental spills that may affect walrus or their prey. None of the data collected to date on walrus reactions to exploration activities indicate that they would be displaced from key areas or resources for more than a few minutes or hours. Careful avoidance of vessel and aircraft traffic around walrus haulouts on land would be important to minimize the risk of calf and juvenile mortality from stampedes. Walrus are legally protected, fulfill an important ecological role in the Arctic, and are important subsistence resources and are therefore considered to be a unique resource for NEPA purposes. Given the level and type of exploration activities that would be authorized under Alternative 6, and considering the mitigation measures that would be required by USFWS LOAs and NMFS in this EIS, the effects on walrus would likely be low in magnitude, distributed over a wide geographic area, and temporary in duration. The effects of Alternative 6 on Pacific walrus would therefore be considered minor.

4.11.8.10.5.2 Past and Present Actions

Past and present actions affecting Pacific walrus within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.5.

4.11.8.10.5.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting Pacific walrus within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.5.

4.11.8.10.5.4 Contribution of Alternative 6 to Cumulative Effects

The exploration activities authorized under Alternative 6 would add to the disturbance of walrus from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be temporary. Exploration activities would contribute negligible risk of additional mortality to walrus, which would continue to be dominated by subsistence harvest. Exploration activities could contribute to habitat change through on-ice surveys, icebreaking efforts, and discharge of drilling muds but these effects would be localized and temporary or short-term. This contribution to habitat change would be negligible compared to the potential for dramatic sea ice loss due to climate change and changes in ecosystems due to ocean acidification. The exploration activities authorized under Alternative 6 would therefore have negligible to minor contributions to the cumulative effects on Pacific walrus.

4.11.8.10.5.5 Conclusion

Direct and indirect effects associated with Alternative 6 on Pacific walrus would be minor. The overall contribution of Alternative 6 to cumulative effects on Pacific walrus would be negligible to minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with Pacific walrus were discussed under Alternative 2 (Section 4.11.4.10.5).

4.11.8.10.6 Polar Bears

4.11.8.10.6.1 Summary of Direct and Indirect Effects

The direct and indirect effects of Alternative 6 on polar bears are described in Section 4.9.2.4.6 and are summarized here. The types and levels of effects on polar bears are essentially the same under Alternative 6 as for Alternative 4 (Section 4.7.2.4.6). Polar bears have been infrequently encountered during vessel-based exploration activities in the past, as recorded by PSOs on board source vessels and monitoring vessels. These sparse data indicate that polar bears do not react strongly to vessels and active seismic arrays and their behavioral responses are often neutral rather than running or swimming away. The gradual introduction of alternative technologies for seismic surveys would make very little difference to polar bears because they are unlikely to be affected in any biologically meaningful way by seismic noise. They also do not appear to react strongly to icebreaking or on-ice surveys. Some bears keep their distance or move away at some point but others may approach vehicles and equipment out of curiosity. The types of effects of most concern for polar bears during exploration activities involve the risk of bear-human encounters. Mitigation measures and polar bear safety/interaction plans required by USFWS LOAs since the early 1990s have reduced the risk of these encounters for both people and bears. None of the data collected to date on polar bear reactions to exploration activities indicate that polar bears would be displaced from key areas or resources for more than a few minutes or hours and they are unlikely to experience any measurable effects on their reproductive success or survival as a result. Polar bears are legally protected, have a unique ecological role in the Arctic, and are important to subsistence cultures and are therefore considered a unique resource. Given the level and type of exploration activities that would be authorized under Alternative 6, and considering the mitigation measures that would be required by USFWS LOAs and NMFS in this EIS, the effects on polar bears would likely be low in magnitude, distributed over a wide geographic area, and temporary in duration. The effects of Alternative 6 on polar bears would therefore be considered minor.

4.11.8.10.6.2 Past and Present Actions

Past and present actions affecting polar bears within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.6.

4.11.8.10.6.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting polar bears within the EIS project area are discussed under Alternative 2, Section 4.11.4.10.6.

4.11.8.10.6.4 Contribution of Alternative 6 to Cumulative Effects

The exploration activities authorized under Alternative 6 would add to the disturbance of polar bears from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be temporary. Exploration activities would contribute negligible risk of additional mortality to polar bears, which would continue to be dominated by subsistence harvest. Exploration activities could contribute to habitat change through on-ice surveys, icebreaking efforts, and discharge of drilling muds but these effects would be localized and temporary or short-term. This contribution to habitat change would be negligible compared to the potential for dramatic sea ice loss due to climate change and changes in ecosystems due to ocean acidification. The exploration activities authorized under Alternative 6 would therefore have negligible to minor contributions to the cumulative effects on polar bears.

4.11.8.10.6.5 Conclusion

Direct and indirect effects associated with Alternative 6 on polar bears would be minor. The overall contribution of Alternative 6 to cumulative effects on polar bears would be negligible to minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with polar bears were discussed under Alternative 2 (Section 4.11.4.10.6).

4.11.8.11 Terrestrial Mammals

4.11.8.11.1 Summary of Direct and Indirect Effects

Activity levels in Alternative 6 are the same as in Alternative 4, and this alternative includes mitigation measures that focus on alternative technologies for seismic exploration. These mitigation measures do not affect terrestrial mammals in the EIS project area, so the impacts discussed for Alternatives 2 and 3 are the same for Alternative 6 and the overall impact to terrestrial mammals would be minor.

4.11.8.11.2 Past and Present Actions

Past and present actions affecting caribou within the EIS project area are discussed under Alternative 2, Section 4.11.4.11.

4.11.8.11.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting caribou within the EIS project area are discussed under Alternative 2, Section 4.11.4.11.

4.11.8.11.4 Contribution of Alternative to Cumulative Effects

The contribution of this alternative to cumulative effects is the same as described under Alternative 2.

4.11.8.11.5 Conclusion

The incremental contribution of activities associated with Alternative 6 to cumulative effects on caribou would be negligible.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with caribou were discussed under Alternative 2 (Section 4.11.4.11).

4.11.8.12 Time/Area Closures

The analysis of the cumulative effects under Alternative 6 associated with time/area closure locations can be found in Sections 4.11.8.10 (Marine Mammals), 4.11.8.9 (Marine and Coastal Birds) and 4.11.8.14 (Subsistence).

4.11.8.13 Socioeconomics

4.11.8.13.1 Summary of Direct and Indirect Effects

Direct and indirect effects associated with Alternative 6 are the similar to those described for Alternative 2. Alternative technologies may result in additional costs to lease holders due to increased time to complete surveys. To the extent that alternative technologies benefit to marine mammals and reduce net impacts to subsistence activities, there would be some potential socioeconomic benefits to the non-cash economy. The summary impact level for Socioeconomics under Alternative 6 is minor, not exceeding the significance threshold.

4.11.8.13.2 Past and Present Actions

Past and present actions affecting socioeconomics within the EIS project area are discussed under Alternative 2, Section 4.11.4.13.

4.11.8.13.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting socioeconomics within the EIS project area are discussed under Alternative 2, Section 4.11.4.13. This analysis assumes current levels of oil and gas production and on-shore exploration would continue, but does not assume that offshore exploration associated with Alternative 6 would result in future oil and gas production.

4.11.8.13.4 Contribution of Alternative to Cumulative Effects

The incremental contribution of Alternative 6 to socioeconomic cumulative effects would be minor and positive. They differ from Alternative 2 by the potential for some lost productivity for lease holders due to alternative technologies and mitigation measures and countervailing positive impacts to subsistence resources and activities and therefore would have a countervailing positive impact to the non-cash economy. The summary contribution of these impacts to the cumulative effectives of socioeconomics is negligible to minor at a statewide and national level and minor at the local level.

4.11.8.13.5 Conclusion

The direct and indirect effects of Alternative 6 would be positive and minor. The contribution to cumulative effects of socioeconomics would be minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with socioeconomics were discussed under Alternative 2 (Section 4.11.4.13).

4.11.8.14 Subsistence

4.11.8.14.1 Summary of Direct and Indirect Effects

Using the impact criteria identified in Table 4.5-25, the direct and indirect effect of oil and gas exploration activities on subsistence resources and harvests resulting from implementation of Alternative 6 would be of low intensity, temporary in duration, local in extent, and the context would be common to unique. Protected resources (bowhead whales and polar bears are considered unique in context as these resources are protected by legislation (e.g. MMPA, ESA) or are considered an important subsistence resource (beluga whales). The impacts of implementing Alternative 6 could be considered beneficial to subsistence harvests and users as the implementation of new technologies could reduce the levels of noise introduced to the marine environment and then reduce the levels of noise disturbance to marine mammal subsistence resources. New alternative technologies may extend the transmission time of impulsive sounds and source signals could become less impulsive and could be reclassified as continuous noise that would be unlikely to affect subsistence resources. Direct and indirect impacts to subsistence harvest and subsistence resources are likely to be similar or less than those of Alternative 4 as discussed in Section 4.7.3.2 and Section 4.11.6.14. The summary impact to subsistence is therefore considered to range from negligible to moderate depending upon the specific subsistence resource affected and source of disturbance (Section 4.5.3.2 and Section 4.9.3.2).

4.11.8.14.2 Past and Present Actions

Past and present actions affecting subsistence resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.14.

4.11.8.14.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting subsistence resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.14.

4.11.8.14.4 Contribution of Alternatives to Cumulative Effects

The activities authorized under Alternative 6 would add to the disturbance of subsistence resources from marine vessels and aircraft traffic in the Alaskan Beaufort and Chukchi seas. Most of this disturbance would occur during the open-water season and would be low in intensity, temporary in duration and local in extent and affect subsistence resources that are common to unique in context. A low number of seals and polar bears could be disturbed during on-ice seismic surveys. Exploration activities would constitute a minor contribution to the disturbance of subsistence resources. Exploration activities could contribute to habitat change of subsistence resources through aircraft and vessel traffic, icebreaking efforts, on-ice surveys and discharge of drilling muds but these effects would be of low intensity, localized to regional in extent, temporary in duration, and affect subsistence resources that are common to unique in context. This contribution to habitat change would be negligible when compared to the potential for dramatic sea ice loss due to climate change and changes in ecosystems and resource abundance due to ocean acidification. The exploration activities authorized under Alternative 6 would therefore have a minor to moderate contribution to the cumulative effects on subsistence resources. Implementation of Alternative 6 would be considered beneficial to cumulative effects on subsistence resources.

The exploration activities authorized under Alternative 6 would occur at the same level as Alternative 4 but are considered beneficial to subsistence harvests and users as implementing new technologies that reduce the levels of noise into the marine environment could reduce the potential for disturbance to marine mammal subsistence resources. The exploration activities authorized under Alternative 6 would have a minor to moderate contribution to the cumulative effects on subsistence resources. Implementation of Alternative 6 would be considered beneficial to cumulative effects on subsistence resources.

4.11.8.14.5 Conclusion

Under Alternative 6, the direct and indirect effects to subsistence resources are considered low in intensity, temporary in duration, local in extent and affect subsistence resources that range from common to unique in context. Implementation of Alternative 6 would be a beneficial contribution to cumulative effects on subsistence resources as it would implement new technologies that would reduce the potential for disturbance to marine mammal subsistence resources. The contribution of the direct and indirect impacts in consideration of the past, present, and reasonably foreseeable future actions would be negligible to moderate on subsistence.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with subsistence resources were discussed under Alternative 2 (Section 4.11.4.14).

4.11.8.15 Public Health

4.11.8.15.1 Summary of Direct and Indirect Effects

As described in Section 4.9.3.3, anticipated direct and indirect effects on public health and safety as a result of Alternative 6 are expected to be similar to those expected under Alternative 4. Alternative 6 includes requirements for the use of alternative technologies. However, as discussed in Section 4.9.3.3, the effectiveness of these alternative technologies in reducing adverse impacts to subsistence uses is at present unknown, and thus the benefits of the additional measures are theoretical. Therefore, these additional mitigations do not affect the overall impact criteria rating for public health for Alternative 6. If, however, the alternative technologies are demonstrated to be effective and feasible to implement, there is the possibility that additional benefit to public health may accrue.

4.18.8.15.2 Past and Present Actions

The effects of past and present actions on public health and safety are the same as those described in Section 4.11.4.15.

4.11.8.15.3 Reasonably Foreseeable Future Actions

The effects of reasonably foreseeable future actions on public health and safety are the same as those described in Section 4.11.4.15.

4.11.8.15.4 Contribution of Alternative to Cumulative Effects

The contribution of Alternative 6 to cumulative effects on public health and safety are the same as those for Alternative 2, described in Section 4.11.4.15.

4.11.8.15.5 Conclusion

Similar to the contribution of Alternative 2 described in Section 4.11.4.15, Alternative 6 contributes to cumulative impacts on public health and safety via the relatively small contribution of the direct and indirect impacts.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with public health and safety were discussed under Alternative 2 (Section 4.11.4.15).

4.11.8.16 Cultural Resources

4.11.8.16.1 Summary of Direct and Indirect Effects

Activity levels in Alternative 6 are the same as in Alternative 4, and this alternative includes mitigation measures that focus on alternative technologies for seismic exploration. These mitigation measures do not affect cultural resources in the EIS project area, so the impacts discussed for Alternatives 2 and 3 are the same for Alternative 6 and the overall impact to cultural resources would be minor.

4.11.8.16.2 Past and Present Actions

Past and present actions affecting cultural resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.16.

4.11.8.16.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting cultural resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.16.

4.11.8.16.4 Contribution of Alternative to Cumulative Effects

The contribution of this alternative to cumulative effects is the same as described under Alternative 2.

4.11.8.16.5 Conclusion

The incremental contribution of activities associated with Alternative 6 to cumulative effects on cultural resources would be negligible.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with cultural resources were discussed under Alternative 2 (Section 4.11.4.16).

4.11.8.17 Land and Water Ownership, Use, and Management

4.11.8.17.1 Summary of Direct and Indirect Effects

As discussed in Section 4.9.3.5, the direct and indirect impacts on land and water ownership would be low magnitude, temporary duration, local extent, and common in context. The direct and indirect impacts on land and water use would have a high magnitude, be temporary in duration, local and common. The direct and indirect impacts to land and water management would be low intensity, temporary in nature, local, and common. In summary, the impacts of Alternative 6 on land and water ownership, use, and management would be negligible, moderate, and minor, respectively.

4.11.8.17.2 Past and Present Actions

Past and present actions affecting land and water ownership, use, and management within the EIS project area are discussed under Alternative 2, Section 4.11.4.17.

4.11.8.17.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting land and water ownership, use, and management within the EIS project area are discussed under Alternative 2, Section 4.11.4.17.

4.11.8.17.4 Contribution of Alternative to Cumulative Effects

Alternative 6 is the same as Alternative 4 except with use of alternative technologies. The cumulative effects discussed in Section 4.11.6.17 for Alternative 4 are applicable for this alternative. The conclusions for Alternative 4 are applicable to Alternative 6; the contribution of Alternative 6 to cumulative effects to land and water ownership, use, and management would be negligible, moderate, and minor, respectively.

4.11.8.17.5 Conclusion

Under Alternative 6, the levels of direct, indirect and cumulative impact for land and water ownership, use, and management are negligible, moderate, and minor, respectively. Based on this, the overall level of impact of Alternative 6 is considered minor.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with land and water ownership, use, and management were discussed under Alternative 2 (Section 4.11.4.17).

4.11.8.18 Transportation

4.11.8.18.1 Summary of Direct and Indirect Effects

Direct and indirect impacts on regional transportation systems and existing infrastructure would be expected to be the same as those discussed under Alternative 4 as discussed in Section 4.7.3.2. Alternative technologies are likely to use the same types of transportation equipment and infrastructure at the same levels as that currently used for seismic surveys, on-ice surveys and exploratory drilling as Alternatives 2, 3, 4, and 5.

4.11.8.18.2 Past and Present Actions

Past and present actions affecting transportation within the EIS project area are discussed under Alternative 2, Section 4.11.4.18.

4.11.8.18.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting transportation within the EIS project area are discussed under Alternative 2, Section 4.11.4.18.

4.11.8.18.4 Contribution of Alternative to Cumulative Effects

The contribution of impacts from Alternative 6 would be similar as those described for Alternative 4 in Section 4.11.6.18.

4.11.8.18.5 Conclusion

In summary, no concerns related to adverse cumulative impacts have been identified. Some cumulative impacts may exist if Alternative 6 overlaps with another large-scale development project but those impacts would be of low intensity, temporary in duration affecting local areas of common resources and are considered unlikely to have long-term impacts on regional transportation infrastructure.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with transportation were discussed under Alternative 2 (Section 4.11.4.18).

4.11.8.19 Recreation and Tourism

4.11.8.19.1 Summary of Direct and Indirect Effects

The direct impacts would be low intensity, temporary duration, local extent, and common in context. Indirect impacts would be the same levels as direct impacts, except that the geographic area would be broader, extending beyond the region to a state-wide level and potentially beyond. In summary, the impact of Alternative 6 on recreation and tourism would be minor.

4.11.8.19.2 Past and Present Actions

Past and present actions affecting recreation and tourism within the EIS project area are discussed under Alternative 2, Section 4.11.4.19.

4.11.8.19.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting recreation and tourism within the EIS project area are discussed under Alternative 2, Section 4.11.4.19.

4.11.8.19.4 Contribution of Alternative to Cumulative Effects

Activity levels in Alternative 6 are the same as in Alternative 4, and this alternative includes mitigation measures for that focus on alternative technologies for seismic exploration. These mitigation measures do not affect recreation or tourism in the EIS project area, so the cumulative effects discussed in Sections 4.11.4.19 and 4.11.5.19 for Alternatives 2 and 3 are the same for Alternative 6; the overall impact to recreation and tourism would be minor.

4.11.8.19.5 Conclusion

Alternative 6 would have a minor contribution to cumulative effects on recreation and tourism.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with recreation and tourism were discussed under Alternative 2 (Section 4.11.4.19).

4.11.8.20 Visual Resources

4.11.8.20.1 Summary of Direct and Indirect Effects

Direct and indirect effects of past and present actions are identical to those described in Section 4.11.6.20, Alternative 4.

4.11.8.20.2 Past and Present Actions

Past and present actions affecting visual resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.20.

4.11.8.20.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting visual resources within the EIS project area are discussed under Alternative 2, Section 4.11.4.20.

4.11.8.20.4 Contribution of Alternative to Cumulative Effects

The contribution of Alternative 6 to cumulative effects would be identical to that described in Section 4.11.6.20, Alternative 4.

4.11.8.20.5 Conclusion

Under Alternative 6, anticipated cumulative effects to visual resources are expected to be major. Impacts would be of high intensity, long-term in duration, regional in geographic extent and occurring in an important context.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with visual resources were discussed under Alternative 2 (Section 4.11.4.20).

4.11.8.21 Environmental Justice

4.11.8.21.1 Summary of Direct and Indirect Effects

Direct and indirect effects to subsistence and public health associated with Alternative 6 would be minor, similar to those described for Alternative 2. Alternative technologies may reduce the likelihood of disturbance to marine mammals which in turn could reduce detrimental impacts to subsistence users. However, the effectiveness of these alternative technologies in reducing adverse impacts to subsistence users is unknown and therefore the benefits of these technologies to lessen impacts to subsistence and public health are theoretical and do affect the overall impact criteria rating.

4.11.8.21.2 Past and Present Actions

Past and present actions affecting environmental justice within the EIS project area are discussed under Alternative 2, Section 4.11.4.21.

4.11.8.21.3 Reasonably Foreseeable Future Actions

Reasonably foreseeable future actions affecting environmental justice within the EIS project area are discussed under Alternative 2, Section 4.11.4.21.

4.11.8.21.4 Contribution of Alternative to Cumulative Effects

The incremental contribution of Alternative 6 to the overall industrial activity in the area would be similar that that described for Alternative 2. Therefore, the contribution of Alternative 6 to environmental justice indicator cumulative effects would be minor.

4.11.8.21.5 Conclusion

The direct and indirect effects of Alternative 6 would be minor. The contribution to the cumulative effect of environmental justice indicators would be minor. Therefore, there would be a disproportionate impact to Alaska Native communities in the EIS project area.

The additive effects resulting from a VLOS in the Beaufort or Chukchi seas associated with environmental justice were discussed under Alternative 2 (Section 4.11.4.21). A VLOS would have disproportionate adverse impacts to Alaska Natives living in the communities near the EIS project area.

4.12 Relationship Between Short-term Uses of the Environment and the Maintenance and Enhancement of Long-term Productivity

This section addresses this subject from a broad perspective incorporating the information and conclusions from detailed analysis provided in previous sections of the EIS (Sections 4.4-4.10). No construction activities are associated with the Proposed Action; therefore, short-term uses of the environment would primarily relate to seismic surveys and exploratory drilling operations. Short- and long-term commitments of labor and capital and the use of non-renewable materials for power and maintenance would be employed to achieve the short-term goal of discovering oil and gas resources and the long-term goal of developing oil and gas resources in the Beaufort and Chukchi seas.

Bowhead whales may be temporarily affected by noise from seismic surveys, exploratory drilling, vessel and aircraft traffic, and small oil spills on a short-term basis. Minor to moderate impacts are expected to occur to bowhead and beluga whales under the action alternatives. Polar bears could experience minor impacts through disturbance from vessel and aircraft traffic, ice breaking and an on-ice seismic survey in the Beaufort Sea. Steller's eiders and spectacled eiders may be negatively impacted by frequent vessel and aircraft disturbance and collisions with vessels and aircrafts, especially during molting. The impact to Steller's eiders and spectacled eiders are considered minor.

Short- and long-term effects on Iñupiat subsistence-harvest activities could be considered disproportionately adverse if seismic survey and exploratory drilling operations are not sufficiently mitigated. No unmitigable adverse impacts are expected to occur to subsistence resources and harvest. Short-term effects of seismic survey and exploratory drilling operations to social systems, cultural values, and institutional organization are not expected to have long-term adverse consequences. Archaeological resources finds discovered as a result of the seismic surveys could enhance long-term knowledge. Such finds could help fill gaps in knowledge of the history and early inhabitants of the area; but any destruction of archaeological sites or unauthorized removal of artifacts would represent long-term losses.

With respect to the short-term uses of the environment and the maintenance and enhancement of long-term productivity, the following could be expected to occur to the economy: federal revenues on offshore lease areas could increase; local and state employment could increase; and personal income could be generated.

In conclusion, the environmental effects of the proposed action alternatives would be temporary in nature and would have no adverse long-term impacts on the long-term productivity of the Beaufort and Chukchi seas, if properly mitigated as proposed. No losses of marine habitats are expected to occur from seismic survey activities. However, the quality of marine habitat surrounding seismic survey activities could be adversely affected in the short-term as airguns are fired to ensonify the area. Other noises originating from exploratory drilling operations (e.g. drilling, vessel traffic, the operation of ship-board equipment, and aircraft traffic) would also cause a temporary degradation of the marine environment, especially for marine mammals, marine birds, and fish unless mitigated as proposed. The benefits offered to the Nation by the long-term productivity of the Proposed Action are expected to offset the short-term use of the environment, if properly mitigated as proposed.

4.13 Irreversible and Irretrievable Commitments of Resources

This section describes the irreversible and irretrievable commitments of resources associated with implementing the alternatives of the Proposed Action. Irreversible and irretrievable commitment of resources refers to impacts or losses to resources that cannot be reversed or recovered. Resources include renewable and nonrenewable natural and mineral resources, including fish and wildlife habitat.

A commitment of resources is irreversible when a proposed action impacts limit the future options for a resource or cannot be reversed, except perhaps in the extreme long-term. It applies primarily to the effects of use of nonrenewable resources, which are those resources that cannot be replenished by natural means, such as oil, natural gas, iron ore, and cultural resources. An irretrievable commitment refers to the use or consumption of a resource that is neither renewable nor recoverable for use by future generations or is lost for a period of time. It applies to the loss of productivity, harvest, or use of natural resources.

No resources would be irreversibly and irretrievably committed (i.e. affected) by construction activities because none of the action alternatives have construction activities associated with them. Any irreversible and irretrievable commitments of resources would be limited to the implementation of seismic survey activities and exploratory drilling operations.

Irreversible and irretrievable nonrenewable resources committed for use by seismic survey vessels, support vessels, and support aircraft include any seismic survey or exploratory drilling equipment that could not be recovered or recycled, diesel fuel, gasoline, aviation fuel, lubricating oil, and drilling mud. The Proposed Action would also require a commitment of human and financial resources (time and labor). Water is the only renewable natural resource used to implement the alternatives. Water would be used on the seismic survey vessels, drilling rigs, and support vessels for cooking, drinking, and processing human wastes.

Any irretrievable or irreversible commitment of resources important to the long-term survival and recovery of threatened or endangered species would violate the Endangered Species Act and the Marine Mammal Protection Act, unless such commitment was made to help protect and aid in its conservation and recovery. Under certain circumstances bowhead whales, polar bears, Steller's eider, and spectacled eiders could be subjected to temporary non-lethal effects of disturbance due to noise from seismic survey activities, vessel and aircraft traffic and from small petroleum spills. It is unlikely that such effects could lead to permanent (irreversible) losses of these resources, particularly for the bowhead whale population, as their population is increasing.

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5.0 IMPLEMENTATION, MONITORING AND REPORTING, AND ADAPTIVE MANAGEMENT

The purpose of Chapter 5 is to describe certain procedures that are used to ensure NEPA and MMPA compliance for the issuance of G&G permits and authorizing ancillary activities by BOEM and MMPA ITAs by NMFS for Arctic oil and gas exploration activities. Specifically, this chapter describes and analyzes several issues:

(1) How the EIS will be used to support NMFS's and BOEM's NEPA compliance;

(2) How the MMPA has been implemented by NMFS in recent years for Arctic oil and gas activities and how it could be implemented in the future;

(3) The purposes, goals, and objectives of monitoring and reporting under the MMPA;

(4) Tools for mitigating impacts on the availability of marine mammals for subsistence uses; and

(5) Recommendations for adaptive management.

5.1 EIS Implementation and NEPA Compliance

5.1.1 Need for NEPA Compliance

NEPA was passed by Congress in 1969 and signed into law on January 1, 1970. Its primary focus is to ensure the incorporation of environmental planning into all major federal actions so that "environmental amenities and values may be given appropriate consideration in decision-making along with economic and technical considerations" (Sec. 102 [42 USC 4332] (b)). NEPA mandates that federal agencies prepare a detailed statement of the effects of "major Federal actions significantly affecting the quality of the human environment."

The CEQ is responsible for the development and oversight of regulations and procedures implementing NEPA. The CEQ regulations provide guidance for federal agencies regarding NEPA's requirements (40 CFR Part 1500). Federal agencies are required to produce their own regulations and guidance regarding NEPA implementation. U.S. Department of the Interior's (USDOI) NEPA procedures regulations are codified at 43 CFR Parts 46.10 to 46.450 and can be found at http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&tpl=/ecfrbrowse/Title43/43cfr46_main_02.tpl or http://www.doi.gov/oepc/nepafr.html. The BOEM NEPA procedures can be found in the USDOI Department Manual at http://elips.doi.gov/app_dm/index.cfm?fuseaction=home. The NOAA NEPA NAO 216-6 provides guidance on environmental review procedures for implementing NEPA. NAO 216-6 can be found at http://www.corporateservices.noaa.gov/ames/administrative_orders/chapter_216/216-6.html.

NMFS and BOEM staff, permit applicants, stakeholders, and the general public should understand how NMFS and BOEM will meet their obligations under NEPA. This EIS addresses Arctic oil and gas exploration activities (i.e. seismic surveys, site clearance and shallow hazards surveys, and exploratory drilling) that may occur. This EIS will inform BOEM decisions on specific G&G permit applications and ancillary activity surveys (i.e., not including drilling). This EIS will inform NMFS decisions on specific MMPA ITA requests related to G&G surveys, ancillary activity surveys, and exploratory drilling programs. BOEM will complete site-specific NEPA evaluation of proposed exploration drilling, incorporating the analyses in this EIS by reference, as appropriate.

5.1.2 NMFS NEPA Compliance

The Effects of Oil and Gas Activities in the Arctic Ocean Final EIS will cover oil and gas industry exploration activities that may impact the human environment in general, but it is not specific to the request for or issuance of any particular ITA. Thus, each project-specific authorization application will require its own NEPA compliance review. The form of this additional NEPA review will depend on the nature and scope of the proposed activity and may take the form of a Memorandum to the File, an EA, a supplemental EIS, or a new EIS.

In the future, NMFS anticipates receipt of applications to take marine mammals incidental to oil and gas industry exploration activities in both state and federal waters (i.e. G&G and ancillary surveys and exploratory drilling) pursuant to Sections 101(a)(5)(A) and (D) of the MMPA. There is no formal schedule for submission of ITA applications; however, Section 101(a)(5)(D) places a 120-day limit on the processing of an Incidental Harassment Authorization request. Therefore, requests can be submitted throughout the calendar year, meaning that the schedule is initiated and driven by the applicants. Each time an application is received, the request will be reviewed by NMFS to determine whether the proposed activity and its anticipated effects fall within the scope of the Effects of Oil and Gas Activities in the Arctic Ocean Final EIS.

The Effects of Oil and Gas Activities in the Arctic Ocean Final EIS will identify the Preferred Alternative, including an analysis of potential environmental consequences and mitigation measures. The ROD associated with the EIS will identify any conditions of approval that are relevant to Arctic oil and gas industry exploration authorization requests and will provide a listing of activities addressed by the Preferred Alternative. Proposed oil and gas exploration activities that are identified and analyzed within the Preferred Alternative will be reviewed to determine whether the proposed action and its anticipated effects fall within the scope of the Effects of Oil and Gas Activities in the Arctic Ocean Final EIS (see description of NMFS's NEPA compliance process below). Proposed oil and gas activities that are not identified and analyzed within the Preferred Alternative will undergo their own NEPA review, to be determined at the time the application is submitted.

New requests for the take of marine mammals incidental to seismic surveys, site clearance and shallow hazards surveys, and exploratory drilling activities will be reviewed by NMFS Permits and Conservation Division, Office of Protected Resources. NMFS will:

- Review the proposed ITA application to determine if the activities proposed by the applicant and the anticipated effects fall within the scope of the Preferred Alternative identified in the Effects of Oil and Gas Activities in the Arctic Ocean Final EIS. NMFS staff will conduct an internal review to determine whether or not the application falls within the scope of the Preferred Alternative.
- If NMFS determines the activities proposed by the applicant and the anticipated effects fall within the scope of the Preferred Alternative in the Effects of Oil and Gas Activities in the Arctic Ocean Final EIS, NMFS could develop a Memorandum to the File. The Memorandum would include a description of the proposed action, the anticipated effects, and include a discussion of the agency's rationale as to whether the proposed action and its anticipated effects are covered by the Effects of Oil and Gas Activities in the Arctic Ocean Final EIS. NMFS may, as appropriate, include any conditions of approval that apply as documented in the ROD.

If NMFS determines through the above process that the proposed activities were not analyzed within the Preferred Alternative, an additional NEPA compliance review (such as an Environmental Assessment) would be conducted. The NOAA NEPA Handbook and NAO 216-6 provide guidance for agency officials on this step of NEPA review, including the process for tiering analyses from a general or broad-scope EIS to a project-specific review, and incorporating by reference.

The EIS will also assist NMFS in carrying out other statutory responsibilities (e.g. assessing environmental impacts on listed species under the ESA [Section 7 consultation] and effects of the proposed action on EFH under the MSFCMA) and serve to support future decisions relating to the agency's role in authorizing the take of marine mammals incidental to deep penetration geophysical surveys, shallow hazards surveys, and exploratory drilling activities, as NMFS is required to ensure compliance with all applicable statutes when issuing an MMPA ITA.

Alternative 6 of this EIS analyzes the use of alternative technologies that could potentially augment or replace the use of airguns in traditional seismic surveys at some point in the future. Because the majority of these technologies have not yet been built and/or tested, it is difficult to fully analyze the level of impacts from these devices in this EIS. Additionally, the amount of reduction in impacts is dependent upon how many traditional seismic surveys (i.e. use of airgun arrays) can potentially be replaced or augmented by these alternative technologies, which is unknown at this time. This EIS examines a projected use of alternative technologies, but the actual amount that might be used during the timeframe of this EIS is not fully known at this time. Therefore, NMFS has determined that additional NEPA analyses would likely be required if applications are received requesting to use these technologies during seismic surveys. As described above, NMFS would review the application request to determine how much of the request is already described and analyzed by the Preferred Alternative and ROD. Because of the lack of details on these technologies, it is unlikely that a Memorandum to the File would be sufficient. Therefore, NMFS would likely tier from this EIS and prepare a supplemental NEPA document, incorporating key sections of this EIS by reference as appropriate and where relevant.

5.1.3 BOEM NEPA Compliance

BOEM anticipates receipt of applications to conduct exploration seismic surveys pursuant to the OCS Lands Act. 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, which states that a notice must be submitted before conducting G&G data collection pursuant to a lease issued or maintained under the OCS Lands Act (30 CFR Part 550.208). BOEM will conduct site-specific NEPA reviews for G&G permit applications and proposed ancillary surveys. 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 Final EIS. The form of additional NEPA review will depend on the nature and scope of the proposed activity and may take the form of a Determination on NEPA Adequacy, a Categorical Exclusion Review, or an EA, a supplemental EIS, or a new EIS that tier from this EIS and incorporate information and analyses in this EIS by reference (see 40 CFR Part 1506.2). While this EIS is not being used by BOEM to analyze the approval of exploration drilling plans or by the Bureau of Safety and Environmental Enforcement (BSEE) for approval of applications for permits to drill, BOEM plans to incorporate by reference the content of this EIS into future site-specific NEPA and other environmental analyses for exploratory drilling, as appropriate. BOEM performs a site-specific NEPA compliance review (typically an EA) for exploratory drilling activities for each Exploration Plan to issue permits for on-lease exploration operations.

This EIS will also assist BOEM in carrying out other statutory responsibilities related to the issuance of G&G permits and ancillary activity notices, as discussed in Section 1.1 of this document. In accordance with applicable law and the need to conduct various consultations and analyses before issuing such permits, BOEM will coordinate closely with BSEE, NMFS, and the USFWS to verify compliance with the ESA, MSFCMA, NHPA, and, MMPA requirements. BOEM has the authority to modify permit conditions or lease operations, if necessary, to ensure OCS activities meet the requirements of the ESA or MMPA or other authorization.

5.2 MMPA Implementation and Compliance History and Process

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.

ITAs may be issued as either (1) regulations and associated LOAs or (2) IHAs. NMFS's implementing regulations state that 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. IHAs cannot be valid for more than 12 consecutive months, whereas LOAs can be valid for up to five consecutive years. The Secretary of Commerce is required to authorize the take of small numbers of marine mammals incidental to a specified activity if the taking would have no more than a "negligible impact" on marine mammal species or stocks and not have an "unmitigable adverse impact" on the availability of such species or stocks for taking for subsistence uses.

Since 2006, NMFS has issued IHAs to various oil and gas industry or seismic operators for the take of marine mammals incidental to conducting seismic and site clearance and shallow hazards survey programs both on-ice and in open-water in the U.S. Beaufort and Chukchi seas. Between 2006 and 2012, NMFS issued 15 IHAs for open-water seismic and site clearance and shallow hazards survey programs and four IHAs for on-ice seismic surveys. NMFS also issued one IHA for the take of marine mammals incidental to an exploratory drilling program in the Beaufort Sea in 2007; however, the program was enjoined by a federal court. In 2012, NMFS issued two IHAs for exploratory drilling programs in the U.S. Arctic Ocean. However, only limited operations were conducted, with no drilling into hydrocarbon bearing zones. Starting in 2000, NMFS also issued several sets of five-year regulations and subsequent LOAs to BP for the take of marine mammals incidental to the construction and operation of its Northstar development and production facility in the Beaufort Sea. However, this type of production drilling activity is not covered by this EIS.

NMFS has explored the possibility of issuing regulations and associated LOAs to companies for oil and gas exploration activities in the Arctic. Doing so would provide some administrative streamlining. However, to date, regulations and LOAs have not been requested in the Arctic for oil and gas exploration activities. Because NMFS has determined in the past that the activities would not result in serious injury or mortality (or such impacts were negated through mitigation measures), NMFS has not required that applicants request regulations instead of IHAs. While past practice has been to issue IHAs for exploration activities instead of regulations and associated LOAs, NMFS could issue regulations and LOAs in the future. Therefore, through this EIS, NMFS is considering issuing either type of ITA (i.e. IHAs or LOAs) for oil and gas exploration activities in the Arctic.

5.3 Monitoring and Reporting

5.3.1 Purposes, Goals, and Objectives of MMPA Monitoring and Reporting Plans

The MMPA mandates that an authorization issued for the incidental take of marine mammals include requirements pertaining to the monitoring and reporting of the taking. The MMPA implementing regulations (50 CFR Part 216.104(a)(13)) further define the information that an applicant must provide when requesting an ITA, including the means of accomplishing monitoring and reporting that will result in increased knowledge of the species and the level of taking or impacts on populations of marine mammals that are expected to be present while conducting activities. The regulations further suggest that monitoring plans should include a description of the survey techniques that would be used to determine the movement and activity of marine mammals near the activity site(s), including migration and other habitat uses, such as feeding.

NMFS has developed more detailed guidance for applicants and analysts that further specifies the type of monitoring that can be used to comply with the broad goals outlined in the MMPA and its implementing regulations. Monitoring measures developed to comply with, and prescribed in, MMPA authorizations 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, e.g., 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) A better understanding and record of the manner in which the authorized entity complies with the incidental take authorization and incidental take statement.

(i) 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.

Proposed Monitoring Plans are evaluated in the context of NMFS's implementing regulations and the above guidance, with consideration of the likelihood of effectively answering the questions that they have been designed to answer (e.g. what is the density of beluga whales in a given area; how do bowhead whales respond to drilling sounds at 160, 140, and 120 dB; how effective are forward looking infrared devices at detecting seals on the ice at night, etc.), given the proven success of the proposed methods in the past, as well as the proposed amount of effort. Efforts should be made to target questions that have been identified as priorities (i.e. to fill data gaps). Additionally, as described in Section 5.3.2 below, in the specific case of any activity that may affect the availability of marine mammals for subsistence uses and for which an IHA or LOA has been requested, MMPA implementing regulations require that monitoring plans or other research proposals undergo an independent peer review.

5.3.2 Monitoring Plan Peer Reviews

Prior to issuing an ITA for an activity that would occur in Arctic waters (i.e. north of 60º North latitude), and that may affect the availability of a species or stock for taking for subsistence purposes, the applicant's monitoring plan must be independently peer reviewed. The MMPA requires that in considering an application for an IHA, monitoring plans be independently peer reviewed "where the proposed activity may affect the availability of a species or stock for taking for subsistence uses" (16 U.S.C. 1371(a)(5)(D)(ii)(III)). Regarding this requirement, NMFS's implementing regulations state, "Upon receipt of a complete monitoring plan, and at its discretion, [NMFS] will either submit the plan to members of a peer review panel for review or within 60 days of receipt of the proposed monitoring plan, schedule a workshop to review the plan" (50 CFR § 216.108(d)). Although the MMPA only includes this requirement for IHAs, NMFS also requires independent peer review of monitoring plans as part of any petition for regulations and associated LOA(s) (50 CFR § 216.105(b)(3)).

As discussed in Section 5.3.1, an applicant's monitoring program should be designed to accomplish one or more of the following: document the effects of the activity on marine mammals; document or estimate the actual level of take as a result of the activity; increase the knowledge of the affected species; or increase knowledge of the anticipated impacts on marine mammal populations. Section 5.3.1 also discussed specific goals that should be accomplished by an applicant's monitoring program.

NMFS has hosted a one-to-two day Open Water Meeting each year since 1994. The purpose of these meetings is to bring together ITA applicants, subsistence hunters, agency scientists, and outside scientists with relevant expertise to review the design of industry monitoring plans for the upcoming open water season. Review of study results from the previous year's open water season is also undertaken. The inclusion of subsistence hunters in the review process ensures that both study designs and data interpretation are consistent with real-world observations of marine mammal behaviors and reactions to anthropogenic impacts. ITA applicants adjust their study designs and/or data interpretation techniques based on discussions in these meetings. In the early years, these meetings satisfied the requirement for an independent peer review via the workshop option described in the regulations.

Prior to 2006, the meetings were small with approximately 15 to 30 participants. The meetings from 2006 to 2012 drew approximately 150 to 250 participants each day of the two- to three-day meetings, thus making it difficult to achieve the focused and detailed reviews of the applicants' monitoring plans and reports provided in earlier meetings. Additional discussion about the Open Water Meeting is provided in Section 5.4.2.

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 stakeholder input meeting (discussed in Section 5.4.2), and one smaller meeting where a pre-selected group of scientists and affected subsistence hunters (who are available to answer questions and provide input) specifically gathers to review the proposed monitoring plans. In 2010, 2011, 2012, and 2013, after soliciting nominations from the industry ITA applicants, the Marine Mammal Commission, and the affected subsistence organizations, NMFS convened panels of approximately five 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 chapter. The panel members were asked to review the proposed monitoring plans, determine whether they were designed to accomplish their intended purpose - to document the effects of the activity on marine mammals, document or estimate the actual level of take as a result of the activity, increase the knowledge of the affected species, or increase knowledge of the anticipated impacts on marine mammal populations - and then make recommendations for how these goals could be better achieved. Panel members were provided the ITA applications and monitoring plans ahead of time in order to prepare for the discussions. Time was also set aside for the panel members to ask questions of the applicants in order to gain a better understanding of their proposal and what changes they may be able to implement. After the meetings, the panel members provided a final report to NMFS with their recommendations.

NMFS reviewed the final peer review panel report in the context of the applicants' activities and the requirements of the MMPA and selected recommendations that were appropriate for potential inclusion in the applicant's final monitoring plans. NMFS worked with the applicants regarding the feasibility of including these measures and protocols, and then included the selected measures as requirements in the issued ITAs.

This process is still developing, and some strengths and weaknesses have been identified. 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. However, panel members have 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 the 2012 peer review panel meeting. Therefore, NMFS will strive to provide additional time for interaction where feasible. 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.

5.3.3 Potential Improvements for Monitoring and Reporting Plans

As described above, applicants for MMPA authorizations are required to include proposed monitoring plans. In the past, through the Open Water Meetings, public comments on NEPA and MMPA documents, POC meetings, etc., a broad range of recommendations have been made regarding monitoring plans for oil and gas exploration activities. In the last few years, more focused input has been provided via the new peer review format described above. However, in the former example (i.e. Open Water Meeting, public comments, etc.) input has often been unfocused and too broad to be effectively incorporated into MMPA authorizations, and in the latter example (i.e. independent peer review) much of the input is related to modifications to what a given company has already specifically proposed. What is missing is focused prioritization of needs and guidance to applicants in advance of their development of their initial applications.

In 2010 and 2011, the independent peer reviewers included in their report (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.

In the interest of more comprehensive prioritization and planning of monitoring that could be required and implemented as part of MMPA ITAs, NMFS is considering the following:

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

Following are examples of some of the issues that have been identified as a priority for monitoring and reporting pursuant to MMPA ITAs for oil and gas exploration:

- Identification of presence, abundance, and distribution of multiple species in the winter months;
- Bowhead movement patterns following initial deflection from industry activities during fall migration;
- Development of a real-time monitoring approach that can adequately detect marine mammals during darkness or inclement weather;
- Results of impacts to marine mammals from oil and gas activities since 2006;
- Behavioral responses of bowheads, and other species, to acoustic exposure at specific levels (160 dB, 120 dB);
- Behavioral responses of bowhead cow-calf pairs to acoustic exposure at specific levels;
- Measurement of sound produced by icebreakers and the resulting impacts to marine mammals; and
- Industry information and data regarding their activities (e.g. specifically when and where a seismic or shallow hazards/site clearance survey was taking place and the times airguns or other devises were operating) and specific monitoring data not being publically available.

Building upon the existing public input tools, NMFS could develop an iterative and systematic annual means of identifying and prioritizing the monitoring goals for Arctic oil and gas exploration activities. These priorities could be available to potential applicants on the NMFS website along with specific methodology recommendations summarized from previous peer review recommendations. This would provide direction and guidance for applicants and allow for the most effective use of resources to answer the most pressing questions related to the effects of oil and gas exploration on marine mammals. NMFS intends to explore this way forward through public input on this EIS and at future Open Water Meetings.

5.3.4 BOEM Environmental Studies Program

The OCS Lands Act, as amended, established policy for the management of the OCS energy and mineral resources and for the protection of marine and coastal environments. Section 20 of the OCS Lands Act authorizes an Environmental Studies Program (ESP). The ESP aims to establish the information needed for assessment and management of environmental impacts on the human, marine, and coastal environments of the OCS and the potentially affected coastal areas, to predict impacts on the marine biota which may result from chronic, low level pollution or large spills associated with OCS production, from drilling fluids and cuttings discharges, pipeline emplacement, or onshore facilities, and to monitor human, marine, and coastal environments to provide time series and data trend information for identification of significant changes in the quality and productivity of these environments, and to identify the causes of these changes. Nationally, the applied research conducted through the ESP informs management decisions relating to OCS activities from the earliest stage of OCS planning through the final removal of the OCS structure at the end of its productive life.

The *Alaska Annual Studies Plan* complements and reinforces the goals of the ESP. The ESP is guided by several broad themes, which include:

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

To be prepared to make decisions arising from activities associated with current oil and gas leases and potential future leasing and changing offshore technologies, the Alaska OCS Region continually proposes new studies and pursues information needs in conjunction with ESP goals. Due to the great differences that exist between Alaska environments and other OCS areas, the Alaska ESP remains especially flexible in planning and implementing needed studies. At each step of the offshore leasing and development process, a variety of potential issues or resource-use conflicts may be encountered. Two questions are fundamental:

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

Environmental studies are the primary means to provide information on these questions for use by decision-makers. Currently, the Alaska ESP is primarily focused on upcoming developments, exploration activities and existing leases, and potential future lease sales in the Beaufort Sea and Chukchi Sea Planning Areas. Current offshore oil and gas-related issues addressed by ongoing and proposed studies in the Beaufort Sea and the Chukchi Sea include, but are not limited to:

- What refinements are there to our knowledge of major oceanographic and meteorological processes and how they influence the human, marine, and coastal environment?
- What role will currents play in distribution of anthropogenic pollutants near development prospects?
- What long-term changes in heavy metal and hydrocarbon levels may occur near Beaufort Sea development prospects, such as Liberty, or regionally along the Beaufort Sea coast?
- How do we improve our model predictions regarding the fate of potential oil spills?
- If oil is spilled in broken ice, what will its fate be?
- What effects might pipeline construction have on nearby marine communities or organisms?
- What changes might occur in sensitive benthic communities such as the Stefansson Sound “Boulder Patch” and other Beaufort Sea kelp communities or fish habitats?
- What are the current spatial and temporal use patterns of these planning areas by species that are potentially sensitive, such as bowhead whales, polar bears, ice seals, walrus, other marine mammals, seabirds and other birds, or fish?
- What is the extent of endangered whale feeding in future proposed or potential lease sale areas?

- What changes might occur in habitat use, distribution, abundance, movement or health of potentially sensitive key species such as bowhead whales, polar bears, ice seals, walrus, other marine mammals, seabirds and other birds, or fish?
- What interactions between human activities and the physical environment have affected potentially sensitive species?
- What changes might occur in socioeconomics and subsistence lifestyles of coastal Alaska communities?
- What are current patterns of subsistence harvest, distribution, and consumption and what changes might occur in key social indicators as a result of offshore exploration and development?
- How can we continue to integrate local and/or traditional knowledge into studies related to the Alaska ESP?

Further information on Alaska Region's ESP and Studies Plan can be found at the BOEM website http://www.boem.gov/Environmental-Stewardship/Environmental-Studies/Alaska-Region/Index.aspx.

5.4 Tools for Mitigating Impacts on Subsistence

As discussed in Section 2.3.4 of this EIS, 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 to thrive in conjunction with oil and gas exploration and development. Some of these processes are Federally-mandated while others have been voluntary between the industry and local communities. This section of the EIS discusses three of these tools in more detail: (1) POCs, which are required by NMFS's implementing regulations (50 CFR § 216.104(a)(12)); (2) Open Water Season CAAs, which are voluntary and not required by any statute or regulation; and (3) the annual Open Water Meeting. For each of these three tools, this section includes an examination and analysis of:

- what each one is and the purpose it has served;
- the process for developing and/or implementing the tool;
- the strengths and weaknesses of the tool; and
- how the tool can be modified or improved in order to aid NMFS in ensuring that the take of marine mammals incidental to oil and gas exploration activities has no unmitigable adverse impacts on the availability of marine mammals for subsistence uses.

5.4.1 Plan of Cooperation and Conflict Avoidance Agreement

In 1985, the Alaska Eskimo Whaling Commission (AEWC) and a number of arctic offshore oil and gas operators began working together to identify and mitigate sources of industrial interference with bowhead whale subsistence hunting. Recognizing the need to facilitate the co-existence of marine mammal subsistence uses and arctic offshore industrial activities, in 1986, Congress amended the MMPA to require that the issuance of ITAs rest on a Secretarial finding of "no unmitigable adverse impact to the availability" of marine mammal subsistence resources. The AEWC and offshore operators undertook an annual initiative to develop mitigation measures, which came to be known as the Open Water Season Conflict Avoidance Agreement (CAA) Process.

Regulations promulgated pursuant to the 1986 MMPA amendments, 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 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 will take to ensure that proposed activities will 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.

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 (which typically contained the components of a POC), then it was possible for a company to conduct their activity without having an unmitigable adverse impact on the subsistence hunt. However, in more recent years, some companies have become reluctant to sign a CAA with the AEWC. Additionally, some stakeholders have raised the issue that a CAA developed by the AEWC does not represent the interests of subsistence hunters of species other than bowhead whales. Last, NMFS and BOEM have no authority to require private agreements between third parties, and neither NMFS nor BOEM can enforce the provisions of CAAs because the federal government is not a party to the agreements. These concerns highlight NMFS' responsibility to conduct a rigorous and comprehensive independent analysis of the likely subsistence impacts and to specifically review the contents of each company's POC. However, the AEWC has raised concerns about the POCs, asserting that while the CAA process traditionally provided content for the regulatory POC process, the POC process as currently implemented by some companies takes place in a one-way fashion, i.e., the company develops a POC without meaningful input from the subsistence communities.

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

5.4.2 Open Water Meeting

As mentioned in Section 5.3.2, during the 1980s and early 1990s, the monitoring plan peer review and Open Water Meeting were the same meeting. However, as attendance at the Open Water Meeting began to grow exponentially beginning in 2006, the need to split these processes into two separate meetings became apparent. The Open Water Meeting now refers to the open access stakeholder meeting (not the monitoring plan review) that is important to ensure NMFS' understanding, from the affected parties, of the effects of industry activity on the subsistence uses of marine mammals.

Since 2006, the Open Water Meeting has attracted members of industry, Federal, state, and local government officials and scientists, Native Alaskan marine mammal commissions, affected Native Alaskan hunters and community members, environmental non-governmental organizations, and other interested members of the public. Typically, each year, the industry presents 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, etc.) present information related to impacts that industry activities may have had (either in the past year or historically) on their ability to effectively hunt a given species. There have also been presentations regarding ongoing western and traditional science programs conducted in the region. Many of these science programs are designed to gain knowledge about the physical and chemical properties of the ecosystem and distribution and abundance trend patterns of marine mammals and other species in the area.

Unlike the monitoring plan peer review, 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 the take of marine mammals resulting from a specific activity will likely have an unmitigable adverse impact on subsistence uses, NMFS has continued to organize this annual meeting. The Open Water Meeting allows the public to provide input on industry proposals while the Federal agencies ultimately responsible for authorizing the activity itself and the incidental take of marine mammals can listen to those comments and participate in the interaction.

5.5 Adaptive Management

A simple definition of adaptive management is "a systematic process for continually improving management policies and practices by learning from the outcomes of operational programs" (Holling, 1978). The process basically involves the following steps: predict, mitigate, implement, monitor, and adapt.

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 needed 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 during the annual Open Water Meetings;

(3) Scientific input from the independent peer review;

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

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

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

(7) Results from the efforts of the NOAA Working Groups 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. 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.

In the past few years, NMFS, BOEM, and USFWS reviewed operational and marine mammal observer reports at weekly environmental/regulatory compliance review meetings related to Arctic OCS activities during the open water season. The purpose of the meetings was to verify environmental/regulatory compliance by the operators during the activity and to determine whether federal decisions on monitoring, mitigation, and reporting were achieving the intended results. If the intended results were not being achieved, the agencies could modify the requirements for ongoing operations, as needed.

NMFS and BOEM intend to continue the review meetings, during OCS activities, with USFWS and BSEE. BSEE has the responsibility to verify that required environmental monitoring, mitigation, and reporting protocols (i.e. for protected species) are implemented during seismic surveying and drilling activities on the OCS. BSEE has the authority to enforce compliance with environmental requirements on all drilling operations. BOEM continues as the regulatory authority for G&G activities.

BOEM and BSEE will also conduct post-activity reviews. The reviews will be used to:

- document environmental compliance;
- determine whether reporting requirements provide sufficient information on operations and their effects;
- evaluate monitoring and mitigation effectiveness;
- improve site-specific monitoring and mitigation requirements, if needed; and
- support the incorporation of compliance, mitigation, and monitoring efforts into future programmatic and site-specific environmental analyses.

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6.0 CONSULTATION AND COORDINATION

6.1 Development of the EIS

The Notice of Intent (NOI) to prepare an EIS was published in the *Federal Register* on February 8, 2010 (75 FR 6175). The scoping period, during which issues and concerns are identified, was initiated February 8, 2010. This provided an opportunity for the oil industry, government organizations, tribal and local governments, environmental groups, the general public, and all other interested parties to comment on areas of interest or special concern regarding this EIS. The NOI also requested stakeholders to identify and provide information that should be considered by NMFS in preparation of the EIS. Scoping comments were received through April 9, 2010 as specified in the NOI and were used to identify issues of concern and develop the alternatives for this EIS. The scoping report summarizing the scoping comments and issues of concern is posted on the NMFS website at:

http://www.nmfs.noaa.gov/pr/permits/eis/arctic.htm.

On January 30, 2013, NMFS published an NOI to prepare a Supplemental DEIS (78 FR 6303). The public was afforded 60 days to provide comments on the DEIS, which went out for public comment on December 30, 2011 (76 FR 82275). The comment letters received during the DEIS public comment period, as well as the transcripts of the public meetings, can be found at the above mentioned website.

NMFS is the lead agency for this EIS and is responsible for the development of the EIS in collaboration with the cooperating agencies. BOEM and the NSB are participating as cooperating agencies. The EPA is participating as a consulting agency. NMFS is also working with the AEWC on the development of this EIS per our co-management agreement.

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 and the public comment period for the DEIS, 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 at the scoping stage 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

All of the above mentioned groups were also notified at the DEIS public comment stage, and the Native Village of Kivalina was also contacted at that time.

6.2 Consultation

Section 7(a)(2) of the ESA requires each federal agency to ensure that any action that it authorizes, funds, or carries out is not likely to jeopardize the continued existence of a listed species or result in the adverse modification of designated critical habitat. To satisfy its ESA obligations, NMFS will engage in the consultation and coordination processes with other regulatory agencies at the MMPA stage, and BOEM and BSEE will fulfill this requirement at the time of activity review.

6.3 Agencies and Organizations Contacted

The following are lists of the federal, state, Tribal and local government agencies; academic institutions; members of the oil and gas industry; special interest groups; and other organizations who were notified of the availability of the Supplemental DEIS.

Federal – Executive Branch	
Department of Commerce	National Marine Fisheries Service; Bowhead Whale Project, Alaska Regional Office, Anchorage National Oceanic and Atmospheric Administration; Policy and Strategic Planning, Information Services Division Office of the Assistant Secretary for Oceans and Atmosphere
Department of Defense	U.S. Army Corps of Engineers; Regulatory Branch, Alaska District U.S. Navy; NEPA Natural Resources
Department of Homeland Security	U.S. Coast Guard
Department of the Interior	Bureau of Indian Affairs; West Central Alaska Field Office Bureau of Land Management; State Director, Northern Field Office, Fairbanks National Park Service; Regional Director, Subsistence Division Office of Environmental Policy and Compliance Special Assistant to the Secretary for Alaskan Affairs U.S. Fish and Wildlife Service; Regional Office, Migratory Bird Management, Subsistence and Fisheries, Anchorage Ecological Services U.S. Geological Survey; Biological Resources Division
Federal – Legislative Branch	
U.S. House of Representatives	Congressman Don Young
U.S. Senate	Senator Mark Begich Senator Lisa Murkowski
Federal – Administrative Agencies and Other Agencies	
	Arctic Research Commission Marine Mammal Commission Environmental Protection Agency; Office of Federal Activities, Region 10, NPDES Permit Unit, Alaska Operations Office, Anchorage

<table>
<tr><th colspan="2">State of Alaska</th></tr>
<tr><td>Alaska Oil and Gas Conservation Commission
Department of Community and Regional Affairs
Department of Environmental Conservation
• Anchorage District Office
• Northern Alaska District Office
Department of Fish and Game
• Region II, H&R
• Subsistence Division
Department of Natural Resources
• Citizen’s Advisory Commission on Federal Areas</td><td>Department of Natural Resources (continued)
• Division of Geological and Geophysical Surveys
• Division of Oil and Gas
• Division of Water, Fairbanks
• Office of Project Management and Permitting
Department of Transportation and Public Facilities
• Joint Pipeline Office
• State Pipeline Coordinator
Office of the Governor
• Governor Sean Parnell
State of Alaska Washington, DC Representative</td></tr>
<tr><th colspan="2">Tribal and Local Governments – Alaska Native Organizations</th></tr>
<tr><td>Alaska Beluga Whale Commission
Alaska Eskimo Walrus Commission, Barrow
Alaska Eskimo Walrus Commission, Nome
Alaska Eskimo Whaling Commission
Alaska Federation of Natives
Alaska Inter-Tribal Council
Alaska Nanuuq Commission
Alaska Native Science Commission
Arctic Slope Native Association
Arctic Slope Regional Corporation
Barrow Whaling Captains Association
City of Barrow, Mayor
City of Kaktovik, Mayor
City of Kotzebue, Planning Division
City of Nome, City Manager
City of Nuiqsut, Mayor
City of Point Hope, Mayor
City of Wainwright, Mayor
Cully Corporation, Point Lay
Ice Seal Committee
Iñupiat Community of the Arctic Slope</td><td>Kaktovik Iñupiat Corporation
Kaktovik Whaling Captains Association
Kikiktagruk Iñupiat Corporation, Kotzebue
Kuukpik Village Corporation, Nuiqsut
NANA Regional Corporation Inc., Kotzebue
Native Village of Barrow
Native Village of Kaktovik
Native Village of Kivalina
Native Village of Kotzebue IRA
Native Village of Nuiqsut
Native Village of Point Hope
Native Village of Point Lay
Native Village of Wainwright
North Slope Borough Mayor’s Office
North Slope Borough, Department of Wildlife Management
Northwest Arctic Borough
Nunamiut Corporation, Anaktuvuk Pass
Olgoonik Corporation, Wainwright</td></tr>
</table>

Tribal and Local Governments – Alaska Native Organizations (continued)	
Point Hope Whaling Captains Association Tigara Corporation, Point Hope Tikigaq Corporation, Point Hope Village Coordinator, Anaktuvuk Pass	Village Coordinator, Atqasuk Village Coordinator, Kaktovik Village Coordinator, Nuiqsut Village Coordinator, Point Hope Village Coordinator, Wainwright
Libraries	
Alaska Pacific University Alaska Resources Library and Information Service (ARLIS) Chukchi Consortium Library, Kotzebue Fairbanks North Star Borough Noel Wien Library Government Publications, Juneau Juneau Public Library Kali Community School/Community Library	Kaveolook School Library, Kaktovik Kegoyah Kozpa Public Library, Nome Tikigaq Library, Point Hope Trapper School Community Library, Nuiqsut Tuzzy Consortium Library, Barrow University of Alaska, Anchorage Consortium Library University of Alaska, Fairbanks Elmer E. Rasmuson Library • Geophysical Institute • Government Documents • Institute of Arctic Biology Z.J. Loussac Library, Anchorage
Petroleum Industry	
AEC Oil and Gas (USA) Inc. Alaska Clean Seas Alaska Support Industry Alliance Amerada Hess Corporation American Petroleum Institute Amoco Production Co. Anadarko Petroleum Corporation Armstrong Oil and Gas Inc. Atofina Petrochemicals, Inc. Aurora Gas LLC BP Exploration (Alaska) Inc. Burlington Resources Chevron U.S.A. Inc. ConocoPhillips Alaska Inc	Devon Energy Production Company Encana Oil and Gas, Inc. Eni Petroleum Exploration Co Inc ExxonMobil Oil Corporation ExxonMobil Production Company Forest Oil Corporation Hess Corporation Liberty Petroleum Corporation Marathon Oil Company Murphy Exploration (Alaska), Inc. Murphy Exploration and Production Company Pennzoil Petrobras-USA Petro-Canada (Alaska) Inc.

Petroleum Industry (continued)	
Phillips Alaska, Inc.	Statoil
Phillips Petroleum Company	Texaco Inc.
Pioneer Natural Resources USA Inc	Total E&P USA Inc
Shell Frontier Oil & Gas, Inc.	Union Oil Company of California
Shell Offshore Inc.	Western Geophysical Company
Associations, Companies, Special Interest Groups, and Others	
Alaska Coalition	Greenpeace
Alaska Conservation Foundation	Indigenous Peoples Council for Marine Mammals
Alaska Journal of Commerce	Iñupiat Heritage Center
Alaska Marine Conservation Council	LGL, Alaska Research Associates
Alaska Native Knowledge Network, Fairbanks	Marine Advisory Program
Alaska Natural Heritage Program	Munger Oil Information Services
Alaska Newspapers, Inc.	National Audubon Society
Alaska Oil and Gas Association	National Ocean Industries Association
Alaska Public Interest Research Group	National Parks and Conservation Association
Alaska Public Radio Network, Anchorage	National Wildlife Federation
Alaska Wilderness League	Natural Resources Defense Council
Applied Sociocultural Research	Northern Alaska Environmental Center
Arctic Connections	Ocean Conservancy
Arctic Marine Resource Commission	PEW Environmental Group
Arctic Sounder	Prince William Sound RCAC
Audubon Alaska	Resource Development Council for Alaska, Inc.
Center for Biological Diversity	Sierra Club
Center for Regulatory Effectiveness	Trustees for Alaska
Defenders of Wildlife	University of Alaska, Anchorage Institute of Social and Economic Research
EarthJustice, Juneau	Wilderness Society
Exxon Valdez Oil Spill Trustee Council	World Wildlife Fund

6.4 List of Preparers

Representatives from NMFS, BOEM, EPA, and NSB reviewed draft documents. Earlier versions of chapters were drafted by contractors.

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NSB	Tom Lohman; Environmental Resource Specialist, North Slope Borough Department of Wildlife Management Robert Suydam; Wildlife Biologist, North Slope Borough Department of Wildlife Management
URS and Subcontractors	
URS	Jon Isaacs; Principal in Charge Amy Rosenthal; Project Manager Jack Colonell; Senior Review, Physical Environment Bridget Easley; Biological Environment Task Lead Joan Kluwe; Social Environment and Public Involvement Task Leads Dan LaPlant; Physical Environment Task Lead Taylor Breslford; Senior Review, Social Environment Tara Bellion; Administrative Record and Public Involvement Joanne Jones; Geographic Information Systems Linda Harriss; Word Processor Ida Krajsek; Word Processor Bill Loskutoff; Quality Controls and Quality Assurance
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8.0 GLOSSARY

Acute—Sudden, short term, severe, critical, crucial, intense, but usually of short duration.

Anadromous fish—Fish that migrate up river from the sea to breed in fresh water.

Annelid—Worm with a cylindrical body segmented both internally and externally.

Annular preventer—A component of the pressure control system in the Blowout Preventer that forms a seal in the annular space around any object in the wellbore or upon itself, enabling well control operations to commence.

Anthropogenic—Coming from human sources, relating to the effect of humankind on nature.

Aphotic zone—Zone where the levels of light entering through the surface are not sufficient for photosynthesis or for animal response.

Archaeological resource—Any material remains of human life or activities that are at least fifty years of age and that are of archaeological interest.

Aromatic—Class of organic compounds containing benzene rings or benzenoid structures.

Attainment area—An area that is shown by monitored data or by air-quality modeling calculations to be in compliance with primary and secondary ambient air quality standards established by the USEPA.

Barrel (bbl)—A volumetric unit used in the petroleum industry; equivalent to 42 U.S. gallons or 158.99 liters.

Benthic—Literally, living on the bottom. Refers to material, especially sediment, at the bottom of an aquatic ecosystem, or it can be used to describe the organisms that live on, or in, the bottom of a water body or the sea.

Benthos—A region that includes the bottom of the sea and the littoral zone; also refers to the benthic invertebrate community, which is a group of animals that lives on or in the bottom sediments.

Biological Opinion—The FWS or NMFS evaluation of the impact of a proposed action on endangered and threatened species, in response to formal consultation under Section 7 or the endangered Species Act.

Block—A geographical area portrayed on official BOEMRE protraction diagrams or leasing maps that contains approximately 2,331 ha (9 mi2).

Blowout—An uncontrolled flow of fluids below the mudline from appurtenances on a wellhead or from a wellbore.

Blowout preventer (BOP)—One of several valves installed at the wellhead to prevent the escape of pressure either in the annular space between the casing and drill pipe or in open hole (i.e., hole with no drill pipe) during drilling completion operations. Blowout preventers on jackup or platform rigs are located at the water's surface; on floating offshore rigs, BOP's are located on the seafloor.

Brackish—Slightly salty water.

Cetacean—Large aquatic carnivorous mammal with fin-like forelimbs, no hind limbs includes whales, dolphins, porpoises, and narwhals. Also of or relating to these animals.

Chemosynthetic—Organisms that obtain their energy from the oxidation of various inorganic compounds rather than from light (photosynthesis).

Critical habitat—Specific areas within the geographical area occupied by the species at the time of listing (under the ESA), if they contain physical or biological features essential to conservation, and those features may require special management considerations or protection; and specific areas outside the geographical area occupied by the species if the agency (USFWS or NMFS) determines that the area itself is essential for conservation.

Coastal waters—Waters within the geographical areas defined by each State's Coastal Zone Management Program.

Coastal wetlands—Forested and nonforested habitats, mangroves, and marsh islands exposed to tidal activity. These areas directly contribute to the high biological productivity of coastal waters by input of detritus and nutrients, by providing nursery and feeding areas for shellfish and finfish, and by serving as habitat for birds and other animals.

Coastal zone—The coastal waters (including the lands therein and thereunder) and the adjacent shore lands (including the waters therein and thereunder) strongly influenced by each other and in proximity to the shorelines of the several coastal states; the zone includes islands, transitional and intertidal areas, salt marshes, wetlands, and beaches and extends seaward to the outer limit of the United States territorial sea. The zone extends inland from the shorelines only to the extent necessary to control shore lands, the uses of which have a direct and significant impact on the coastal waters. Excluded from the coastal zone are lands the use of which is by law subject to the discretion of or which is held in trust by the Federal Government, its officers, or agents. (The State land and water area officially designated by the State as "coastal zone" in its State coastal zone program as approved by the U.S. Department of Commerce under the Coastal Zone Management Act.)

Condensate—Liquid hydrocarbons produced with natural gas; they are separated from the gas by cooling and various other means. Condensates generally have an API gravity of 50o-120o.

Continental margin—The ocean floor that lies between the shoreline and the abyssal ocean floor, includes the continental shelf, continental slope, and continental rise.

Continental shelf—The gently seaward-sloping surface that extends between the shoreline and the top of the continental slope at about 150 meters (345 feet) depth. The average gradient of the shelf is between 1:500 and 1:1000 and, although it varies greatly, the average width is approximately 70 kilometers (44 miles). This can also be a judicial term; for example, the outer limit of the legal continental shelf is determined by reference to be a distance of 200 nautical miles (370 kilometers, 230 miles) or to the outer edge of the geological continental margin, wherever the margin extends beyond 200 nautical miles (370 kilometers; 230 miles).

Contingency Plan—A plan for possible offshore emergencies prepared and submitted by the oil or gas operator as part of the plan of development and production, and which may be required for part of the plan of exploration.

Continental slope—That part of the continental margin that lies between the continental shelf and the bottom of the ocean. Sunlight does not penetrate this area, and mostly it is home to scavengers. It is characterized by a relatively steep slope of 3 to 6 degrees.

Critical habitat—a designated area that is essential to the conservation of an endangered or threatened species that may require special management considerations or protection.

Crude oil—Petroleum in its natural state as it emerges from a well, or after it passes through a gas-oil separator but before refining or distillation. An oily, flammable, bituminous liquid that is essentially a complex mixture of hydrocarbons of different types with small amounts of other substances.

Crustacean—Includes a diversity of marine, freshwater, and terrestrial animals. All crustaceans have a head and five pairs of appendages, two of which are antennae. Many microscopic crustaceans, like krill and brine shrimp, are marine plankton, an important food source for other animals in the sea. Shrimp, lobsters, crabs, crayfish, and barnacles are crustaceans.

Deferral—Action taken by the Secretary of the Interior at the time of the Area Identification to remove certain areas/blocks from the proposed sale.

Delineation well—A well that is drilled for the purpose of determining the size and/or volume of an oil or gas reservoir.

***Deepwater Horizon* (DWH) event**—All actions stemming from the April 20, 2010, explosion and subsequent sinking of the Transocean drillship *Deepwater Horizon*, up to and including the Macondo well kill declaration on September 19, 2010.

Depleted species—Defined by the MMPA as any case in which: (a) the Secretary of Commerce, after consultation with the Marine Mammal Commission and the Committee of Scientific Advisors on Marine Mammals, determines that a species or population stock is below its optimum sustainable population; (b) a State determines that such species or stock is below its optimum sustainable population; or (c) a species or population stock is listed as a threatened species or endangered species under the ESA.

Demersal—Living near, deposited on, or sinking to the bottom of the sea.

Development—Activities that take place following discovery of economically recoverable mineral resources, including geophysical surveying, drilling, platform construction, operation of onshore support facilities, and other activities that are for the purpose of ultimately producing the resources.

Development Operations Coordination Document (DOCD)—A document that must be prepared by the operator and submitted to BOEMRE for approval before any development or production activities are conducted on a lease in the Western Gulf.

Diapause—A state of rest, halted development, or arrested development or growth, accompanied by greatly decreased metabolism, often correlated with the seasons, usually applied only to insects.

Dilution—The reduction in the concentration of dissolved or suspended substrates by mixing with water.

Direct employment—Consists of those workers involved the primary industries of oil and gas exploration, development, and production operations (Standard Industrial Classification Code 13—Oil and Gas Extraction).

Discharge—Something that is emitted; flow rate of a fluid at a given instant expressed as volume per unit of time.

Dispersant—A suite of chemicals and solvents used to break up an oil slick into small droplets, which increases the surface area of the oil and hastens the processes of weathering and microbial degradation.

Dispersion—A suspension of finely divided particles in a medium.

Distinct Population Segment (DPS)—A vertebrate population or group of populations that is discrete from other populations of the species and significant in relation to the entire species. Distinct population segments may be listed as threatened or endangered under the ESA.

Drilling mud—A mixture of clay, water or refined oil, and chemical additives pumped continuously downhole through the drill pipe and drill bit, and back up the annulus between the pipe and the walls of the borehole to a surface pit or tank. The mud lubricates and cools the drill bit, lubricates the drill pipe as it turns in the wellbore, carries rock cuttings to the surface, serves to keep the hole from crumbling or collapsing, and provides the weight or hydrostatic head to prevent extraneous fluids from entering the well bore and to downhole pressures; also called drilling fluid.

Drillship—A self-propelled, self-contained vessel equipped with a derrick amidships for drilling wells in deep water.

Effluent—A waste product that is discharged to the environment, usually used to mean treated wastewater discharged from a wastewater treatment plant, sewer, or industrial outfall.

Effluent limitations—Any restriction established by a State or the USEPA on quantities, rates, and concentrations of chemical, physical, biological, and other constituents discharged from point sources into U.S. waters, including schedules of compliance.

Endangered species—Defined under the ESA as "any species which is in danger of extinction throughout all or a significant portion of its range."

Environmental Assessment—A concise public document required by the National Environmental Policy Act of 1969 (NEPA). In the document, a Federal agency proposing (or reviewing) and action provides evidence and analysis for determining whether it must prepare an Environmental Impact Statement (EIS) or whether it finds there is no significant impact (i.e., Finding of No Significant Impact [FONSI]).

Environmental effect—A measurable alteration or change in environmental conditions.

Environmental Impact Statement (EIS)—A statement required by the National Environmental Policy Act of 1969 (NEPA) or similar State law in relation to any major action significantly affecting the environment; a NEPA document.

Epifaunal—Animals living on the surface of hard substrate.

Essential Fish Habitat (EFH)—Defined under the Magnuson-Stevens Fishery Conservation and Management Act as waters and substrate that are necessary to the fish species for spawning, breeding, feeding, or growth to maturity.

Estuary—Coastal semienclosed body of water that has a free connection with the open sea and where freshwater meets and mixes with seawater.

Eutrophication—The process whereby an aquatic environment becomes rich in dissolved nutrients, causing excessive growth and decomposition of oxygen-depleting plant life and resulting in injury or death to other organisms.

Exclusive Economic Zone (EEZ)—The maritime region extending 200 nmi from the baseline of the territorial sea, in which the United States has exclusive rights and jurisdiction over living and nonliving natural resources.

Exploration—The process of searching for minerals. Exploration activities include: (1) geophysical surveys where magnetic, gravity, seismic, or other systems are used to detect or infer the presence of such minerals; and (2) any drilling, except development drilling, whether on or off known geological structures. Exploration also includes the drilling of a well in which a discovery of oil or natural gas in paying quantities is made, and the drilling, after such a discovery, of any additional well that is needed to delineate a reservoir and to enable the lessee to determine whether to proceed with development and production.

Exploration Plan (EP)—A plan that must be prepared by the operator and submitted to BOEMRE for approval before any exploration or delineation drilling is conducted on a lease.

Exploration well—A well drilled in unproven or semi-proven territory to determining whether economic quantities of oil or natural gas deposit are present; exploratory well.

Fault—A fracture in the earth's crust accompanied by a displacement of one side of the fracture with respect to the other.

Field—An accumulation, pool, or group of pools of hydrocarbons in the subsurface. A hydrocarbon field consists of a reservoir in a shape that will trap hydrocarbons and that is covered by an impermeable, sealing rock.

Fixed or bottom founded—Permanently or temporarily attached to the seafloor.

Flyway—An established air route of migratory birds.

Formation—A bed or deposit sufficiently homogeneous to be distinctive as a unit. Each different formation is given a name, frequently as a result of the study of the formation outcrop at the surface and sometimes based on fossils found in the formation.

Fugitive emissions—Emission into the atmosphere that could not reasonably pass through a stack, chimney, vent or other functionally equivalent opening.

Gathering lines—A pipeline system used to bring oil or gas production from a number of separate wells or production facilities to a central trunk pipeline, storage facility, or processing terminal.

Geochemical—Of or relating to the science dealing with the chemical composition of and the actual or possible chemical changes in the crust of the earth.

Geologic hazard—A feature or condition that, if unmitigated, may seriously jeopardize offshore oil and gas exploration and development activities. Mitigation may necessitate special engineering procedures or relocation of a well.

Geophysical—Of or relating to the physics of the earth, especially the measurement and interpretation of geophysical properties of the rocks in an area.

Geophysical data—Facts, statistics, or samples that have not been analyzed or processed, pertaining to gravity, magnetic, seismic, or other surveys/systems.

Geophysical survey—A method of exploration in which geophysical properties and relationships are measured remotely by one or more geophysical methods.

Habitat—A specific type of environment that is occupied by an organism, a population, or a community.

Halophytic—A plant that can tolerate or thrive in alkaline soil rich in sodium or calcium salts; tolerant of saline (salty) conditions.

Harassment—Under the 1994 amendments to the MMPA, harassment is statutorily defined as any act of pursuit, torment, or annoyance which: has the potential to injure a marine mammal or marine mammal stock in the wild (Level A Harassment); or 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 but which does not have the potential to injure a marine mammal or marine mammal stock in the wild (Level B Harassment).

Haulout area—Specific locations where pinnipeds come ashore and concentrate in numbers to rest, breed, and/or bear young.

Holocene Epoch—A geologic time segment of the Quaternary Period, dating from the end of the Pleistocene Epoch, approximately 8,000 years ago until the present.

Hydrocarbons—Any of a large class of organic compounds containing primarily carbon and hydrogen. Hydrocarbon compounds are divided into two broad classes: aromatic and aliphatics. They occur primarily in petroleum, natural gas, coal, and bitumens.

Hypothermia—Condition in which body temperature drops below the level required for normal metabolism and/or bodily function to take place.

Hypoxia—Depressed levels of dissolved oxygen in water, usually resulting in decreased metabolism.

Incidental take—Takings that result from, but are not the purpose of, carrying out an otherwise lawful activity (e.g., fishing) conducted by a Federal agency or applicant (see Taking).

Indigenous—Originating where it is found. Refers to species or peoples found locally and from the local area.

Indirect effects—Effects caused by activities that are stimulated by an action but not directly related to it.

Industry infrastructure—The facilities associated with oil and gas development, e.g., refineries, gas processing plants, etc.

Indirect employment—Secondary or supporting oil- and gas-related industries, such as the processing of crude oil and gas in refineries, natural gas plants, and petrochemical plants.

Intertidal—The zone between the high and low water marks.

Invertebrate—An animal without a backbone or spinal column, such as an insect.

Isobath—Line connecting points of equal water depth on a nautical chart; a seabed contour.

Jackup rig—A barge-like, floating platform with legs at each corner that can be lowered to the sea bottom to raise the platform above the water.

Lagoon—A water body often separated from ocean water exchange, with enclosure as a defining characteristic.

Lease—Authorization that is issued under and that authorizes exploration for, and development and production of, minerals. Lease means an agreement that is issued under Section 8 or maintained under Section 6 of the Outer Continental Shelf Lands Act and that authorizes exploration for, and development and production of, minerals. The term also means the area covered by that authorization, whichever the context requires.

Lease sale—The competitive auction of leases granting companies or individuals the right to explore for and develop certain minerals under specified conditions and periods of time.

Lease term—The initial period for oil and gas leases, usually a period of 5, 8, or 10 years depending on water depth or potentially adverse conditions.

Lessee—A party who has entered into a lease with the United States to explore for, develop, and produce the leased minerals.

Lightering—Smaller boats supplying larger boats with supplies and/or carrying fuel; lightering operations include transfers within the vessel, to lightering barges, or if necessary, into the sea.

Lithic—Of or pertaining to stone.

Macondo Oil Spill—The name given to the oil spill that resulted from the explosion and sinking of the *Deepwater Horizon* rig from the period between April 24, 2010, when search and recovery vessels on site reported oil at the sea surface until uncontrolled flow from the Macondo well was capped.

Marshes—Persistent, emergent, nonforested wetlands characterized by predominantly cordgrasses, rushes, and cattails.

Migratory bird—Any mutation or hybrid of a listed species, as well as any part, egg, or nest of such bird. Protected under the Migratory Bird Treaty Act.

Minerals—As used in this document, minerals include oil, gas, sulphur, and associated resources, and all other minerals authorized by an Act of Congress to be produced from public lands as defined in Section 103 of the Federal Land Policy and Management Act of 1976.

Mollusk—An invertebrate having a soft unsegmented body, usually enclosed in a shell. Also a group of freshwater and saltwater animals, including oysters, clams, mussels, snails, conches, scallops, squid, and octopus.

Mysticete—A whale that has baleen (plates of keratinized tissue that hang from the upper jaw) instead of teeth (suborder Mysticeti). Examples include the humpback whale (*Megaptera novaeangliae*), gray whale (*Eschrichtius robustus*), and minke whale (*Balaenoptera acutorostrata*).

Nautical mile—A distance measurement equivalent to 1.15 statutory miles, or 1.8 kilometers.

Nearshore waters—Offshore open waters that extend from the shoreline out to the limit of the territorial seas (twelve nautical miles).

Nonattainment area—An area that is shown by monitoring data or by air-quality modeling calculations to exceed primary or secondary ambient air quality standards established by the USEPA.

Odontocete—Toothed marine mammals (suborder Odontoceti). Examples include the sperm whale (*Physeter macrocephalus*), beluga whale (*Delphinapterus leucas*), harbor porpoise (*Phocoena phocoena*), and bottlenose dolphin (*Tursiops truncatus*).

Offloading—Unloading liquid cargo, crude oil, or refined petroleum products.

Offshore—In beach terminology, the comparatively flat zone of variable width, extending from the shore to the edge of the continental shelf. It is continually submerged. Also the breaker zone directly seaward of the low tide line.

Oil spill contingency plan—A plan submitted by the lease or unit operator along with or prior to a submission of a plan of exploration or a development/production plan that details provisions for fully defined specific actions to be taken following discovery and notification of an oil spill occurrence.

Operational discharge—Any incidental pumping, pouring, emitting, emptying, or dumping of wastes generated during routine offshore drilling and production activities.

Operator—An individual, partnership, firm, or corporation having control or management of operations on a leased area or portion thereof. The operator may be a lessee, designated agent of the lessee, or holder of operating rights under an approved operating agreement.

Organic matter—Material derived from living plants or animals.

Outer Continental Shelf (OCS)—All submerged lands that comprise the continental margin adjacent to the United States and seaward of State offshore lands.

Pelagic—Of or pertaining to the open sea; associated with open water beyond the direct influence of coastal systems.

Perturbation—A secondary influence on a system that causes it to deviate.

Plankton—Passively floating or weakly motile aquatic plants (phytoplankton) and animals (zooplankton).

Pathology—The scientific study of the nature of disease and its causes, processes, development, and consequences.

Phocid—True or earless seals (family Phocidae). Examples include the bearded seal (*Erignathus barbatus*) and ringed seal (*Phoca hispida*).

Phytoplankton—Microscopic floating aquatic plants that produce their own nutrients through photosynthesis.

Pinniped—Aquatic carnivorous mammals having a streamlined body specialized for swimming with limbs modified as flippers, for example, seals.

Platform—A steel or concrete structure from which offshore development wells are drilled.

Plankton—Very small, free-floating organisms of the ocean or other aquatic systems, including phytoplankton and zooplankton, which get their nutrients from organisms.

Play—A prospective subsurface area for hydrocarbon accumulation that is characterized by a particular structural style or depositional relationship.

Plume—A narrow thermal feature, which can be either hot or cold, that rises or sinks because of its anomalous temperature compared to the surrounding fluid.

Polychaete—A class of mainly marine annelids, characterized by parapodia bearing numerous hairs; for example, bristle worm.

Polychlorinated Biphenyls (PCBs)—A group of toxic, carcinogenic organic compounds previously used for industrial purposes.

Polycyclic Aromatic Hydrocarbon (PAH)—Chemical compounds that consist of fused aromatic rings; many are known or suspected carcinogens.

Potential impact (effect)—The range of alterations or changes to environmental conditions that could be caused by an action.

Primary production—Organic material produced by photosynthetic or chemosynthetic organisms.

Produced water—Total water discharged from the oil and gas extraction process; production water or production brine.

Production—Activities that take place after the successful completion of any means for the extraction of resources, including bringing the resource to the surface, transferring the produced resource to shore, monitoring operations, and drilling additional wells or workovers.

Promulgated—Formally made public; published accounts.

Prospect—An untested geologic feature having the potential for trapping and accumulating hydrocarbons.

Province—A spatial entity with common geologic attributes. A province may include a single dominant structural element such as a basin or a fold belt, or a number of contiguous related elements.

Refining—Fractional distillation of petroleum, usually followed by other processing (for example, cracking).

Relief—The difference in elevation between the high and low points of a surface.

Reserves—Proved oil or gas resources.

Reservoir—A subsurface, porous, permeable rock boy in which hydrocarbons have accumulated.

Rig—A structure used for drilling an oil or gas well.

Right-of-way—A legal right of passage, an easement; the specific area or route for which permission has been granted to place a pipeline, (and) ancillary facilities, and for normal maintenance thereafter.

Rookery—The nesting or breeding grounds of gregarious (i.e., social) birds or mammals; also a colony of such birds or mammals.

Royalty—A share of the minerals produced from a lease paid in either money or "in-kind" to the landowner by the lessee.

Sale area—The geographic area of the Outer Continental Shelf (OCS) being offered for lease for the exploration, development, and production of mineral resources.

Scoping—The process prior to Environmental Impact Statement (EIS) preparation to determine the range and significance of issues to be addressed in the EIS for each proposed major federal action.

Seagrass beds—More or less continuous mats of submerged, rooted marine flowering vascular plants occurring in shallow tropical and temperate waters. Seagrass beds provide habitat, including breeding and feeding grounds, for adults and/or juveniles of many of the economically important shellfish and finfish.

Seismic—Pertaining to, characteristic of, or produced by water, earthquakes or earth vibration; having to do with elastic waves in the earth; also geophysical when applied to surveys.

Sediment—Material that has been transported and deposited by water, wind, glacier, precipitation, or gravity; a mass of deposited material.

Seeps (hydrocarbon)—Gas or oil that reaches the surface along bedding planes, fractures, unconformities, or fault planes.

Sensitive area—An area containing species, populations, communities, or assemblages of living resources, that is susceptible to damage from normal OCS-related activities. Damage includes interference with established ecological relationships.

Stranding—Defined under the MMPA as "an event in the wild in which (A) a marine mammal is dead and is (i) on a beach or shore of the United States; or (ii) in waters under the jurisdiction of the United States (including any navigable waters); or (B) a marine mammal is alive and is (i) on a beach or shore of the United States and is unable to return to the water; (ii) on a beach or shore of the United States and, although able to return to the water, is in need of apparent medical attention; or (iii) in the waters under the jurisdiction of the United States (including any navigable waters), but is unable to return to its natural habitat under its own power or without assistance."

Stipulations—Specific measures imposed upon a lessee that apply to a lease. Stipulations are attached as a provision of a lease; they may apply to some or all tracts in a sale. For example, a stipulation might limit drilling to a certain time period of the year or certain areas.

Subarea—A discrete analysis area.

Subsistence uses—The customary and traditional uses by rural residents of wild, renewable resources for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation; for making and selling of handcraft articles out of nonedible byproducts of fish and wildlife resources take for personal or family consumption; for barter, or sharing for personal or family consumption; and for customary trade.

Substrate—Any stratum lying underneath another.

Supply vessel—A boat that ferries food, water, fuel, and drilling supplies and equipment to an offshore rig or platform and returns to land with refuse that cannot be disposed of at sea.

Take—In the Marine Mammal Protection Act, meaning "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." In the Endangered Species Act, the definition includes to harass, harm, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct. A notable component of this definition is "harm," which means an act that actually kills or injures protected wildlife. Such acts may include significant habitat modification or degradation that actually kills or injures wildlife by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering.

Tertiary—A geologic period dating from 63 million to 2 million years ago.

Threatened species—Defined under the Endangered Species Act as “any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.”

Total suspended solids—The total amount of suspended solids in water.

Turbidity—Reduced water clarity due to the presence of suspended matter.

Trawling—The operation of towing a net (trawl) to catch fish and/or shellfish. Trawls are towed either with bottom contact or in midwater. The towing speed varies, according to such factors as the type of trawl and trawling and the target species.

Trophic—Trophic levels refer to the hierarchy of organisms form photosynthetic plants to carnivores, such as man; feeding trophic levels refer to the hierarchy of organisms from photosynthetic plants to carnivores in which organisms at one level are fed upon by those at the next higher level (e.g., phytoplankton eaten by zooplankton eaten by fish).

Turbidity—Reduced water clarity resulting from the presence of suspended matter.

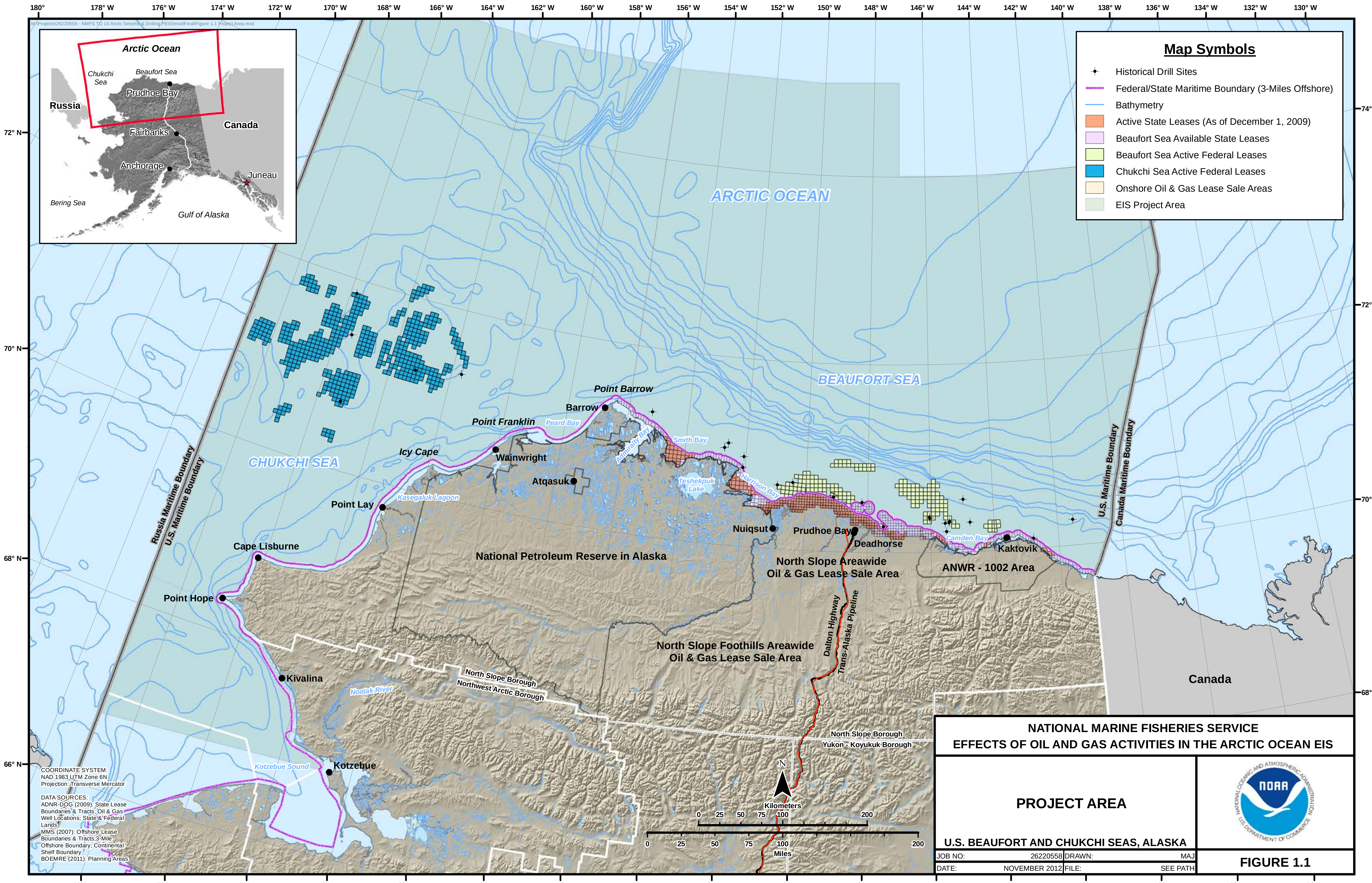
Upwelling—Divergence of water currents or the movement of surface water away from land, leading to upward movement of cold nutrient-rich water from the ocean depths; often associated with great production of fish and fisheries.

Volatile organic compound (VOC)—Any reactive organic compound that is emitted to the atmosphere as a vapor. The definition does not include methane.

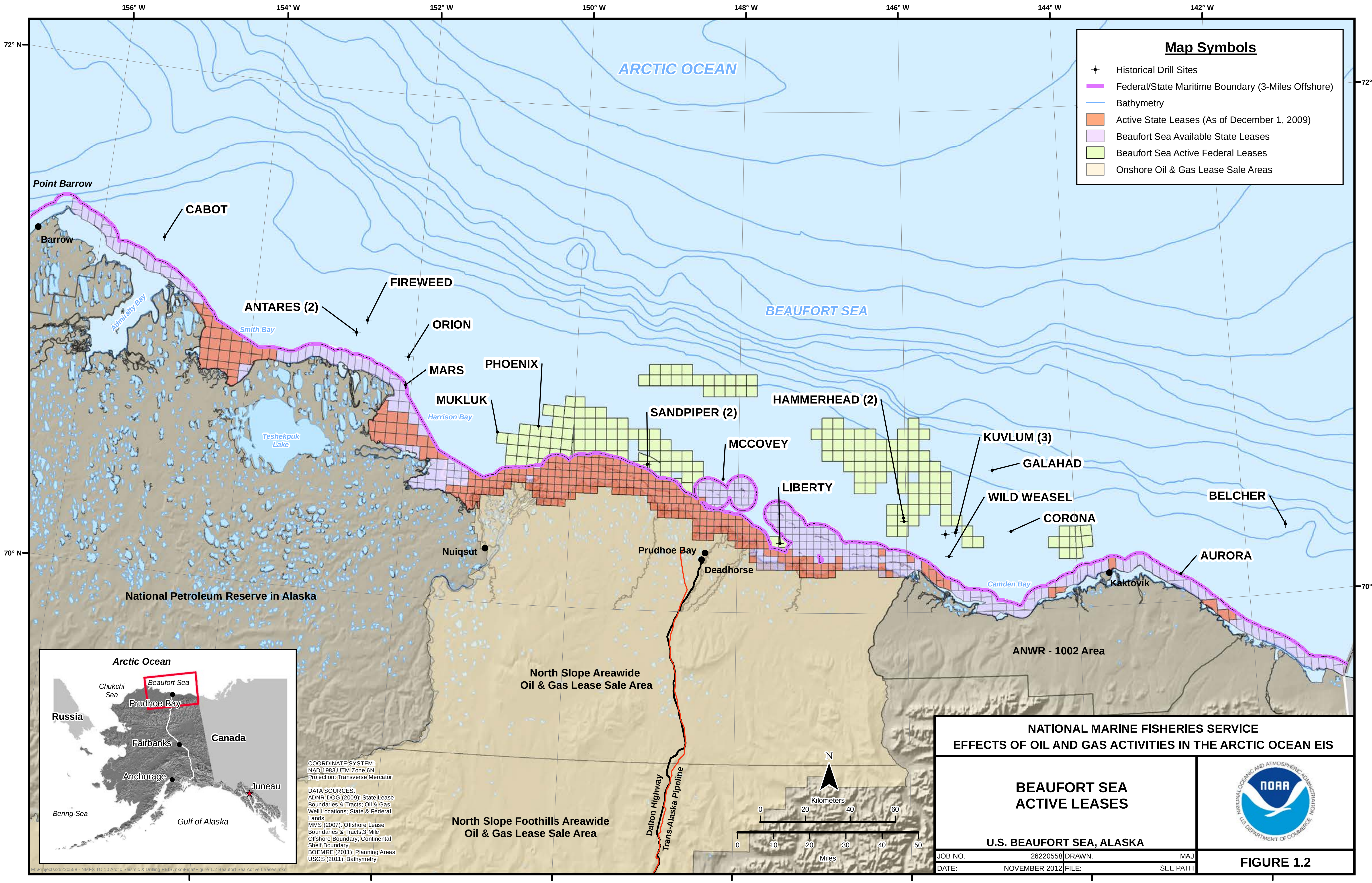
Weathering (of oil)—The aging of oil due to its exposure to the atmosphere, causing marked alterations in its physical and chemical makeup.

FIGURES

CHAPTER 1 FIGURES



Map Symbols
Historical Drill Sites
Federal/State Maritime Boundary (3-Miles Offshore)
Bathymetry
Active State Leases (As of December 1, 2009)
Beaufort Sea Available State Leases
Beaufort Sea Active Federal Leases
Chukchi Sea Active Federal Leases
Onshore Oil & Gas Lease Sale Areas
EIS Project Area
Arctic Ocean
Chukchi Sea
Beaufort Sea
Russia
Prudhoe Bay
Canada
Fairbanks
Anchorage
Juneau
Bering Sea
Gulf of Alaska
ARCTIC OCEAN
BEAUFORT SEA
CHUKCHI SEA
Russia Maritime Boundary
U.S. Maritime Boundary
U.S. Maritime Boundary
Canada Maritime Boundary
Point Barrow
Barrow
Point Franklin
Peard Bay
Admiralty Bay
Smith Bay
Icy Cape
Wainwright
Atqasuk
Teshekpuk Lake
Harrison Bay
Point Lay
Kasegaluk Lagoon
Nuiqsut
Prudhoe Bay
Deadhorse
Camden Bay
Kaktovik
Cape Lisburne
National Petroleum Reserve in Alaska
North Slope Areawide Oil & Gas Lease Sale Area
ANWR - 1002 Area
Point Hope
Dalton Highway
Trans-Alaska Pipeline
North Slope Foothills Areawide Oil & Gas Lease Sale Area
Kivalina
Noatak River
North Slope Borough
Northwest Arctic Borough
Canada
North Slope Borough
Yukon - Koyukuk Borough
Kotzebue Sound
Kotzebue
Kilometers
0 25 50 75 100 200
0 25 50 75 100 200
Miles
COORDINATE SYSTEM:
NAD 1983 UTM Zone 6N
Projection: Transverse Mercator
DATA SOURCES:
ADNR-DOG (2009): State Lease Boundaries & Tracts; Oil & Gas Well Locations; State & Federal Lands
MMS (2007): Offshore Lease Boundaries & Tracts; 3-Mile Offshore Boundary; Continental Shelf Boundary
BOEMRE (2011): Planning Areas
NATIONAL MARINE FISHERIES SERVICE
EFFECTS OF OIL AND GAS ACTIVITIES IN THE ARCTIC OCEAN EIS
PROJECT AREA
U.S. BEAUFORT AND CHUKCHI SEAS, ALASKA
JOB NO: 26220558
DRAWN: MAJ
DATE: NOVEMBER 2012
FILE: SEE PATH
FIGURE 1.1



ARCTIC OCEAN
BEAUFORT SEA
Map Symbols
Historical Drill Sites
Federal/State Maritime Boundary (3-Miles Offshore)
Bathymetry
Active State Leases (As of December 1, 2009)
Beaufort Sea Available State Leases
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Point Barrow
Barrow
CABOT
FIREWEED
ANTARES (2)
ORION
MARS
PHOENIX
MUKLUK
SANDPIPER (2)
HAMMERHEAD (2)
MCCOVEY
KUVLUM (3)
GALAHAD
LIBERTY
WILD WEASEL
CORONA
BELCHER
AURORA
Admiralty Bay
Smith Bay
Harrison Bay
Teshekpuk Lake
Camden Bay
Nuiqsut
Prudhoe Bay
Deadhorse
Kaktovik
National Petroleum Reserve in Alaska
North Slope Areawide Oil & Gas Lease Sale Area
North Slope Foothills Areawide Oil & Gas Lease Sale Area
ANWR - 1002 Area
Dalton Highway
Trans-Alaska Pipeline
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Chukchi Sea
Beaufort Sea
Prudhoe Bay
Russia
Canada
Fairbanks
Anchorage
Juneau
Bering Sea
Gulf of Alaska
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BOEMRE (2011): Planning Areas
USGS (2011): Bathymetry
N
Kilometers
0 20 40 60
0 10 20 30 40 50
Miles
156° W
154° W
152° W
150° W
148° W
146° W
144° W
142° W
72° N
70° N
NATIONAL MARINE FISHERIES SERVICE
EFFECTS OF OIL AND GAS ACTIVITIES IN THE ARCTIC OCEAN EIS
BEAUFORT SEA
ACTIVE LEASES
U.S. BEAUFORT SEA, ALASKA
JOB NO: 26220558
DRAWN: MAJ
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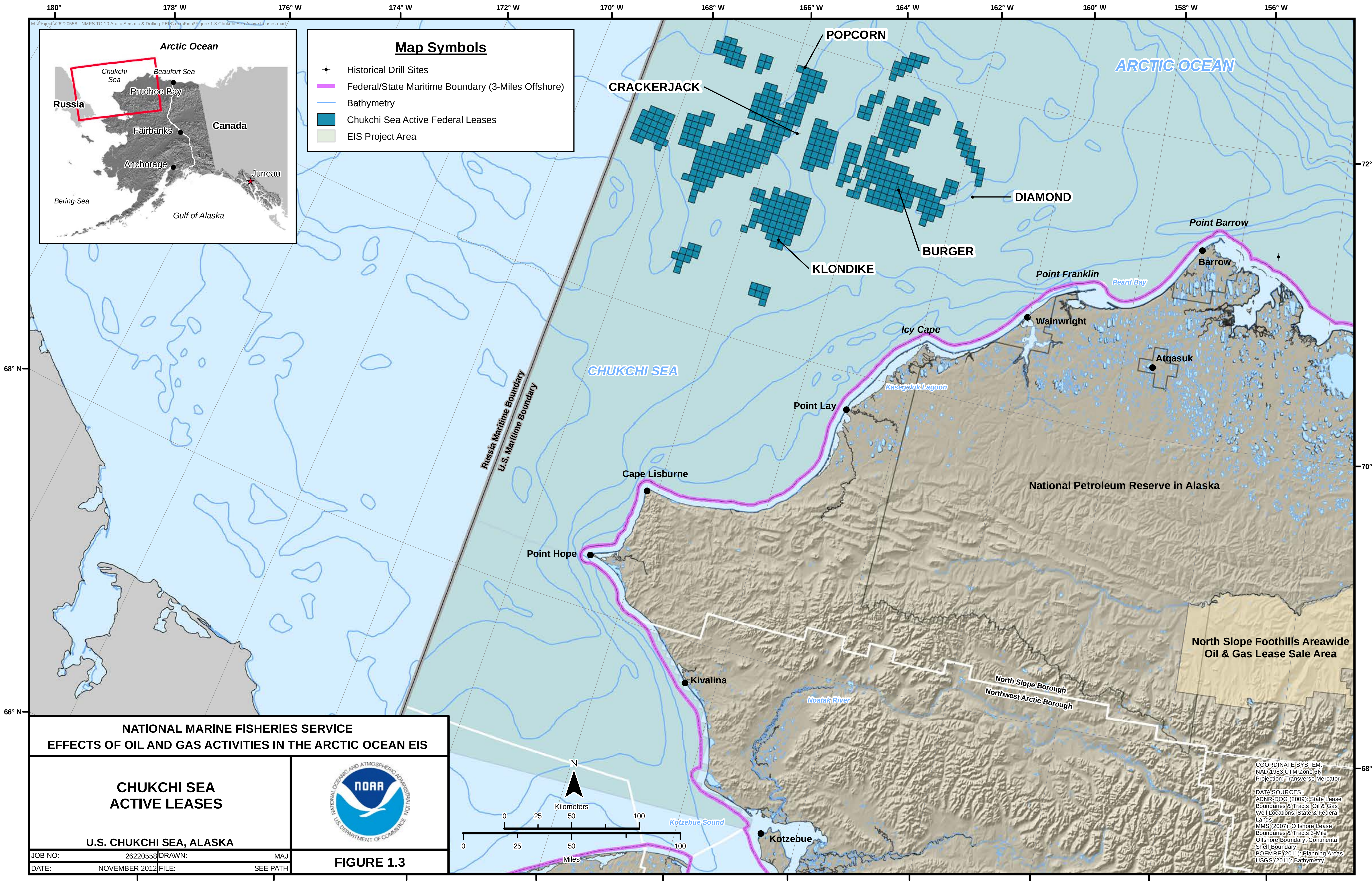
FILE: SEE PATH
FIGURE 1.2


Arctic Ocean
Chukchi Sea
Beaufort Sea
Prudhoe Bay
Russia
Canada
Fairbanks
Anchorage
Juneau
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CRACKERJACK
DIAMOND
BURGER
KLONDIKE
ARCTIC OCEAN
CHUKCHI SEA
Russia Maritime Boundary
U.S. Maritime Boundary
Point Barrow
Barrow
Point Franklin
Peard Bay
Wainwright
Icy Cape
Atqasuk
Kasegaluk Lagoon
Point Lay
Cape Lisburne
Point Hope
National Petroleum Reserve in Alaska
North Slope Foothills Areawide Oil & Gas Lease Sale Area
North Slope Borough
Northwest Arctic Borough
Kivalina
Noatak River
Kotzebue Sound
Kotzebue
Kilometers
Miles
COORDINATE SYSTEM:
NAD 1983 UTM Zone 6N
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DATA SOURCES:
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NATIONAL MARINE FISHERIES SERVICE
EFFECTS OF OIL AND GAS ACTIVITIES IN THE ARCTIC OCEAN EIS
CHUKCHI SEA ACTIVE LEASES
U.S. CHUKCHI SEA, ALASKA
JOB NO: 26220558
DRAWN: MAJ
DATE: NOVEMBER 2012
FILE: SEE PATH
FIGURE 1.3

CHAPTER 2 FIGURES

Figure 2.1 Simple Illustration of a Marine Seismic Survey Operation using Streamers.
Source: USDOI, MMS 2006a

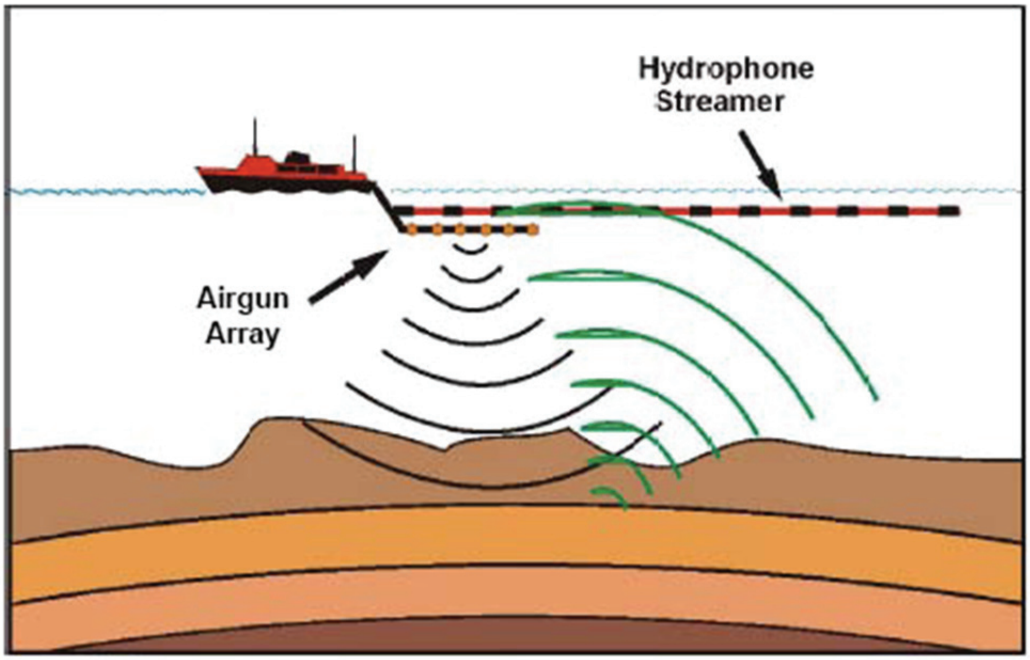

Figure 2.2 Illustration of Ocean Bottom Cable survey.
Source: Schlumberger 2011

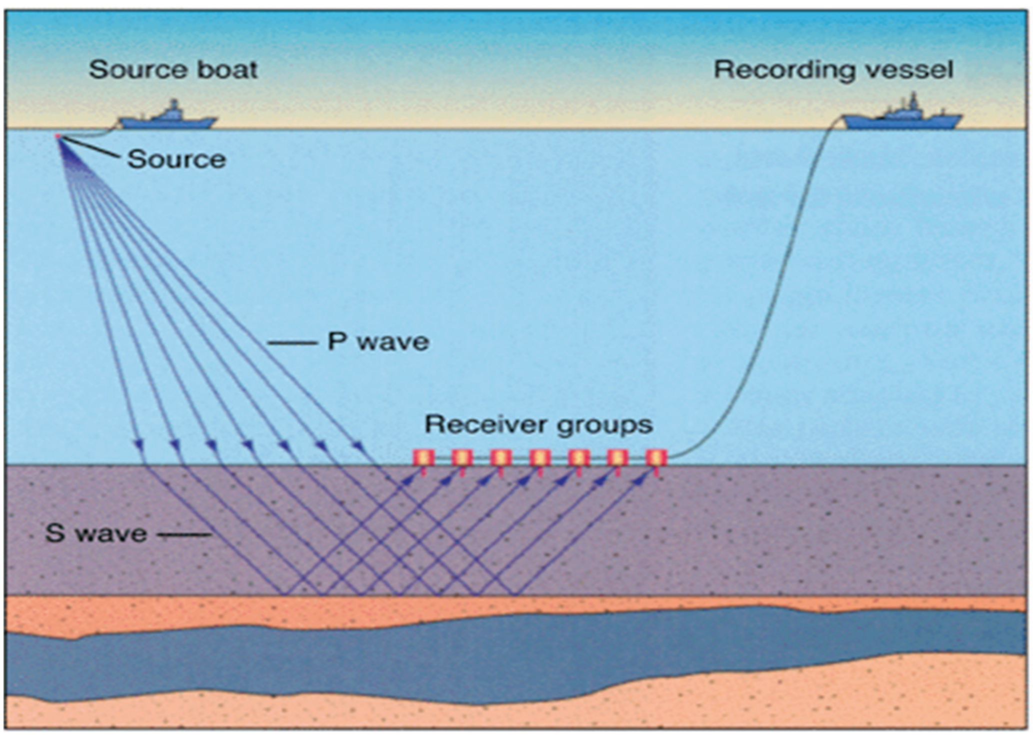

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Figure 2.3 Schematic view of a Controlled Source Electromagnetic (CSEM) survey.
A horizontal electric dipole is towed above receivers that are deployed on the seafloor.

Source: 2010 Electromagnetic Geoservices ASA

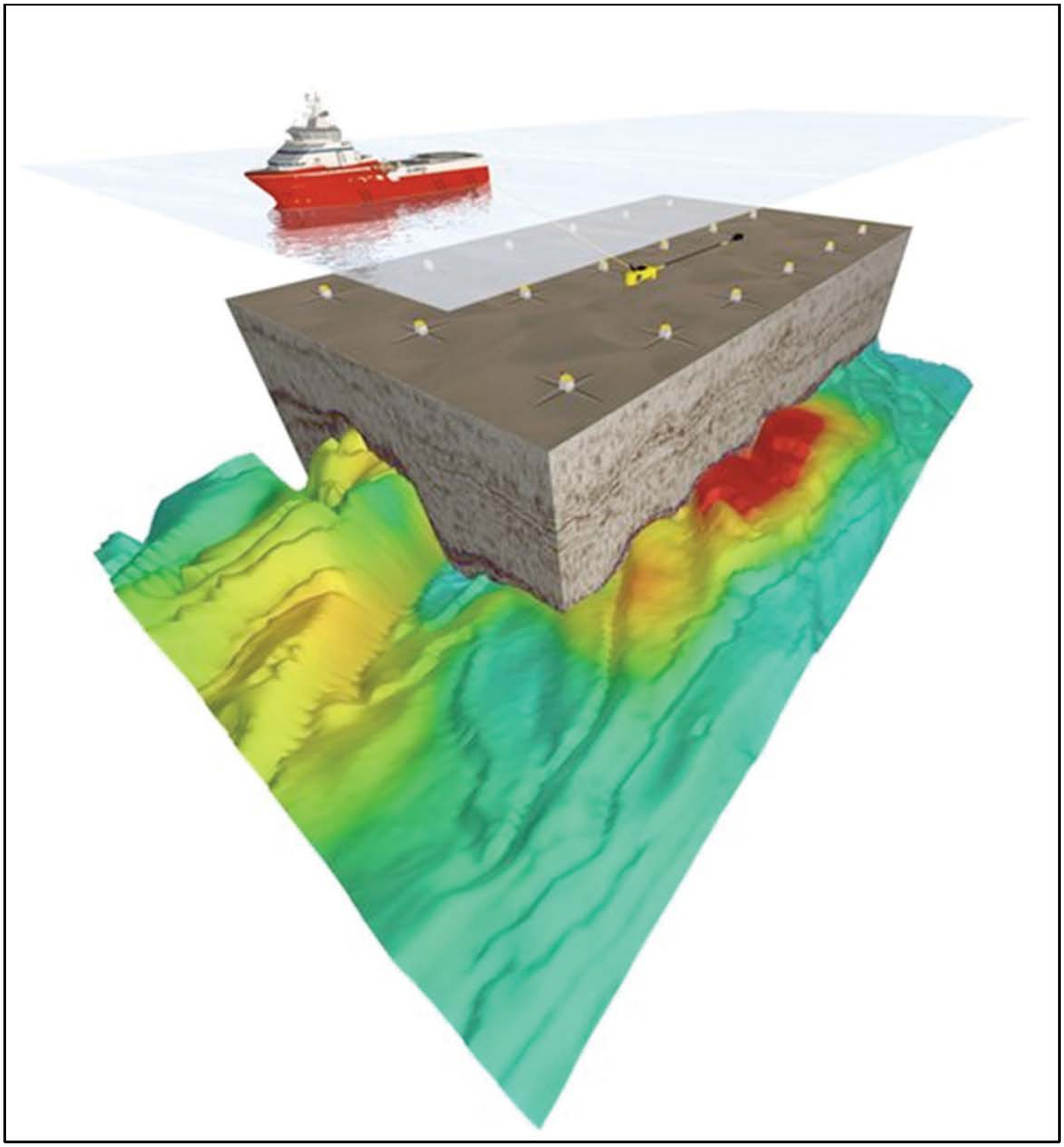


Figure 2.4 SDC operating in the Beaufort Sea.

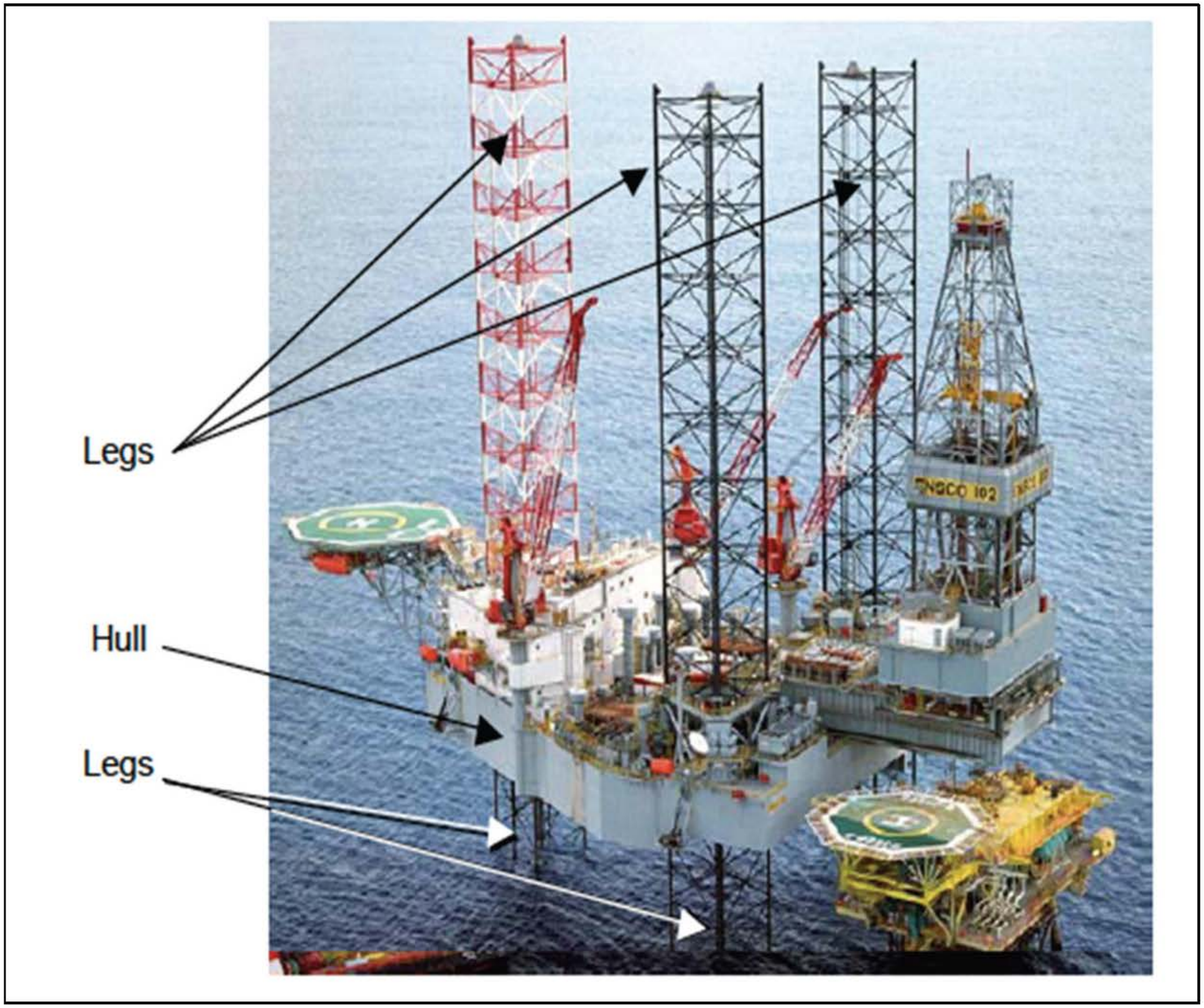
Source: ICETECH 2010 Conference

Figure 2.5 M/V Noble Discoverer.

Source: Shell Inc. 2010a

Figure 2.6 ***Jackup Rig.***

Source: Bennet & Associates LLC and Offshore Technology Development Inc. 2011



CHAPTER 3 FIGURES

Figure 3.1-1 General circulation map of the Beaufort and Chukchi seas.
Source: Weingartner and Danielson 2010

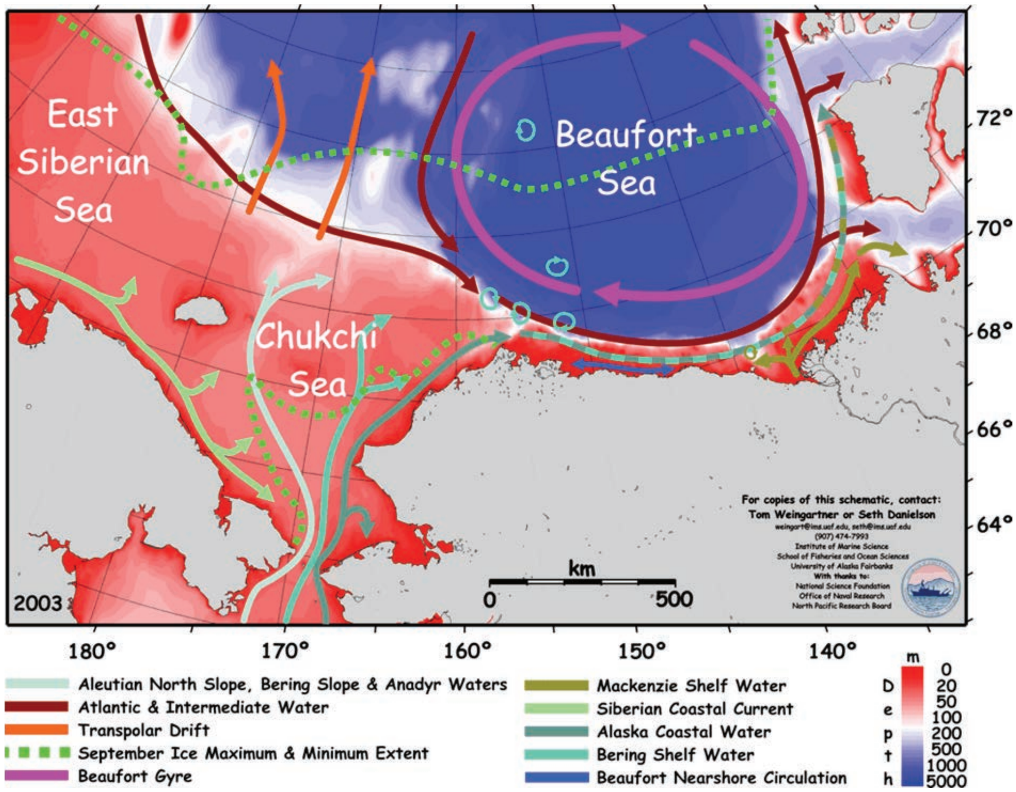


Figure 3.1-2 Bathymetry of the Beaufort Sea, with place names indicated.
Source: Weingartner 2008

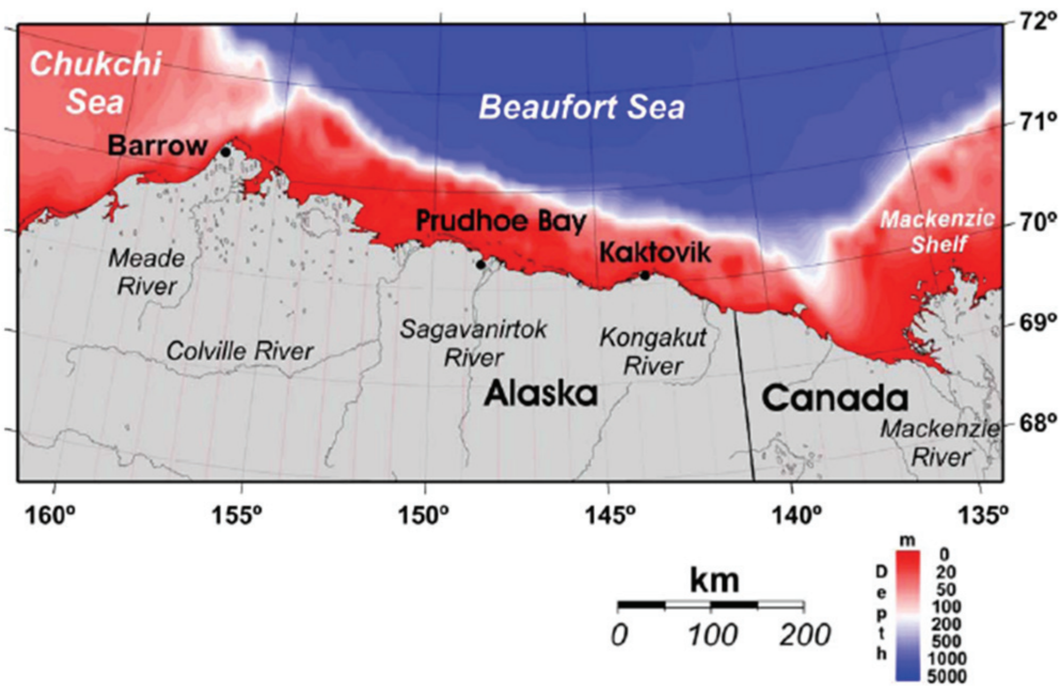


Figure 3.1-3 Schematic circulation map of the Beaufort and Chukchi shelves showing the flow of Bering Strait water through the Chukchi Sea along three principal pathways that are associated with distinct bathymetric features: the Herald Valley, the Central Channel, and Barrow Canyon.

Source: Weingartner and Danielson 2010

Three branches of the inflowing Pacific water are color-coded with navy blue (Anadyr Water) being the most nutrient-rich water and light blue (Alaska Coastal Water) being the least nutrient-rich. The Siberian Coastal Current (green) is present in summer and fall, but absent or weak in winter and spring. On the continental slope, the Pacific-origin water encounters Atlantic-origin Water (red) which is flowing counter-clockwise around the Arctic basin. Offshore of the slope, in the interior of the Canada Basin, is the clockwise wind-driven flow of the Beaufort Gyre (purple)

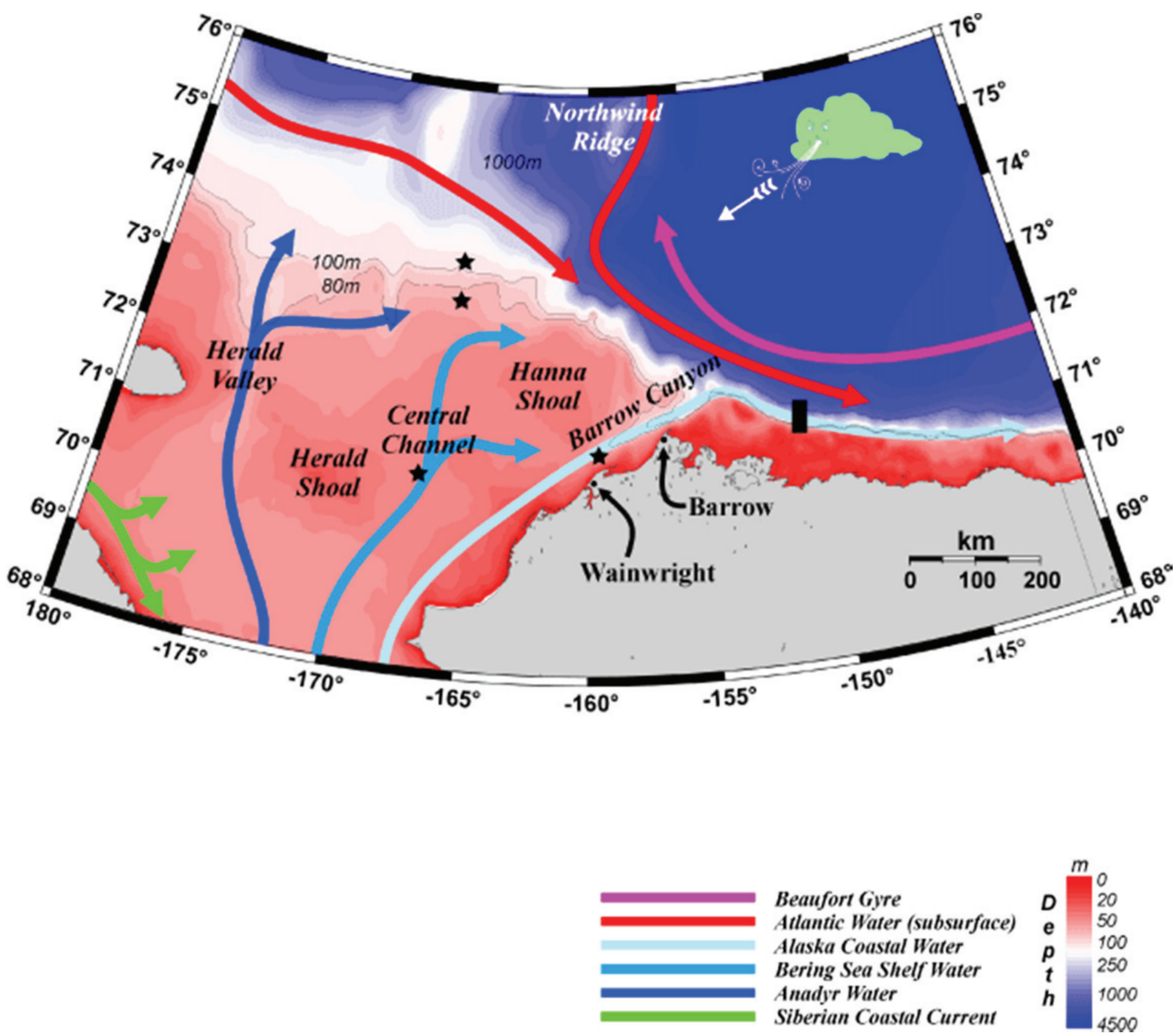
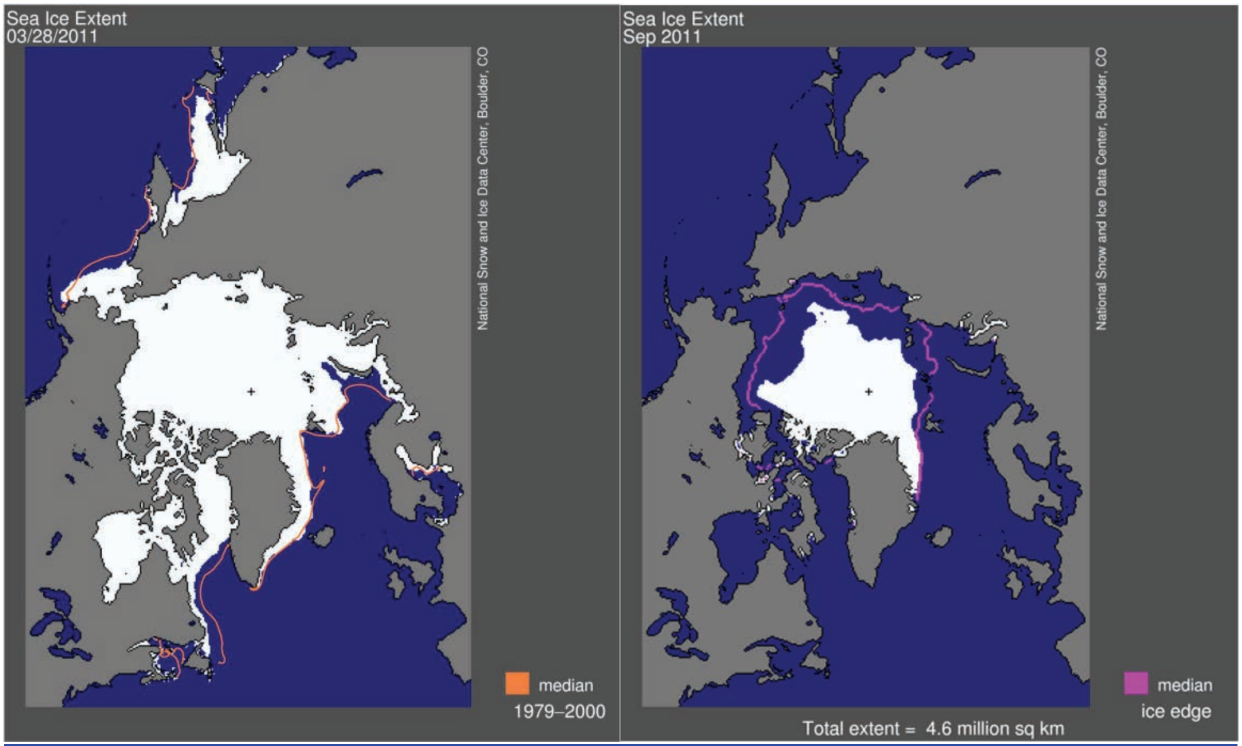


Figure 3.1-4 a) Sea Ice Extent March 2011 and September 2011. b) Average Monthly Arctic Sea Ice Extent March 1979 – 2011 and September 1979 – 2011.

Sources: NSIDC, 2011a,b

a) Map shows the maximum sea ice extent (in white) for March 2011, and also the median sea ice extent (red line) for the period 1979–2000. Graph shows the average monthly sea ice extent over the period 1979–2011.



b) Map shows the minimum sea ice extent (in white) for September 2011, and the median sea ice extent (red line) for the period 1979–2000. Graph shows the average monthly sea ice extent over the period 1979–2011.

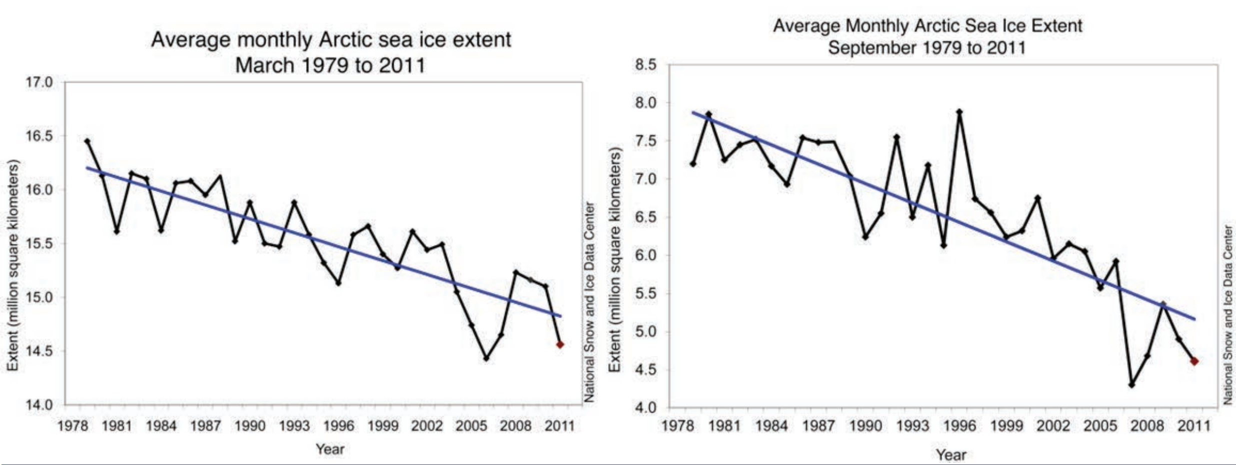


Figure 3.1-5 Sound Level Metrics.

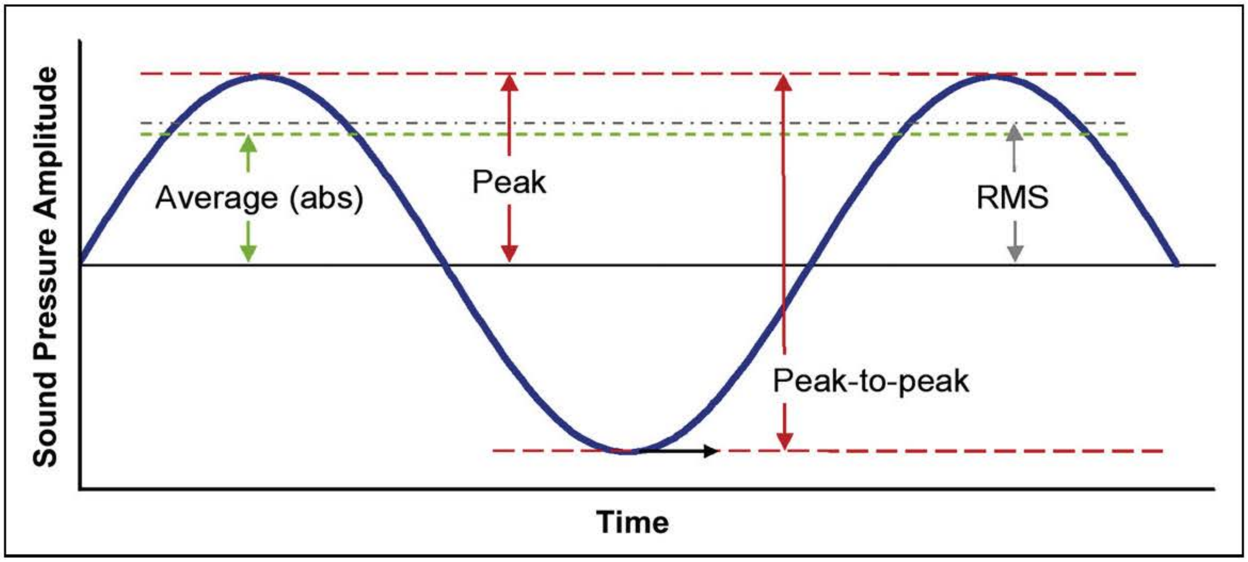


Figure 3.1-6a An audiogram of human hearing.
Source: Discovery of Sound in the Sea 2011

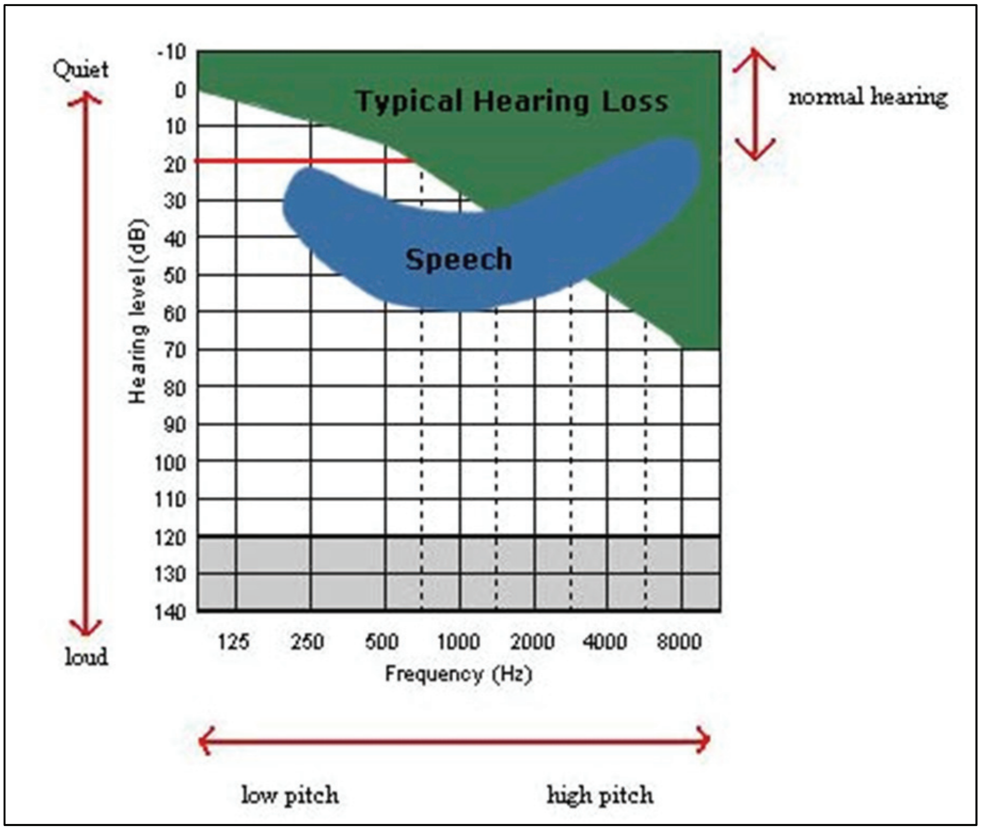


Figure 3.1-6b Graphic showing A-weighting function for human hearing.
Source: Harris 1998

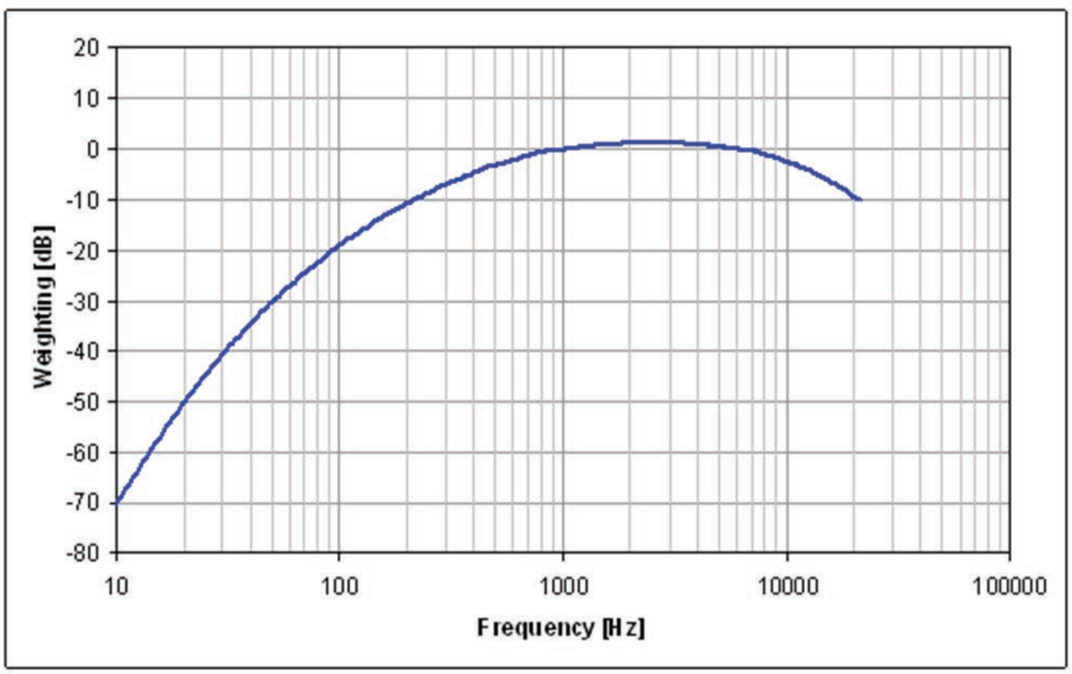


Figure 3.1-7 Hearing curves for some marine mammals in water and a typical human in air.

Source: Discovery of Sound in the Sea 2011

There are two sets of y-axes (vertical) because different reference pressures are used to measure sound in water (re 1 µPa; left axis) vs in air (re 20 µPa; right axis). Notice that the decibel values differ by 61.5 dB for the same value of intensity (watts/ m 2). The x-axis (horizontal) is the frequency of a sound on a logarithmic scale.

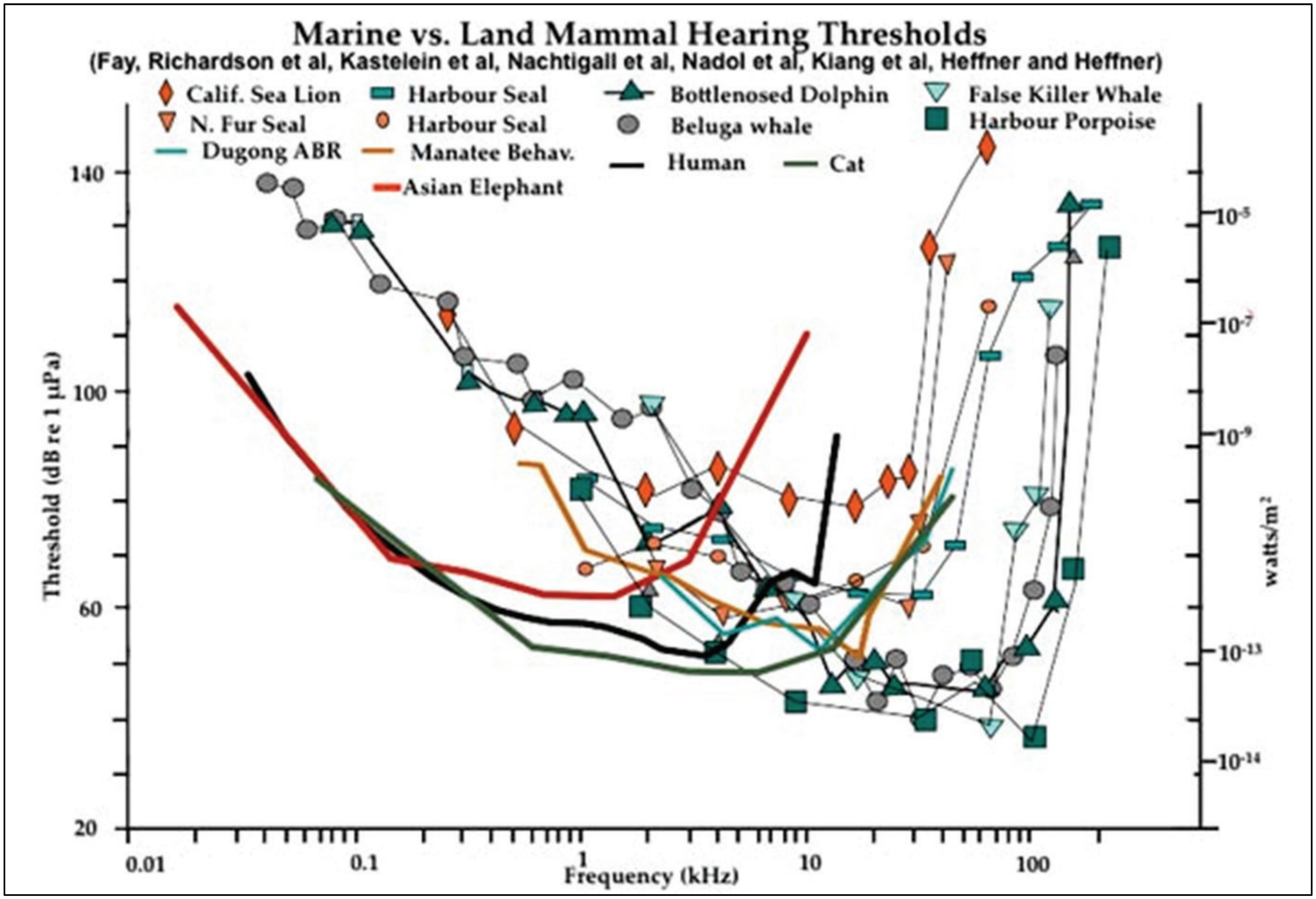


Figure 3.1-8 Graphic showing M-weighting functions for marine mammal hearing for (A) low, mid, and high frequency cetaceans, and (B) for pinnipeds in water and air.

Source: Southall et al. (2007)

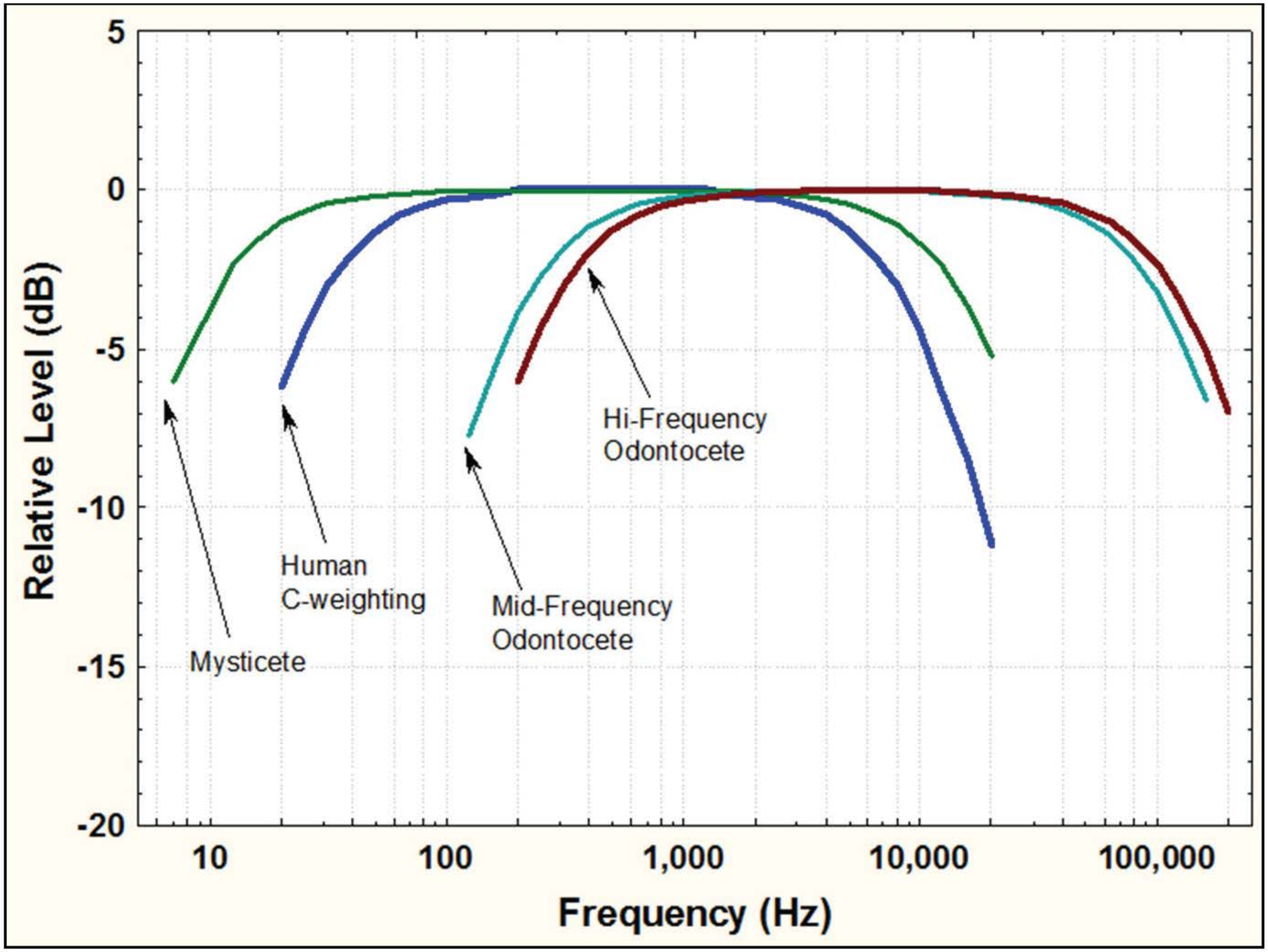


Figure 3.1-9 Prevailing underwater sound levels.

Source: NRC 2003a

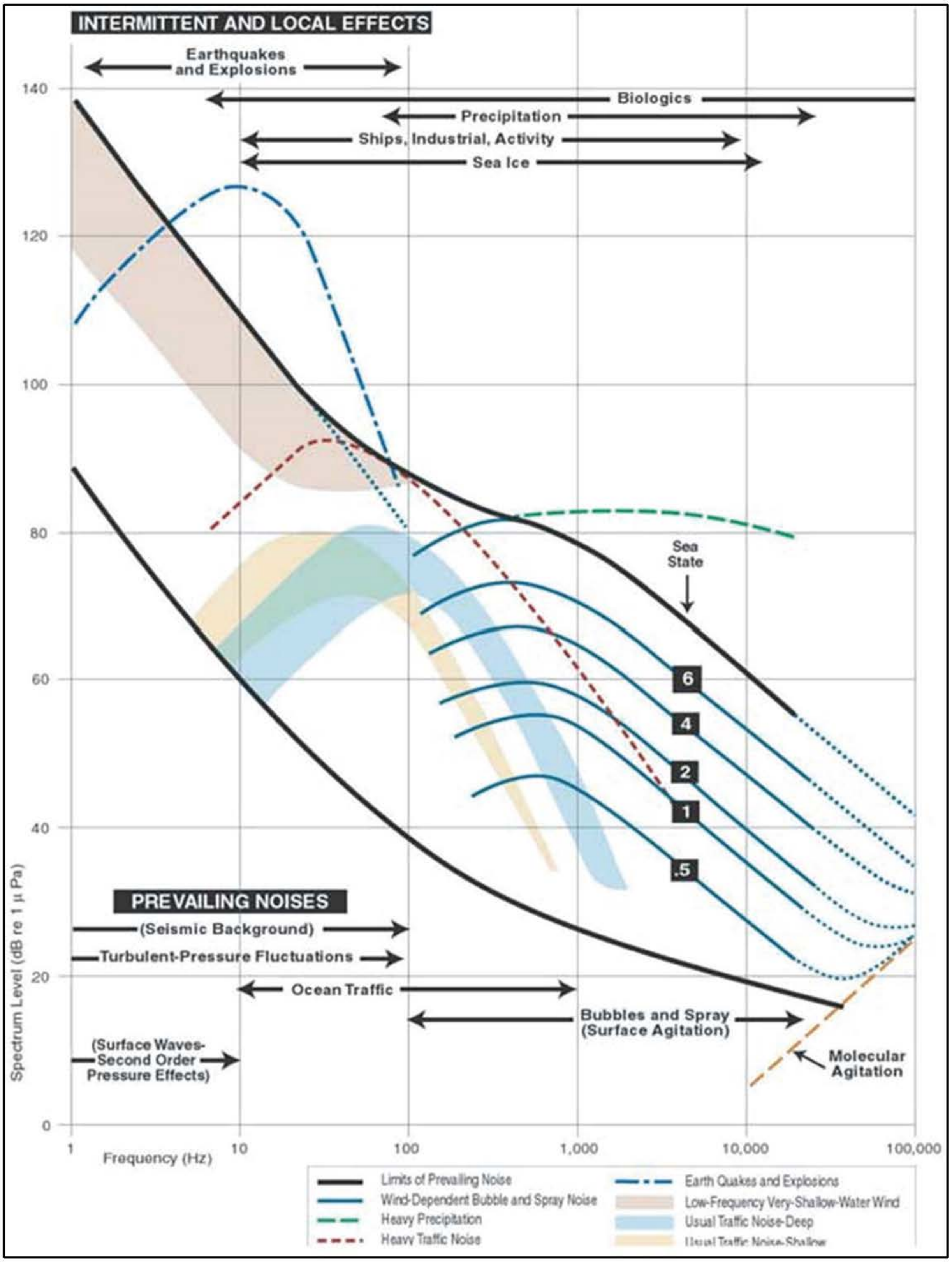
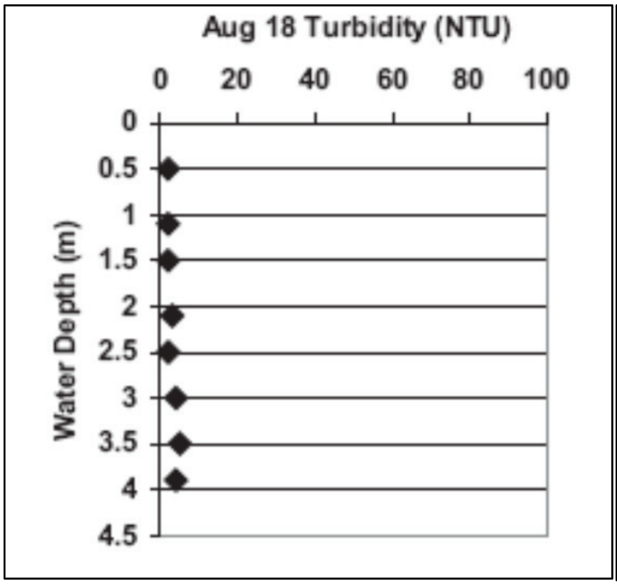
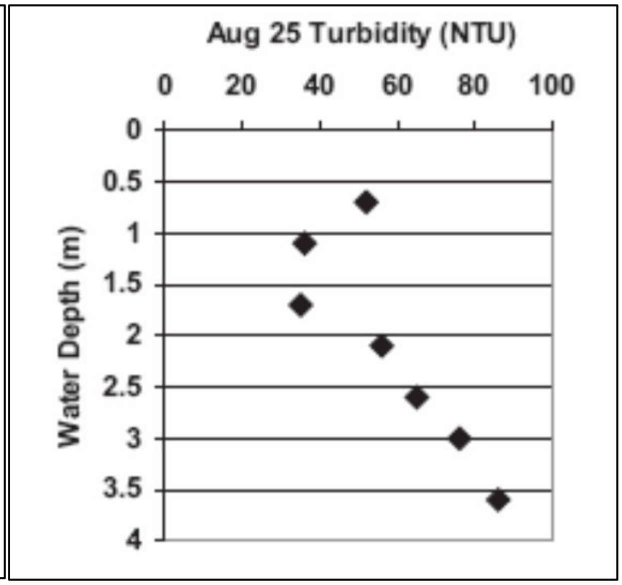


Figure 3.1-10 Depth profiles of natural turbidity levels measured in the nearshore Alaskan Beaufort Sea in 1999.

Source: Boehm 2001

Profile (a) shows turbidity levels before a storm event; profile (b) shows turbidity levels immediately following a storm event

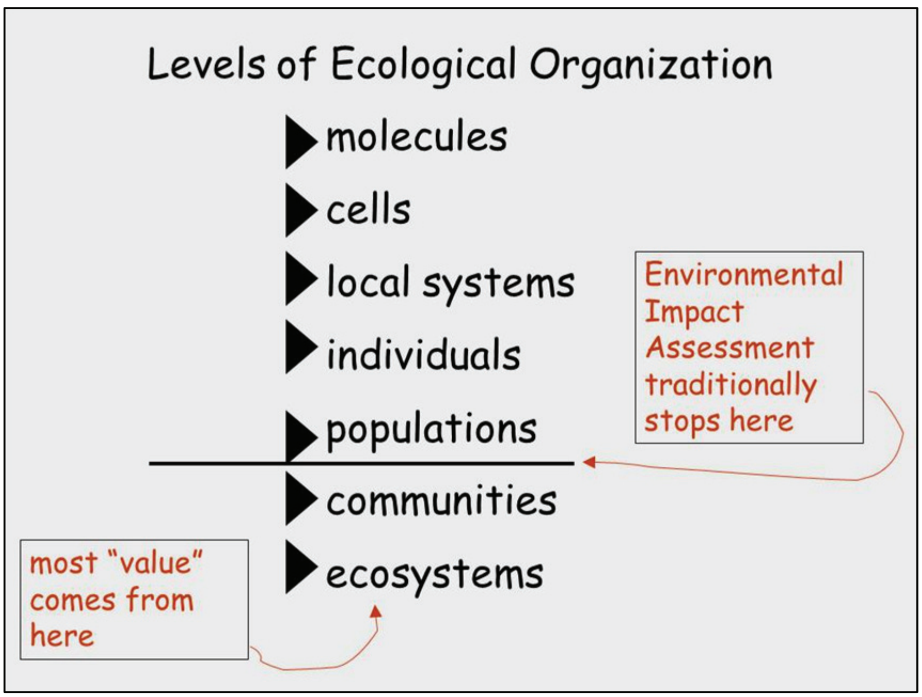


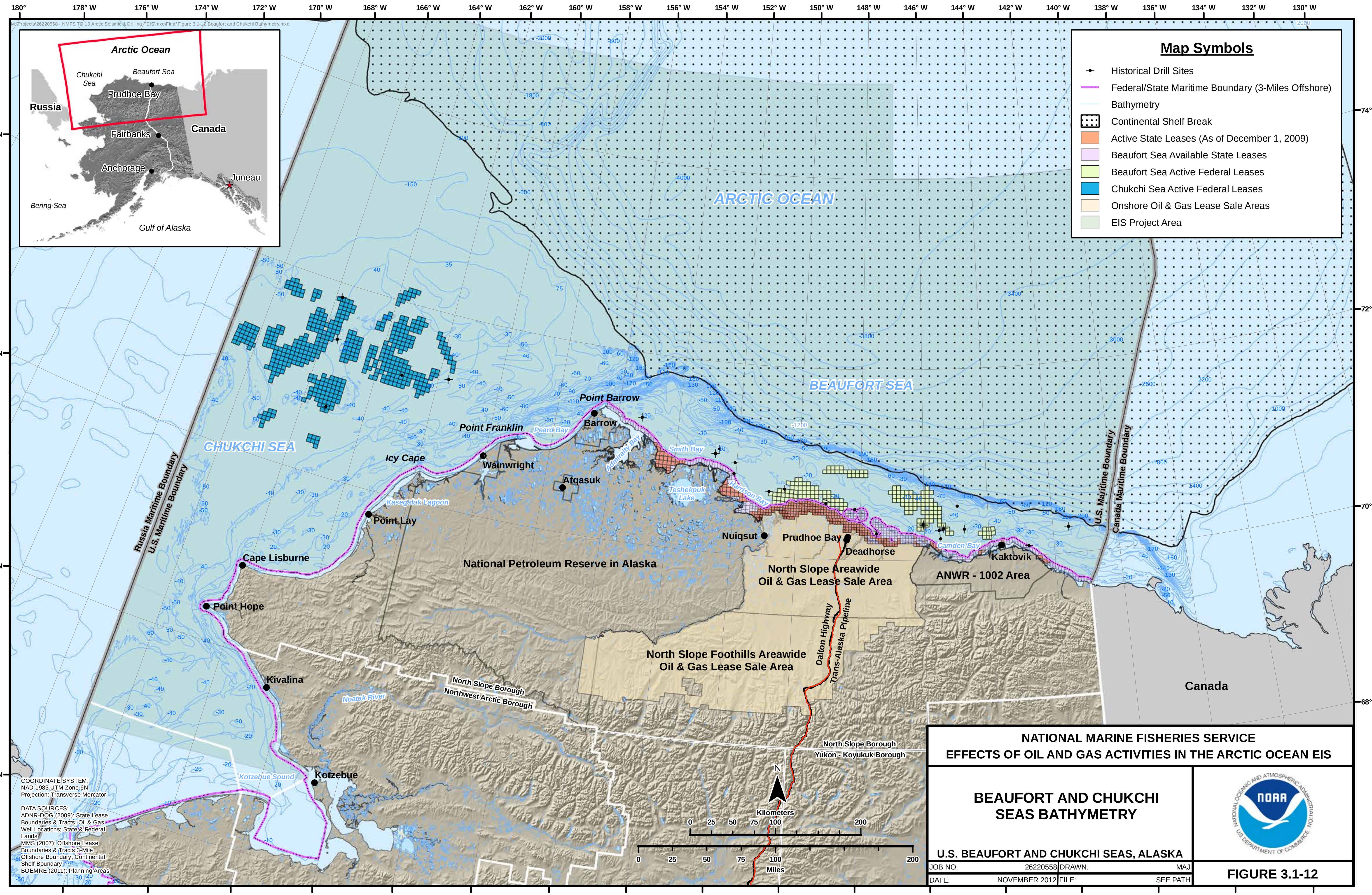


(a) (b)

Figure 3.1-11 Levels of Ecological Organization.

The dose-response model traditionally used in environmental impact assessment only considers the effects of stressors on individuals or populations. However, the value of ecosystem goods and services is usually derived from interactions among physical, chemical, and biological ecosystem components.





Map Symbols
Historical Drill Sites
Federal/State Maritime Boundary (3-Miles Offshore)
Bathymetry
Continental Shelf Break
Active State Leases (As of December 1, 2009)
Beaufort Sea Available State Leases
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Chukchi Sea Active Federal Leases
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CHUKCHI SEA
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U.S. Maritime Boundary
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Smith Bay
Harrison Bay
Teshekpuk Lake
Icy Cape
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Point Lay
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Kivalina
Noatak River
Kotzebue Sound
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Dalton Highway
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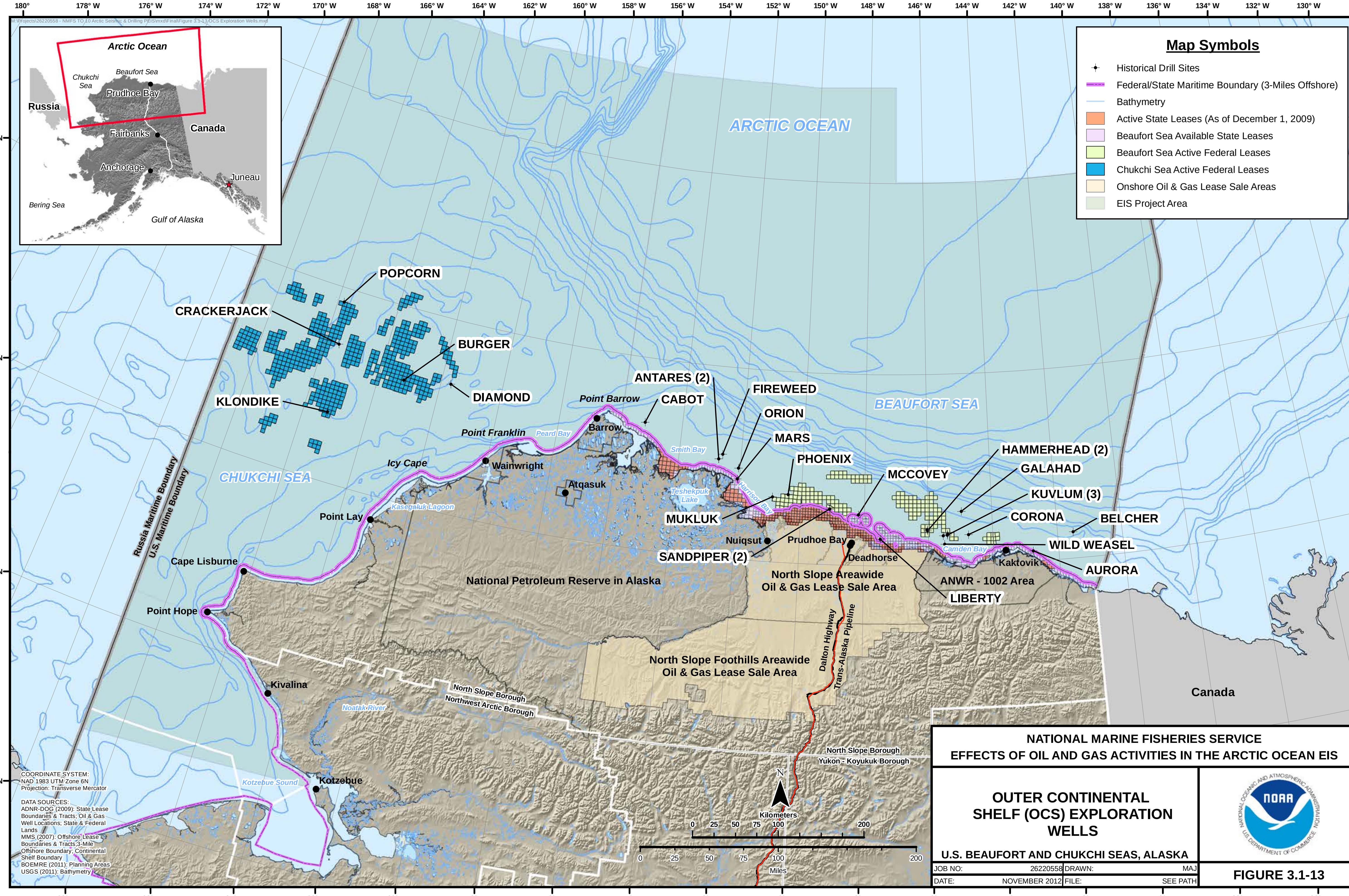
North Slope Borough
Northwest Arctic Borough
North Slope Borough
Yukon - Koyukuk Borough
Canada
COORDINATE SYSTEM:
NAD 1983 UTM Zone 6N
Projection: Transverse Mercator
DATA SOURCES:
ADNR-DOG (2009): State Lease Boundaries & Tracts; Oil & Gas Well Locations; State & Federal Lands
MMS (2007): Offshore Lease Boundaries & Tracts; 3-Mile Offshore Boundary; Continental Shelf Boundary
BOEMRE (2011): Planning Areas
Kilometers
0 25 50 75 100 200
0 25 50 75 100 200
Miles
NATIONAL MARINE FISHERIES SERVICE
EFFECTS OF OIL AND GAS ACTIVITIES IN THE ARCTIC OCEAN EIS
BEAUFORT AND CHUKCHI SEAS BATHYMETRY
U.S. BEAUFORT AND CHUKCHI SEAS, ALASKA
JOB NO: 26220558
DRAWN: MAJ
DATE: NOVEMBER 2012
FILE: SEE PATH
FIGURE 3.1-12



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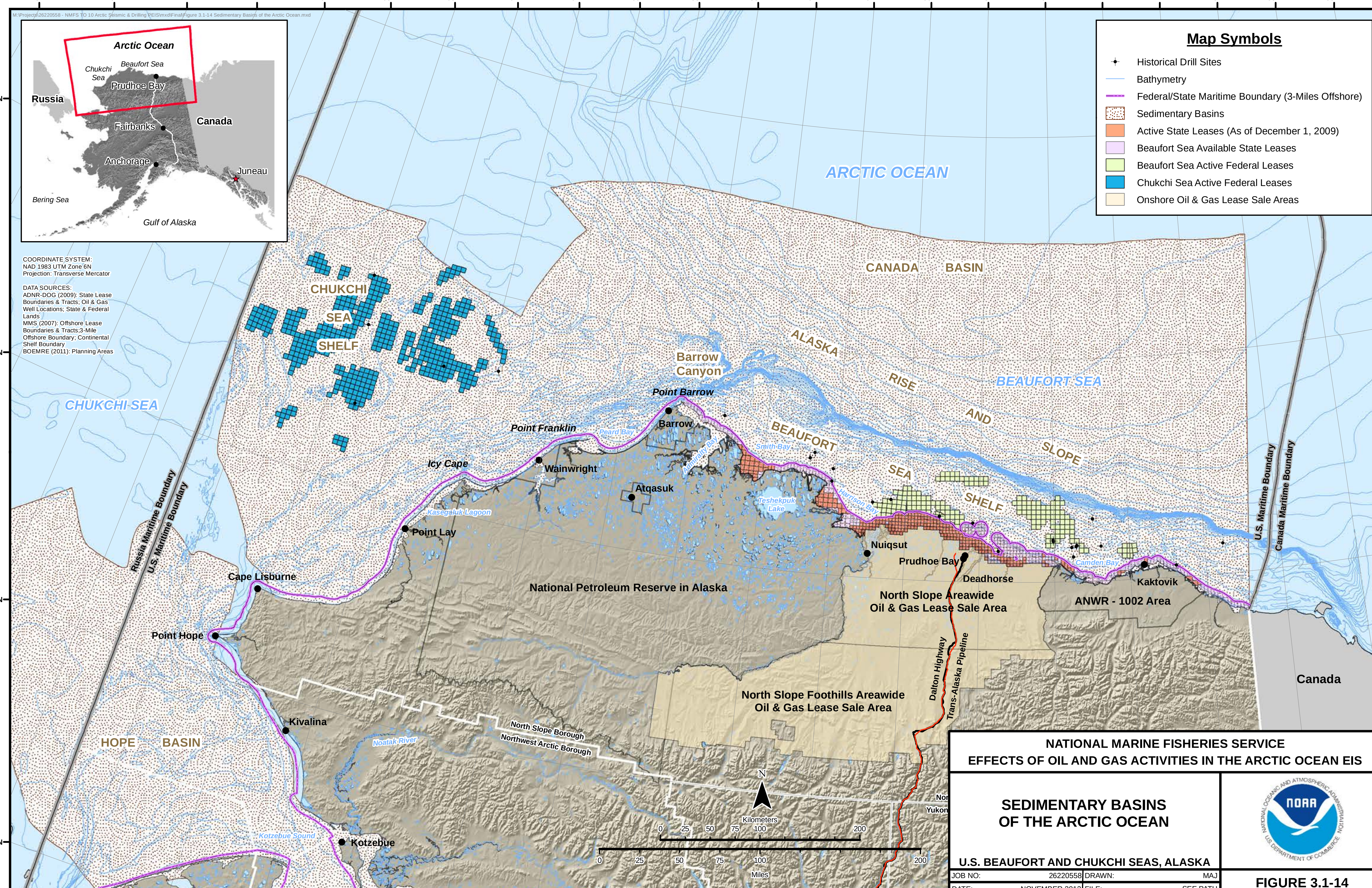
OUTER CONTINENTAL SHELF (OCS) EXPLORATION WELLS

U.S. BEAUFORT AND CHUKCHI SEAS, ALASKA

FIGURE 3.1-13



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SEDIMENTARY BASINS OF THE ARCTIC OCEAN

U.S. BEAUFORT AND CHUKCHI SEAS, ALASKA

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FIGURE 3.1-14

Figure 3.2-1 Simplified Food Web of the Arctic Ocean Ecosystem.

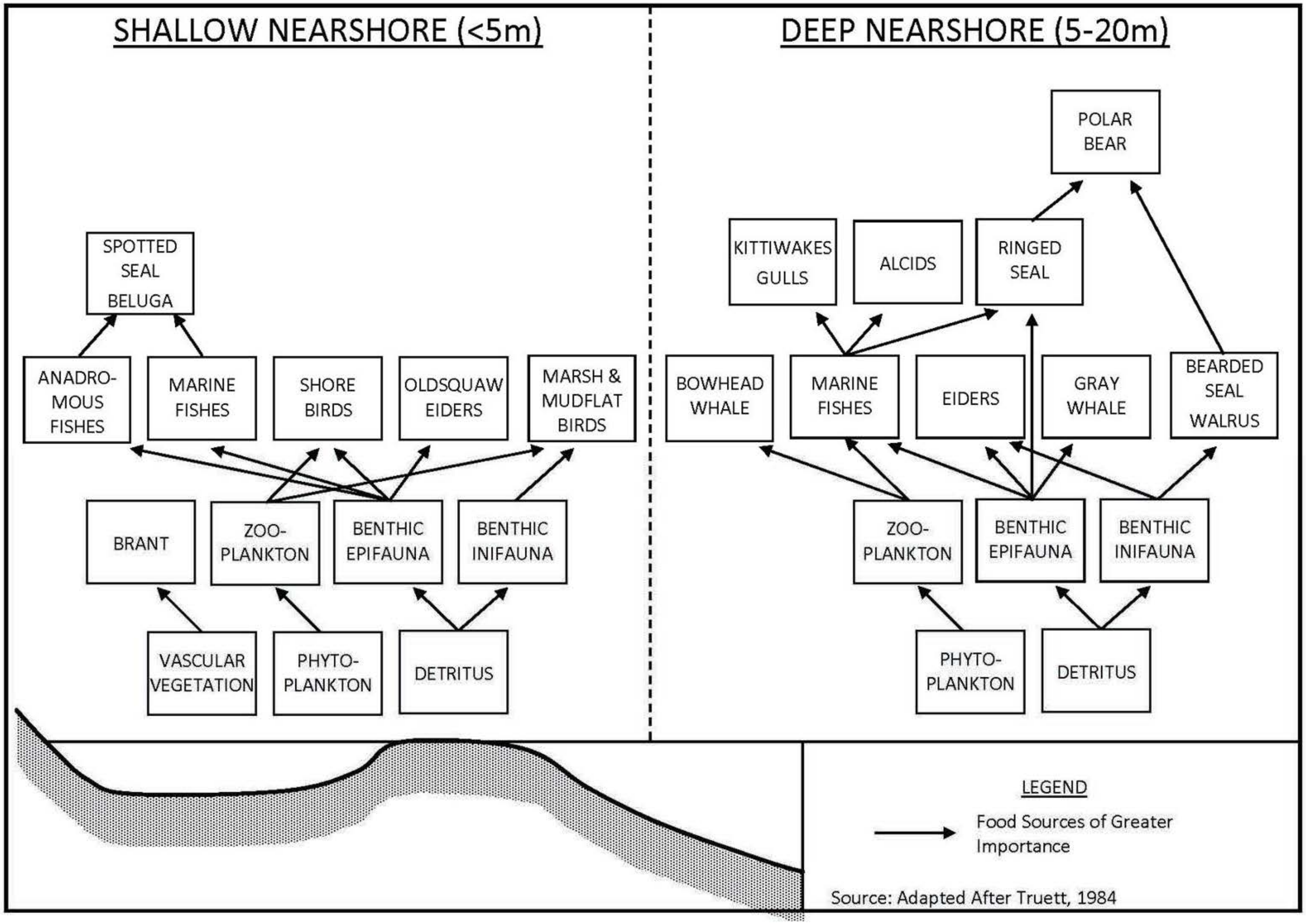


Figure 3.2-2 Seasonal ranges of the Western Arctic caribou herd with locations of satellite-collared caribou collected during the 2006-2007 regulatory year.

Source: ADF&G 2003

Data excludes first year caribou was collared; all collars standardized to one location every six days.

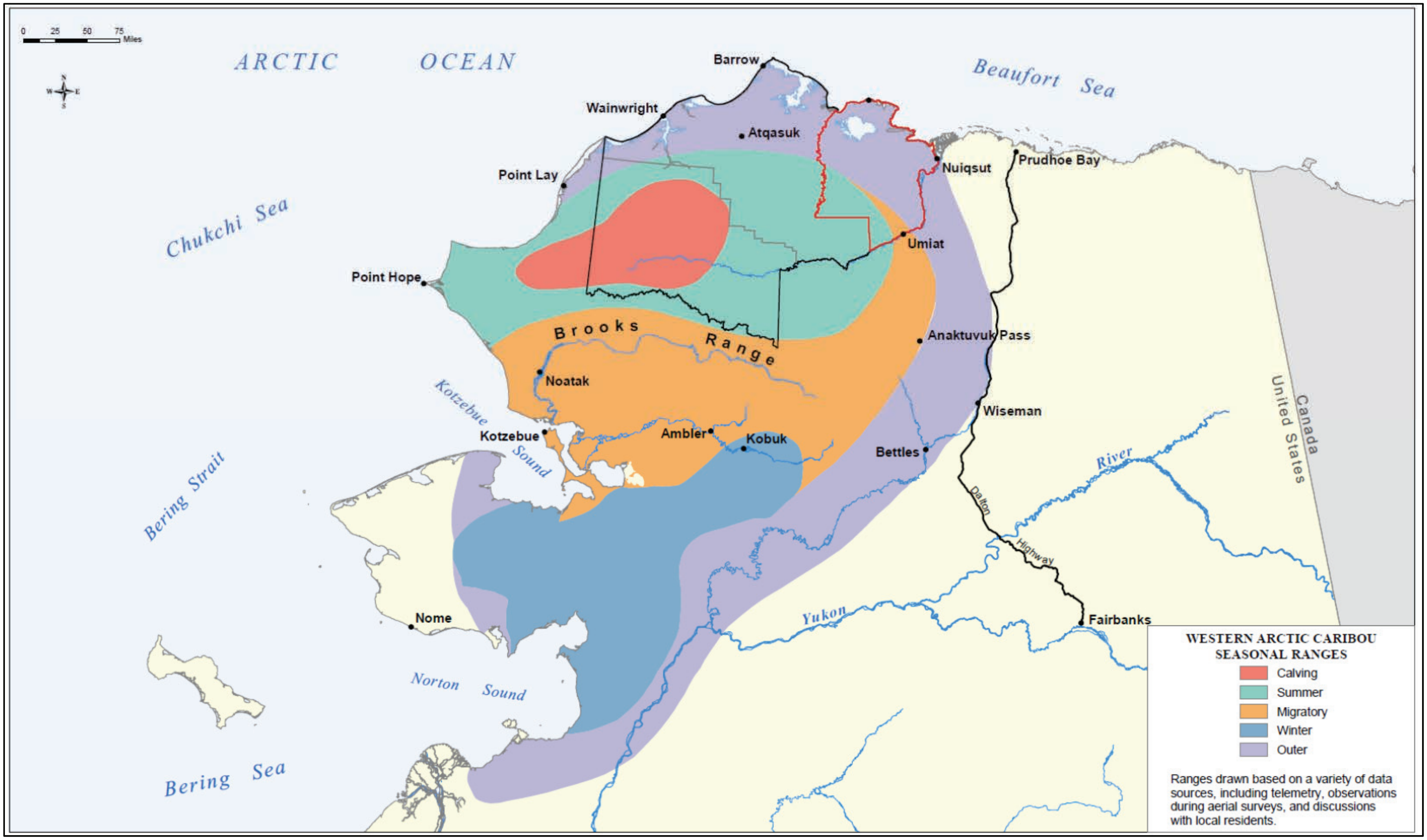
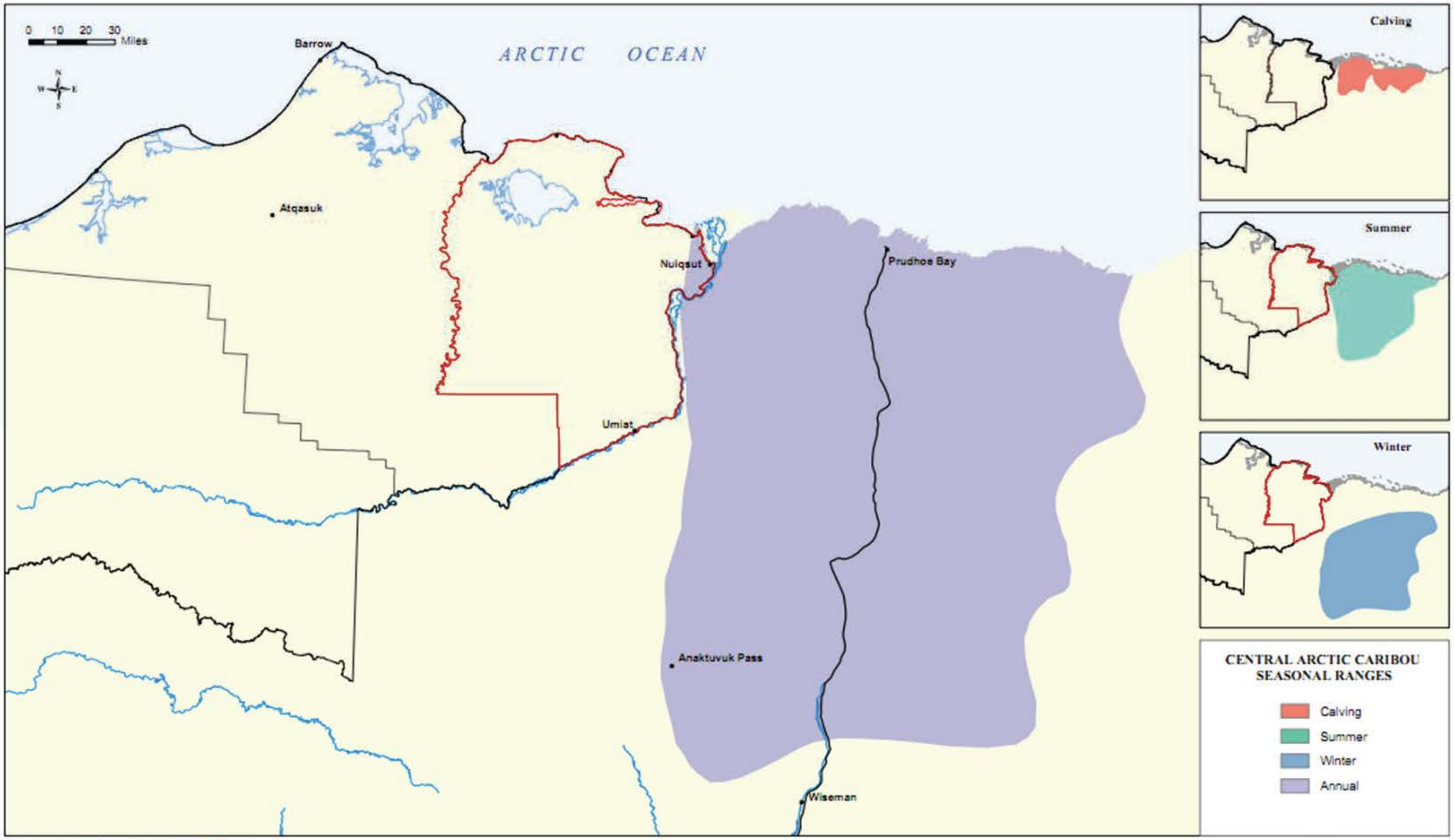


Figure 3.2-3 Central Arctic Caribou Herd Seasonal Ranges in Northern Alaska.
Source: BLM 2005



Source: Alaska Department of Fish & Game

Figure 3.2-4 Caribou calving areas within the Arctic National Wildlife Refuge.

Source: USFWS 2008 The Teshekpuk Caribou Herd

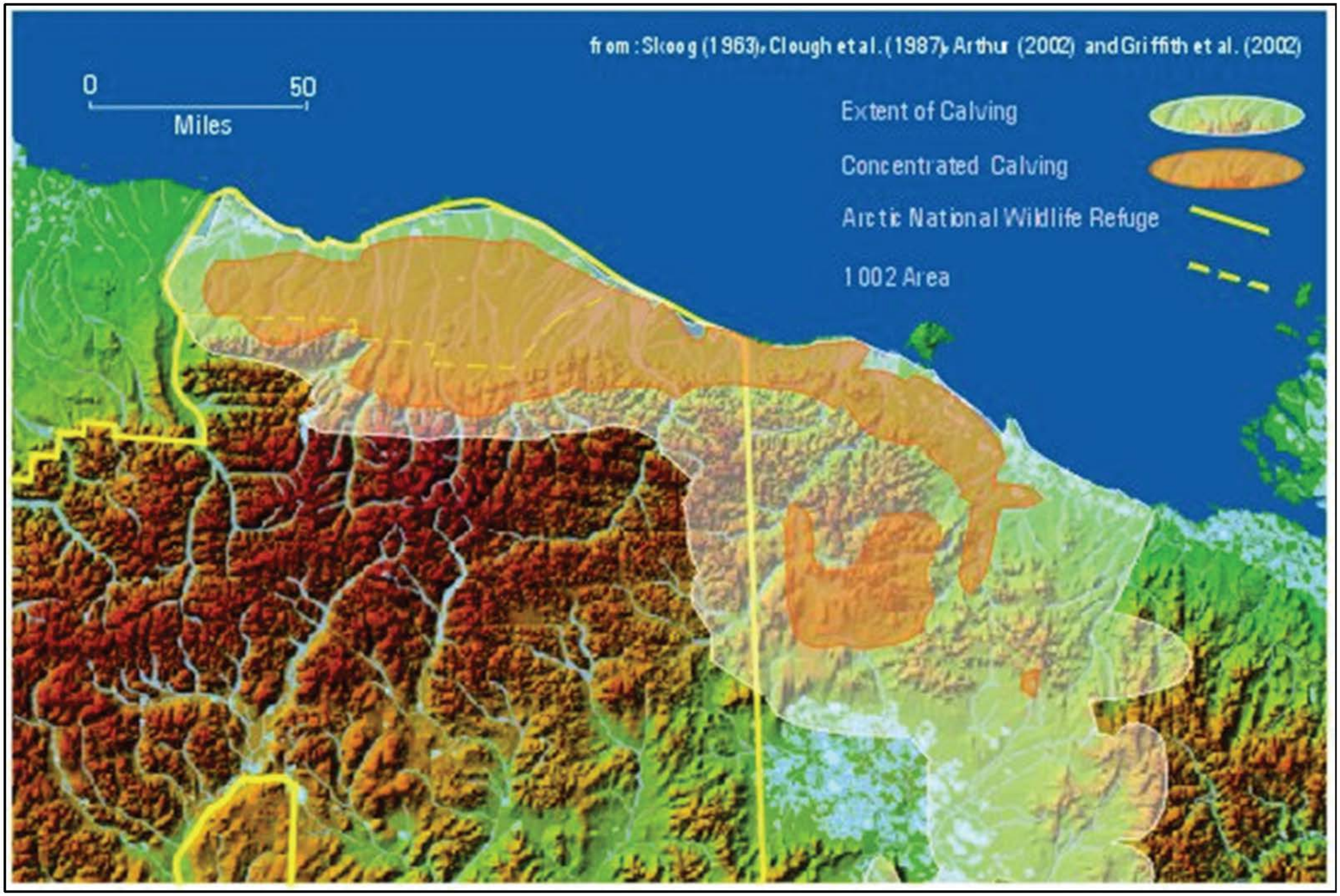
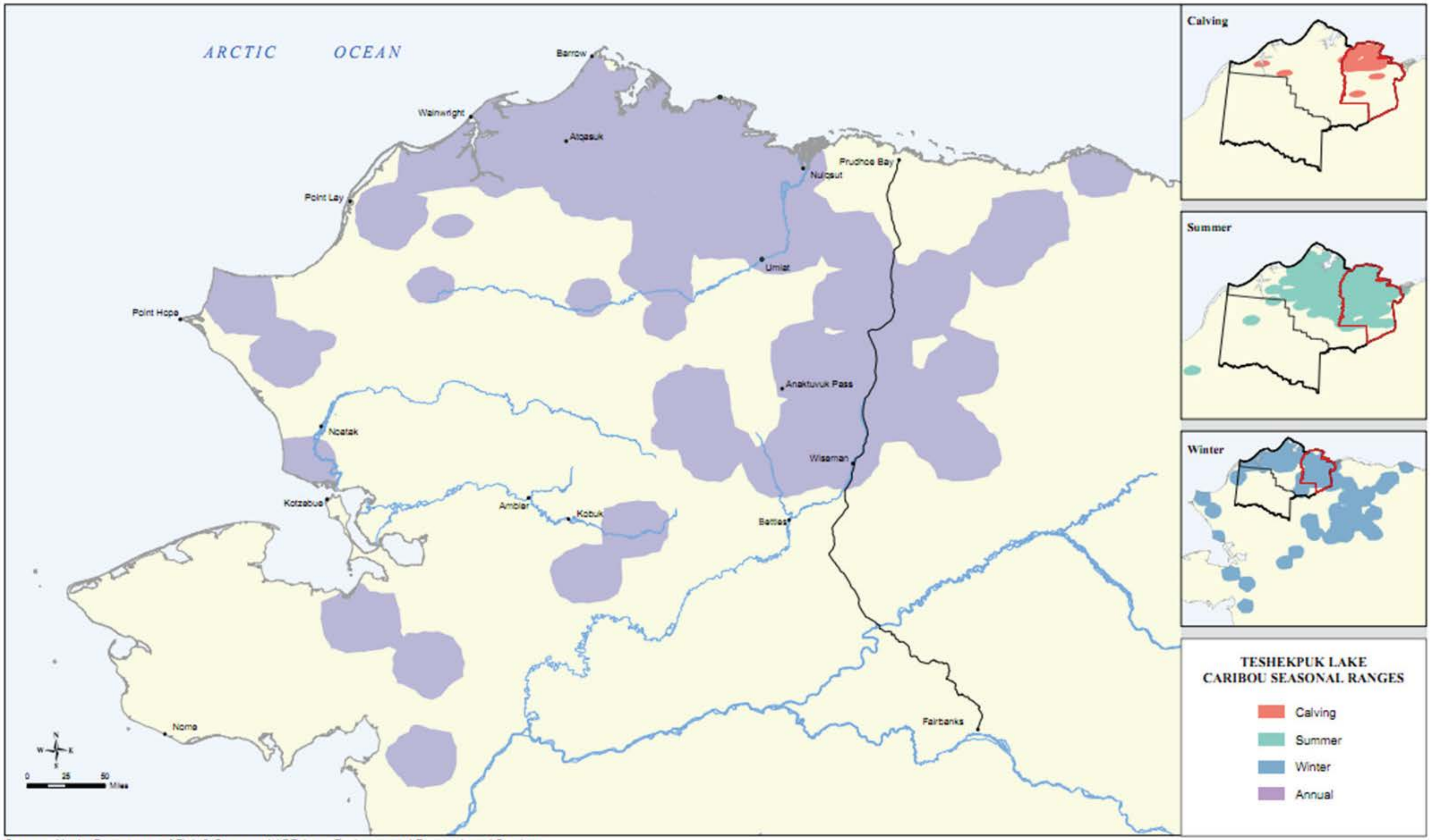


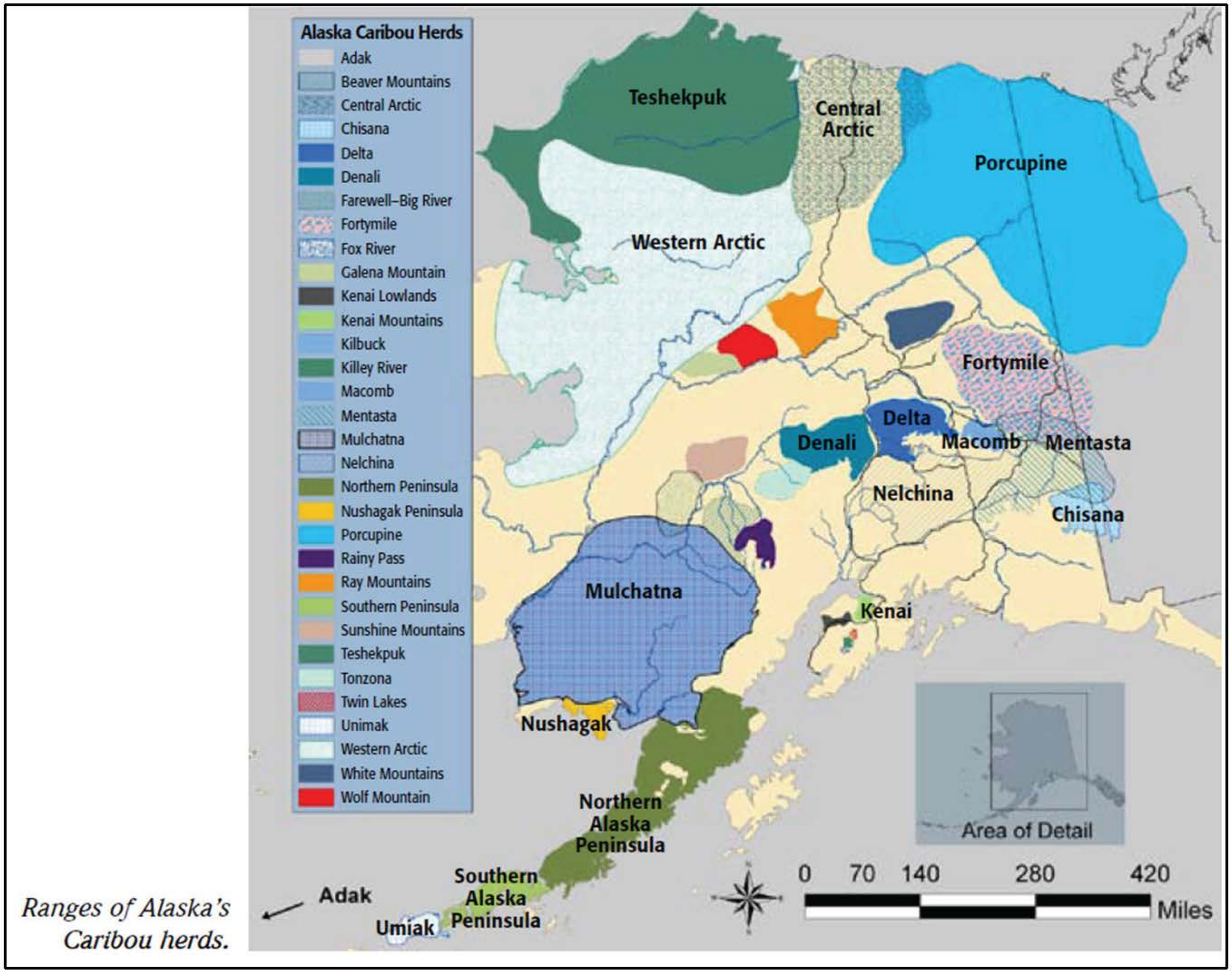
Figure 3.2-5 Teshekpuk Lake Caribou Herd Seasonal Ranges in Northern Alaska (1990 – 2005 Satellite Telemetry Data).
Source: BLM 2005

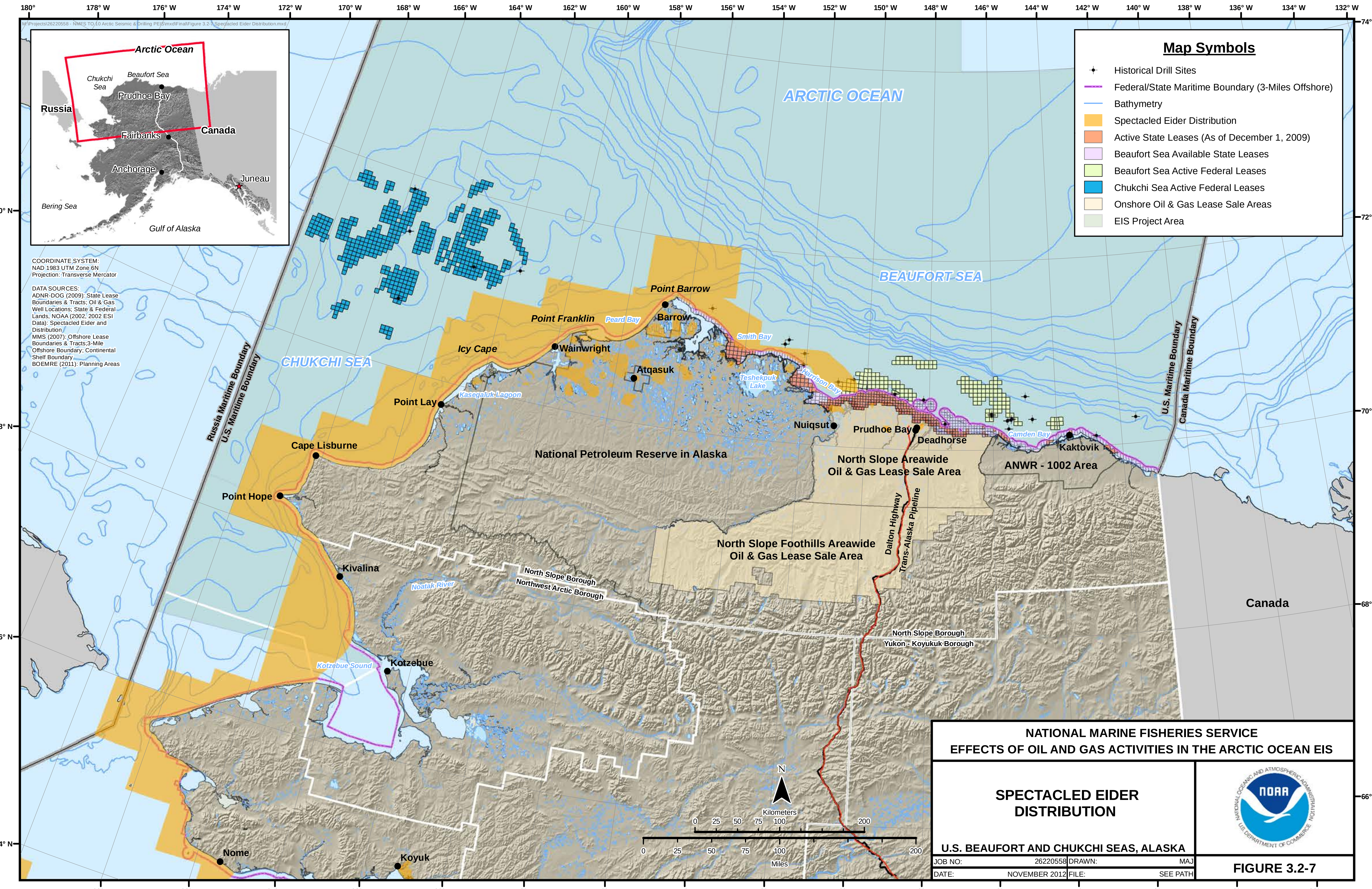


Map 3-20. Teshekpuk Lake Caribou Herd Seasonal Ranges in Northern Alaska (1990 - 2005 Satellite Telemetry Data)

Figure 3.2-6 Ranges of Alaska's Caribou herds.

Source: ADFG 2010a




Map Symbols
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Federal/State Maritime Boundary (3-Miles Offshore)
Bathymetry
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Active State Leases (As of December 1, 2009)
Beaufort Sea Available State Leases
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Chukchi Sea Active Federal Leases
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Arctic Ocean
Chukchi Sea
Beaufort Sea
Prudhoe Bay
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Fairbanks
Canada
Anchorage
Juneau
Bering Sea
Gulf of Alaska
COORDINATE SYSTEM:
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Projection: Transverse Mercator
DATA SOURCES:
ADNR-DOG (2009): State Lease Boundaries & Tracts; Oil & Gas Well Locations; State & Federal Lands, NOAA (2002, 2002 ESI Data): Spectacled Eider and Distribution
MMS (2007): Offshore Lease Boundaries & Tracts;3-Mile Offshore Boundary; Continental Shelf Boundary
BOEMRE (2011): Planning Areas
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Northwest Arctic Borough
Yukon - Koyukuk Borough
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Kotzebue Sound
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U.S. BEAUFORT AND CHUKCHI SEAS, ALASKA
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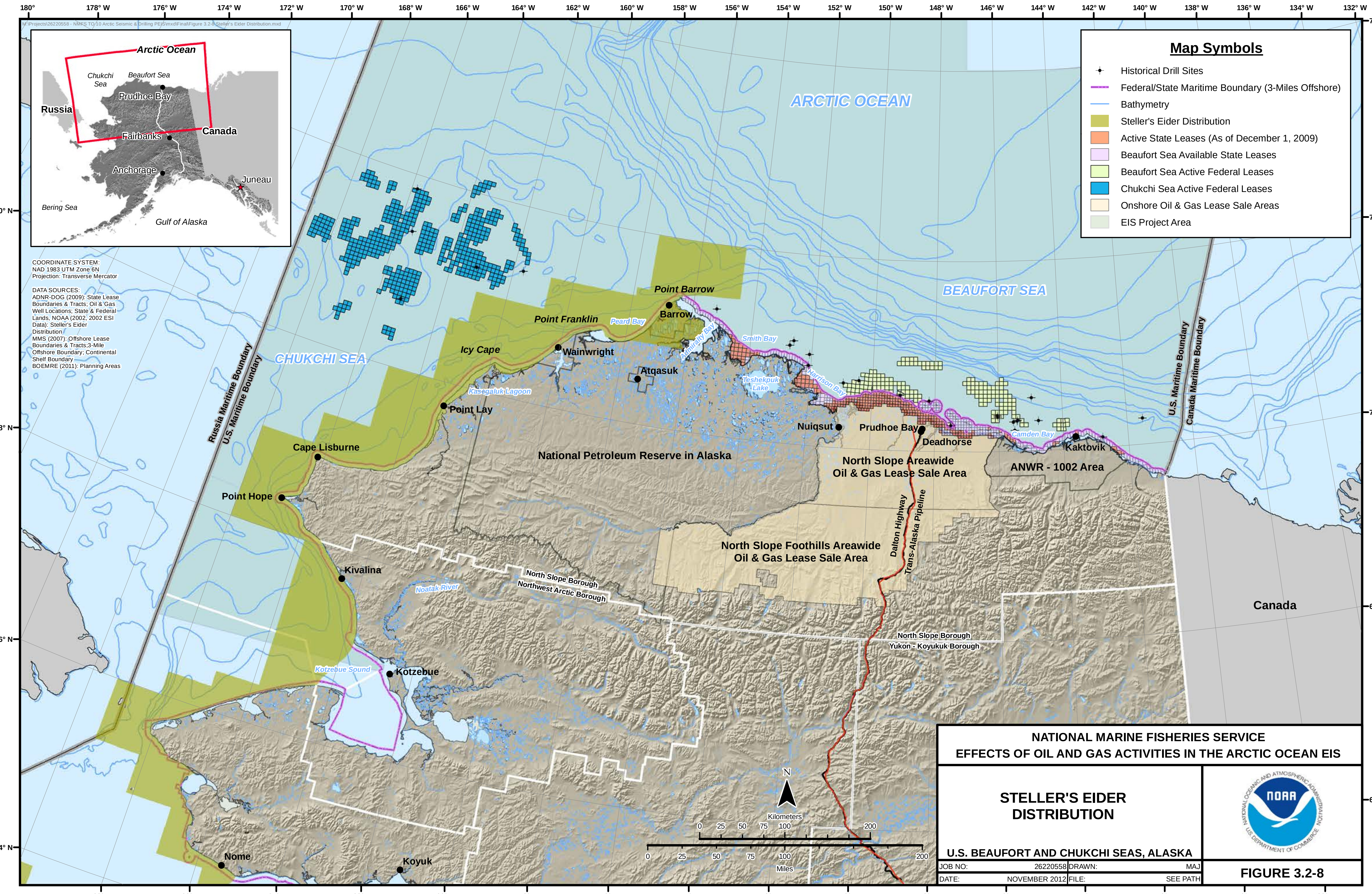
DATE: NOVEMBER 2012 FILE: SEE PATH
FIGURE 3.2-7



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BOEMRE (2011): Planning Areas
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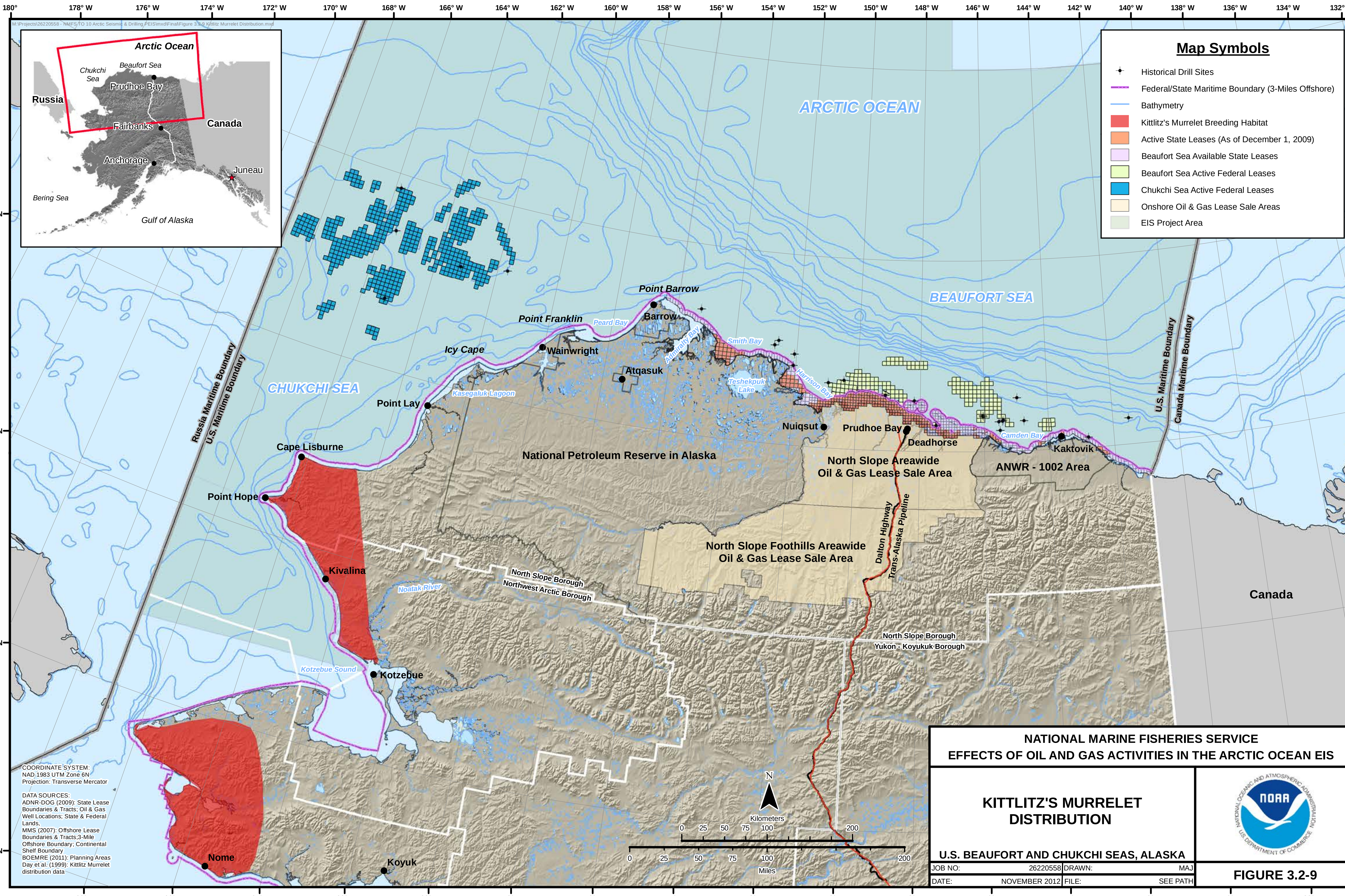

Map Symbols
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Kittlitz's Murrelet Breeding Habitat
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Chukchi Sea Active Federal Leases
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MMS (2007): Offshore Lease Boundaries & Tracts;3-Mile Offshore Boundary; Continental Shelf Boundary
BOEMRE (2011): Planning Areas
Day et al. (1999): Kittlitz Murrelet distribution data
NATIONAL MARINE FISHERIES SERVICE
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KITTLITZ'S MURRELET DISTRIBUTION
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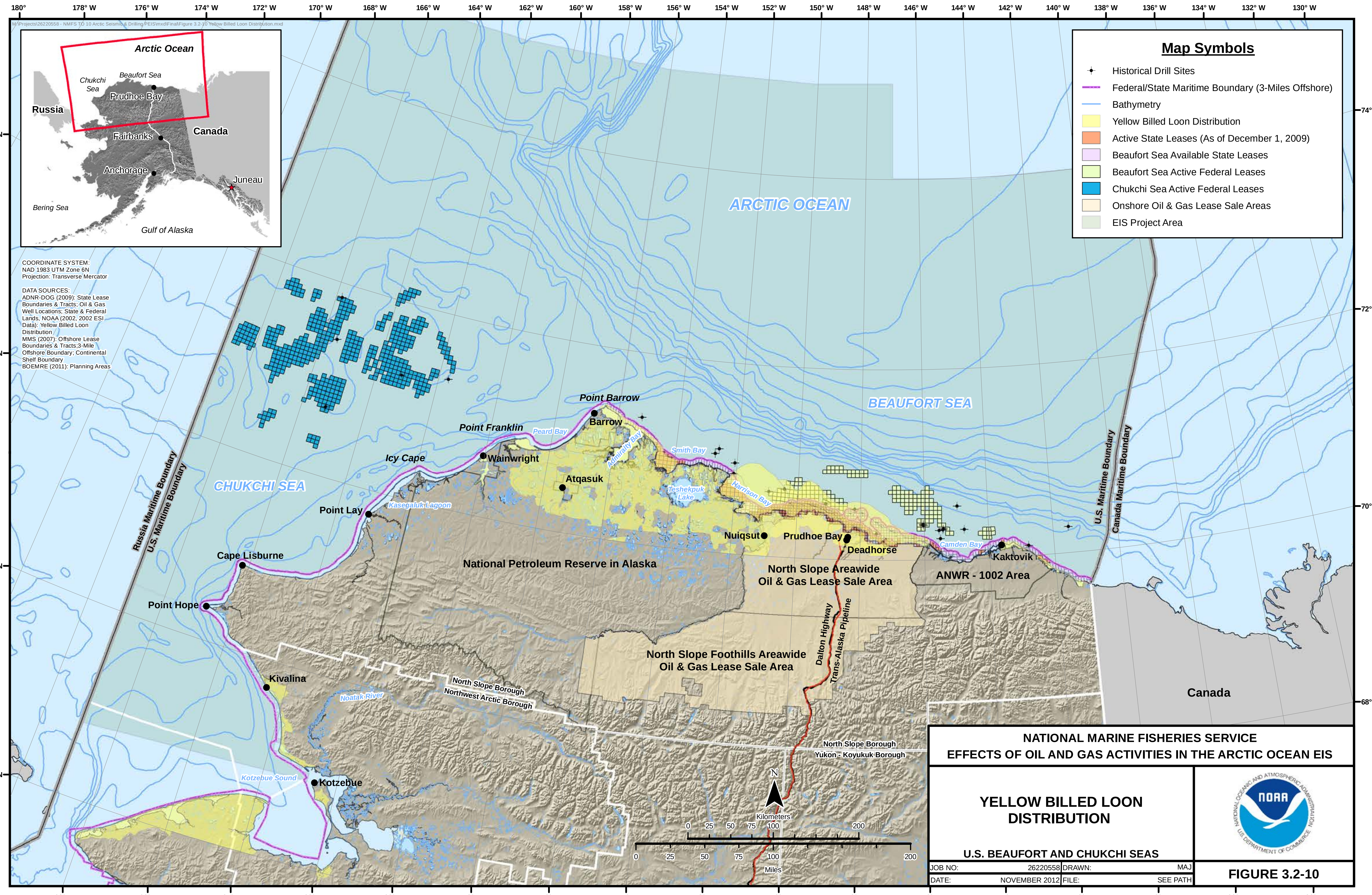
NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

FIGURE 3.2-9


Map Symbols
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Federal/State Maritime Boundary (3-Miles Offshore)
Bathymetry
Yellow Billed Loon Distribution
Active State Leases (As of December 1, 2009)
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Projection: Transverse Mercator
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ADNR-DOG (2009): State Lease Boundaries & Tracts; Oil & Gas Well Locations; State & Federal Lands, NOAA (2002, 2002 ESI Data): Yellow Billed Loon Distribution
MMS (2007): Offshore Lease Boundaries & Tracts;3-Mile Offshore Boundary; Continental Shelf Boundary
BOEMRE (2011): Planning Areas
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Kilometers
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Miles
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72° N 70° N 68° N 66° N
74° N 72° N 70° N 68° N
168° W 166° W 164° W 162° W 160° W 158° W 156° W 154° W 152° W 150° W 148° W 146° W 144° W 142° W 140° W 138° W 136° W
NATIONAL MARINE FISHERIES SERVICE
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YELLOW BILLED LOON DISTRIBUTION
U.S. BEAUFORT AND CHUKCHI SEAS
JOB NO: 26220558
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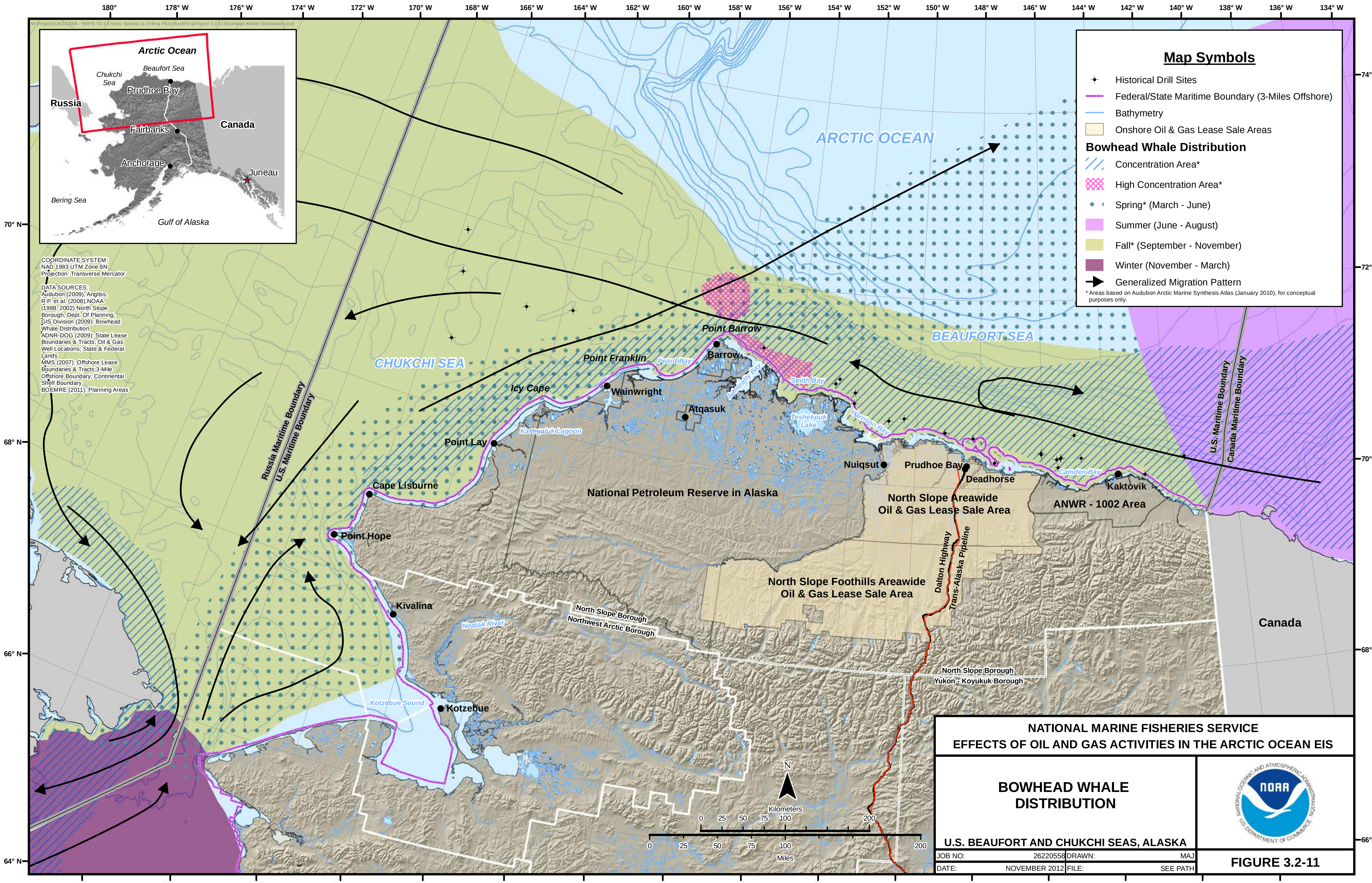
DATE: NOVEMBER 2012
FILE: SEE PATH
FIGURE 3.2-10



Arctic Ocean
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Chukchi Sea
Prudhoe Bay
Russia
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Fairbanks
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Bering Sea
Gulf of Alaska
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NAD 1983 UTM Zone 6N
Projection: Transverse Mercator
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Audubon (2009), Angliss, R.P. et al. (2008),NOAA (1988, 2002) North Slope Borough, Dept. Of Planning, GIS Division (2009): Bowhead Whale Distribution
ADNR-DOG (2009): State Lease Boundaries & Tracts; Oil & Gas Well Locations; State & Federal Lands
MMS (2007): Offshore Lease Boundaries & Tracts;3-Mile Offshore Boundary; Continental Shelf Boundary
BOEMRE (2011): Planning Areas
Map Symbols
Historical Drill Sites
Federal/State Maritime Boundary (3-Miles Offshore)
Bathymetry
Onshore Oil & Gas Lease Sale Areas
Bowhead Whale Distribution
Concentration Area*
High Concentration Area*
Spring* (March - June)
Summer (June - August)
Fall* (September - November)
Winter (November - March)
Generalized Migration Pattern
* Areas based on Audubon Arctic Marine Synthesis Atlas (January 2010), for conceptual purposes only.
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BEAUFORT SEA
CHUKCHI SEA
Russia Maritime Boundary
U.S. Maritime Boundary
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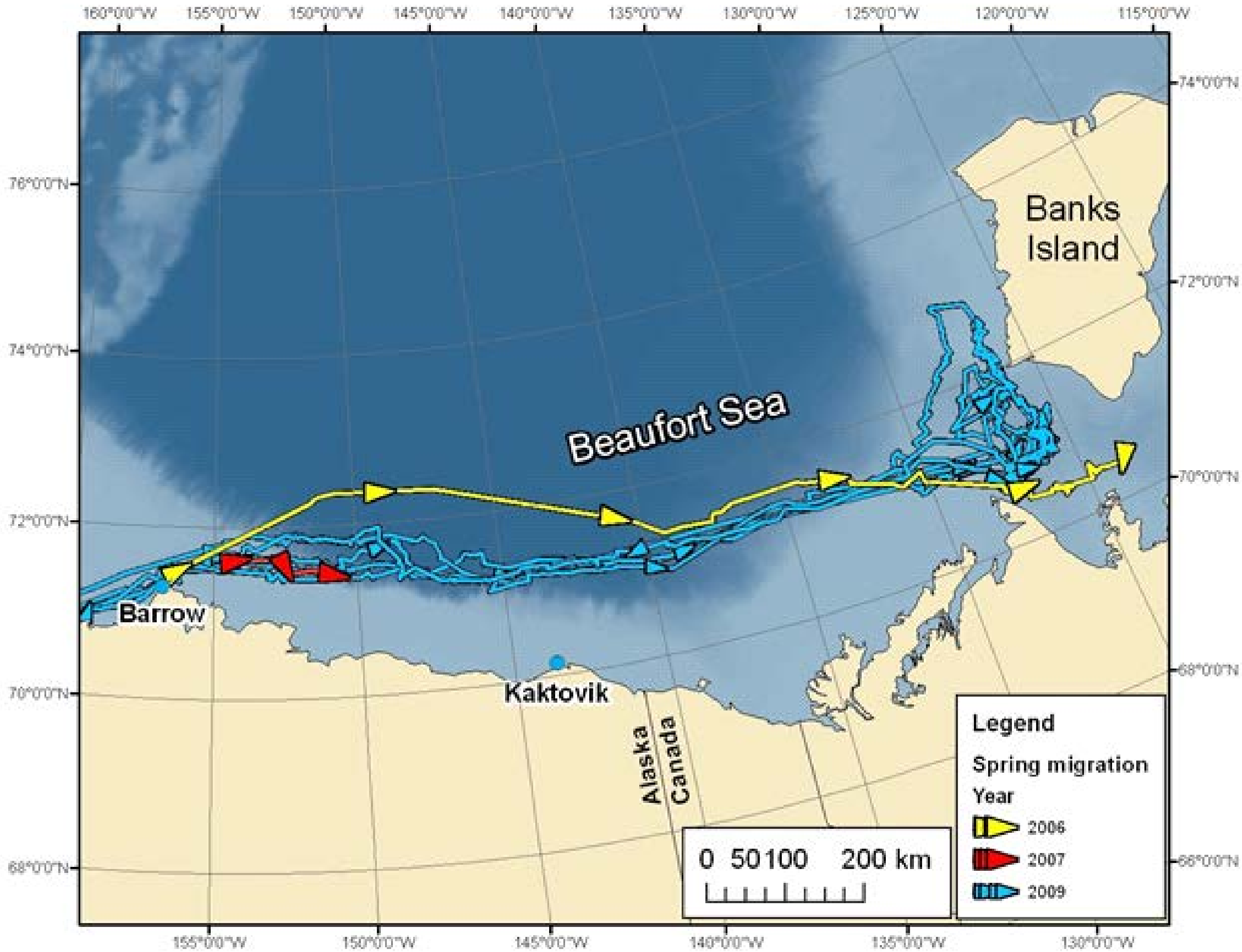
Dalton Highway
Trans-Alaska Pipeline
North Slope Foothills Areawide Oil & Gas Lease Sale Area
Kivalina
North Slope Borough
Northwest Arctic Borough
Noatak River
Canada
North Slope Borough
Yukon - Koyukuk Borough
Kotzebue Sound
Kotzebue
Kilometers
0 25 50 75 100 200
Miles
0 25 50 75 100 200
N
NATIONAL MARINE FISHERIES SERVICE
EFFECTS OF OIL AND GAS ACTIVITIES IN THE ARCTIC OCEAN EIS
BOWHEAD WHALE DISTRIBUTION
U.S. BEAUFORT AND CHUKCHI SEAS, ALASKA
JOB NO: 26220558
DRAWN: MAJ
DATE: NOVEMBER 2012
FILE: SEE PATH
FIGURE 3.2-11

M:\Projects\26220558 - NMFS TO 10 Arctic Seismic & Drilling PEIS\mxd\Final\Figure 3.2-12 Tracks of Satellite Tagged Bowhead Whales.mxd



DATA SOURCE:
Quakenbush et al. 2010b

NATIONAL MARINE FISHERIES SERVICE
EFFECTS OF OIL AND GAS ACTIVITIES IN THE ARCTIC OCEAN EIS

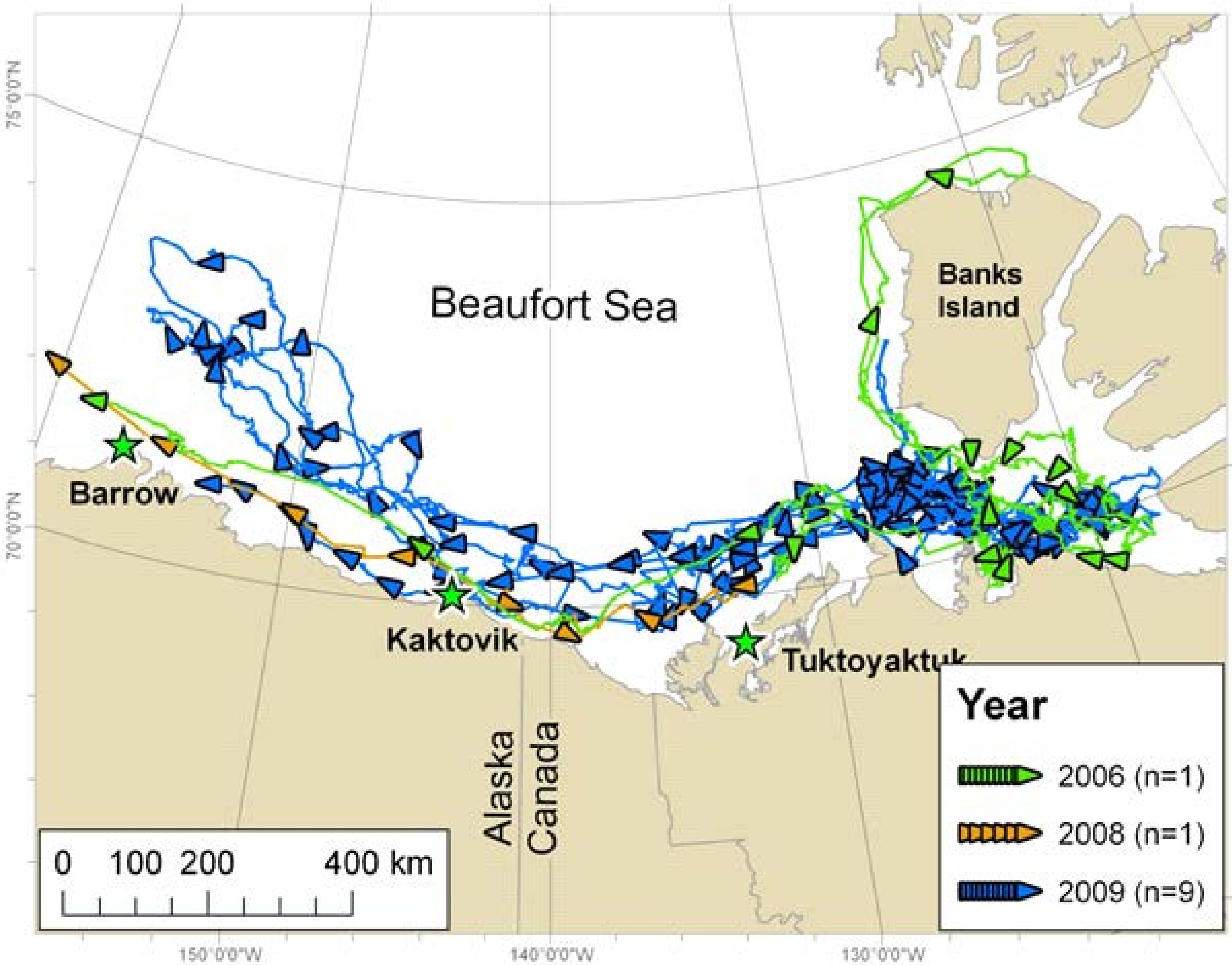
TRACKS OF SATELLITE-TAGGED BOWHEAD WHALES DURING SPRING MIGRATION IN THE BEAUFORT SEA IN 2006, 2007, AND 2009

U.S. BEAUFORT SEA, ALASKA

JOB NO:	26220558	DRAWN:	MAJ
DATE:	NOVEMBER 2012	FILE:	SEE PATH

FIGURE 3.2-12

M:\Projects\26220558 - NMFS TO 10 Arctic Seismic & Drilling PEIS\mxd\Final\Figure 3.2-13 Tracks of Satellite Tagged Bowhead Whales.mxd



NATIONAL MARINE FISHERIES SERVICE
EFFECTS OF OIL AND GAS ACTIVITIES IN THE ARCTIC OCEAN EIS

TRACKS OF ELEVEN SATELLITE-TAGGED BOWHEAD WHALES IN THE BEAUFORT SEA IN SUMMER/FALL 2006-2009

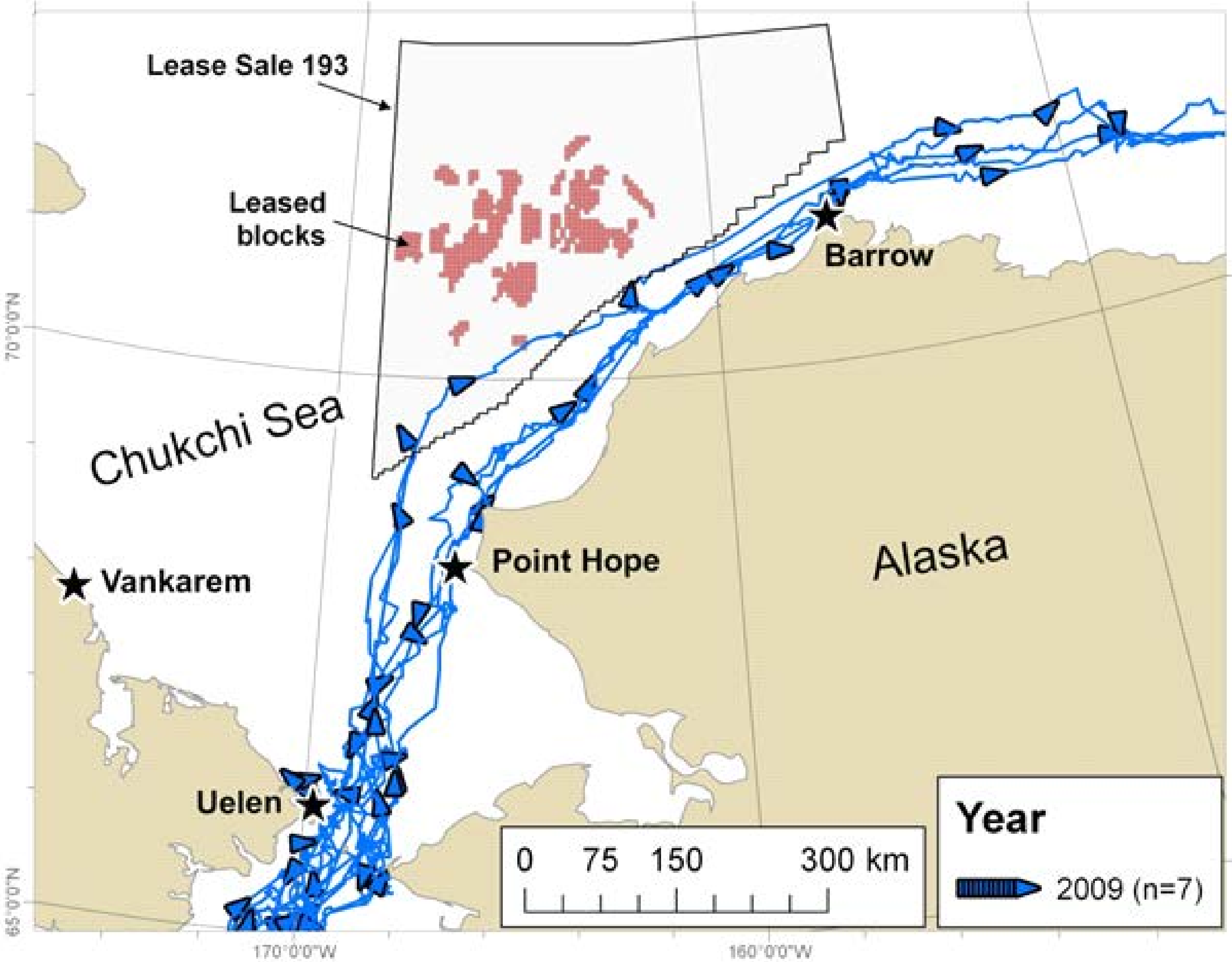
U.S. BEAUFORT SEA, ALASKA

JOB NO:	26220558	DRAWN:	MAJ
DATE:	NOVEMBER 2012	FILE:	SEE PATH

FIGURE 3.2-13

DATA SOURCE:
Quakenbush et al. 2010b

M:\Projects\26220558 - NMFS TO 10 Arctic Seismic & Drilling PEIS\mxd\Final\Figure 3.2-14 Tracks of Satellite Tagged Bowhead Whales.mxd



NATIONAL MARINE FISHERIES SERVICE
EFFECTS OF OIL AND GAS ACTIVITIES IN THE ARCTIC OCEAN EIS

TRACKS OF SATELLITE-TAGGED BOWHEAD WHALES MIGRATING THROUGH THE CHUKCHI SEA AND PAST POINT BARROW IN SPRING 2009

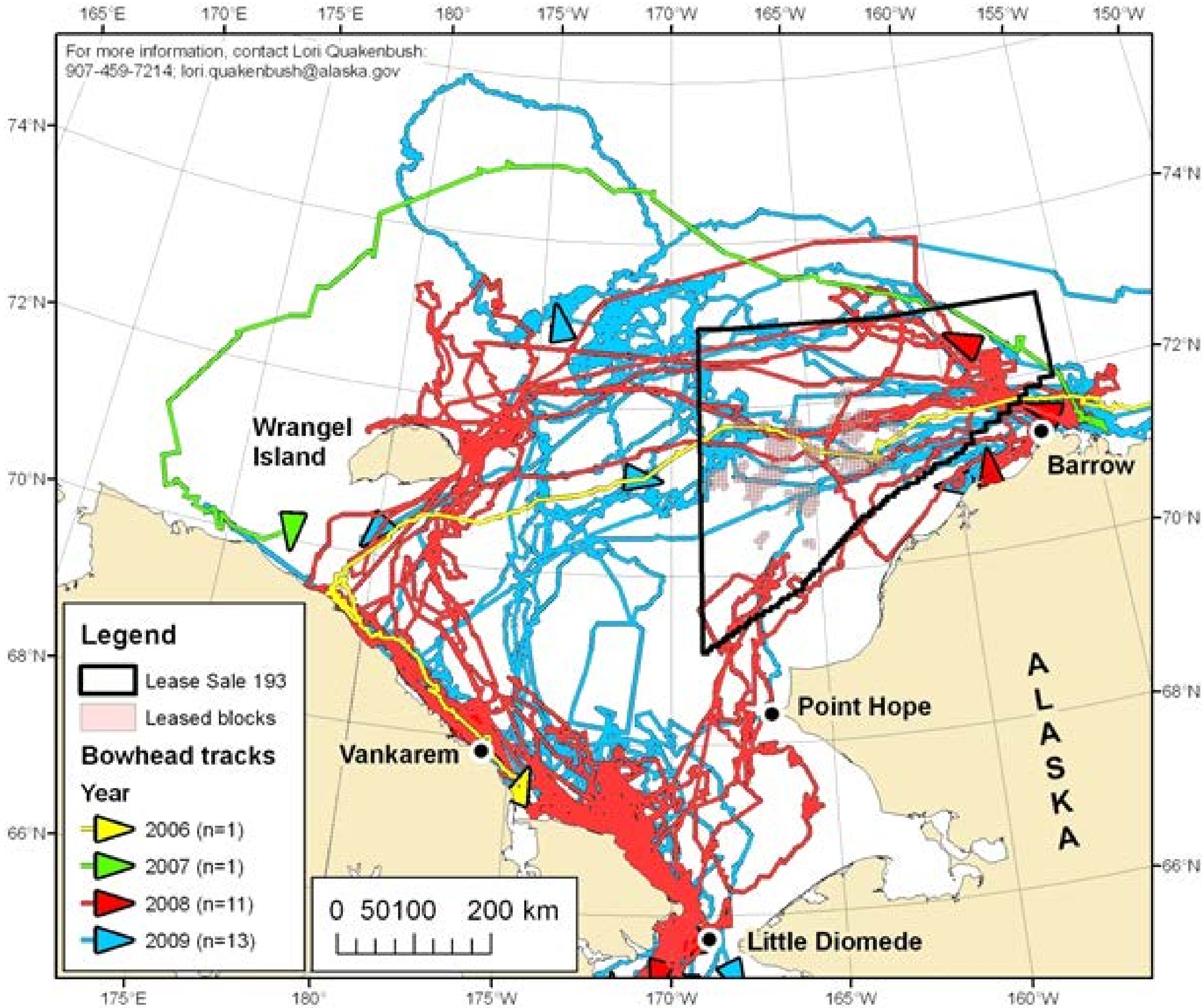
U.S. BEAUFORT AND CHUKCHI SEAS, ALASKA

JOB NO:	26220558	DRAWN:	MAJ
DATE:	NOVEMBER 2012	FILE:	SEE PATH

FIGURE 3.2-14

DATA SOURCE:
Quakenbush et al. 2010b

M:\Projects\26220558 - NMFS TO 10 Arctic Seismic & Drilling PEIS\mxd\Final\Figure 3.2-15 Tracks of Twenty Six Satellite Tagged Bowheads.mxd



NATIONAL MARINE FISHERIES SERVICE
EFFECTS OF OIL AND GAS ACTIVITIES IN THE ARCTIC OCEAN EIS

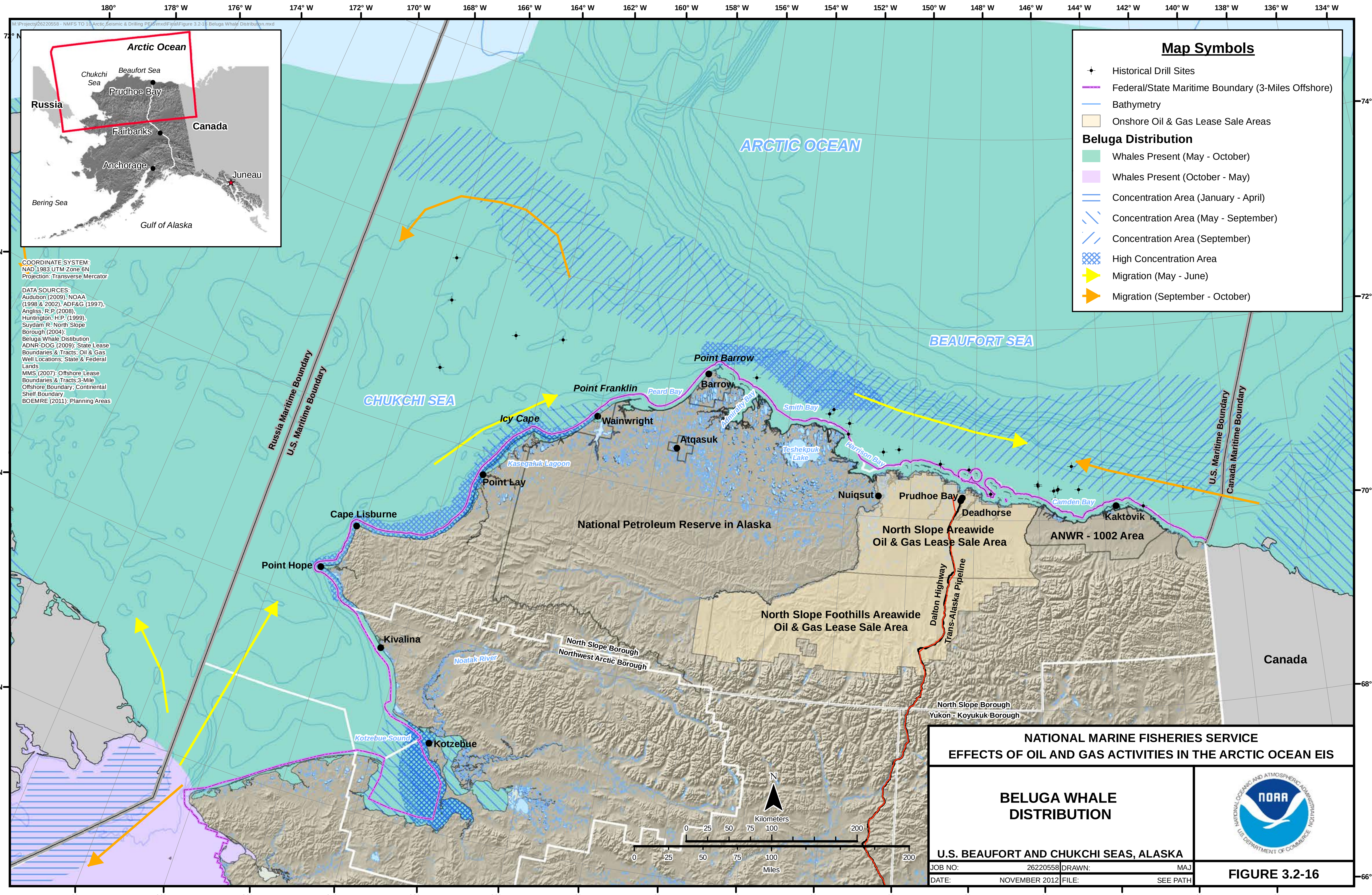
TRACKS OF TWENTY-SIX SATELLITE-TAGGED BOWHEAD WHALES IN THE CHUKCHI SEA DURING FALL 2006-2009

U.S. CHUKCHI SEA, ALASKA

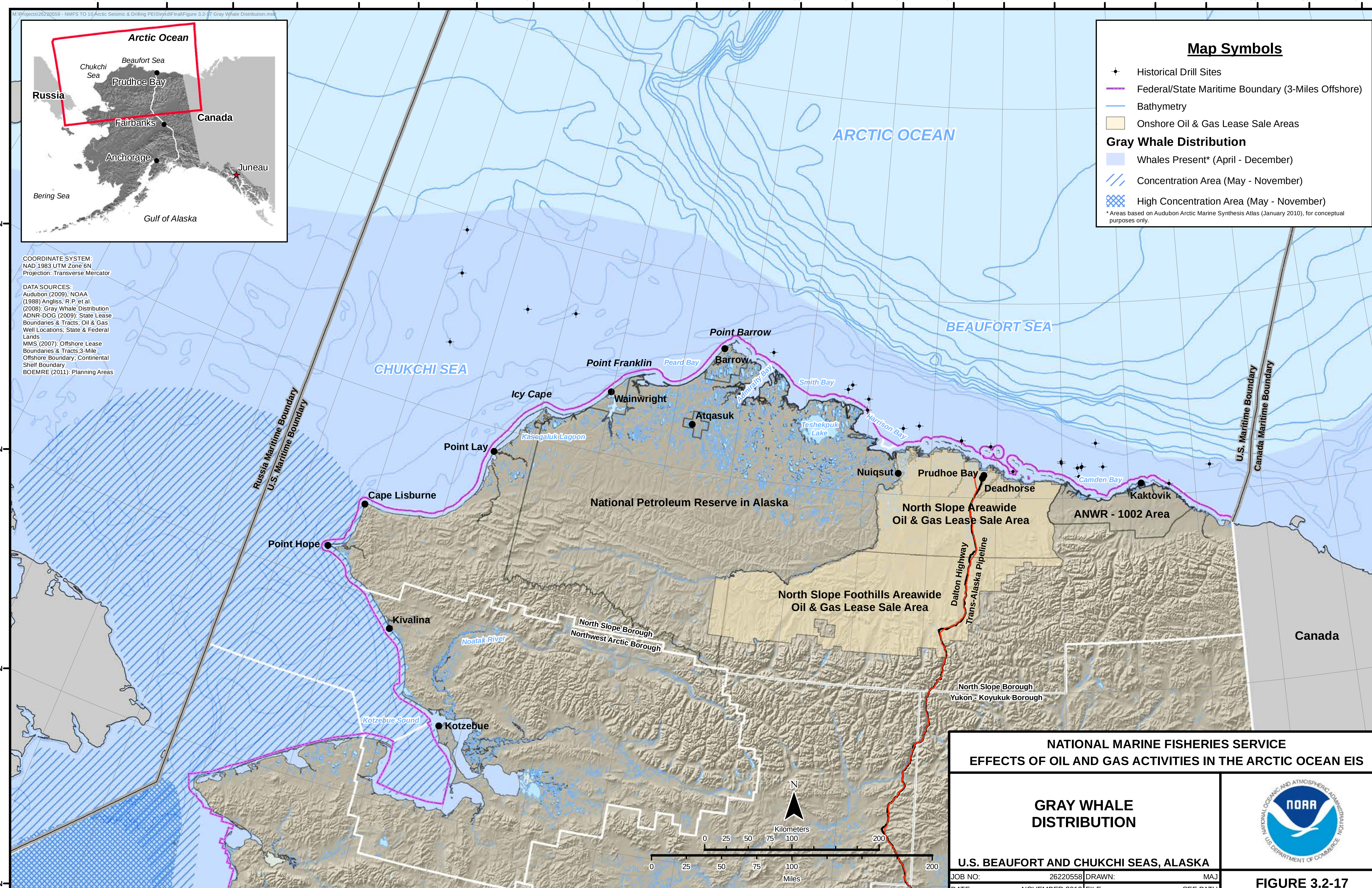
JOB NO:	26220558	DRAWN:	MAJ
DATE:	NOVEMBER 2012	FILE:	SEE PATH

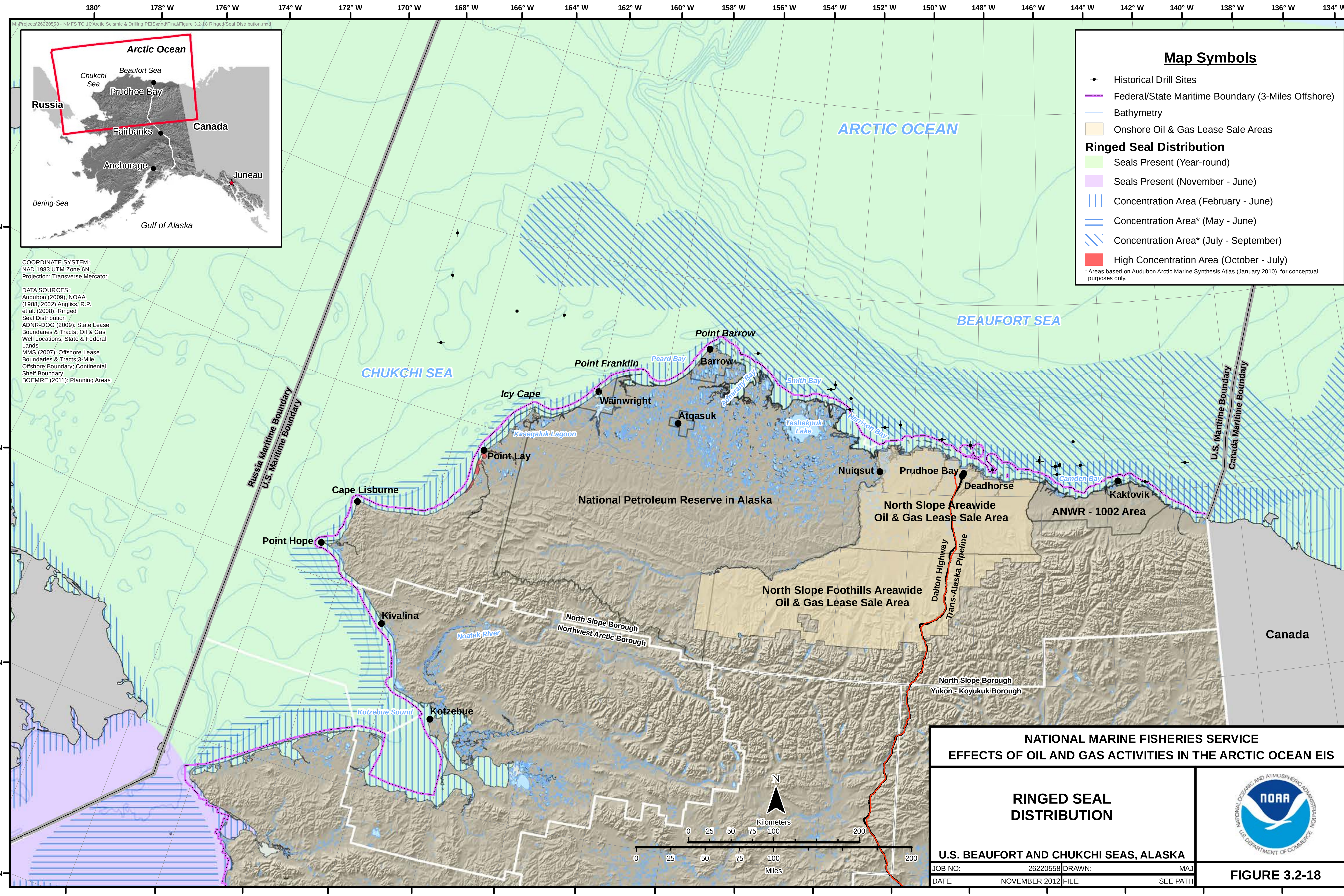
FIGURE 3.2-15

DATA SOURCE:
Quakenbush et al. 2010b

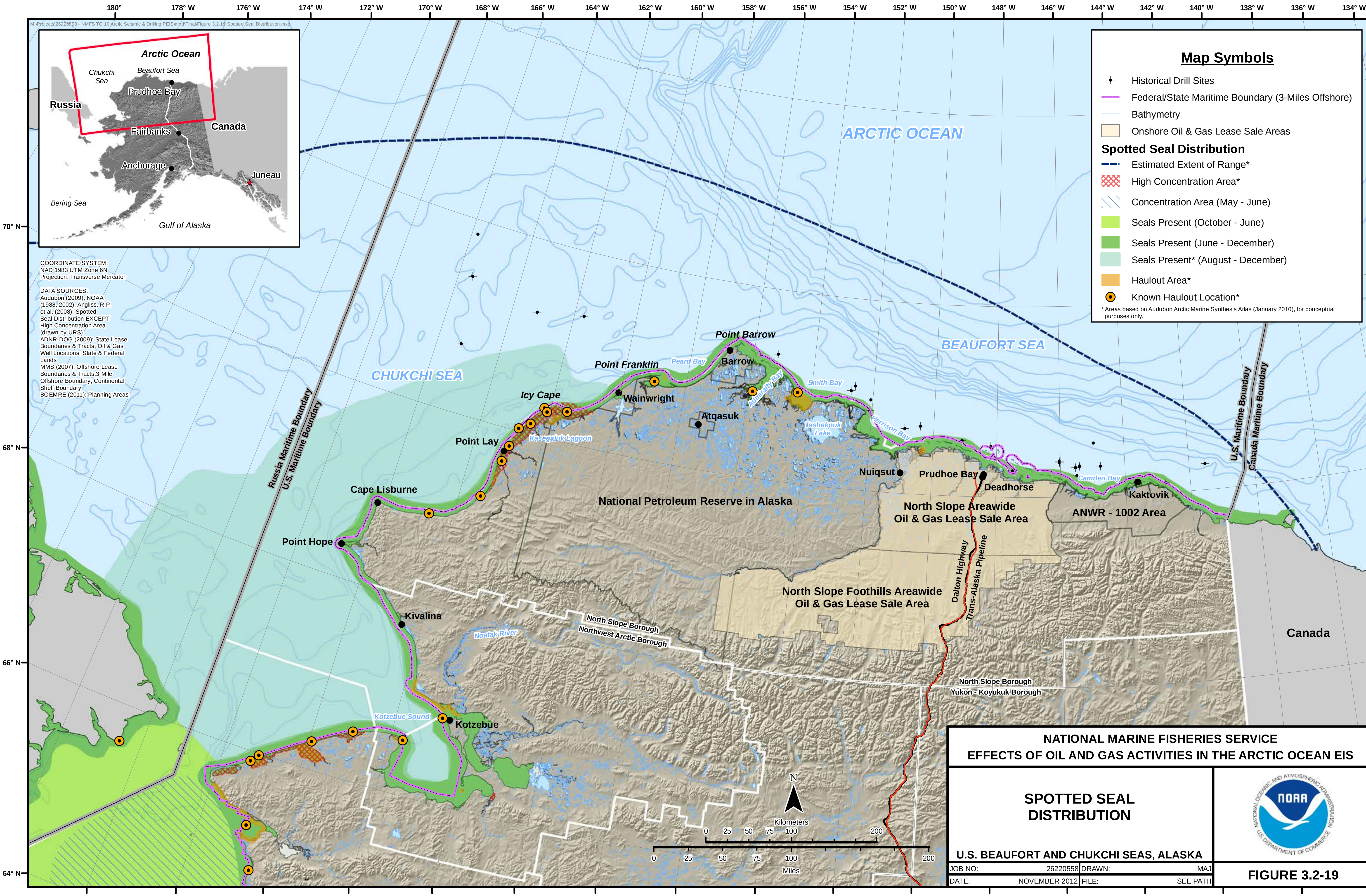


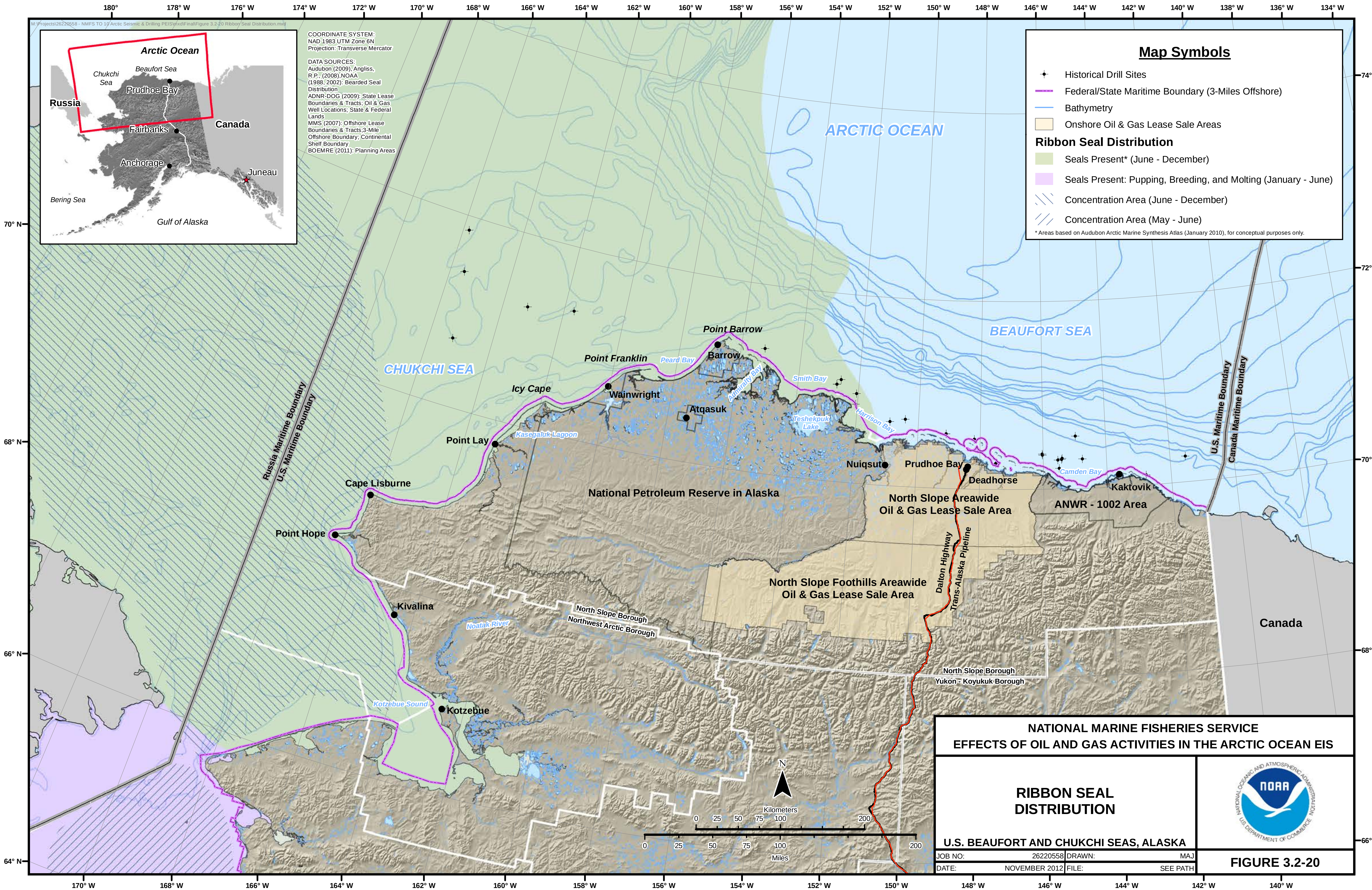
Map Symbols
Historical Drill Sites
Federal/State Maritime Boundary (3-Miles Offshore)
Bathymetry
Onshore Oil & Gas Lease Sale Areas
Beluga Distribution
Whales Present (May - October)
Whales Present (October - May)
Concentration Area (January - April)
Concentration Area (May - September)
Concentration Area (September)
High Concentration Area
Migration (May - June)
Migration (September - October)
Arctic Ocean
Beaufort Sea
Chukchi Sea
Prudhoe Bay
Russia
Fairbanks
Canada
Anchorage
Juneau
Bering Sea
Gulf of Alaska
COORDINATE SYSTEM:
NAD 1983 UTM Zone 6N
Projection: Transverse Mercator
DATA SOURCES:
Audubon (2009), NOAA (1998 & 2002), ADF&G (1997), Angliss, R,P (2008), Huntington, H.P. (1999), Suydam R. North Slope Borough (2004):
Beluga Whale Distibution
ADNR-DOG (2009): State Lease Boundaries & Tracts; Oil & Gas Well Locations; State & Federal Lands
MMS (2007): Offshore Lease Boundaries & Tracts;3-Mile Offshore Boundary; Continental Shelf Boundary
BOEMRE (2011): Planning Areas
ARCTIC OCEAN
BEAUFORT SEA
CHUKCHI SEA
Russia Maritime Boundary
U.S. Maritime Boundary
Canada Maritime Boundary
Point Barrow
Barrow
Point Franklin
Peard Bay
Admiralty Bay
Smith Bay
Icy Cape
Wainwright
Atqasuk
Teshekpuk Lake
Harrison Bay
Kasegaluk Lagoon
Point Lay
Nuiqsut
Prudhoe Bay
Deadhorse
Camden Bay
Kaktovik
Cape Lisburne
National Petroleum Reserve in Alaska
North Slope Areawide Oil & Gas Lease Sale Area
ANWR - 1002 Area
Point Hope
Dalton Highway
Trans-Alaska Pipeline
North Slope Foothills Areawide Oil & Gas Lease Sale Area
Kivalina
North Slope Borough
Northwest Arctic Borough
Noatak River
Canada
North Slope Borough
Yukon - Koyukuk Borough
Kotzebue Sound
Kotzebue
N
Kilometers
0 25 50 75 100 200
Miles
0 25 50 75 100 200
NATIONAL MARINE FISHERIES SERVICE
EFFECTS OF OIL AND GAS ACTIVITIES IN THE ARCTIC OCEAN EIS
BELUGA WHALE DISTRIBUTION
U.S. BEAUFORT AND CHUKCHI SEAS, ALASKA
JOB NO: 26220558
DRAWN: MAJ
DATE: NOVEMBER 2012
FILE: SEE PATH
FIGURE 3.2-16

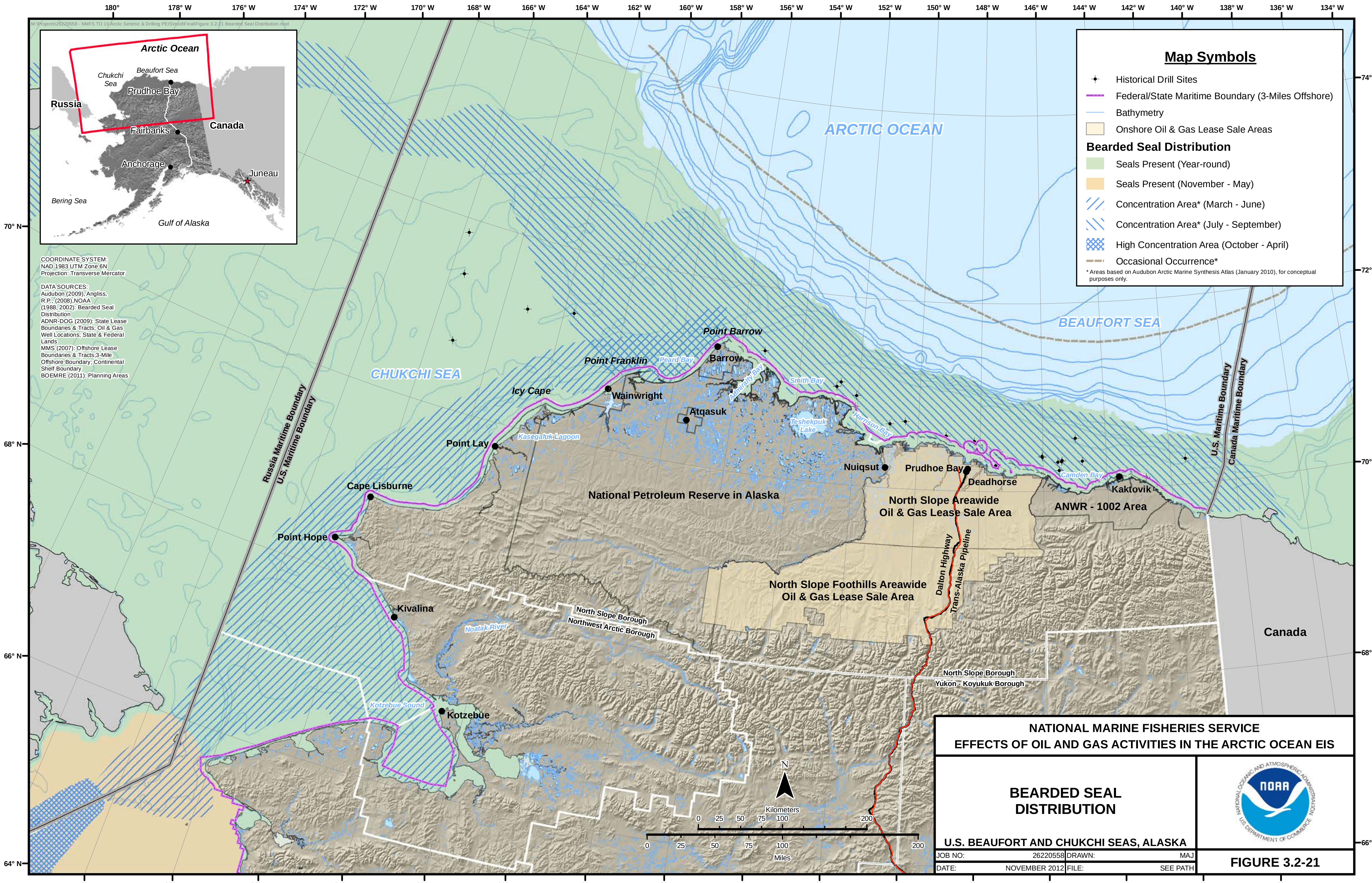

Map Symbols
Historical Drill Sites
Federal/State Maritime Boundary (3-Miles Offshore)
Bathymetry
Onshore Oil & Gas Lease Sale Areas
Gray Whale Distribution
Whales Present* (April - December)
Concentration Area (May - November)
High Concentration Area (May - November)
* Areas based on Audubon Arctic Marine Synthesis Atlas (January 2010), for conceptual purposes only.
Arctic Ocean
Beaufort Sea
Chukchi Sea
Prudhoe Bay
Russia
Fairbanks
Canada
Anchorage
Juneau
Bering Sea
Gulf of Alaska
COORDINATE SYSTEM:
NAD 1983 UTM Zone 6N
Projection: Transverse Mercator
DATA SOURCES:
Audubon (2009), NOAA (1988) Angliss, R.P. et al. (2008): Gray Whale Distribution
ADNR-DOG (2009): State Lease Boundaries & Tracts; Oil & Gas Well Locations; State & Federal Lands
MMS (2007): Offshore Lease Boundaries & Tracts;3-Mile Offshore Boundary; Continental Shelf Boundary
BOEMRE (2011): Planning Areas
ARCTIC OCEAN
BEAUFORT SEA
CHUKCHI SEA
Point Barrow
Barrow
Point Franklin
Peard Bay
Admiralty Bay
Smith Bay
Icy Cape
Wainwright
Atqasuk
Teshekpuk Lake
Harrison Bay
Kasegaluk Lagoon
Point Lay
Nuiqsut
Prudhoe Bay
Deadhorse
Camden Bay
Kaktovik
Cape Lisburne
National Petroleum Reserve in Alaska
North Slope Areawide Oil & Gas Lease Sale Area
ANWR - 1002 Area
Point Hope
Russia Maritime Boundary
U.S. Maritime Boundary
U.S. Maritime Boundary
Canada Maritime Boundary
Dalton Highway
Trans-Alaska Pipeline
North Slope Foothills Areawide Oil & Gas Lease Sale Area
Kivalina
North Slope Borough
Northwest Arctic Borough
Noatak River
Canada
North Slope Borough
Yukon - Koyukuk Borough
Kotzebue Sound
Kotzebue
N
Kilometers
0 25 50 75 100 200
0 25 50 75 100 200
Miles
180° 178° W 176° W 174° W 172° W 170° W 168° W 166° W 164° W 162° W 160° W 158° W 156° W 154° W 152° W 150° W 148° W 146° W 144° W 142° W 140° W 138° W 136° W 134° W
170° W 168° W 166° W 164° W 162° W 160° W 158° W 156° W 154° W 152° W 150° W 148° W 146° W 144° W 142° W 140° W
74° N 72° N 70° N 68° N 66° N
70° N 68° N 66° N 64° N
NATIONAL MARINE FISHERIES SERVICE
EFFECTS OF OIL AND GAS ACTIVITIES IN THE ARCTIC OCEAN EIS
GRAY WHALE DISTRIBUTION
U.S. BEAUFORT AND CHUKCHI SEAS, ALASKA
JOB NO: 26220558
DRAWN: MAJ
DATE: NOVEMBER 2012
FILE: SEE PATH
NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE
FIGURE 3.2-17

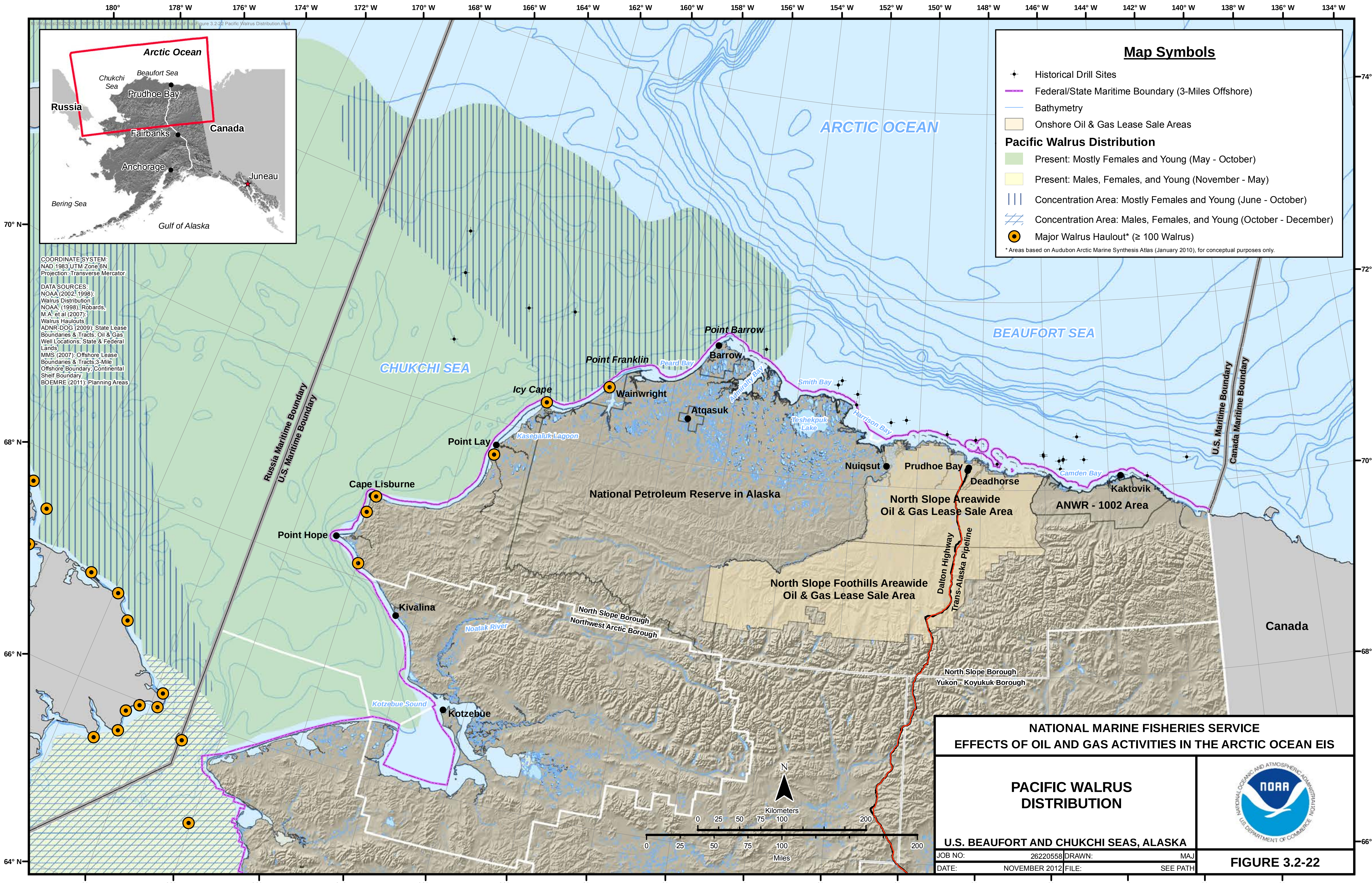


Arctic Ocean
Beaufort Sea
Chukchi Sea
Prudhoe Bay
Russia
Fairbanks
Canada
Anchorage
Juneau
Bering Sea
Gulf of Alaska
COORDINATE SYSTEM:
NAD 1983 UTM Zone 6N
Projection: Transverse Mercator
DATA SOURCES:
Audubon (2009), NOAA (1988, 2002) Angliss, R.P. et al. (2008): Ringed Seal Distribution
ADNR-DOG (2009): State Lease Boundaries & Tracts; Oil & Gas Well Locations; State & Federal Lands
MMS (2007): Offshore Lease Boundaries & Tracts;3-Mile Offshore Boundary; Continental Shelf Boundary
BOEMRE (2011): Planning Areas
Map Symbols
Historical Drill Sites
Federal/State Maritime Boundary (3-Miles Offshore)
Bathymetry
Onshore Oil & Gas Lease Sale Areas
Ringed Seal Distribution
Seals Present (Year-round)
Seals Present (November - June)
Concentration Area (February - June)
Concentration Area* (May - June)
Concentration Area* (July - September)
High Concentration Area (October - July)
* Areas based on Audubon Arctic Marine Synthesis Atlas (January 2010), for conceptual purposes only.
ARCTIC OCEAN
BEAUFORT SEA
CHUKCHI SEA
Russia Maritime Boundary
U.S. Maritime Boundary
Canada Maritime Boundary
Point Barrow
Barrow
Peard Bay
Point Franklin
Wainwright
Icy Cape
Atqasuk
Admiralty Bay
Smith Bay
Teshekpuk Lake
Harrison Bay
Kasegaluk Lagoon
Point Lay
Nuiqsut
Prudhoe Bay
Deadhorse
Camden Bay
Kaktovik
ANWR - 1002 Area
Cape Lisburne
National Petroleum Reserve in Alaska
North Slope Areawide Oil & Gas Lease Sale Area
Point Hope
North Slope Foothills Areawide Oil & Gas Lease Sale Area
Dalton Highway
Trans-Alaska Pipeline
Kivalina
North Slope Borough
Northwest Arctic Borough
Noatak River
Canada
North Slope Borough
Yukon - Koyukuk Borough
Kotzebue Sound
Kotzebue
Kilometers
Miles
NATIONAL MARINE FISHERIES SERVICE
EFFECTS OF OIL AND GAS ACTIVITIES IN THE ARCTIC OCEAN EIS
RINGED SEAL DISTRIBUTION
U.S. BEAUFORT AND CHUKCHI SEAS, ALASKA
JOB NO: 26220558
DRAWN: MAJ
DATE: NOVEMBER 2012
FILE: SEE PATH
NOAA
FIGURE 3.2-18

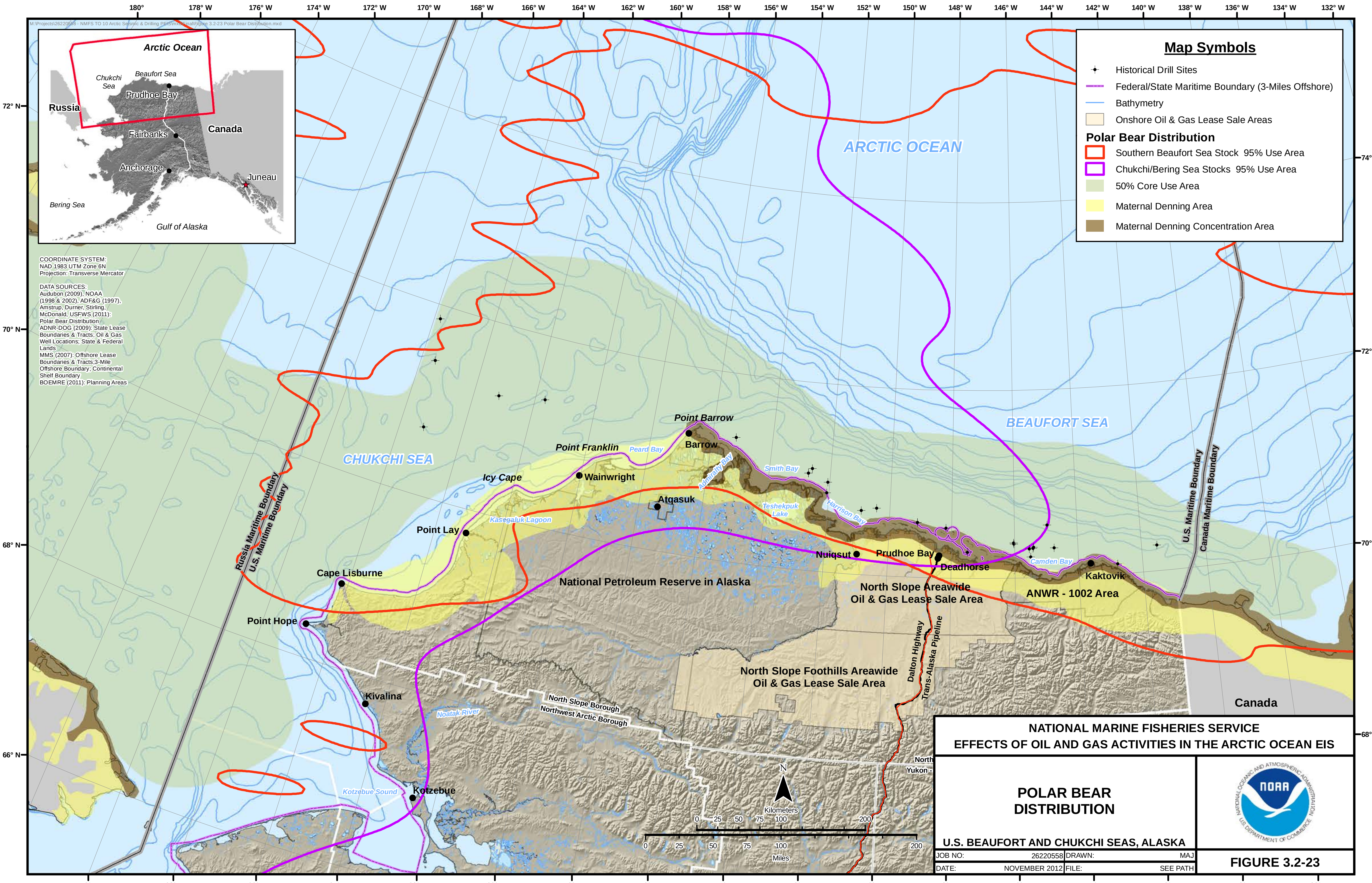

Map Symbols
Historical Drill Sites
Federal/State Maritime Boundary (3-Miles Offshore)
Bathymetry
Onshore Oil & Gas Lease Sale Areas
Spotted Seal Distribution
Estimated Extent of Range*
High Concentration Area*
Concentration Area (May - June)
Seals Present (October - June)
Seals Present (June - December)
Seals Present* (August - December)
Haulout Area*
Known Haulout Location*
* Areas based on Audubon Arctic Marine Synthesis Atlas (January 2010), for conceptual purposes only.
COORDINATE SYSTEM:
NAD 1983 UTM Zone 6N
Projection: Transverse Mercator
DATA SOURCES:
Audubon (2009), NOAA (1988, 2002), Angliss, R.P. et al. (2008): Spotted Seal Distribution EXCEPT High Concentration Area (drawn by URS)
ADNR-DOG (2009): State Lease Boundaries & Tracts; Oil & Gas Well Locations; State & Federal Lands
MMS (2007): Offshore Lease Boundaries & Tracts;3-Mile Offshore Boundary; Continental Shelf Boundary
BOEMRE (2011): Planning Areas
Arctic Ocean
Chukchi Sea
Beaufort Sea
Prudhoe Bay
Russia
Canada
Fairbanks
Anchorage
Juneau
Bering Sea
Gulf of Alaska
ARCTIC OCEAN
BEAUFORT SEA
CHUKCHI SEA
Russia Maritime Boundary
U.S. Maritime Boundary
U.S. Maritime Boundary
Canada Maritime Boundary
Point Barrow
Barrow
Point Franklin
Peard Bay
Wainwright
Icy Cape
Atqasuk
Admiralty Bay
Smith Bay
Teshekpuk Lake
Harrison Bay
Kasegaluk Lagoon
Point Lay
Cape Lisburne
Point Hope
Nuiqsut
Prudhoe Bay
Deadhorse
Camden Bay
Kaktovik
National Petroleum Reserve in Alaska
North Slope Areawide Oil & Gas Lease Sale Area
ANWR - 1002 Area
North Slope Foothills Areawide Oil & Gas Lease Sale Area
Dalton Highway
Trans-Alaska Pipeline
Canada
Kivalina
Noatak River
North Slope Borough
Northwest Arctic Borough
North Slope Borough
Yukon - Koyukuk Borough
Kotzebue Sound
Kotzebue
Kilometers
Miles
NATIONAL MARINE FISHERIES SERVICE
EFFECTS OF OIL AND GAS ACTIVITIES IN THE ARCTIC OCEAN EIS
SPOTTED SEAL DISTRIBUTION
U.S. BEAUFORT AND CHUKCHI SEAS, ALASKA
JOB NO: 26220558
DRAWN: MAJ
DATE: NOVEMBER 2012
FILE: SEE PATH
FIGURE 3.2-19

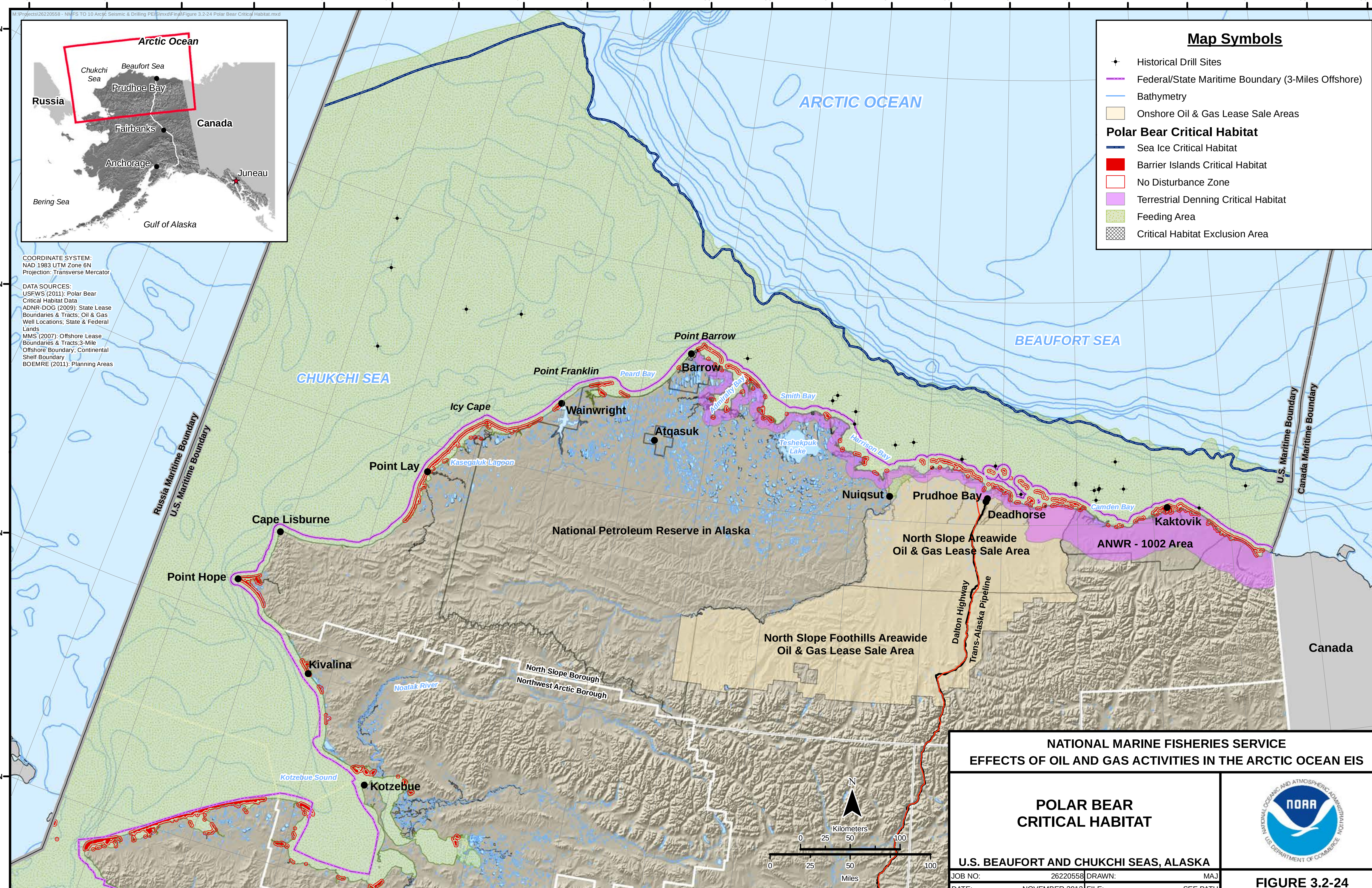

COORDINATE SYSTEM:
NAD 1983 UTM Zone 6N
Projection: Transverse Mercator
DATA SOURCES:
Audubon (2009), Angliss, R.P., (2008),NOAA (1988, 2002): Bearded Seal Distribution
ADNR-DOG (2009): State Lease Boundaries & Tracts; Oil & Gas Well Locations; State & Federal Lands
MMS (2007): Offshore Lease Boundaries & Tracts;3-Mile Offshore Boundary; Continental Shelf Boundary
BOEMRE (2011): Planning Areas
Arctic Ocean
Beaufort Sea
Chukchi Sea
Prudhoe Bay
Russia
Fairbanks
Canada
Anchorage
Juneau
Bering Sea
Gulf of Alaska
Map Symbols
Historical Drill Sites
Federal/State Maritime Boundary (3-Miles Offshore)
Bathymetry
Onshore Oil & Gas Lease Sale Areas
Ribbon Seal Distribution
Seals Present* (June - December)
Seals Present: Pupping, Breeding, and Molting (January - June)
Concentration Area (June - December)
Concentration Area (May - June)
* Areas based on Audubon Arctic Marine Synthesis Atlas (January 2010), for conceptual purposes only.
ARCTIC OCEAN
BEAUFORT SEA
CHUKCHI SEA
Russia Maritime Boundary
U.S. Maritime Boundary
U.S. Maritime Boundary
Canada Maritime Boundary
Point Barrow
Barrow
Point Franklin
Peard Bay
Smith Bay
Admiralty Bay
Icy Cape
Wainwright
Atqasuk
Teshekpuk Lake
Harrison Bay
Point Lay
Kasegaluk Lagoon
Nuiqsut
Prudhoe Bay
Deadhorse
Camden Bay
Kaktovik
Cape Lisburne
National Petroleum Reserve in Alaska
North Slope Areawide Oil & Gas Lease Sale Area
ANWR - 1002 Area
Point Hope
North Slope Foothills Areawide Oil & Gas Lease Sale Area
Dalton Highway
Trans-Alaska Pipeline
Kivalina
North Slope Borough
Northwest Arctic Borough
Noatak River
Canada
North Slope Borough
Yukon - Koyukuk Borough
Kotzebue Sound
Kotzebue
Kilometers
0 25 50 75 100 200
Miles
0 25 50 75 100 200
NATIONAL MARINE FISHERIES SERVICE
EFFECTS OF OIL AND GAS ACTIVITIES IN THE ARCTIC OCEAN EIS
RIBBON SEAL DISTRIBUTION
U.S. BEAUFORT AND CHUKCHI SEAS, ALASKA
JOB NO: 26220558
DRAWN: MAJ
DATE: NOVEMBER 2012
FILE: SEE PATH
FIGURE 3.2-20


Arctic Ocean
Beaufort Sea
Chukchi Sea
Russia
Prudhoe Bay
Fairbanks
Canada
Anchorage
Juneau
Bering Sea
Gulf of Alaska
COORDINATE SYSTEM:
NAD 1983 UTM Zone 6N
Projection: Transverse Mercator
DATA SOURCES:
Audubon (2009), Angliss, R.P., (2008),NOAA (1988, 2002): Bearded Seal Distribution
ADNR-DOG (2009): State Lease Boundaries & Tracts; Oil & Gas Well Locations; State & Federal Lands
MMS (2007): Offshore Lease Boundaries & Tracts;3-Mile Offshore Boundary; Continental Shelf Boundary
BOEMRE (2011): Planning Areas
Map Symbols
Historical Drill Sites
Federal/State Maritime Boundary (3-Miles Offshore)
Bathymetry
Onshore Oil & Gas Lease Sale Areas
Bearded Seal Distribution
Seals Present (Year-round)
Seals Present (November - May)
Concentration Area* (March - June)
Concentration Area* (July - September)
High Concentration Area (October - April)
Occasional Occurrence*
* Areas based on Audubon Arctic Marine Synthesis Atlas (January 2010), for conceptual purposes only.
ARCTIC OCEAN
BEAUFORT SEA
CHUKCHI SEA
Russia Maritime Boundary
U.S. Maritime Boundary
U.S. Maritime Boundary
Canada Maritime Boundary
Point Barrow
Barrow
Point Franklin
Peard Bay
Admiralty Bay
Smith Bay
Icy Cape
Wainwright
Atqasuk
Teshekpuk Lake
Harrison Bay
Point Lay
Kasegaluk Lagoon
Nuiqsut
Prudhoe Bay
Deadhorse
Camden Bay
Kaktovik
Cape Lisburne
National Petroleum Reserve in Alaska
North Slope Areawide Oil & Gas Lease Sale Area
ANWR - 1002 Area
Point Hope
Dalton Highway
Trans-Alaska Pipeline
North Slope Foothills Areawide Oil & Gas Lease Sale Area
Kivalina
North Slope Borough
Northwest Arctic Borough
Noatak River
Canada
North Slope Borough
Yukon - Koyukuk Borough
Kotzebue Sound
Kotzebue
N
Kilometers
0 25 50 75 100 200
0 25 50 75 100 200
Miles
NATIONAL MARINE FISHERIES SERVICE
EFFECTS OF OIL AND GAS ACTIVITIES IN THE ARCTIC OCEAN EIS
BEARDED SEAL DISTRIBUTION
U.S. BEAUFORT AND CHUKCHI SEAS, ALASKA
JOB NO: 26220558
DRAWN: MAJ
DATE: NOVEMBER 2012
FILE: SEE PATH
FIGURE 3.2-21



Map Symbols
Historical Drill Sites
Federal/State Maritime Boundary (3-Miles Offshore)
Bathymetry
Onshore Oil & Gas Lease Sale Areas
Pacific Walrus Distribution
Present: Mostly Females and Young (May - October)
Present: Males, Females, and Young (November - May)
Concentration Area: Mostly Females and Young (June - October)
Concentration Area: Males, Females, and Young (October - December)
Major Walrus Haulout* (≥ 100 Walrus)
* Areas based on Audubon Arctic Marine Synthesis Atlas (January 2010), for conceptual purposes only.
Arctic Ocean
Beaufort Sea
Chukchi Sea
Russia
Prudhoe Bay
Canada
Fairbanks
Anchorage
Juneau
Bering Sea
Gulf of Alaska
COORDINATE SYSTEM:
NAD 1983 UTM Zone 6N
Projection: Transverse Mercator
DATA SOURCES:
NOAA (2002, 1998): Walrus Distribution
NOAA (1998), Robards, M.A. et al (2007): Walrus Haulouts
ADNR-DOG (2009): State Lease Boundaries & Tracts; Oil & Gas Well Locations; State & Federal Lands
MMS (2007): Offshore Lease Boundaries & Tracts;3-Mile Offshore Boundary; Continental Shelf Boundary
BOEMRE (2011): Planning Areas
ARCTIC OCEAN
BEAUFORT SEA
CHUKCHI SEA
Russia Maritime Boundary
U.S. Maritime Boundary
U.S. Maritime Boundary
Canada Maritime Boundary
Point Barrow
Barrow
Point Franklin
Peard Bay
Wainwright
Icy Cape
Admiralty Bay
Atqasuk
Smith Bay
Teshekpuk Lake
Harrison Bay
Point Lay
Kasegaluk Lagoon
Nuiqsut
Prudhoe Bay
Deadhorse
Camden Bay
Kaktovik
ANWR - 1002 Area
Cape Lisburne
National Petroleum Reserve in Alaska
North Slope Areawide Oil & Gas Lease Sale Area
Point Hope
North Slope Foothills Areawide Oil & Gas Lease Sale Area
Dalton Highway
Trans-Alaska Pipeline
Kivalina
North Slope Borough
Northwest Arctic Borough
Noatak River
Canada
North Slope Borough
Yukon - Koyukuk Borough
Kotzebue Sound
Kotzebue
N
Kilometers
0 25 50 75 100 200
0 25 50 75 100 200
Miles
180° 178° W 176° W 174° W 172° W 170° W 168° W 166° W 164° W 162° W 160° W 158° W 156° W 154° W 152° W 150° W 148° W 146° W 144° W 142° W 140° W 138° W 136° W 134° W
170° W 168° W 166° W 164° W 162° W 160° W 158° W 156° W 154° W 152° W 150° W 148° W 146° W 144° W 142° W 140° W
70° N 68° N 66° N 64° N
74° N 72° N 70° N 68° N 66° N
NATIONAL MARINE FISHERIES SERVICE
EFFECTS OF OIL AND GAS ACTIVITIES IN THE ARCTIC OCEAN EIS
PACIFIC WALRUS DISTRIBUTION
U.S. BEAUFORT AND CHUKCHI SEAS, ALASKA
JOB NO: 26220558
DRAWN: MAJ
DATE: NOVEMBER 2012
FILE: SEE PATH
NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE
FIGURE 3.2-22


Map Symbols
Historical Drill Sites
Federal/State Maritime Boundary (3-Miles Offshore)
Bathymetry
Onshore Oil & Gas Lease Sale Areas
Polar Bear Distribution
Southern Beaufort Sea Stock 95% Use Area
Chukchi/Bering Sea Stocks 95% Use Area
50% Core Use Area
Maternal Denning Area
Maternal Denning Concentration Area
Arctic Ocean
Chukchi Sea
Beaufort Sea
Prudhoe Bay
Russia
Canada
Fairbanks
Anchorage
Juneau
Bering Sea
Gulf of Alaska
COORDINATE SYSTEM:
NAD 1983 UTM Zone 6N
Projection: Transverse Mercator
DATA SOURCES:
Audubon (2009), NOAA (1998 & 2002), ADF&G (1997), Amstrup, Durner, Stirling, McDonald, USFWS (2011): Polar Bear Distribution
ADNR-DOG (2009): State Lease Boundaries & Tracts; Oil & Gas Well Locations; State & Federal Lands
MMS (2007): Offshore Lease Boundaries & Tracts;3-Mile Offshore Boundary; Continental Shelf Boundary
BOEMRE (2011): Planning Areas
ARCTIC OCEAN
BEAUFORT SEA
CHUKCHI SEA
Point Barrow
Barrow
Point Franklin
Peard Bay
Admiralty Bay
Smith Bay
Icy Cape
Wainwright
Atqasuk
Teshekpuk Lake
Harrison Bay
Kasegaluk Lagoon
Point Lay
Nuiqsut
Prudhoe Bay
Deadhorse
Camden Bay
Kaktovik
Cape Lisburne
National Petroleum Reserve in Alaska
North Slope Areawide Oil & Gas Lease Sale Area
ANWR - 1002 Area
Point Hope
Russia Maritime Boundary
U.S. Maritime Boundary
U.S. Maritime Boundary
Canada Maritime Boundary
Dalton Highway
Trans-Alaska Pipeline
North Slope Foothills Areawide Oil & Gas Lease Sale Area
Kivalina
Noatak River
North Slope Borough
Northwest Arctic Borough
Kotzebue Sound
Kotzebue
Canada
Kilometers
0 25 50 75 100 200
Miles
0 25 50 75 100 200
NATIONAL MARINE FISHERIES SERVICE
EFFECTS OF OIL AND GAS ACTIVITIES IN THE ARCTIC OCEAN EIS
POLAR BEAR DISTRIBUTION
U.S. BEAUFORT AND CHUKCHI SEAS, ALASKA
JOB NO: 26220558
DRAWN: MAJ
DATE: NOVEMBER 2012
FILE: SEE PATH
FIGURE 3.2-23



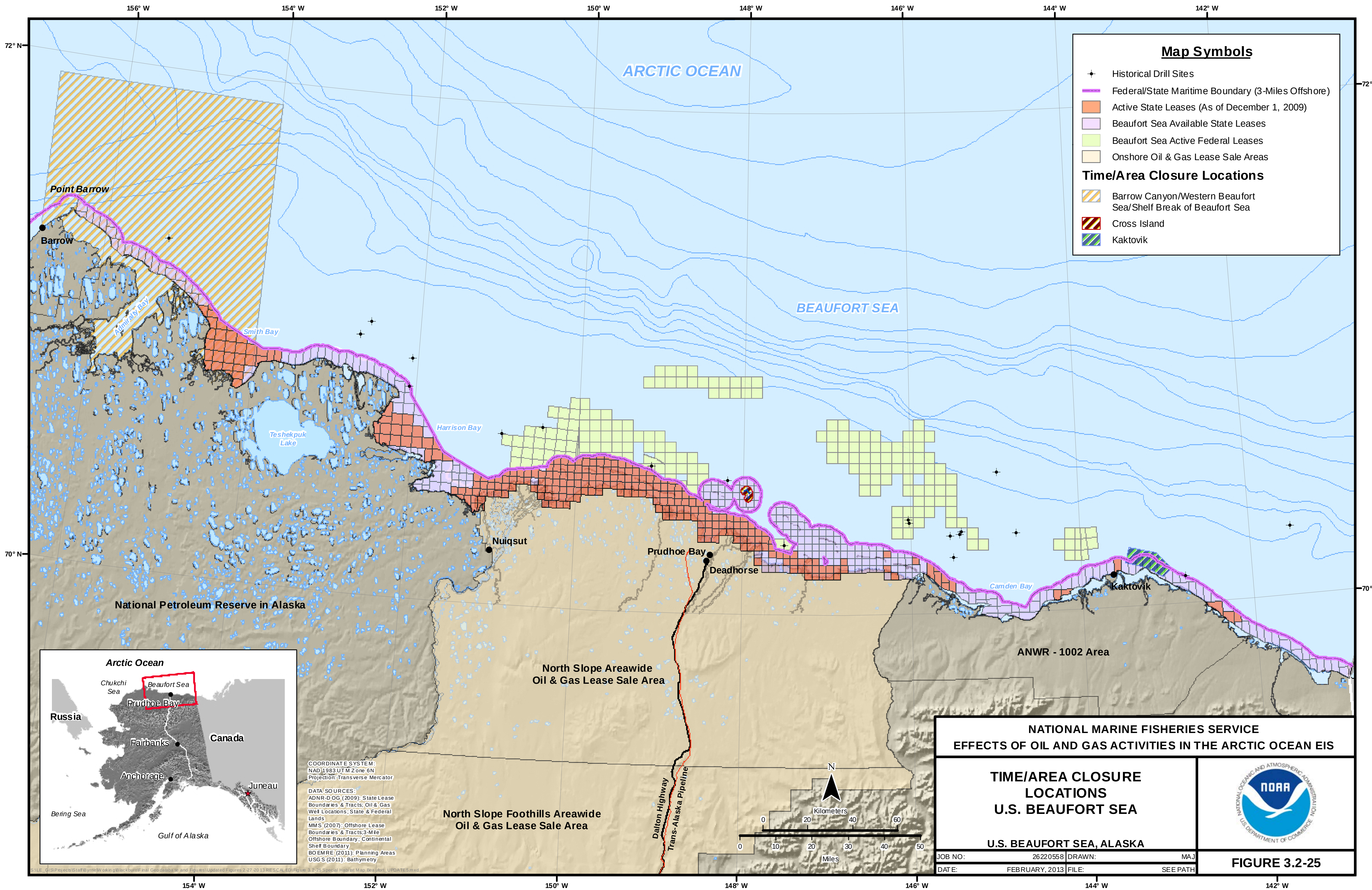
NATIONAL MARINE FISHERIES SERVICE
EFFECTS OF OIL AND GAS ACTIVITIES IN THE ARCTIC OCEAN EIS

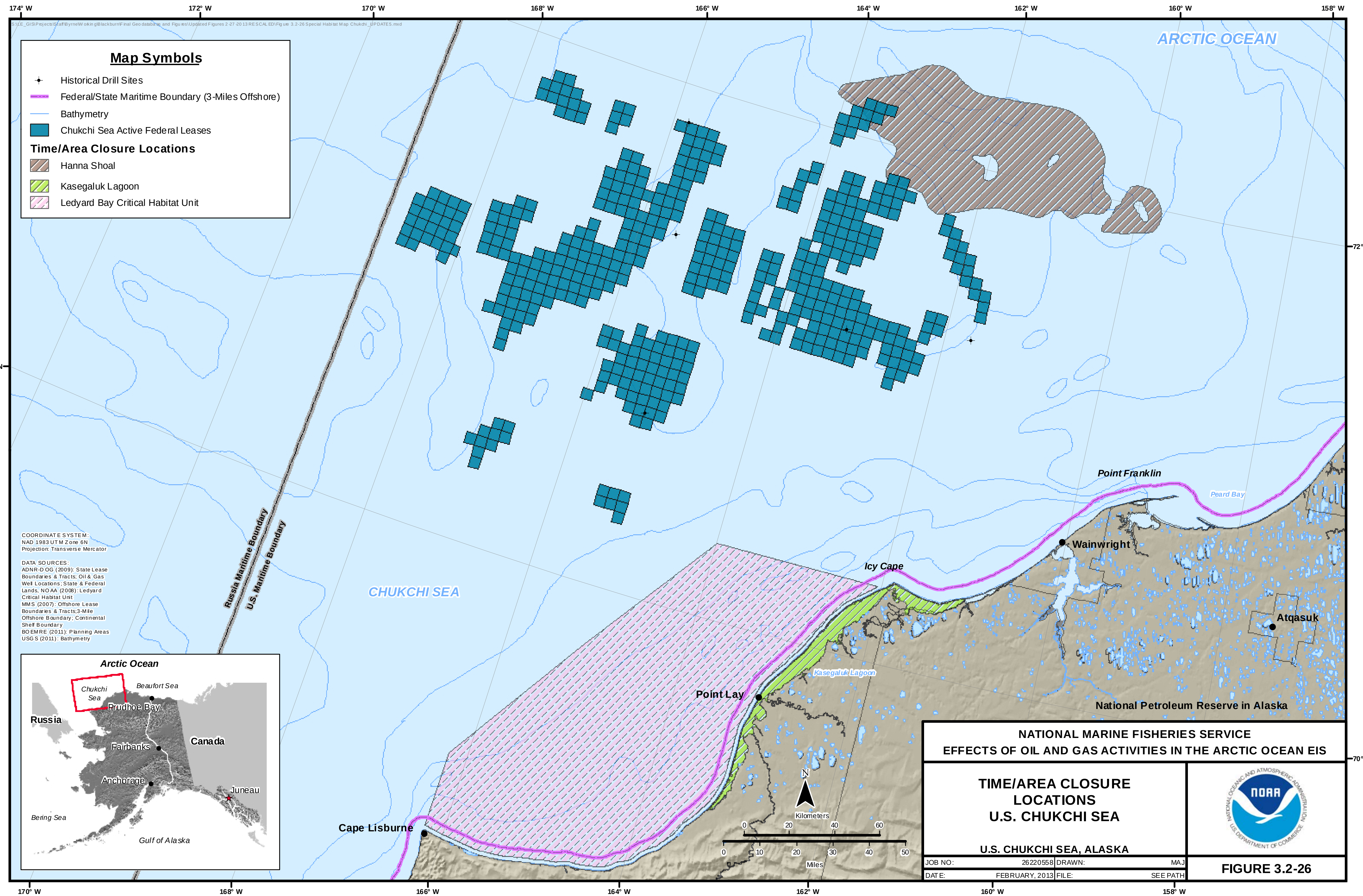
POLAR BEAR CRITICAL HABITAT

U.S. BEAUFORT AND CHUKCHI SEAS, ALASKA

JOB NO:	26220558	DRAWN:	MAJ
DATE:	NOVEMBER 2012	FILE:	SEE PATH

FIGURE 3.2-24


Map Symbols
Historical Drill Sites
Federal/State Maritime Boundary (3-Miles Offshore)
Active State Leases (As of December 1, 2009)
Beaufort Sea Available State Leases
Beaufort Sea Active Federal Leases
Onshore Oil & Gas Lease Sale Areas
Time/Area Closure Locations
Barrow Canyon/Western Beaufort Sea/Shelf Break of Beaufort Sea
Cross Island
Kaktovik
ARCTIC OCEAN
BEAUFORT SEA
Point Barrow
Barrow
Admiralty Bay
Smith Bay
Harrison Bay
Teshekpuk Lake
Nuiqsut
Prudhoe Bay
Deadhorse
Camden Bay
Kaktovik
National Petroleum Reserve in Alaska
North Slope Areawide Oil & Gas Lease Sale Area
North Slope Foothills Areawide Oil & Gas Lease Sale Area
ANWR - 1002 Area
Dalton Highway
Trans-Alaska Pipeline
Arctic Ocean
Chukchi Sea
Beaufort Sea
Prudhoe Bay
Russia
Canada
Fairbanks
Anchorage
Juneau
Bering Sea
Gulf of Alaska
COORDINATE SYSTEM: NAD 1983 UTM Zone 6N Projection: Transverse Mercator
DATA SOURCES: ADNR-DOG (2009): State Lease Boundaries & Tracts, Oil & Gas Well Locations; State & Federal Lands
MMS (2007): Offshore Lease Boundaries & Tracts, 3-Mile Offshore Boundary; Continental Shelf Boundary
BOEMRE (2011): Planning Areas
USGS (2011): Bathymetry
N
Kilometers
0 20 40 60
0 10 20 30 40 50
Miles
156° W
154° W
152° W
150° W
148° W
146° W
144° W
142° W
72° N
70° N
NATIONAL MARINE FISHERIES SERVICE
EFFECTS OF OIL AND GAS ACTIVITIES IN THE ARCTIC OCEAN EIS
TIME/AREA CLOSURE LOCATIONS U.S. BEAUFORT SEA
U.S. BEAUFORT SEA, ALASKA
JOB NO: 26220558
DRAWN: MAJ
DATE: FEBRUARY, 2013
FILE: SEE PATH
FIGURE 3.2-25



Map Symbols
Historical Drill Sites
Federal/State Maritime Boundary (3-Miles Offshore)
Bathymetry
Chukchi Sea Active Federal Leases
Time/Area Closure Locations
Hanna Shoal
Kasegaluk Lagoon
Ledyard Bay Critical Habitat Unit
ARCTIC OCEAN
CHUKCHI SEA
Russia Maritime Boundary
U.S. Maritime Boundary
Point Franklin
Peard Bay
Wainwright
Icy Cape
Atqasuk
Kasegaluk Lagoon
Point Lay
Cape Lisburne
National Petroleum Reserve in Alaska
174° W
172° W
170° W
168° W
166° W
164° W
162° W
160° W
158° W
72° N
70° N
COORDINATE SYSTEM:
NAD 1983 UTM Zone 6N
Projection: Transverse Mercator
DATA SOURCES:
ADNR-DOG (2009): State Lease Boundaries & Tracts; Oil & Gas Well Locations; State & Federal Lands, NOAA (2008): Ledyard Critical Habitat Unit
MMS (2007): Offshore Lease Boundaries & Tracts;3-Mile Offshore Boundary; Continental Shelf Boundary
BOEMRE (2011): Planning Areas
USGS (2011): Bathymetry
Arctic Ocean
Chukchi Sea
Beaufort Sea
Prudhoe Bay
Russia
Fairbanks
Canada
Anchorage
Juneau
Bering Sea
Gulf of Alaska
N
Kilometers
0 20 40 60
0 10 20 30 40 50
Miles
NATIONAL MARINE FISHERIES SERVICE
EFFECTS OF OIL AND GAS ACTIVITIES IN THE ARCTIC OCEAN EIS
TIME/AREA CLOSURE LOCATIONS U.S. CHUKCHI SEA
U.S. CHUKCHI SEA, ALASKA
JOB NO: 26220558
DRAWN: MAJ
DATE: FEBRUARY, 2013
FILE: SEE PATH
FIGURE 3.2-26

Figure 3.3-1 2009 Alaska Economic Performance Report.

Source: ADCCED 2011d

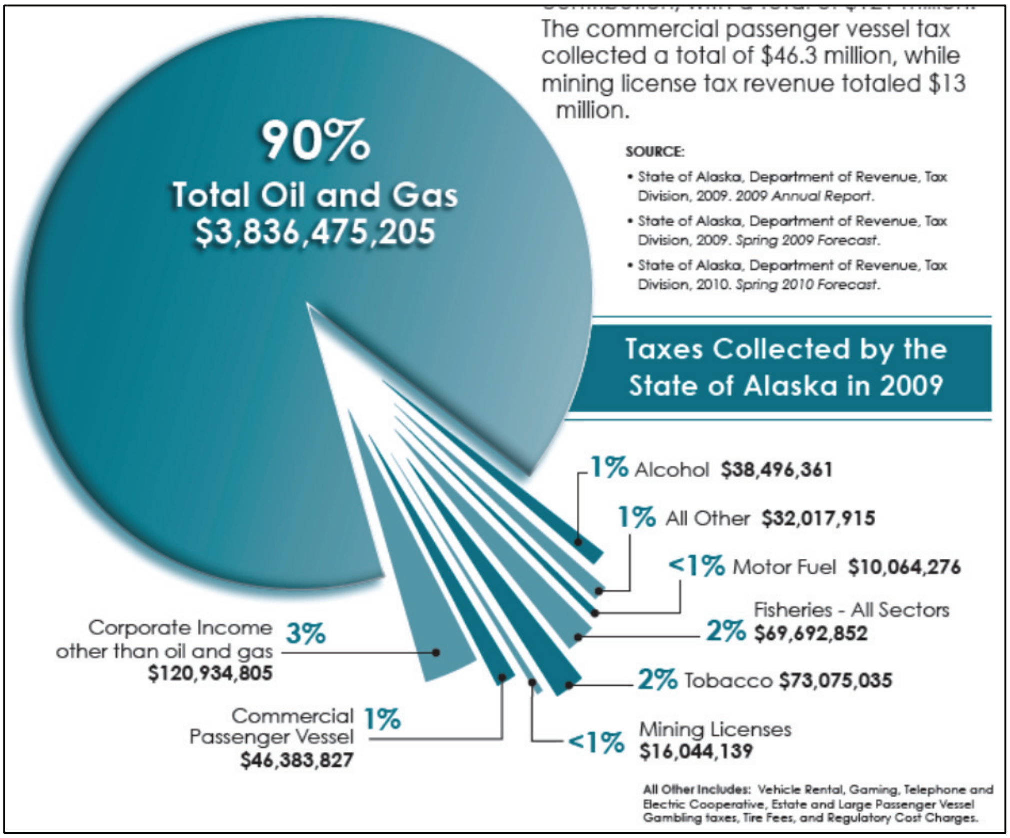


Figure 3.3-2 Statewide Employment by Section (February 2011).

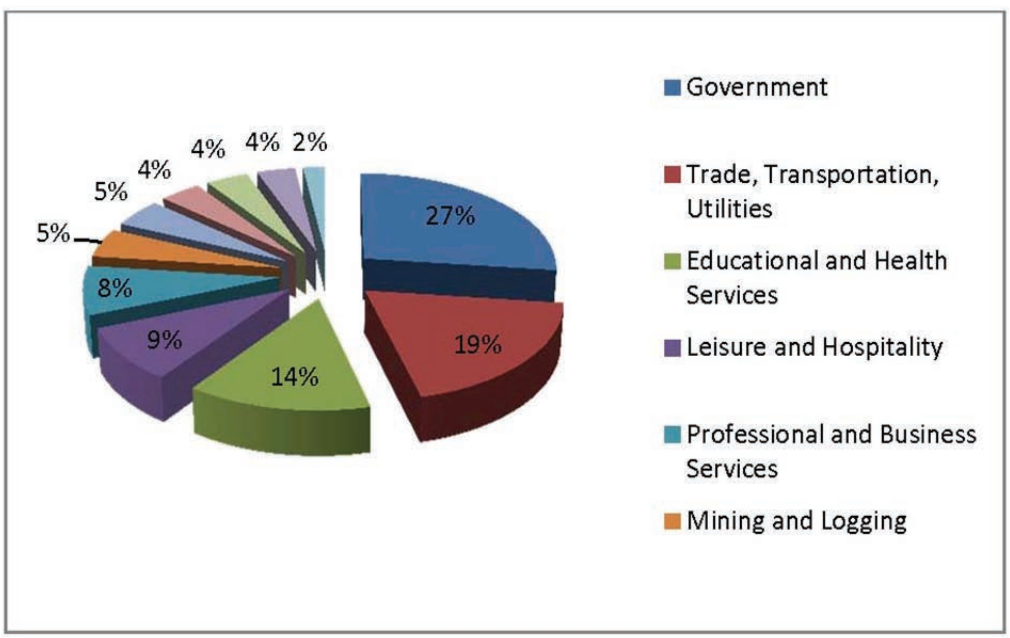


Figure 3.3-3 Local Capture of Large-Scale Resource Extraction from Remote Region Alaska (Million $).

Source: Goldsmith 2007 Calculated by URS in 2003 dollars

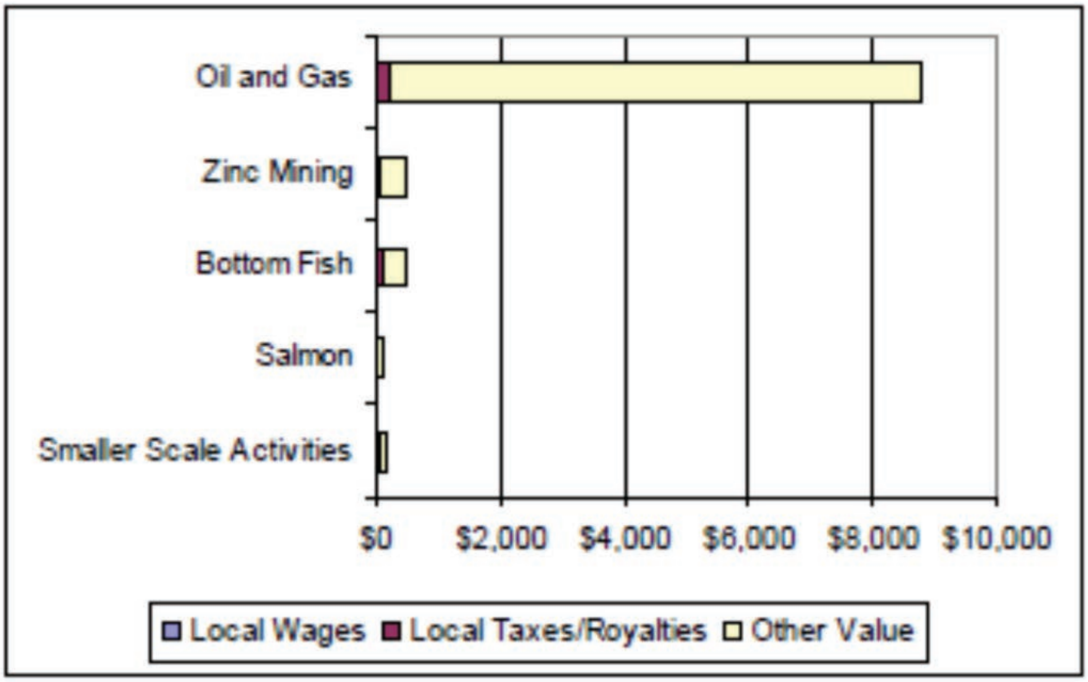


Figure 3.3-4a Top Employers in the NSB (2003).

Source: NSB 2003 Economic Profile and Census Report

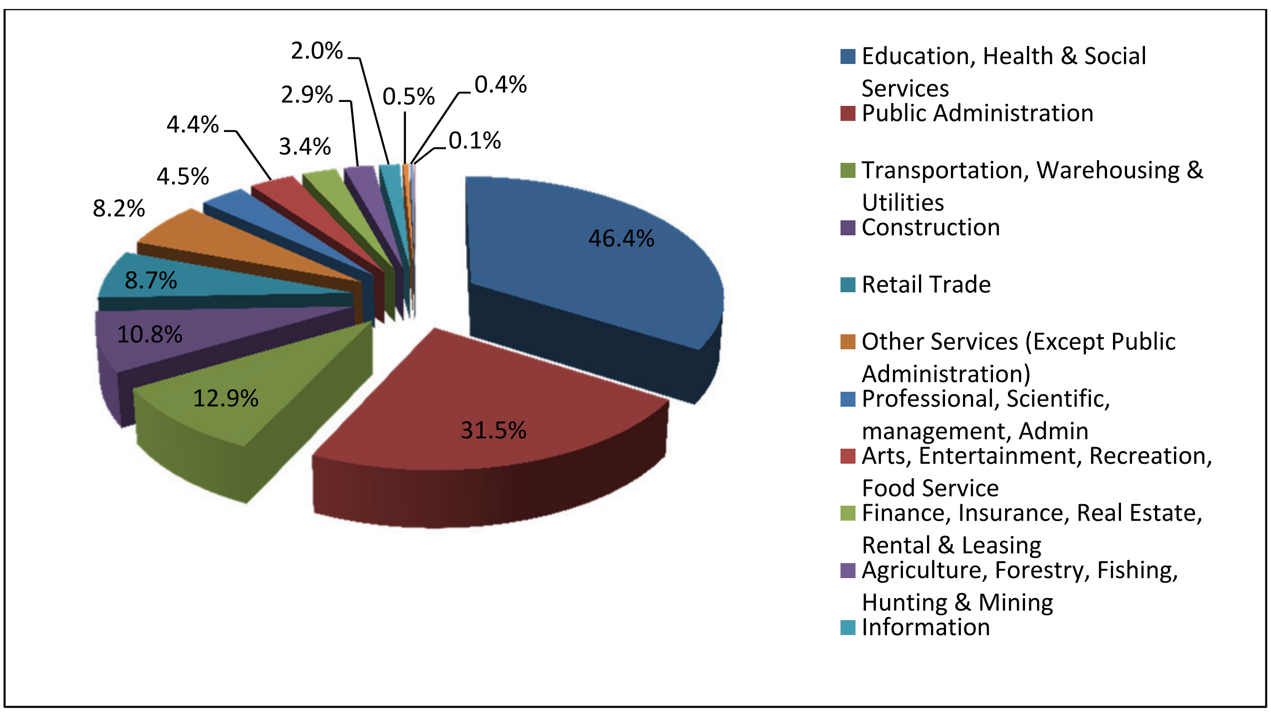


Figure 3.3-4b NSB Employment by Sector (2000).

Source: Alaska Department of Community & Regional Affairs, Community Database Online from 2000 Census

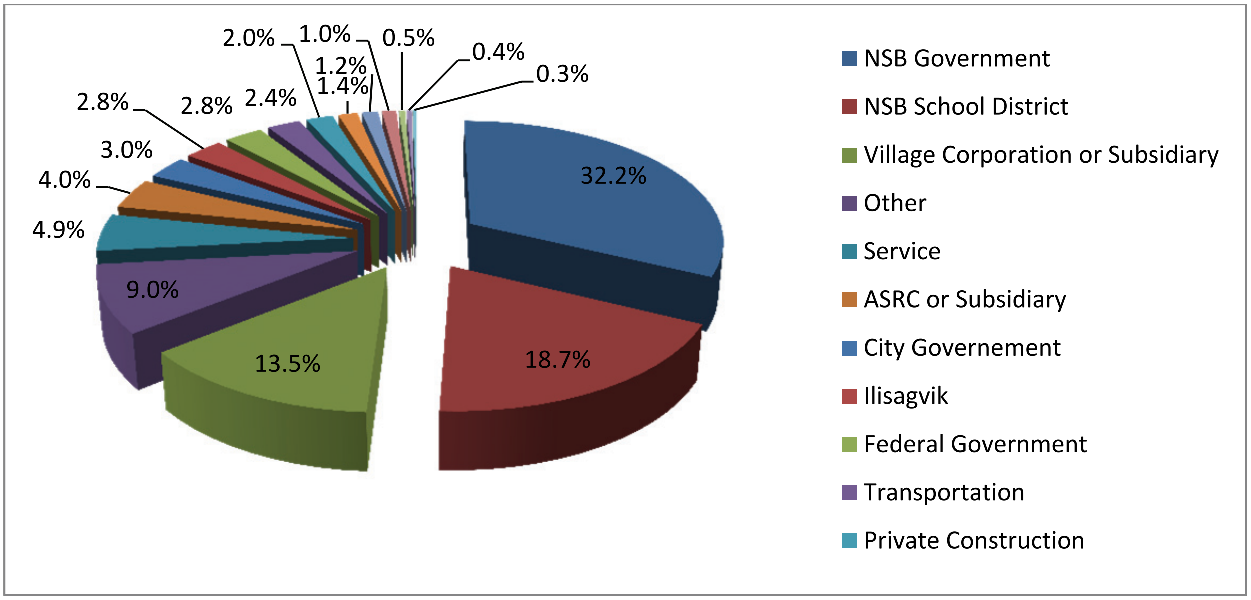


Figure 3.3-4c NAB Major Employment Sectors

Source: Alaska Department of Community & Economic Development, Community Database Online (from 2000 Census)

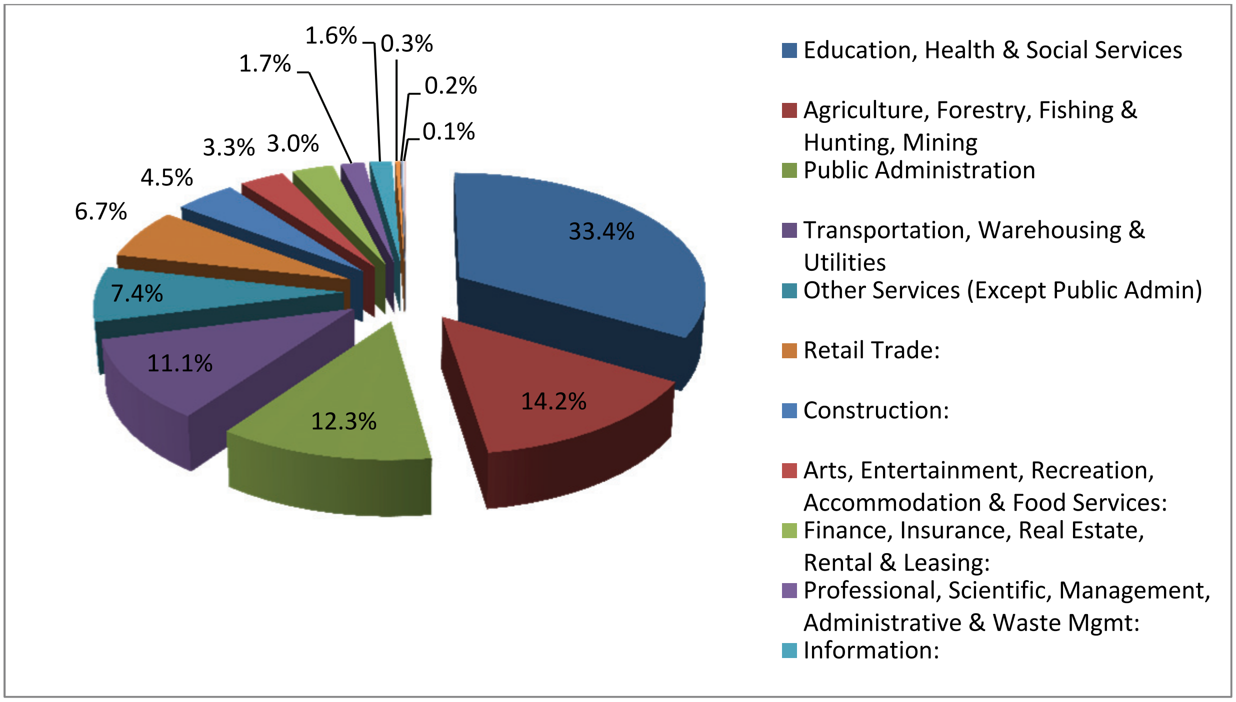


Figure 3.3-5 Percent of Resident Workers by Wage Range (2009).

Source: ADLWD 2011a

Note: Northern Region is indicated in blue (North Slope Borough, Northwest Arctic Borough, and Nome Census Area); State of Alaska is indicated in black.

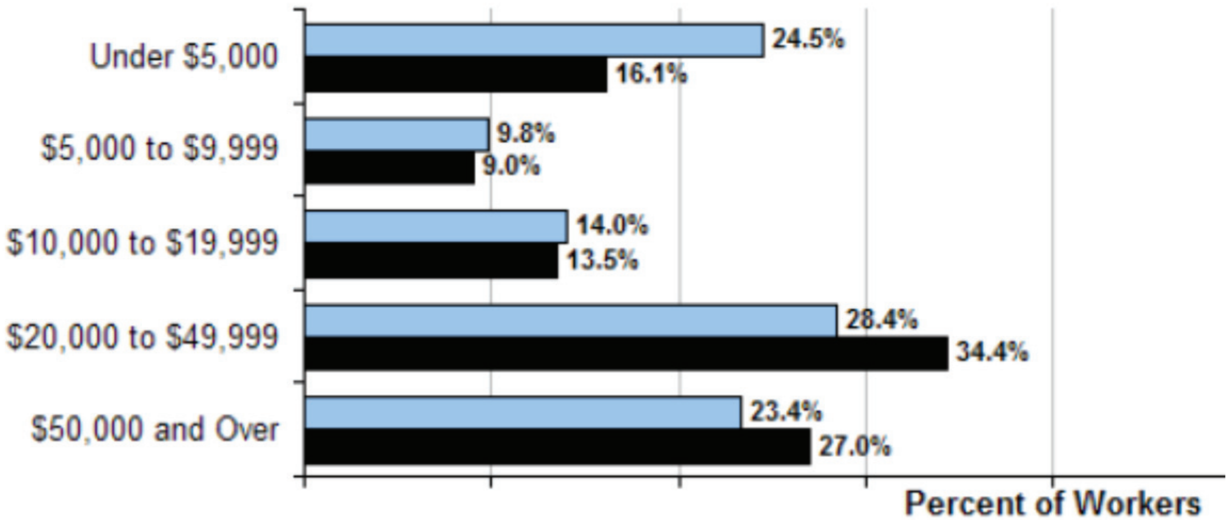


Figure 3.3-6 Efficiency (number landed / number struck) of the bowhead whale subsistence harvest 1973 to 2007.

Source: Suydam et al. 2007

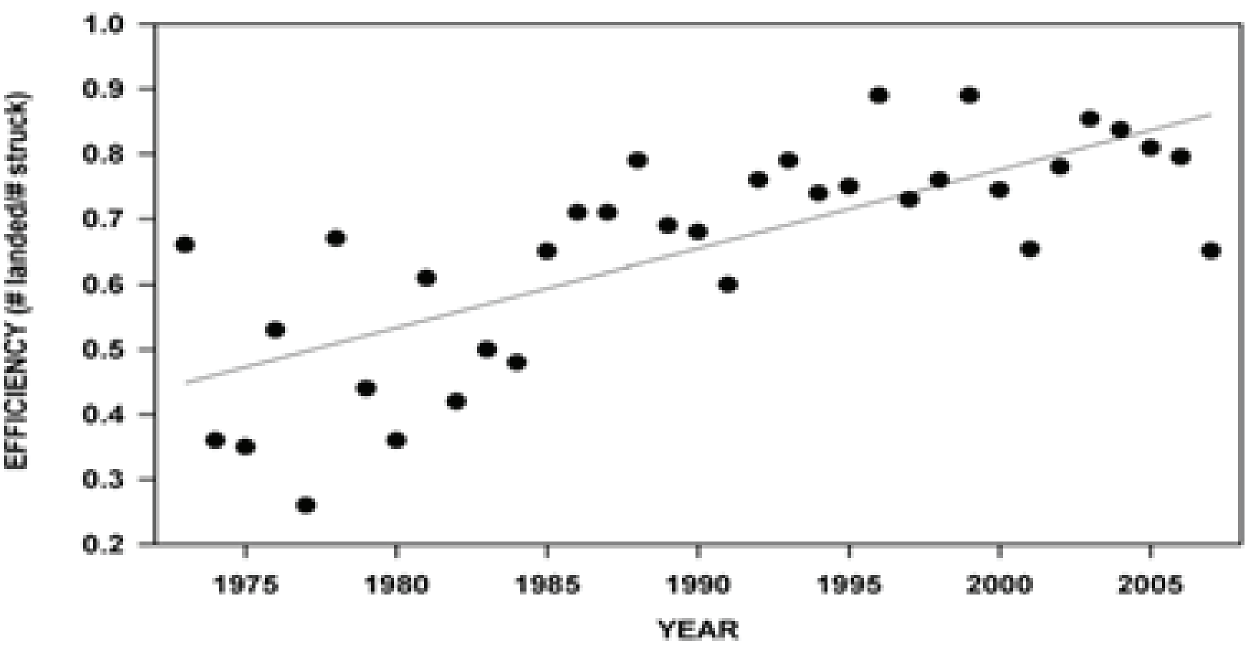


Figure 3.3-7 Number of bowheads landed, and struck by subsistence hunters in the U.S., Canada, and Russia from 1974 to 2006.

Source: NMFS 2008

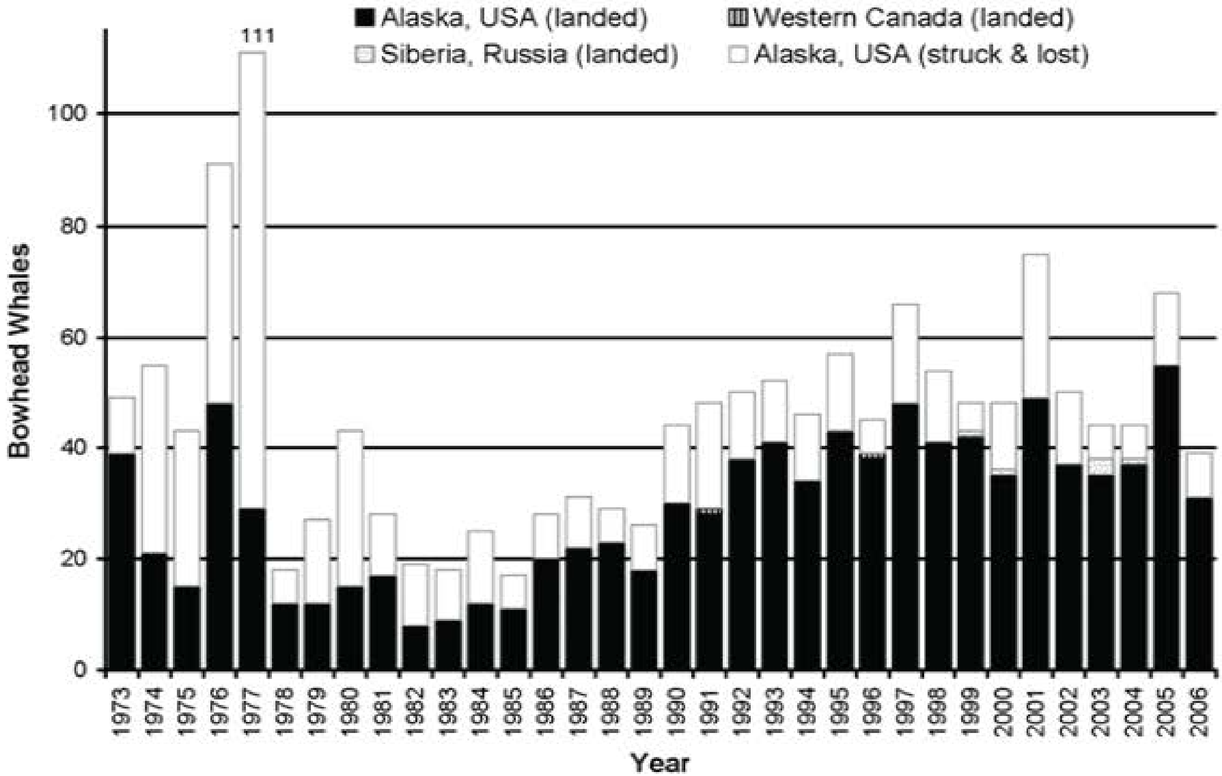


Figure 3.3-8 Winter sea ice in the Beaufort Sea

Source: http://www.photolib.noaa.gov/bigs/corp1014.jpg

Note: Stamukhi zone in the foreground and flatter, smoother, landfast ice in the background.

Figure 3.3-9 Ice floes in the Chukchi Sea

Source: http://www.aslo.org/photopost/showphoto.php/ photo/860/sort/1/size/medium/cat/all/page/2

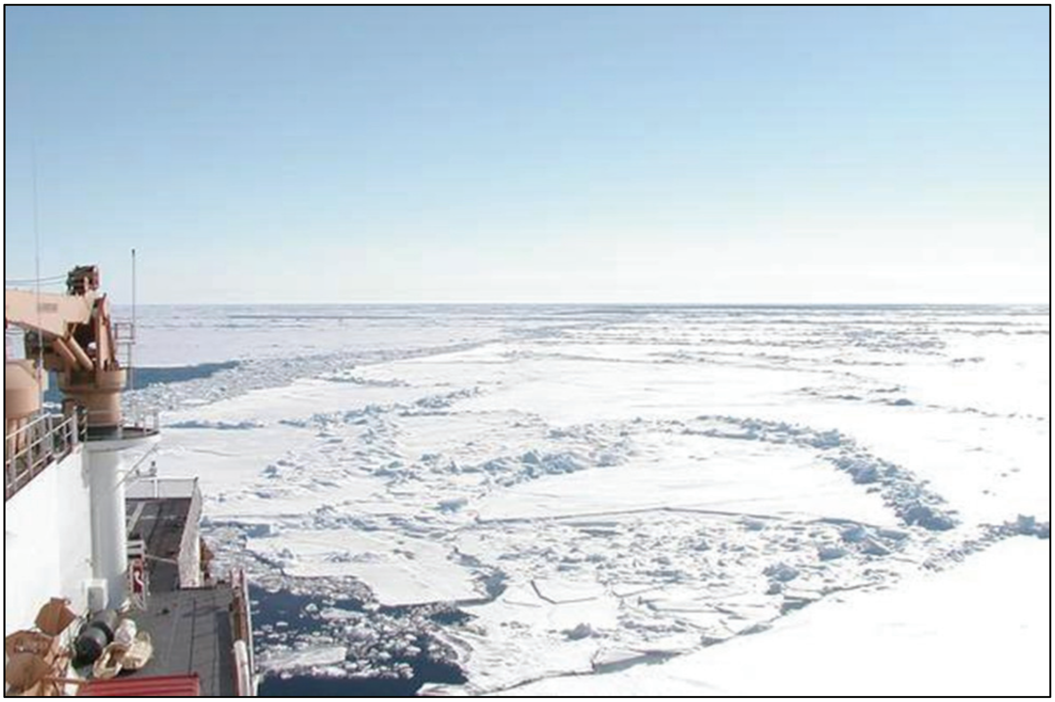


Figure 3.3-10 Coastal flow lead near Barrow, Alaska.

Source: http://boemre-new.gina.alaska.edu/

Note: Landfast ice is on the left and drifting pack ice on the right.

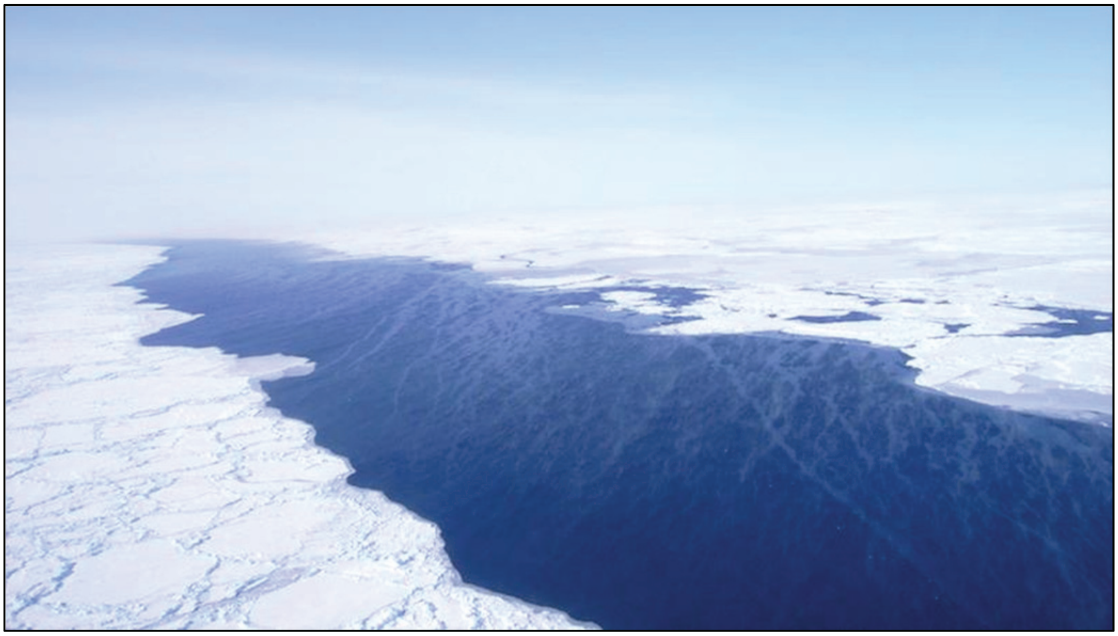


Figure 3.3-11 Open water off the coast of Barrow, Alaska (Summer).

Source: URS Corporation

Figure 3.3-12 Summer in Kotzebue, located on the Chukchi Sea.

Source: http://www.alaska-in-pictures.com/kotzebue-and-chukchi-sea-3103-pictures.htm

Figure 3.3-13 Vegetation located within the EIS project area.

Figure 3.3-14 Oil and Gas Development, Prudhoe Bay.

Source: URS Corporation

Figure 3.3-15 `Mars Ice Island, Beaufort Sea Alaska.

Source: http://www.alaska.boemre. gov/kids/shorts/iceislnd/iceislnd.htm

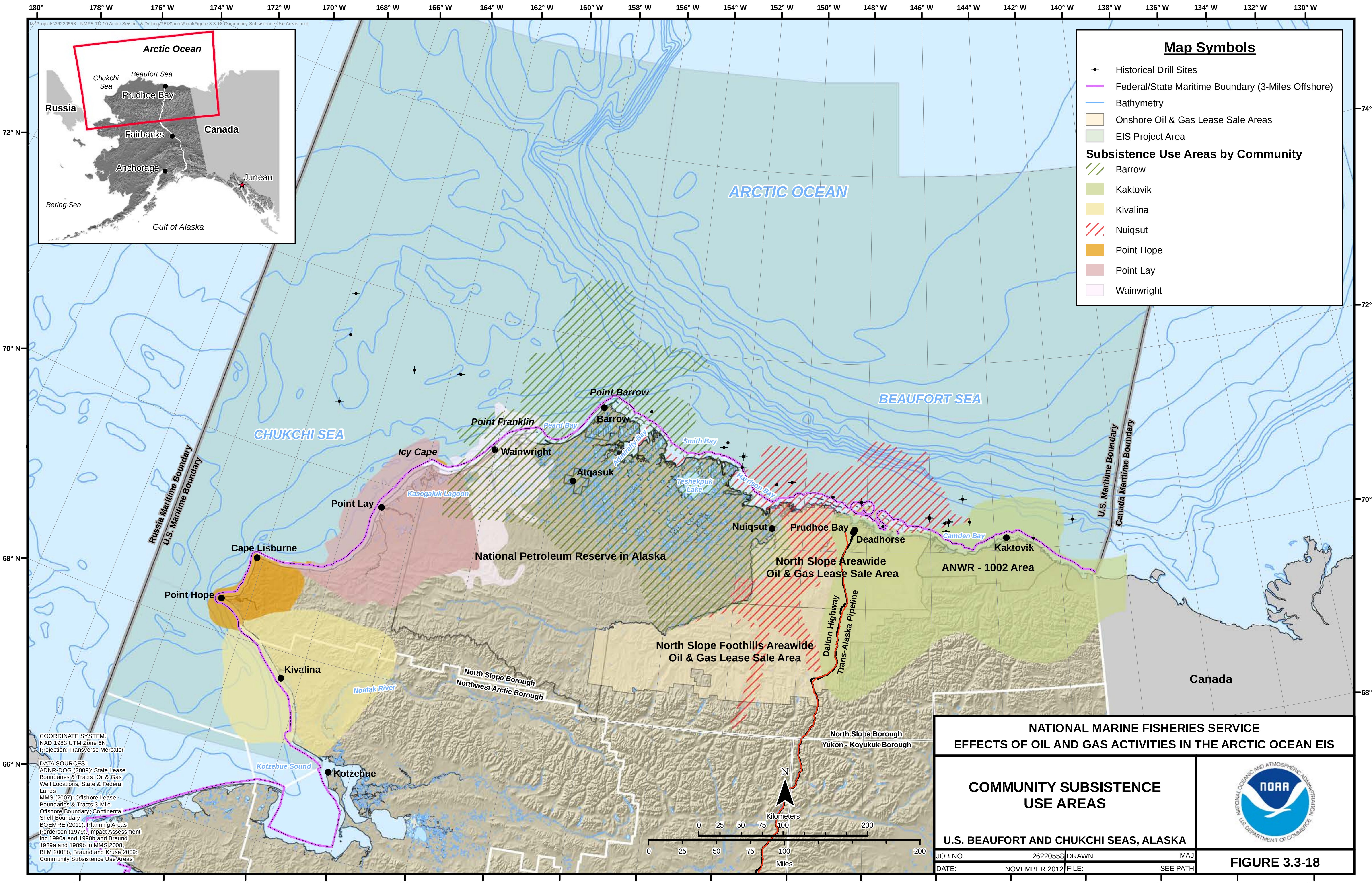
Image shows a 60 day exploratory well built offshore, 8 km off Cape Halkut near NPR-A.

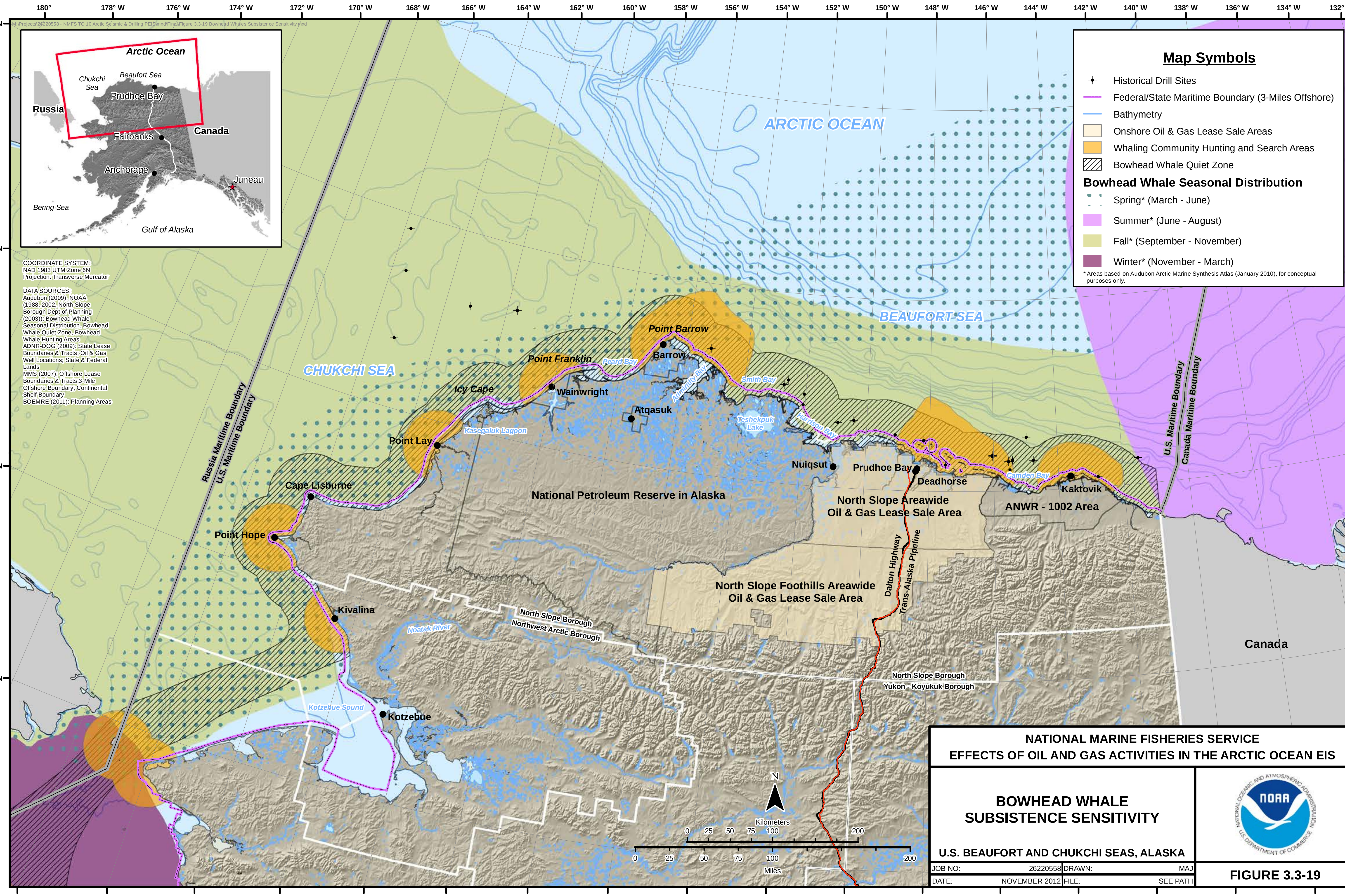
Figure 3.3-16 Pioneer Natural Gas, Oooguruk exploratory drilling site.

Source: http://qa.pennenergy.com/ index/petroleum/display/ 337896/articles/offshore/volume-68/issue-8/Arctic-frontiers/oooguruk-project-offshore-alaska.html

Figure 3.3-17 BP, Liberty exploratory drilling site.

Source: http://www.onepennysheet.com/wp-content/uploads/2010/06/bp-liberty-project-in-ak-fake-island1.jpg


Map Symbols
Historical Drill Sites
Federal/State Maritime Boundary (3-Miles Offshore)
Bathymetry
Onshore Oil & Gas Lease Sale Areas
EIS Project Area
Subsistence Use Areas by Community
Barrow
Kaktovik
Kivalina
Nuiqsut
Point Hope
Point Lay
Wainwright
Arctic Ocean
Chukchi Sea
Beaufort Sea
Prudhoe Bay
Russia
Canada
Fairbanks
Anchorage
Juneau
Bering Sea
Gulf of Alaska
ARCTIC OCEAN
BEAUFORT SEA
CHUKCHI SEA
Russia Maritime Boundary
U.S. Maritime Boundary
U.S. Maritime Boundary
Canada Maritime Boundary
Point Barrow
Barrow
Point Franklin
Peard Bay
Admiralty Bay
Smith Bay
Harrison Bay
Teshekpuk Lake
Icy Cape
Wainwright
Atqasuk
Kasegaluk Lagoon
Point Lay
Cape Lisburne
Point Hope
Kivalina
Noatak River
Kotzebue Sound
Kotzebue
Nuiqsut
Prudhoe Bay
Deadhorse
Camden Bay
Kaktovik
National Petroleum Reserve in Alaska
North Slope Areawide Oil & Gas Lease Sale Area
ANWR - 1002 Area
North Slope Foothills Areawide Oil & Gas Lease Sale Area
Dalton Highway
Trans-Alaska Pipeline
North Slope Borough
Northwest Arctic Borough
North Slope Borough
Yukon - Koyukuk Borough
Canada
COORDINATE SYSTEM:
NAD 1983 UTM Zone 6N
Projection: Transverse Mercator
DATA SOURCES:
ADNR-DOG (2009): State Lease Boundaries & Tracts; Oil & Gas Well Locations; State & Federal Lands
MMS (2007): Offshore Lease Boundaries & Tracts;3-Mile Offshore Boundary; Continental Shelf Boundary
BOEMRE (2011): Planning Areas
Perderson (1979), Impact Assessment Inc 1990a and 1990b and Braund 1989a and 1989b in MMS 2008, BLM 2008b, Braund and Kruse 2009: Community Subsistence Use Areas
Kilometers
0 25 50 75 100 200
Miles
0 25 50 75 100 200
NATIONAL MARINE FISHERIES SERVICE
EFFECTS OF OIL AND GAS ACTIVITIES IN THE ARCTIC OCEAN EIS
COMMUNITY SUBSISTENCE USE AREAS
U.S. BEAUFORT AND CHUKCHI SEAS, ALASKA
JOB NO: 26220558
DRAWN: MAJ
DATE: NOVEMBER 2012
FILE: SEE PATH
FIGURE 3.3-18



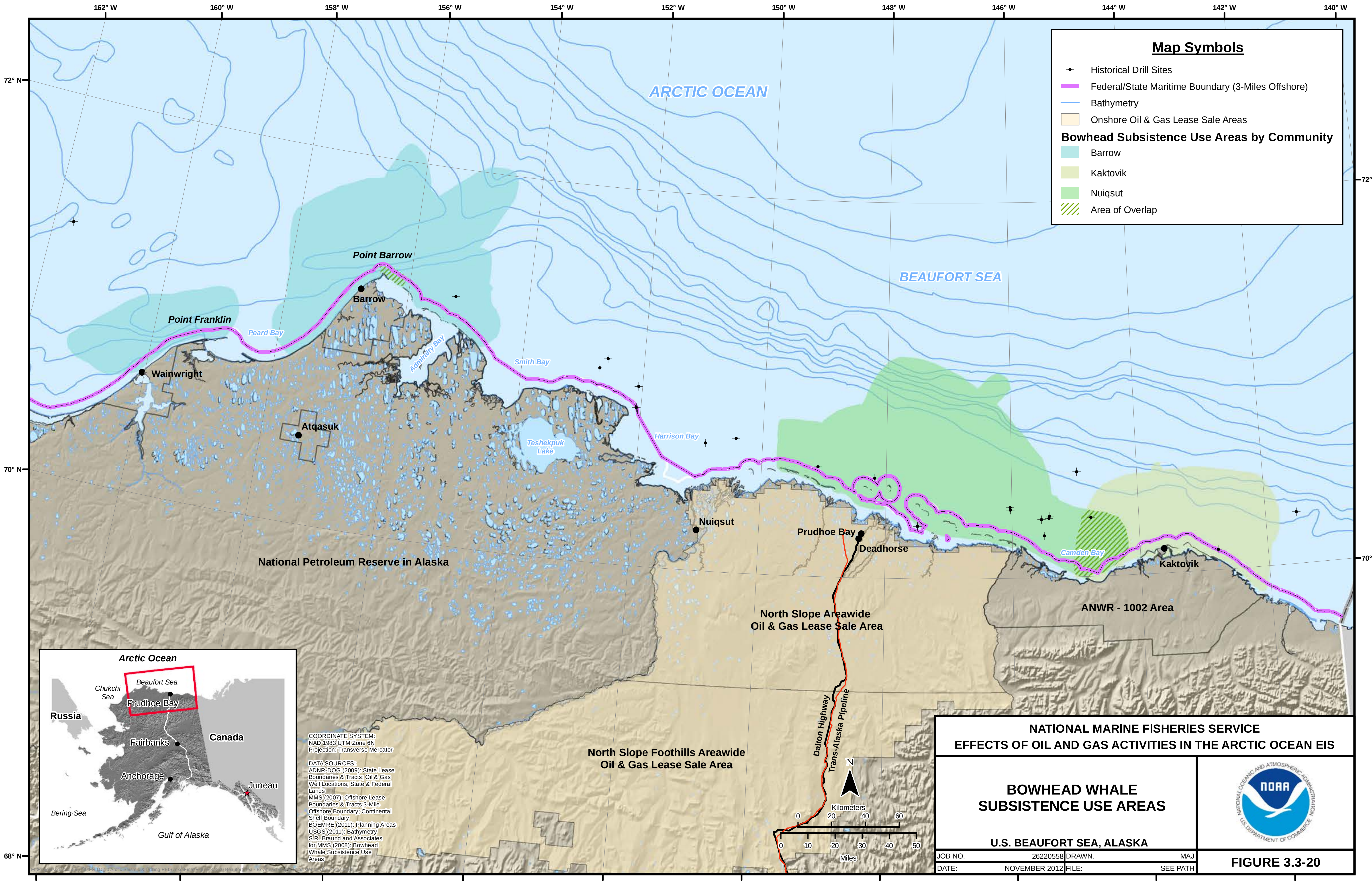
NATIONAL MARINE FISHERIES SERVICE
EFFECTS OF OIL AND GAS ACTIVITIES IN THE ARCTIC OCEAN EIS

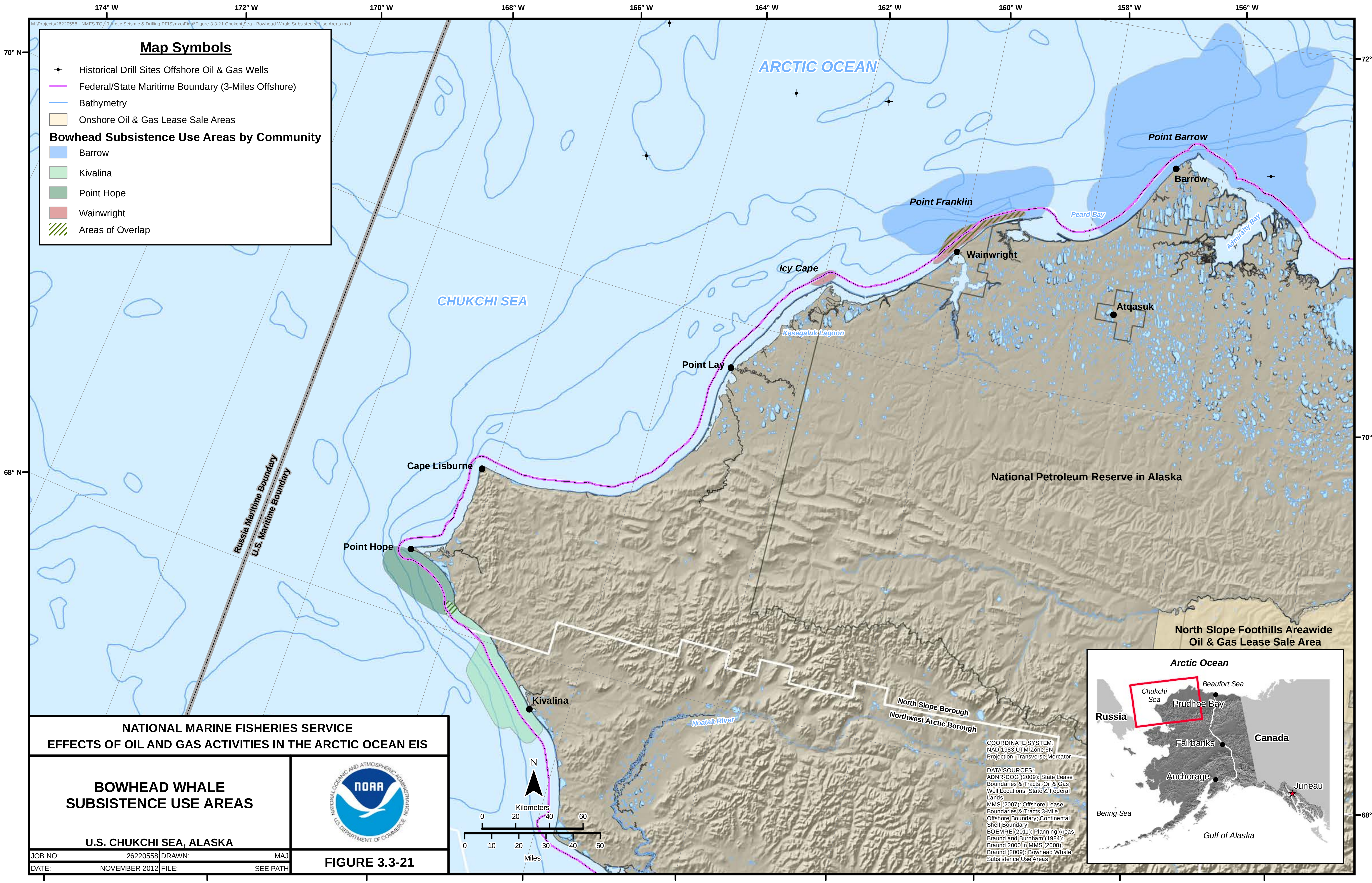
BOWHEAD WHALE SUBSISTENCE SENSITIVITY

U.S. BEAUFORT AND CHUKCHI SEAS, ALASKA

JOB NO:	26220558	DRAWN:	MAJ
DATE:	NOVEMBER 2012	FILE:	SEE PATH

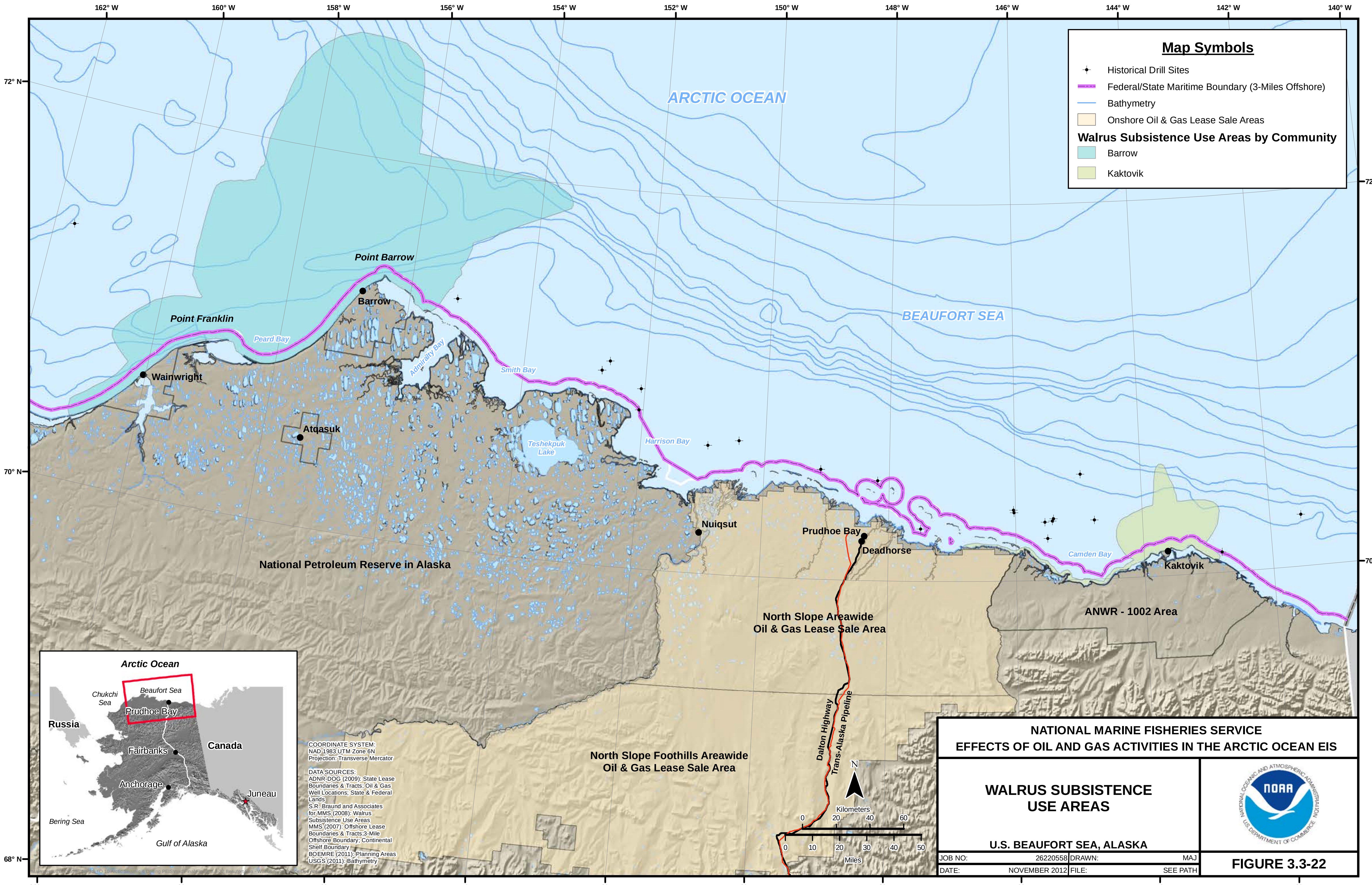
FIGURE 3.3-19


Map Symbols
Historical Drill Sites
Federal/State Maritime Boundary (3-Miles Offshore)
Bathymetry
Onshore Oil & Gas Lease Sale Areas
Bowhead Subsistence Use Areas by Community
Barrow
Kaktovik
Nuiqsut
Area of Overlap
ARCTIC OCEAN
BEAUFORT SEA
Point Barrow
Barrow
Point Franklin
Peard Bay
Wainwright
Admiralty Bay
Smith Bay
Atqasuk
Teshekpuk Lake
Harrison Bay
Nuiqsut
Prudhoe Bay
Deadhorse
Camden Bay
Kaktovik
National Petroleum Reserve in Alaska
North Slope Areawide Oil & Gas Lease Sale Area
ANWR - 1002 Area
North Slope Foothills Areawide Oil & Gas Lease Sale Area
Dalton Highway
Trans-Alaska Pipeline
Arctic Ocean
Chukchi Sea
Beaufort Sea
Prudhoe Bay
Russia
Fairbanks
Canada
Anchorage
Juneau
Bering Sea
Gulf of Alaska
COORDINATE SYSTEM:
NAD 1983 UTM Zone 6N
Projection: Transverse Mercator
DATA SOURCES:
ADNR-DOG (2009): State Lease Boundaries & Tracts; Oil & Gas Well Locations; State & Federal Lands
MMS (2007): Offshore Lease Boundaries & Tracts;3-Mile Offshore Boundary; Continental Shelf Boundary
BOEMRE (2011): Planning Areas
USGS (2011): Bathymetry
S.R. Braund and Associates for MMS (2008): Bowhead Whale Subsistence Use Areas
N
Kilometers
0 20 40 60
0 10 20 30 40 50
Miles
NATIONAL MARINE FISHERIES SERVICE
EFFECTS OF OIL AND GAS ACTIVITIES IN THE ARCTIC OCEAN EIS
BOWHEAD WHALE SUBSISTENCE USE AREAS
U.S. BEAUFORT SEA, ALASKA
JOB NO: 26220558
DRAWN: MAJ
DATE: NOVEMBER 2012
FILE: SEE PATH
FIGURE 3.3-20



Map Symbols
Historical Drill Sites Offshore Oil & Gas Wells
Federal/State Maritime Boundary (3-Miles Offshore)
Bathymetry
Onshore Oil & Gas Lease Sale Areas
Bowhead Subsistence Use Areas by Community
Barrow
Kivalina
Point Hope
Wainwright
Areas of Overlap
ARCTIC OCEAN
CHUKCHI SEA
Point Barrow
Barrow
Peard Bay
Admiralty Bay
Point Franklin
Wainwright
Icy Cape
Atqasuk
Kasegaluk Lagoon
Point Lay
Cape Lisburne
Point Hope
Kivalina
Noatak River
National Petroleum Reserve in Alaska
North Slope Foothills Areawide Oil & Gas Lease Sale Area
North Slope Borough
Northwest Arctic Borough
Russia Maritime Boundary
U.S. Maritime Boundary
174° W
172° W
170° W
168° W
166° W
164° W
162° W
160° W
158° W
156° W
154° W
72° N
70° N
68° N
Kilometers
0 20 40 60
Miles
0 10 20 30 40 50
N
Arctic Ocean
Chukchi Sea
Beaufort Sea
Prudhoe Bay
Russia
Canada
Fairbanks
Anchorage
Juneau
Bering Sea
Gulf of Alaska
COORDINATE SYSTEM:
NAD 1983 UTM Zone 6N
Projection: Transverse Mercator
DATA SOURCES:
ADNR-DOG (2009): State Lease Boundaries & Tracts; Oil & Gas Well Locations; State & Federal Lands
MMS (2007): Offshore Lease Boundaries & Tracts;3-Mile Offshore Boundary; Continental Shelf Boundary
BOEMRE (2011): Planning Areas
Braund and Burnham (1984); Braund 2000 in MMS (2008), Braund (2009): Bowhead Whale Subsistence Use Areas
NATIONAL MARINE FISHERIES SERVICE
EFFECTS OF OIL AND GAS ACTIVITIES IN THE ARCTIC OCEAN EIS
BOWHEAD WHALE SUBSISTENCE USE AREAS
U.S. CHUKCHI SEA, ALASKA
JOB NO: 26220558
DRAWN: MAJ
DATE: NOVEMBER 2012
FILE: SEE PATH

FIGURE 3.3-21



Map Symbols
Historical Drill Sites
Federal/State Maritime Boundary (3-Miles Offshore)
Bathymetry
Onshore Oil & Gas Lease Sale Areas
Walrus Subsistence Use Areas by Community
Barrow
Kaktovik
ARCTIC OCEAN
BEAUFORT SEA
Point Barrow
Barrow
Point Franklin
Peard Bay
Admiralty Bay
Smith Bay
Wainwright
Atqasuk
Teshekpuk Lake
Harrison Bay
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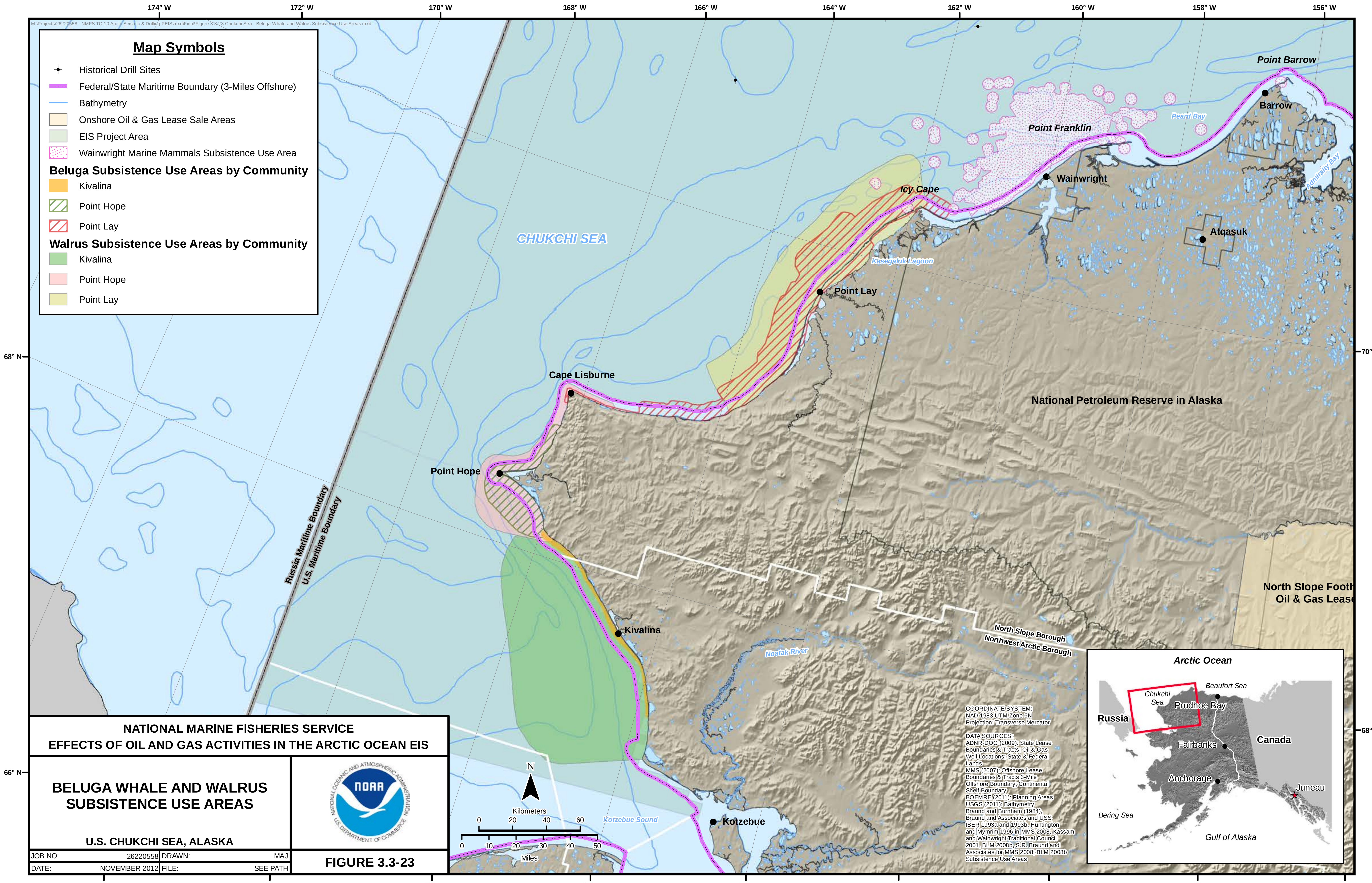
Beaufort Sea
Prudhoe Bay
Russia
Canada
Fairbanks
Anchorage
Juneau
Bering Sea
Gulf of Alaska
COORDINATE SYSTEM:
NAD 1983 UTM Zone 6N
Projection: Transverse Mercator
DATA SOURCES:
ADNR-DOG (2009): State Lease Boundaries & Tracts; Oil & Gas Well Locations; State & Federal Lands
S.R. Braund and Associates for MMS (2008): Walrus Subsistence Use Areas
MMS (2007): Offshore Lease Boundaries & Tracts;3-Mile Offshore Boundary; Continental Shelf Boundary
BOEMRE (2011): Planning Areas
USGS (2011): Bathymetry
N
Kilometers
0 20 40 60
0 10 20 30 40 50
Miles
162° W 160° W 158° W 156° W 154° W 152° W 150° W 148° W 146° W 144° W 142° W 140° W
72° N
70° N
68° N
NATIONAL MARINE FISHERIES SERVICE
EFFECTS OF OIL AND GAS ACTIVITIES IN THE ARCTIC OCEAN EIS
WALRUS SUBSISTENCE USE AREAS
U.S. BEAUFORT SEA, ALASKA
JOB NO: 26220558
DRAWN: MAJ
DATE: NOVEMBER 2012
FILE: SEE PATH
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE
NOAA

FIGURE 3.3-22



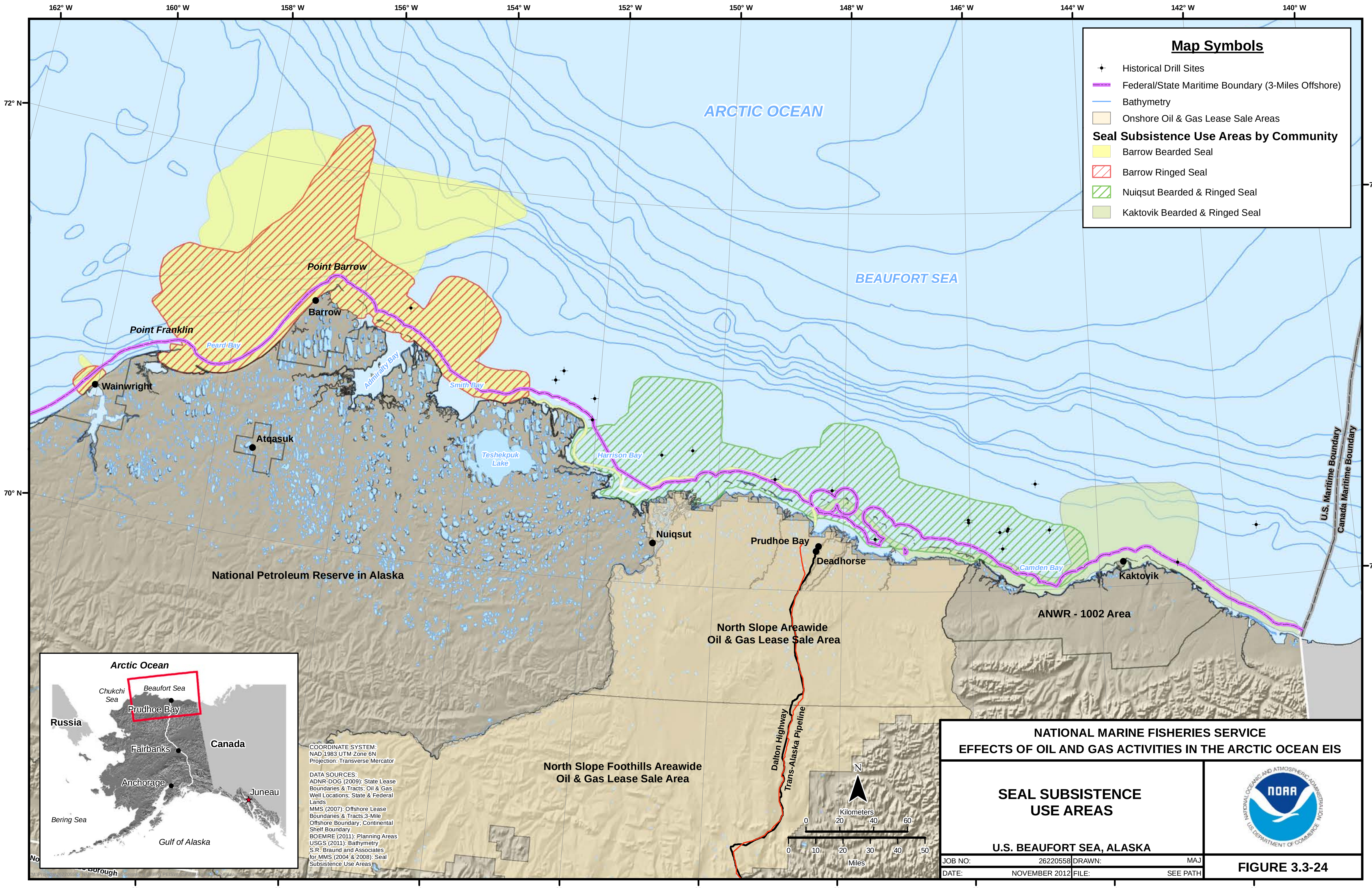
NATIONAL MARINE FISHERIES SERVICE
EFFECTS OF OIL AND GAS ACTIVITIES IN THE ARCTIC OCEAN EIS

BELUGA WHALE AND WALRUS SUBSISTENCE USE AREAS

U.S. CHUKCHI SEA, ALASKA

JOB NO:	26220558	DRAWN:	MAJ
DATE:	NOVEMBER 2012	FILE:	SEE PATH

FIGURE 3.3-23


Map Symbols
Historical Drill Sites
Federal/State Maritime Boundary (3-Miles Offshore)
Bathymetry
Onshore Oil & Gas Lease Sale Areas
Seal Subsistence Use Areas by Community
Barrow Bearded Seal
Barrow Ringed Seal
Nuiqsut Bearded & Ringed Seal
Kaktovik Bearded & Ringed Seal
ARCTIC OCEAN
BEAUFORT SEA
Point Barrow
Barrow
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Wainwright
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Smith Bay
Atqasuk
Teshekpuk Lake
Harrison Bay
Nuiqsut
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Beaufort Sea
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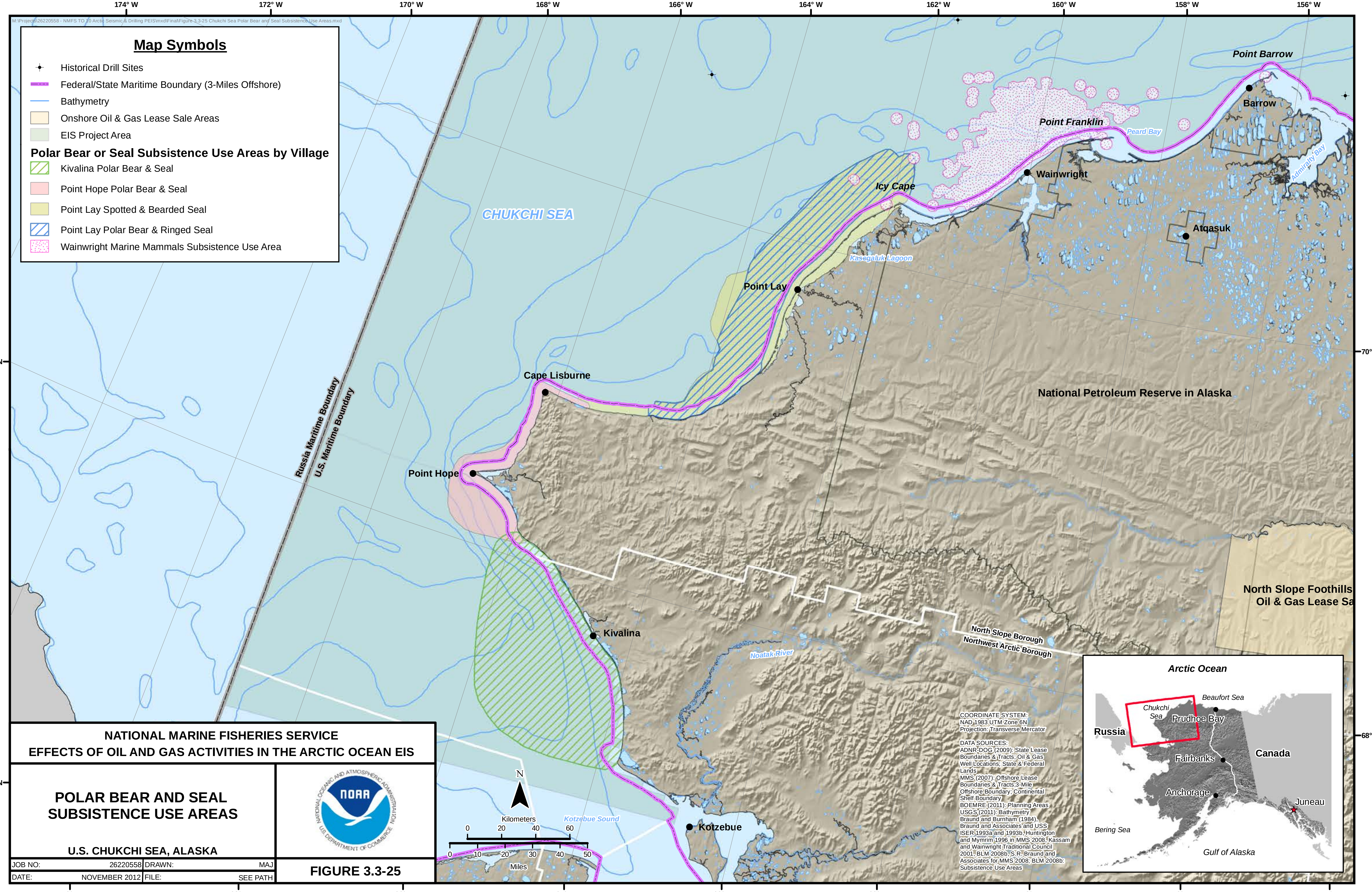
Russia
Fairbanks
Canada
Anchorage
Juneau
Bering Sea
Gulf of Alaska
COORDINATE SYSTEM:
NAD 1983 UTM Zone 6N
Projection: Transverse Mercator
DATA SOURCES:
ADNR-DOG (2009): State Lease Boundaries & Tracts; Oil & Gas Well Locations; State & Federal Lands
MMS (2007): Offshore Lease Boundaries & Tracts;3-Mile Offshore Boundary; Continental Shelf Boundary
BOEMRE (2011): Planning Areas
USGS (2011): Bathymetry
S.R. Braund and Associates for MMS (2004 & 2008): Seal Subsistence Use Areas
N
Kilometers
0 20 40 60
0 10 20 30 40 50
Miles
162° W 160° W 158° W 156° W 154° W 152° W 150° W 148° W 146° W 144° W 142° W 140° W
72° N 70° N
NATIONAL MARINE FISHERIES SERVICE
EFFECTS OF OIL AND GAS ACTIVITIES IN THE ARCTIC OCEAN EIS
SEAL SUBSISTENCE USE AREAS
U.S. BEAUFORT SEA, ALASKA
JOB NO: 26220558
DRAWN: MAJ
DATE: NOVEMBER 2012
FILE: SEE PATH
FIGURE 3.3-24



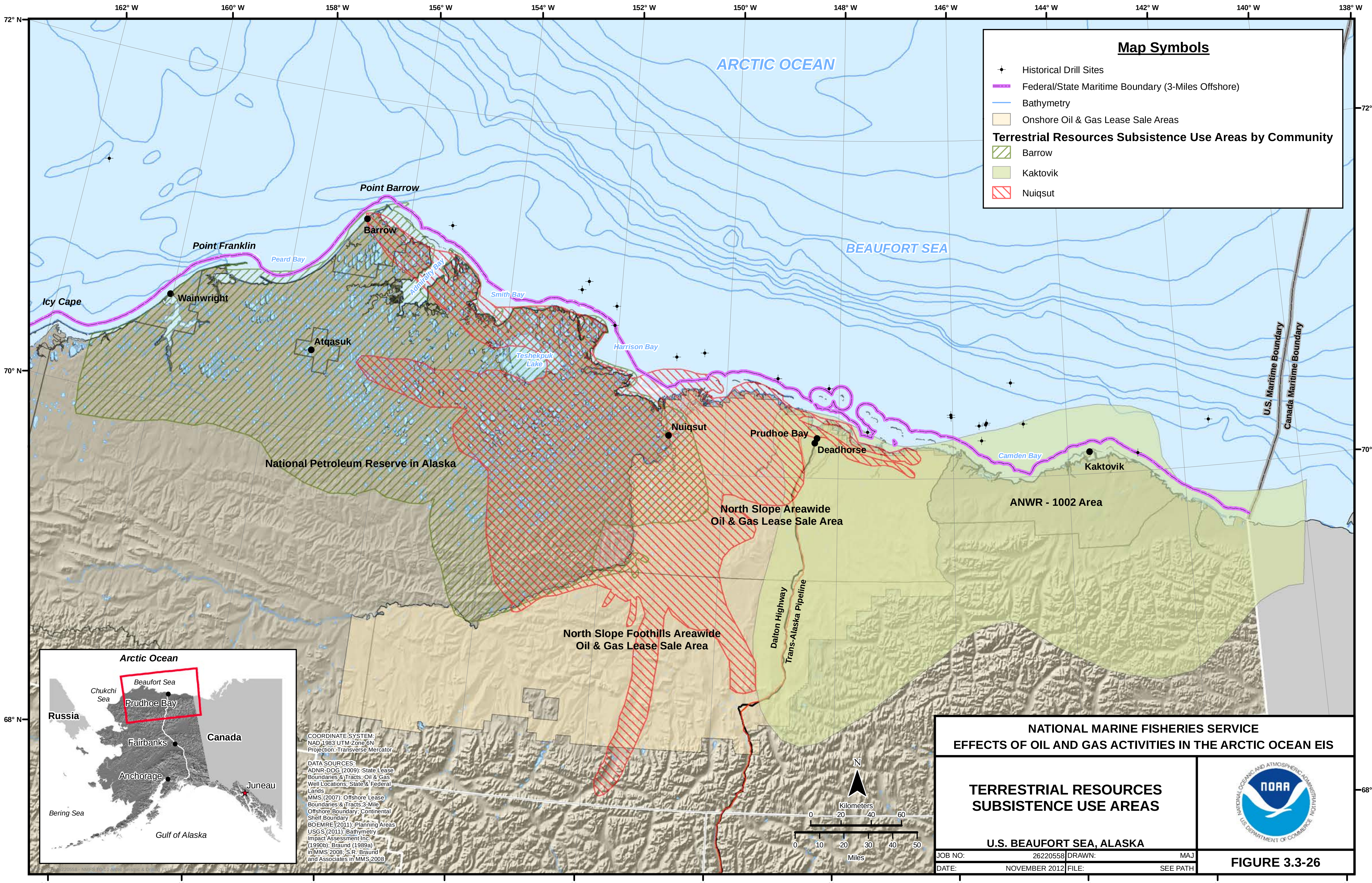
NATIONAL MARINE FISHERIES SERVICE
EFFECTS OF OIL AND GAS ACTIVITIES IN THE ARCTIC OCEAN EIS

POLAR BEAR AND SEAL SUBSISTENCE USE AREAS

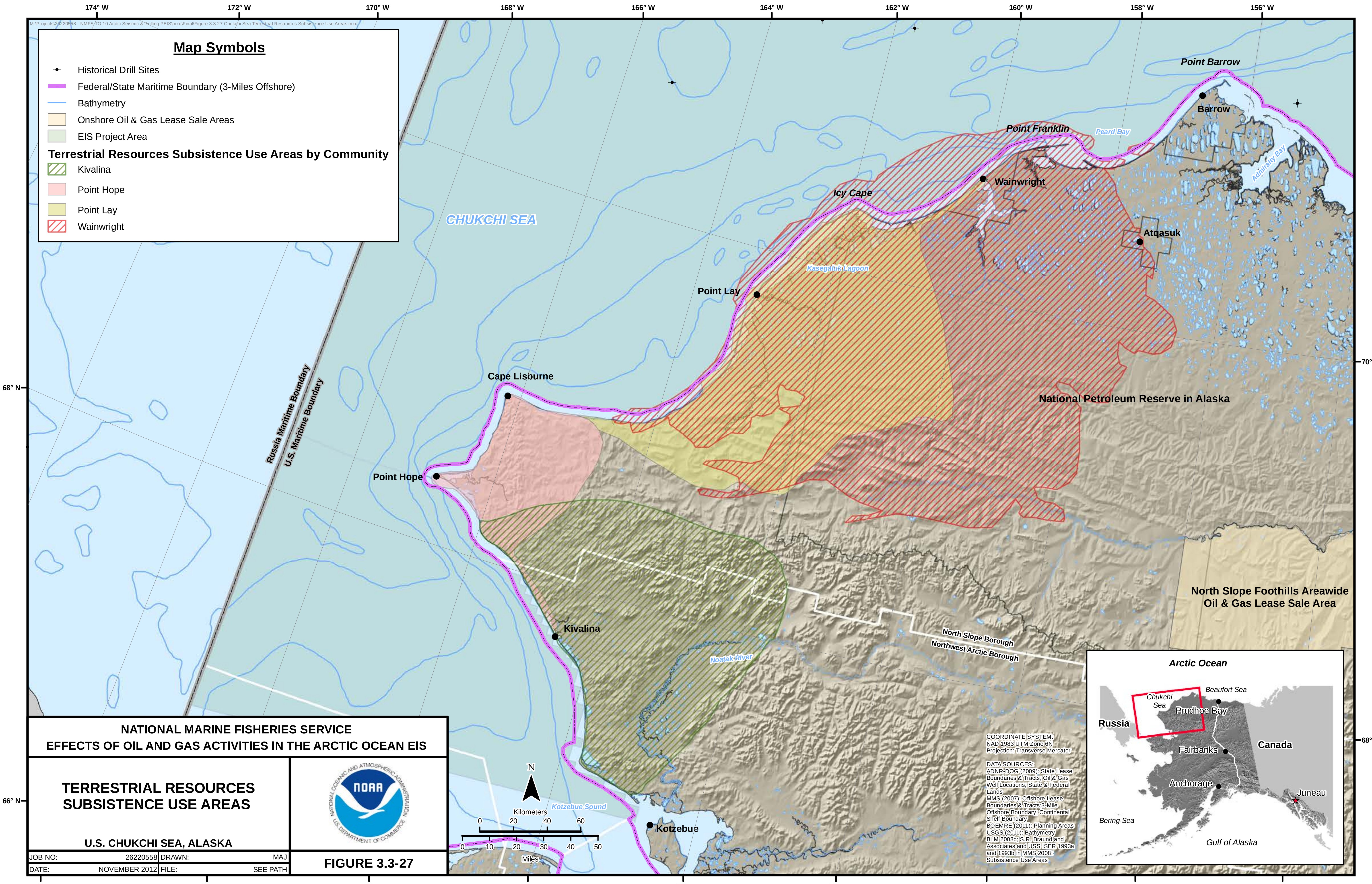
U.S. CHUKCHI SEA, ALASKA

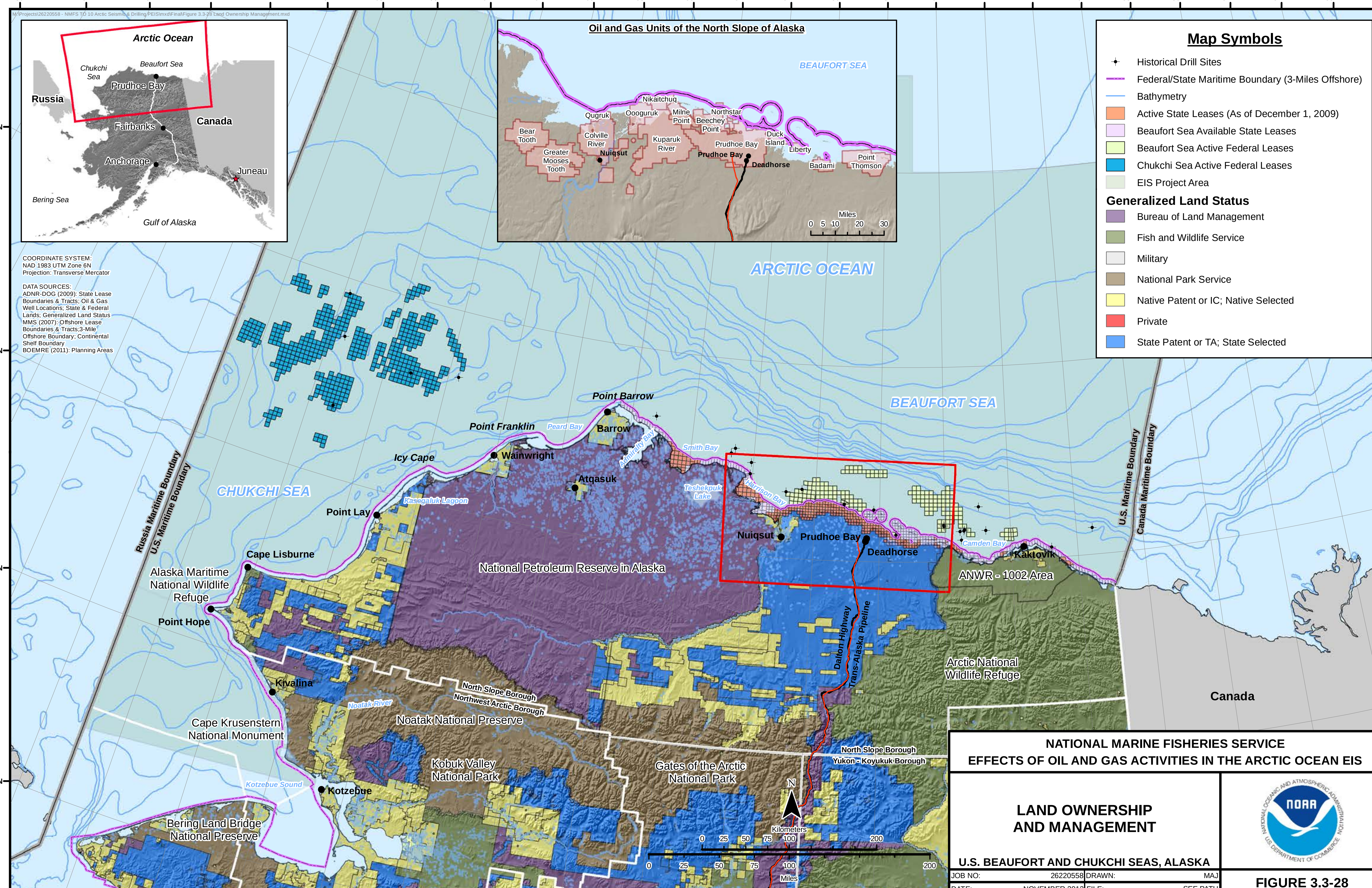
JOB NO: 26220558	DRAWN: MAJ
DATE: NOVEMBER 2012	FILE: SEE PATH

FIGURE 3.3-25



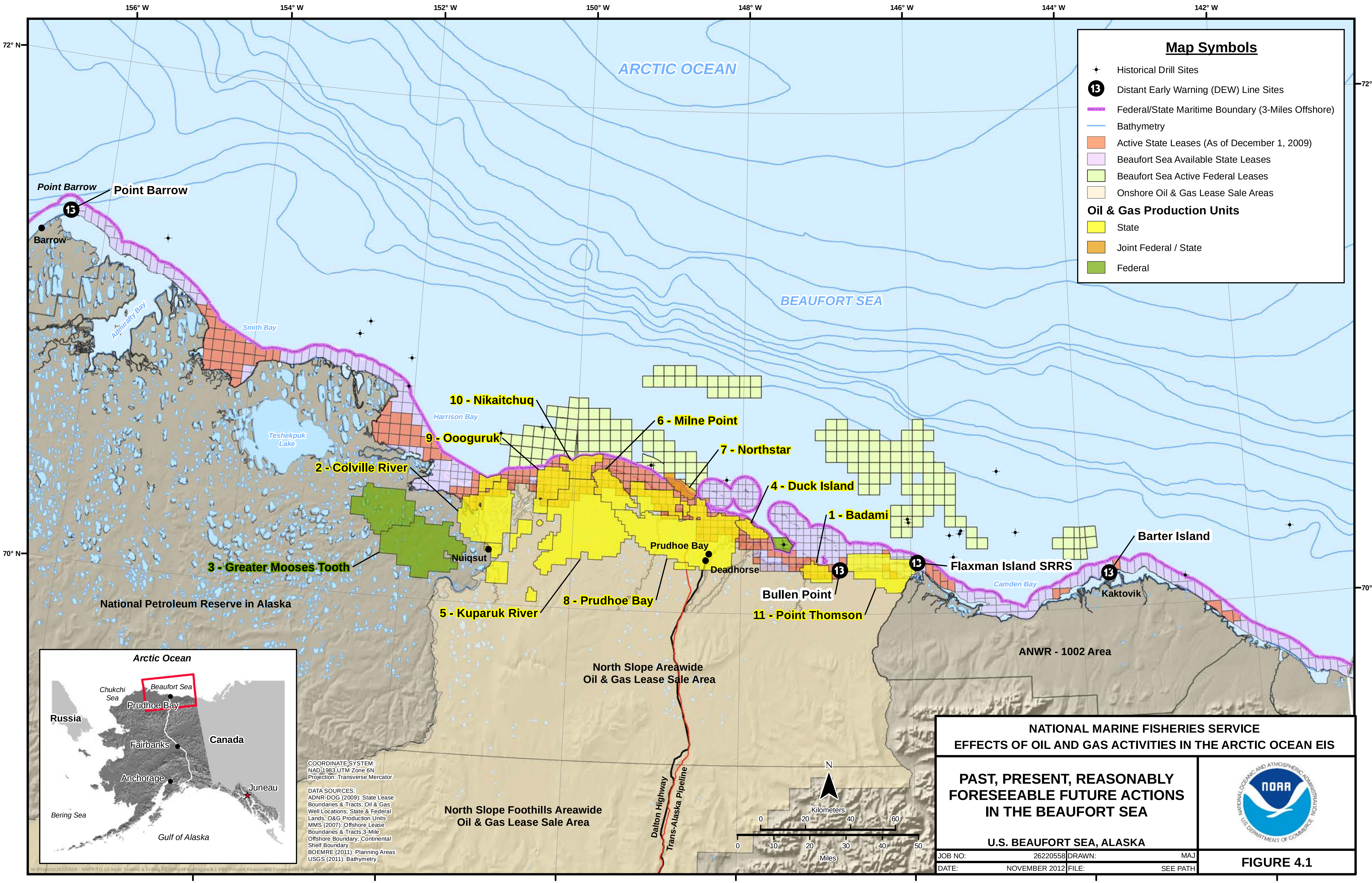
Map Symbols
Historical Drill Sites
Federal/State Maritime Boundary (3-Miles Offshore)
Bathymetry
Onshore Oil & Gas Lease Sale Areas
Terrestrial Resources Subsistence Use Areas by Community
Barrow
Kaktovik
Nuiqsut
ARCTIC OCEAN
BEAUFORT SEA
Point Barrow
Barrow
Point Franklin
Peard Bay
Admiralty Bay
Smith Bay
Harrison Bay
Teshekpuk Lake
Camden Bay
Icy Cape
Wainwright
Atqasuk
Nuiqsut
Prudhoe Bay
Deadhorse
Kaktovik
National Petroleum Reserve in Alaska
North Slope Areawide Oil & Gas Lease Sale Area
North Slope Foothills Areawide Oil & Gas Lease Sale Area
ANWR - 1002 Area
Dalton Highway
Trans-Alaska Pipeline
U.S. Maritime Boundary
Canada Maritime Boundary
Arctic Ocean
Beaufort Sea
Chukchi Sea
Prudhoe Bay
Russia
Canada
Fairbanks
Anchorage
Juneau
Bering Sea
Gulf of Alaska
COORDINATE SYSTEM:
NAD 1983 UTM Zone 6N
Projection: Transverse Mercator
DATA SOURCES:
ADNR-DOG (2009): State Lease Boundaries & Tracts; Oil & Gas Well Locations; State & Federal Lands
MMS (2007): Offshore Lease Boundaries & Tracts;3-Mile Offshore Boundary; Continental Shelf Boundary
BOEMRE (2011): Planning Areas
USGS (2011): Bathymetry
Impact Assessment Inc. (1990b); Braund (1989a) in MMS 2008; S.R. Braund and Associates in MMS 2008
N
Kilometers
0 20 40 60
0 10 20 30 40 50
Miles
162° W 160° W 158° W 156° W 154° W 152° W 150° W 148° W 146° W 144° W 142° W 140° W 138° W
72° N 70° N 68° N
NATIONAL MARINE FISHERIES SERVICE
EFFECTS OF OIL AND GAS ACTIVITIES IN THE ARCTIC OCEAN EIS
TERRESTRIAL RESOURCES SUBSISTENCE USE AREAS
U.S. BEAUFORT SEA, ALASKA
NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE
JOB NO: 26220558
DRAWN: MAJ
DATE: NOVEMBER 2012
FILE: SEE PATH
FIGURE 3.3-26


Map Symbols
Historical Drill Sites
Federal/State Maritime Boundary (3-Miles Offshore)
Bathymetry
Onshore Oil & Gas Lease Sale Areas
EIS Project Area
Terrestrial Resources Subsistence Use Areas by Community
Kivalina
Point Hope
Point Lay
Wainwright
CHUKCHI SEA
Point Barrow
Barrow
Point Franklin
Peard Bay
Admiralty Bay
Wainwright
Icy Cape
Atqasuk
Kasegaluk Lagoon
Point Lay
Cape Lisburne
Point Hope
Kivalina
Noatak River
Kotzebue Sound
Kotzebue
National Petroleum Reserve in Alaska
North Slope Foothills Areawide
Oil & Gas Lease Sale Area
North Slope Borough
Northwest Arctic Borough
Russia Maritime Boundary
U.S. Maritime Boundary
174° W
172° W
170° W
168° W
166° W
164° W
162° W
160° W
158° W
156° W
154° W
68° N
70° N
66° N
Kilometers
0 20 40 60
Miles
0 10 20 30 40 50
N
COORDINATE SYSTEM:
NAD 1983 UTM Zone 6N
Projection: Transverse Mercator
DATA SOURCES:
ADNR-DOG (2009): State Lease Boundaries & Tracts; Oil & Gas Well Locations; State & Federal Lands
MMS (2007): Offshore Lease Boundaries & Tracts;3-Mile Offshore Boundary; Continental Shelf Boundary
BOEMRE (2011): Planning Areas
USGS (2011): Bathymetry
BLM 2008b; S.R. Braund and Associates and USS ISER 1993a and 1993b in MMS 2008: Subsistence Use Areas
Arctic Ocean
Beaufort Sea
Chukchi Sea
Prudhoe Bay
Russia
Canada
Fairbanks
Anchorage
Juneau
Bering Sea
Gulf of Alaska
NATIONAL MARINE FISHERIES SERVICE
EFFECTS OF OIL AND GAS ACTIVITIES IN THE ARCTIC OCEAN EIS
TERRESTRIAL RESOURCES
SUBSISTENCE USE AREAS
U.S. CHUKCHI SEA, ALASKA
JOB NO: 26220558
DRAWN: MAJ
DATE: NOVEMBER 2012
FILE: SEE PATH
FIGURE 3.3-27

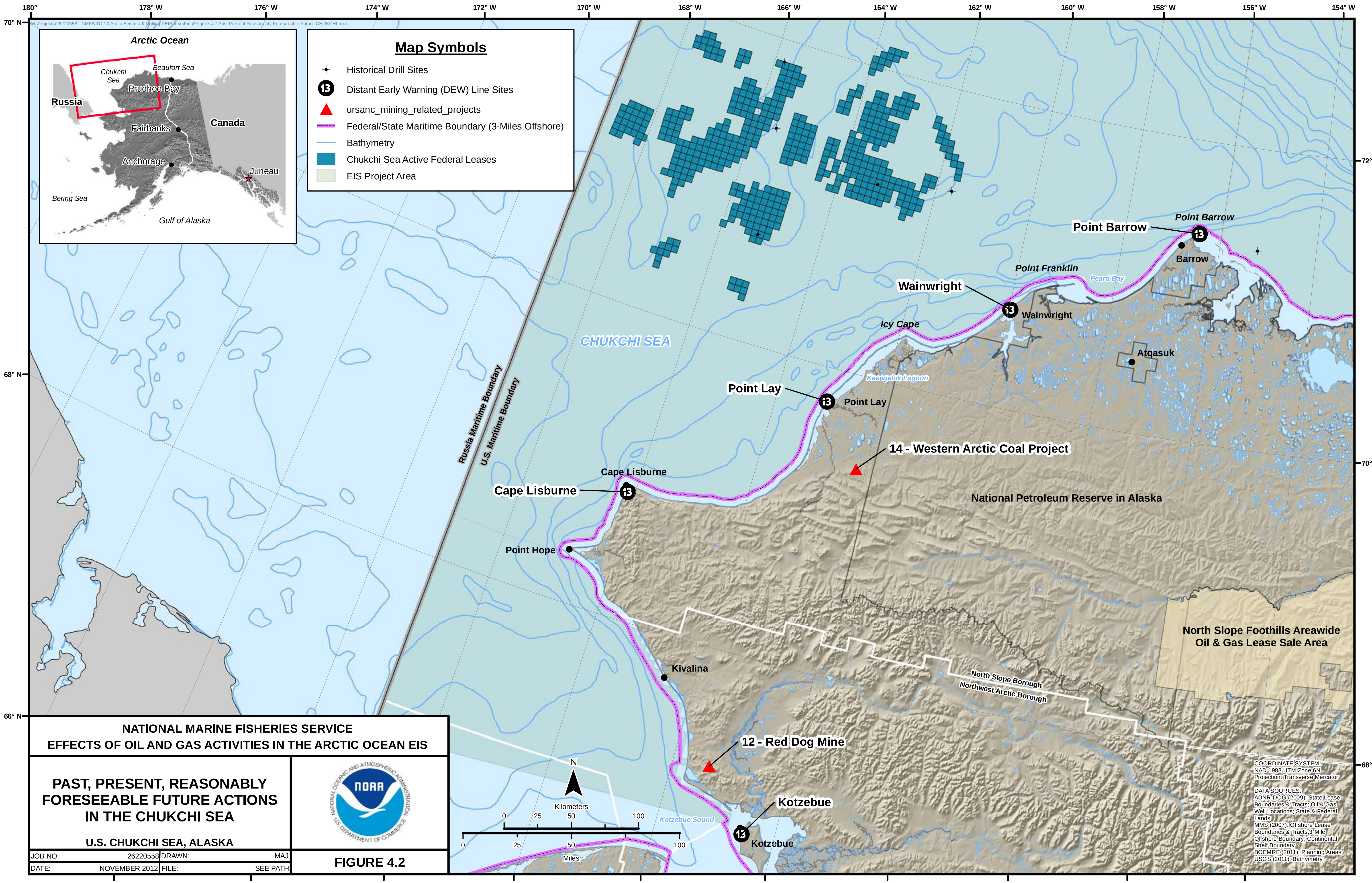


Arctic Ocean
Beaufort Sea
Chukchi Sea
Prudhoe Bay
Russia
Canada
Fairbanks
Anchorage
Juneau
Bering Sea
Gulf of Alaska
Oil and Gas Units of the North Slope of Alaska
BEAUFORT SEA
Nikaitchuq
Qugruk
Oooguruk
Milne Point
Northstar
Beechey Point
Bear Tooth
Colville River
Kuparuk River
Duck Island
Greater Mooses Tooth
Nuiqsut
Prudhoe Bay
Liberty
Deadhorse
Badami
Point Thomson
Miles
0 5 10 20 30
Map Symbols
Historical Drill Sites
Federal/State Maritime Boundary (3-Miles Offshore)
Bathymetry
Active State Leases (As of December 1, 2009)
Beaufort Sea Available State Leases
Beaufort Sea Active Federal Leases
Chukchi Sea Active Federal Leases
EIS Project Area
Generalized Land Status
Bureau of Land Management
Fish and Wildlife Service
Military
National Park Service
Native Patent or IC; Native Selected
Private
State Patent or TA; State Selected
COORDINATE SYSTEM:
NAD 1983 UTM Zone 6N
Projection: Transverse Mercator
DATA SOURCES:
ADNR-DOG (2009): State Lease Boundaries & Tracts; Oil & Gas Well Locations; State & Federal Lands; Generalized Land Status
MMS (2007): Offshore Lease Boundaries & Tracts;3-Mile Offshore Boundary; Continental Shelf Boundary
BOEMRE (2011): Planning Areas
ARCTIC OCEAN
BEAUFORT SEA
CHUKCHI SEA
Russia Maritime Boundary
U.S. Maritime Boundary
U.S. Maritime Boundary
Canada Maritime Boundary
Point Barrow
Barrow
Point Franklin
Peard Bay
Admiralty Bay
Smith Bay
Icy Cape
Wainwright
Atqasuk
Teshekpuk Lake
Harrison Bay
Point Lay
Kasegaluk Lagoon
Nuiqsut
Prudhoe Bay
Deadhorse
Camden Bay
Kaktovik
ANWR - 1002 Area
Cape Lisburne
Alaska Maritime National Wildlife Refuge
Point Hope
National Petroleum Reserve in Alaska
Dalton Highway
Trans-Alaska Pipeline
Arctic National Wildlife Refuge
Canada
Kivalina
North Slope Borough
Northwest Arctic Borough
Noatak River
Noatak National Preserve
Cape Krusenstern National Monument
Kobuk Valley National Park
Gates of the Arctic National Park
North Slope Borough
Yukon - Koyukuk Borough
Kotzebue Sound
Kotzebue
Bering Land Bridge National Preserve
N
Kilometers
0 25 50 75 100 200
0 25 50 75 100 200
Miles
NATIONAL MARINE FISHERIES SERVICE
EFFECTS OF OIL AND GAS ACTIVITIES IN THE ARCTIC OCEAN EIS
LAND OWNERSHIP AND MANAGEMENT
U.S. BEAUFORT AND CHUKCHI SEAS, ALASKA
JOB NO: 26220558
DRAWN: MAJ
DATE: NOVEMBER 2012
FILE: SEE PATH
NOAA
FIGURE 3.3-28

CHAPTER 4 FIGURES



Map Symbols
Historical Drill Sites
Distant Early Warning (DEW) Line Sites
Federal/State Maritime Boundary (3-Miles Offshore)
Bathymetry
Active State Leases (As of December 1, 2009)
Beaufort Sea Available State Leases
Beaufort Sea Active Federal Leases
Onshore Oil & Gas Lease Sale Areas
Oil & Gas Production Units
State
Joint Federal / State
Federal
ARCTIC OCEAN
BEAUFORT SEA
Point Barrow
Point Barrow
Barrow
Admiralty Bay
Smith Bay
Harrison Bay
Teshekpuk Lake
10 - Nikaitchuq
6 - Milne Point
9 - Oooguruk
7 - Northstar
2 - Colville River
4 - Duck Island
1 - Badami
Barter Island
Prudhoe Bay
Deadhorse
Flaxman Island SRRS
3 - Greater Mooses Tooth
Nuiqsut
Bullen Point
Camden Bay
Kaktovik
National Petroleum Reserve in Alaska
8 - Prudhoe Bay
5 - Kuparuk River
11 - Point Thomson
ANWR - 1002 Area
North Slope Areawide Oil & Gas Lease Sale Area
North Slope Foothills Areawide Oil & Gas Lease Sale Area
Dalton Highway
Trans-Alaska Pipeline
Arctic Ocean
Chukchi Sea
Beaufort Sea
Prudhoe Bay
Russia
Fairbanks
Canada
Anchorage
Juneau
Bering Sea
Gulf of Alaska
COORDINATE SYSTEM: NAD 1983 UTM Zone 6N Projection: Transverse Mercator
DATA SOURCES: ADNR-DOG (2009): State Lease Boundaries & Tracts; Oil & Gas Well Locations; State & Federal Lands, O&G Production Units MMS (2007): Offshore Lease Boundaries & Tracts,3-Mile Offshore Boundary; Continental Shelf Boundary BOEMRE (2011): Planning Areas USGS (2011): Bathymetry
N
Kilometers
0 20 40 60
0 10 20 30 40 50
Miles
156° W
154° W
152° W
150° W
148° W
146° W
144° W
142° W
72° N
70° N
NATIONAL MARINE FISHERIES SERVICE
EFFECTS OF OIL AND GAS ACTIVITIES IN THE ARCTIC OCEAN EIS
PAST, PRESENT, REASONABLY FORESEEABLE FUTURE ACTIONS IN THE BEAUFORT SEA
U.S. BEAUFORT SEA, ALASKA
JOB NO: 26220558
DRAWN: MAJ
DATE: NOVEMBER 2012
FILE: SEE PATH
FIGURE 4.1



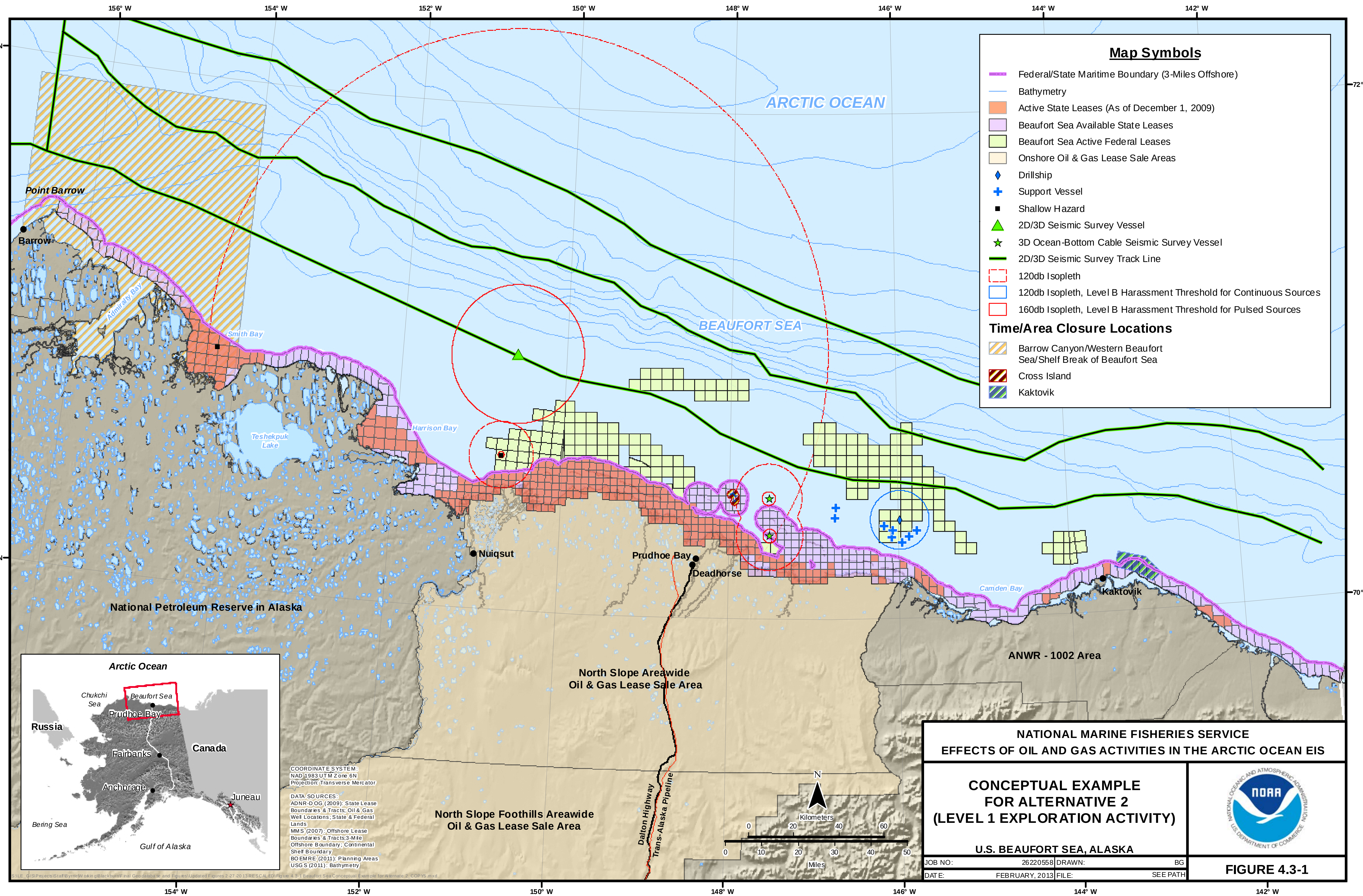
NATIONAL MARINE FISHERIES SERVICE
EFFECTS OF OIL AND GAS ACTIVITIES IN THE ARCTIC OCEAN EIS

PAST, PRESENT, REASONABLY FORESEEABLE FUTURE ACTIONS IN THE CHUKCHI SEA

U.S. CHUKCHI SEA, ALASKA

JOB NO:	26220558	DRAWN:	MAJ
DATE:	NOVEMBER 2012	FILE:	SEE PATH

FIGURE 4.2



Map Symbols
Federal/State Maritime Boundary (3-Miles Offshore)
Bathymetry
Active State Leases (As of December 1, 2009)
Beaufort Sea Available State Leases
Beaufort Sea Active Federal Leases
Onshore Oil & Gas Lease Sale Areas
Drillship
Support Vessel
Shallow Hazard
2D/3D Seismic Survey Vessel
3D Ocean-Bottom Cable Seismic Survey Vessel
2D/3D Seismic Survey Track Line
120db Isopleth
120db Isopleth, Level B Harassment Threshold for Continuous Sources
160db Isopleth, Level B Harassment Threshold for Pulsed Sources
Time/Area Closure Locations
Barrow Canyon/Western Beaufort Sea/Shelf Break of Beaufort Sea
Cross Island
Kaktovik
ARCTIC OCEAN
BEAUFORT SEA
Point Barrow
Barrow
Admiralty Bay
Smith Bay
Harrison Bay
Teshekpuk Lake
Nuiqsut
Prudhoe Bay
Deadhorse
Camden Bay
Kaktovik
National Petroleum Reserve in Alaska
North Slope Areawide Oil & Gas Lease Sale Area
North Slope Foothills Areawide Oil & Gas Lease Sale Area
ANWR - 1002 Area
Dalton Highway
Trans-Alaska Pipeline
156° W
154° W
152° W
150° W
148° W
146° W
144° W
142° W
72° N
70° N
Arctic Ocean
Chukchi Sea
Beaufort Sea
Prudhoe Bay
Russia
Canada
Fairbanks
Anchorage
Juneau
Bering Sea
Gulf of Alaska
COORDINATE SYSTEM:
NAD 1983 UTM Zone 6N
Projection: Transverse Mercator
DATA SOURCES:
ADNR-DOG (2009): State Lease Boundaries & Tracts; Oil & Gas Well Locations; State & Federal Lands
MMS (2007): Offshore Lease Boundaries & Tracts; 3-Mile Offshore Boundary; Continental Shelf Boundary
BOEMRE (2011): Planning Areas
USGS (2011): Bathymetry
N
Kilometers
0 20 40 60
0 10 20 30 40 50
Miles
NATIONAL MARINE FISHERIES SERVICE
EFFECTS OF OIL AND GAS ACTIVITIES IN THE ARCTIC OCEAN EIS
CONCEPTUAL EXAMPLE FOR ALTERNATIVE 2 (LEVEL 1 EXPLORATION ACTIVITY)
U.S. BEAUFORT SEA, ALASKA
JOB NO: 26220558
DRAWN: BG
DATE: FEBRUARY, 2013
FILE: SEE PATH
NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

FIGURE 4.3-1

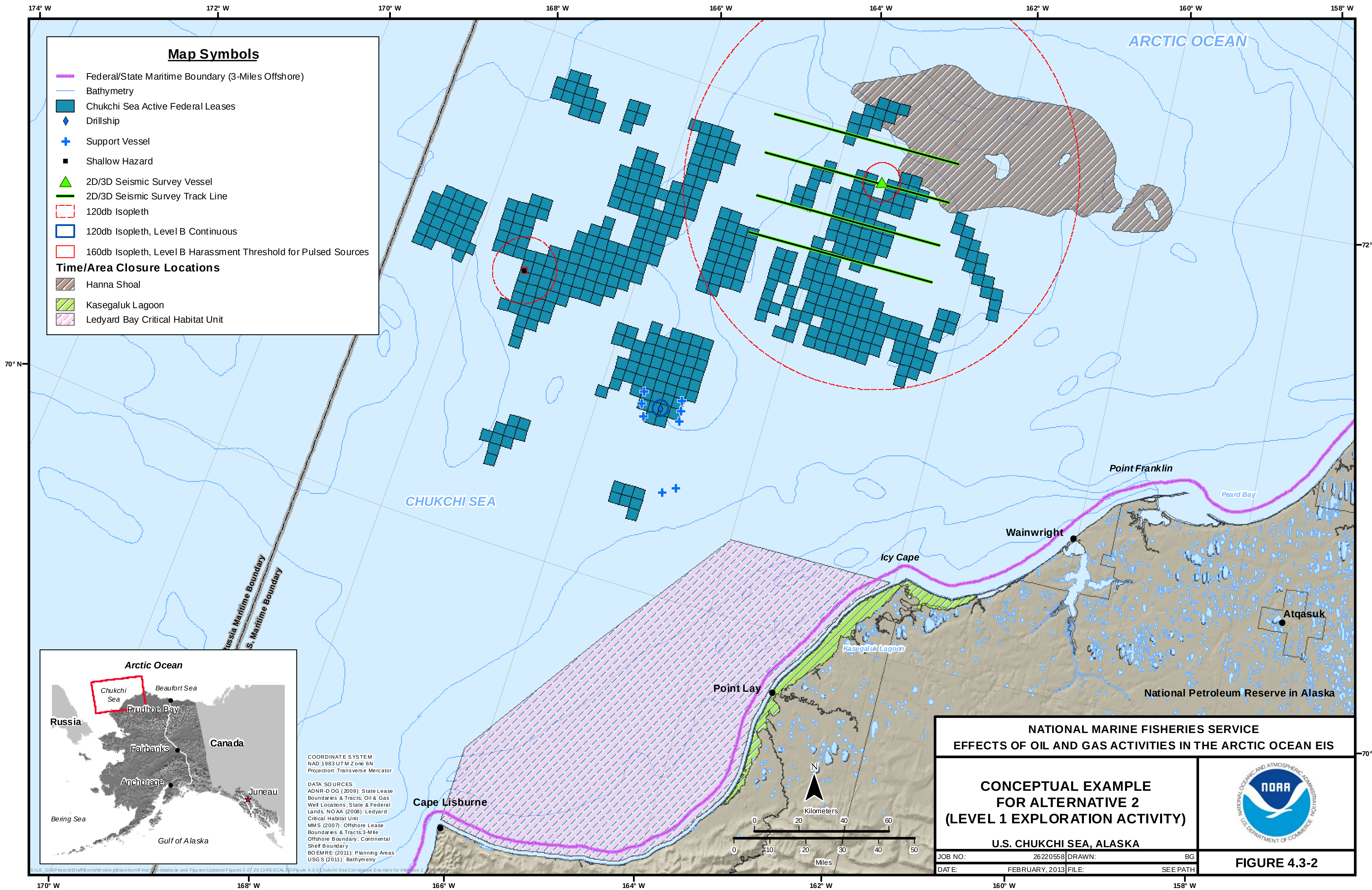
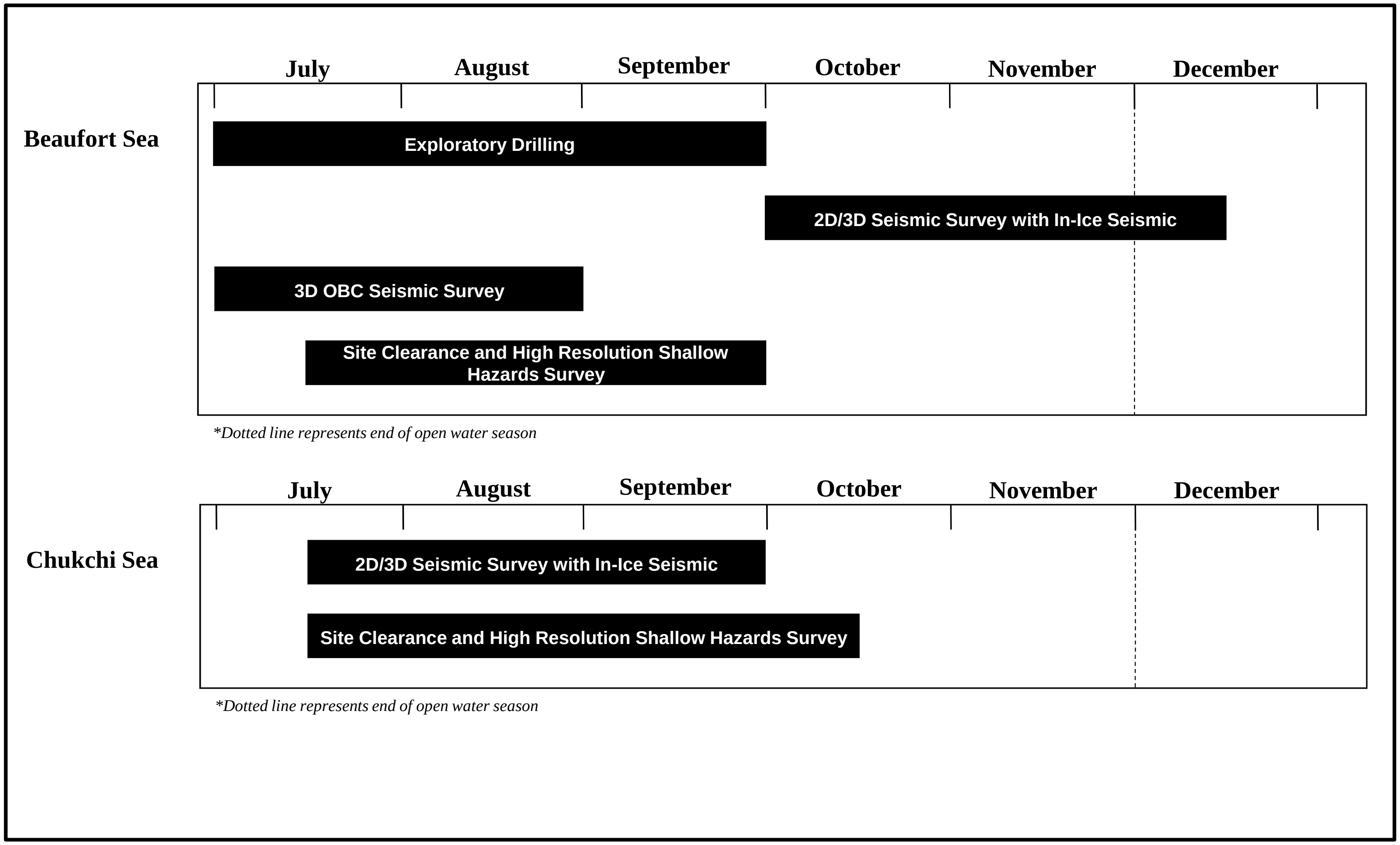
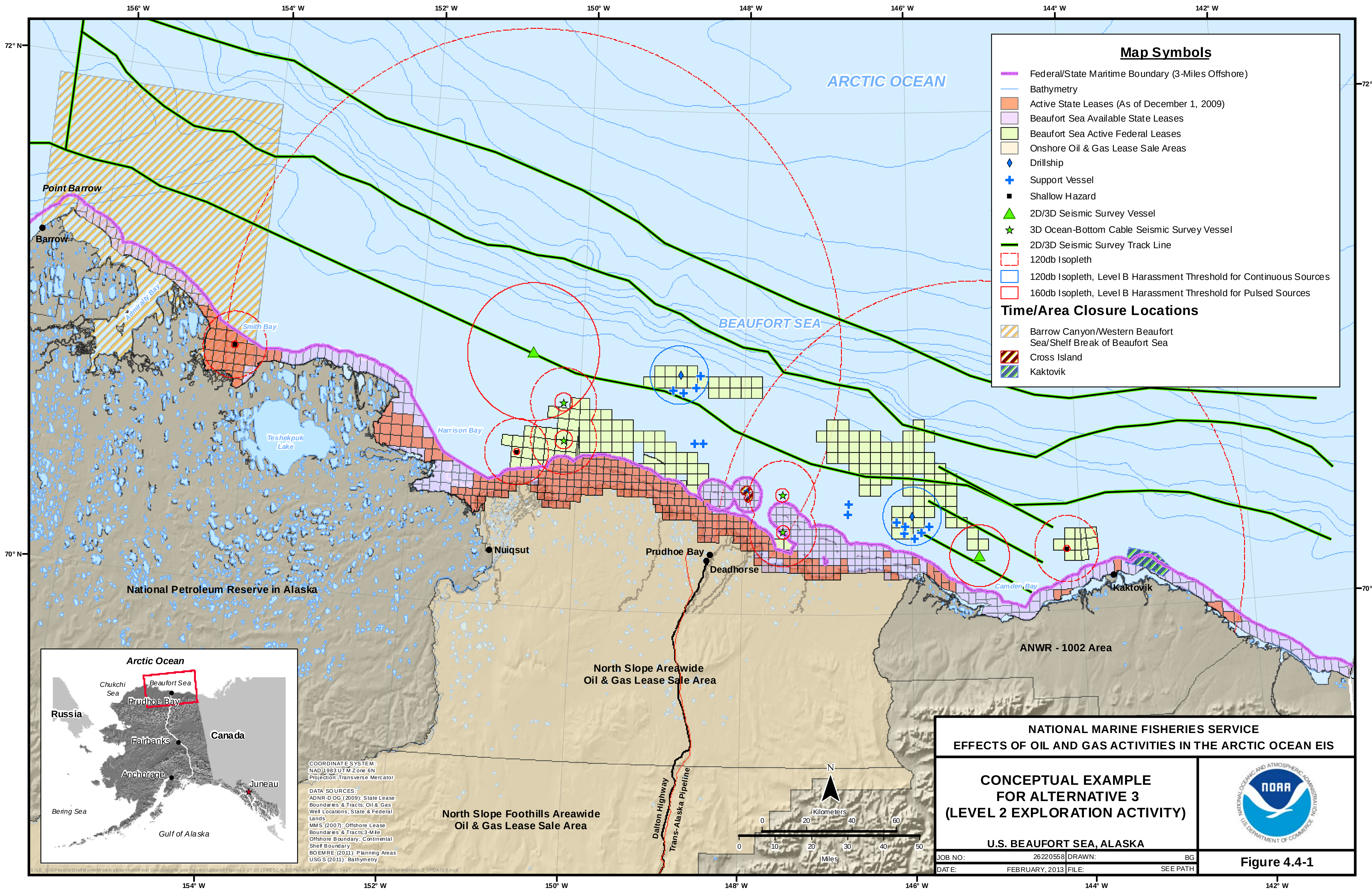
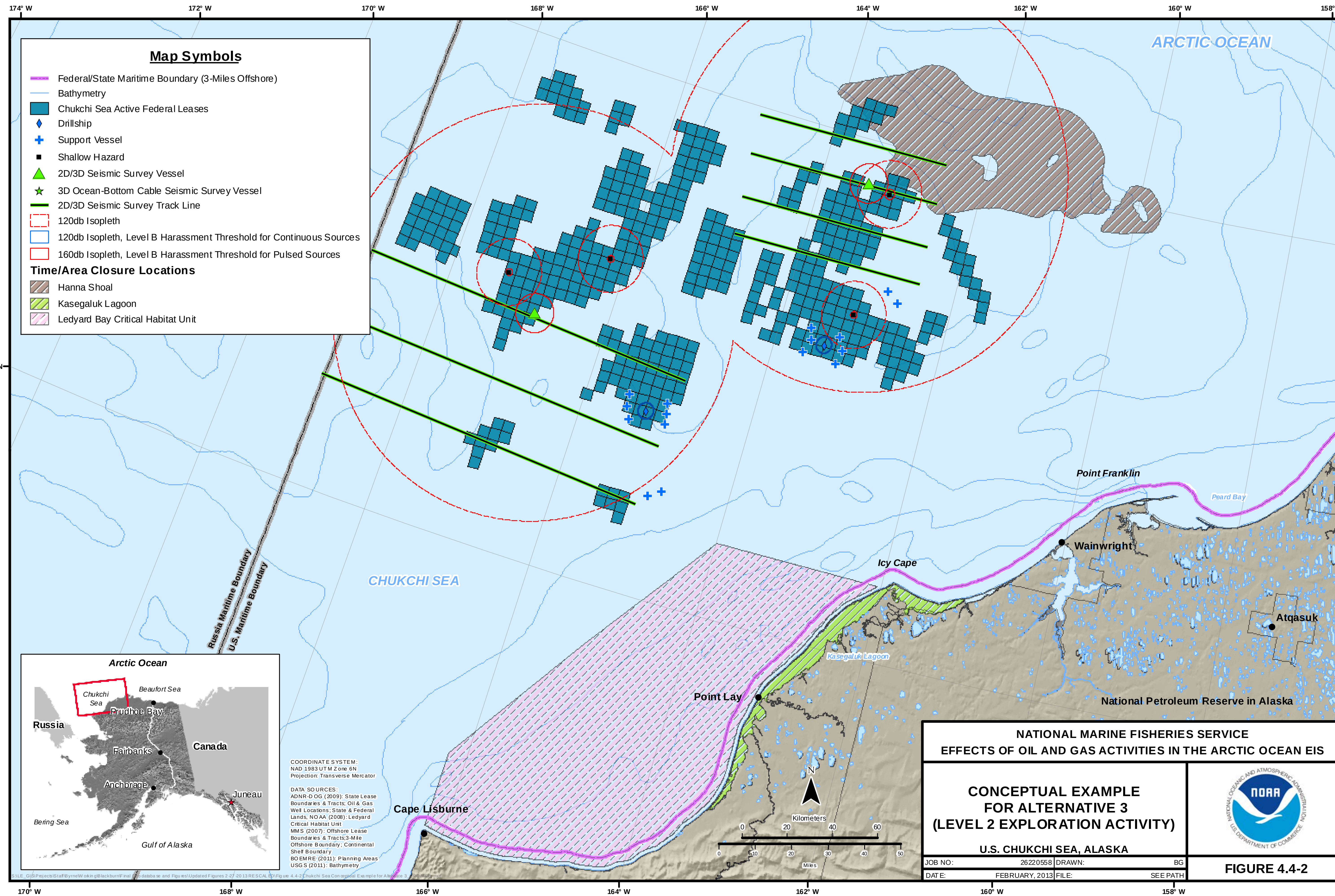

Map Symbols
Federal/State Maritime Boundary (3-Miles Offshore)
Bathymetry
Chukchi Sea Active Federal Leases
Drillship
Support Vessel
Shallow Hazard
2D/3D Seismic Survey Vessel
2D/3D Seismic Survey Track Line
120db Isopleth
120db Isopleth, Level B Continuous
160db Isopleth, Level B Harassment Threshold for Pulsed Sources
Time/Area Closure Locations
Hanna Shoal
Kasegaluk Lagoon
Ledyard Bay Critical Habitat Unit
ARCTIC OCEAN
CHUKCHI SEA
Russia Maritime Boundary
U.S. Maritime Boundary
Point Franklin
Peard Bay
Wainwright
Icy Cape
Kasegaluk Lagoon
Atqasuk
Point Lay
National Petroleum Reserve in Alaska
Cape Lisburne
Arctic Ocean
Chukchi Sea
Beaufort Sea
Prudhoe Bay
Russia
Canada
Fairbanks
Anchorage
Juneau
Bering Sea
Gulf of Alaska
COORDINATE SYSTEM:
NAD 1983 UTM Zone 6N
Projection: Transverse Mercator
DATA SOURCES:
ADNR-DOG (2009): State Lease Boundaries & Tracts; Oil & Gas Well Locations; State & Federal Lands, NOAA (2008): Ledyard Critical Habitat Unit
MMS (2007): Offshore Lease Boundaries & Tracts; 3-Mile Offshore Boundary; Continental Shelf Boundary
BOEMRE (2011): Planning Areas
USGS (2011): Bathymetry
N
Kilometers
0 20 40 60
0 10 20 30 40 50
Miles
174° W
172° W
170° W
168° W
166° W
164° W
162° W
160° W
158° W
72° N
70° N
NATIONAL MARINE FISHERIES SERVICE
EFFECTS OF OIL AND GAS ACTIVITIES IN THE ARCTIC OCEAN EIS
CONCEPTUAL EXAMPLE
FOR ALTERNATIVE 2
(LEVEL 1 EXPLORATION ACTIVITY)
U.S. CHUKCHI SEA, ALASKA
JOB NO: 26220558
DRAWN: BG
DATE: FEBRUARY, 2013
FILE: SEE PATH
FIGURE 4.3-2

Figure 4.3-3 Temporal Conceptual Example under Alternative 2 (Level 1 Exploration Activity)





Map Symbols
Federal/State Maritime Boundary (3-Miles Offshore)
Bathymetry
Active State Leases (As of December 1, 2009)
Beaufort Sea Available State Leases
Beaufort Sea Active Federal Leases
Onshore Oil & Gas Lease Sale Areas
Drillship
Support Vessel
Shallow Hazard
2D/3D Seismic Survey Vessel
3D Ocean-Bottom Cable Seismic Survey Vessel
2D/3D Seismic Survey Track Line
120db Isopleth
120db Isopleth, Level B Harassment Threshold for Continuous Sources
160db Isopleth, Level B Harassment Threshold for Pulsed Sources
Time/Area Closure Locations
Barrow Canyon/Western Beaufort Sea/Shelf Break of Beaufort Sea
Cross Island
Kaktovik
ARCTIC OCEAN
BEAUFORT SEA
Point Barrow
Barrow
Admiralty Bay
Smith Bay
Teshekpuk Lake
Harrison Bay
Nuiqsut
Prudhoe Bay
Deadhorse
Camden Bay
Kaktovik
National Petroleum Reserve in Alaska
North Slope Areawide Oil & Gas Lease Sale Area
North Slope Foothills Areawide Oil & Gas Lease Sale Area
ANWR - 1002 Area
Dalton Highway
Trans-Alaska Pipeline
156° W
154° W
152° W
150° W
148° W
146° W
144° W
142° W
72° N
70° N
Arctic Ocean
Chukchi Sea
Beaufort Sea
Prudhoe Bay
Russia
Canada
Fairbanks
Anchorage
Juneau
Bering Sea
Gulf of Alaska
COORDINATE SYSTEM:
NAD 1983 UTM Zone 6N
Projection: Transverse Mercator
DATA SOURCES:
ADNR-DOG (2009): State Lease Boundaries & Tracts; Oil & Gas Well Locations; State & Federal Lands
MMS (2007): Offshore Lease Boundaries & Tracts;3-Mile Offshore Boundary; Continental Shelf Boundary
BOEMRE (2011): Planning Areas
USGS (2011): Bathymetry
N
Kilometers
0 20 40 60
0 10 20 30 40 50
Miles
NATIONAL MARINE FISHERIES SERVICE
EFFECTS OF OIL AND GAS ACTIVITIES IN THE ARCTIC OCEAN EIS
CONCEPTUAL EXAMPLE FOR ALTERNATIVE 3 (LEVEL 2 EXPLORATION ACTIVITY)
U.S. BEAUFORT SEA, ALASKA
JOB NO: 26220558
DRAWN: BG
DATE: FEBRUARY, 2013
FILE: SEE PATH
Figure 4.4-1



NATIONAL MARINE FISHERIES SERVICE
EFFECTS OF OIL AND GAS ACTIVITIES IN THE ARCTIC OCEAN EIS

CONCEPTUAL EXAMPLE FOR ALTERNATIVE 3 (LEVEL 2 EXPLORATION ACTIVITY)

U.S. CHUKCHI SEA, ALASKA

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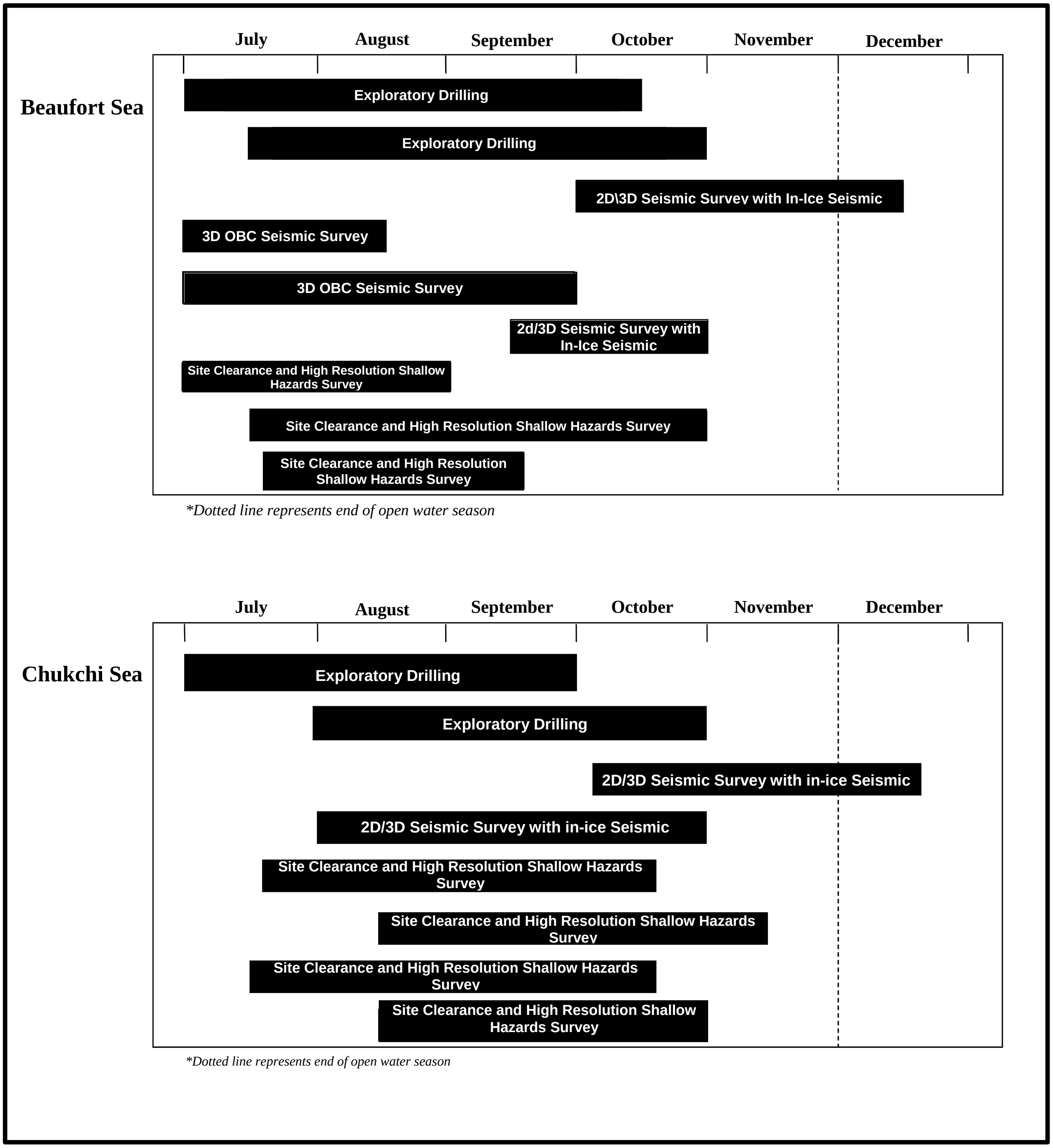
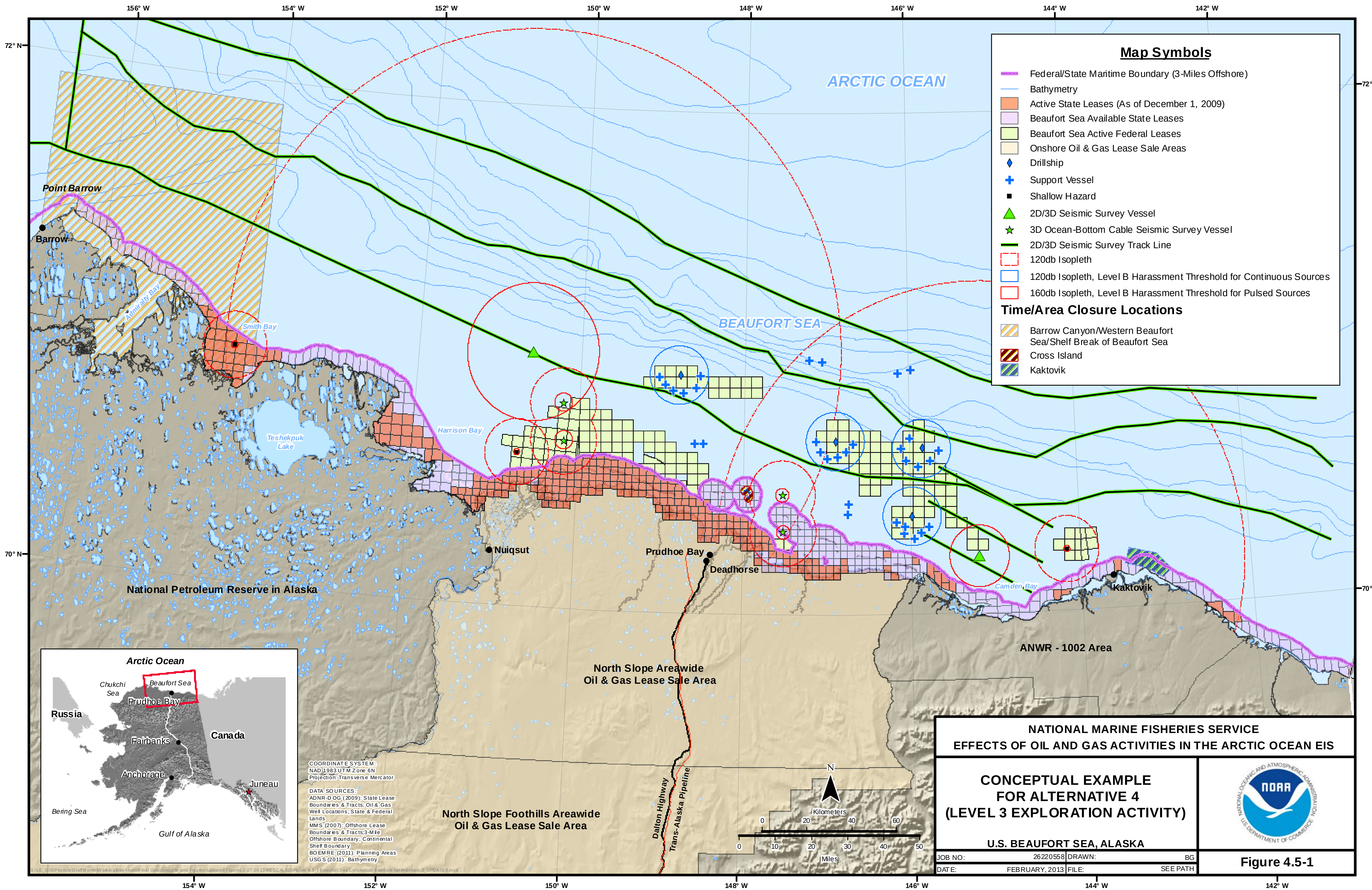
DATE:	FEBRUARY, 2013	FILE:	SEE PATH

FIGURE 4.4-2

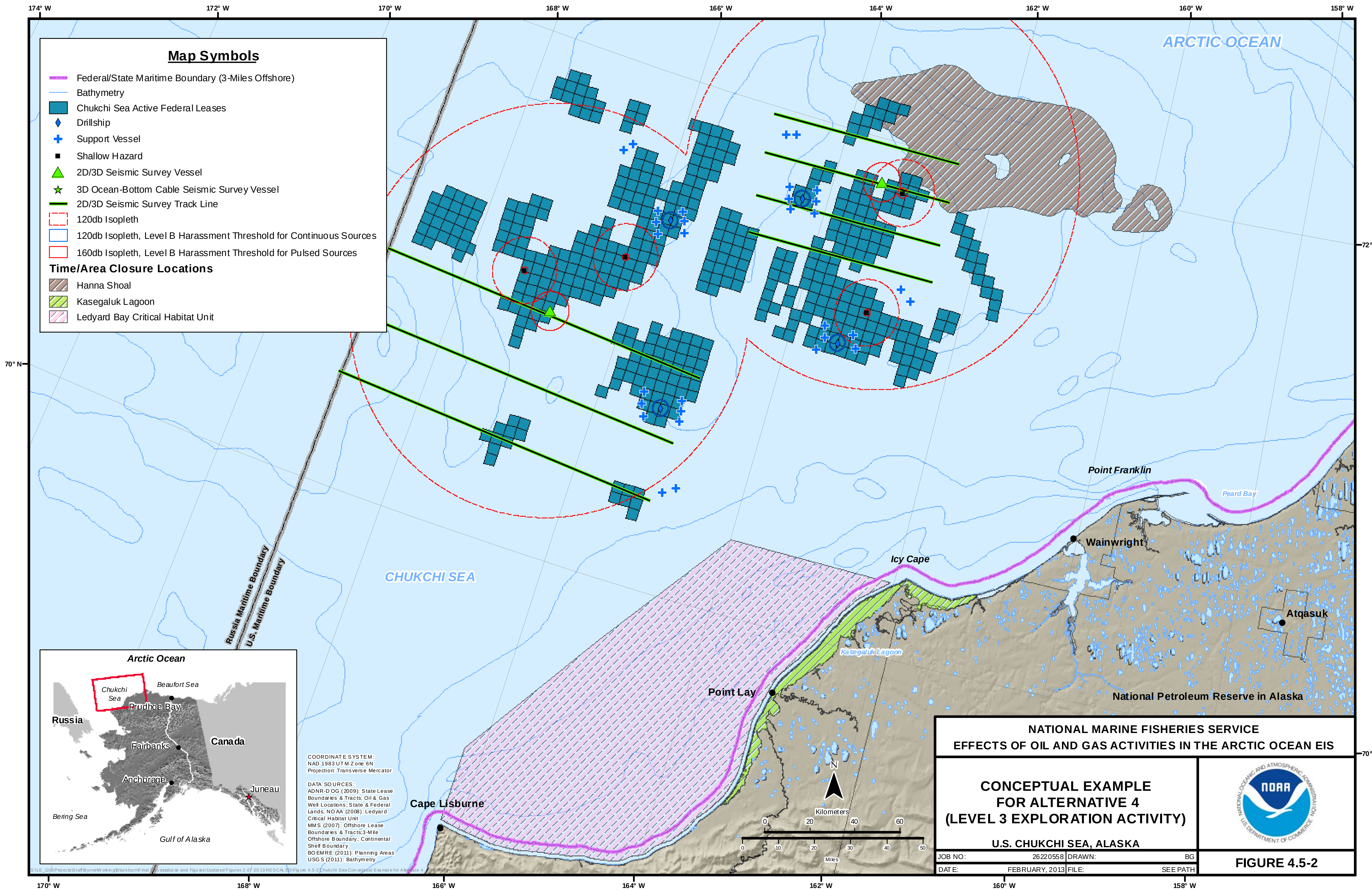
Figure 4.4-3 Temporal Conceptual Examples under Alternative 3 (Level 2 Exploration Activity)





Map Symbols
Federal/State Maritime Boundary (3-Miles Offshore)
Bathymetry
Active State Leases (As of December 1, 2009)
Beaufort Sea Available State Leases
Beaufort Sea Active Federal Leases
Onshore Oil & Gas Lease Sale Areas
Drillship
Support Vessel
Shallow Hazard
2D/3D Seismic Survey Vessel
3D Ocean-Bottom Cable Seismic Survey Vessel
2D/3D Seismic Survey Track Line
120db Isopleth
120db Isopleth, Level B Harassment Threshold for Continuous Sources
160db Isopleth, Level B Harassment Threshold for Pulsed Sources
Time/Area Closure Locations
Barrow Canyon/Western Beaufort Sea/Shelf Break of Beaufort Sea
Cross Island
Kaktovik
156° W
154° W
152° W
150° W
148° W
146° W
144° W
142° W
72° N
70° N
ARCTIC OCEAN
BEAUFORT SEA
Point Barrow
Barrow
Admiralty Bay
Smith Bay
Harrison Bay
Teshekpuk Lake
Nuiqsut
Prudhoe Bay
Deadhorse
Camden Bay
Kaktovik
National Petroleum Reserve in Alaska
North Slope Areawide Oil & Gas Lease Sale Area
North Slope Foothills Areawide Oil & Gas Lease Sale Area
ANWR - 1002 Area
Dalton Highway
Trans-Alaska Pipeline
Arctic Ocean
Chukchi Sea
Beaufort Sea
Prudhoe Bay
Russia
Fairbanks
Canada
Anchorage
Juneau
Bering Sea
Gulf of Alaska
COORDINATE SYSTEM:
NAD 1983 UTM Zone 6N
Projection: Transverse Mercator
DATA SOURCES:
ADNR-DOG (2009): State Lease Boundaries & Tracts; Oil & Gas Well Locations; State & Federal Lands
MMS (2007): Offshore Lease Boundaries & Tracts;3-Mile Offshore Boundary; Continental Shelf Boundary
BOEMRE (2011): Planning Areas
USGS (2011): Bathymetry
N
Kilometers
0 20 40 60
0 10 20 30 40 50
Miles
NATIONAL MARINE FISHERIES SERVICE
EFFECTS OF OIL AND GAS ACTIVITIES IN THE ARCTIC OCEAN EIS
CONCEPTUAL EXAMPLE FOR ALTERNATIVE 4 (LEVEL 3 EXPLORATION ACTIVITY)
U.S. BEAUFORT SEA, ALASKA
JOB NO: 26220558
DRAWN: BG
DATE: FEBRUARY, 2013
FILE: SEE PATH

Figure 4.5-1



NATIONAL MARINE FISHERIES SERVICE
EFFECTS OF OIL AND GAS ACTIVITIES IN THE ARCTIC OCEAN EIS

CONCEPTUAL EXAMPLE
FOR ALTERNATIVE 4
(LEVEL 3 EXPLORATION ACTIVITY)

U.S. CHUKCHI SEA, ALASKA

JOB NO:	26220558	DRAWN:	BG
DATE:	FEBRUARY, 2013	FILE:	SEE PATH

FIGURE 4.5-2

Figure 4.5-3 Temporal Conceptual Examples under Alternative 4 (Level 3 Exploration Activity)

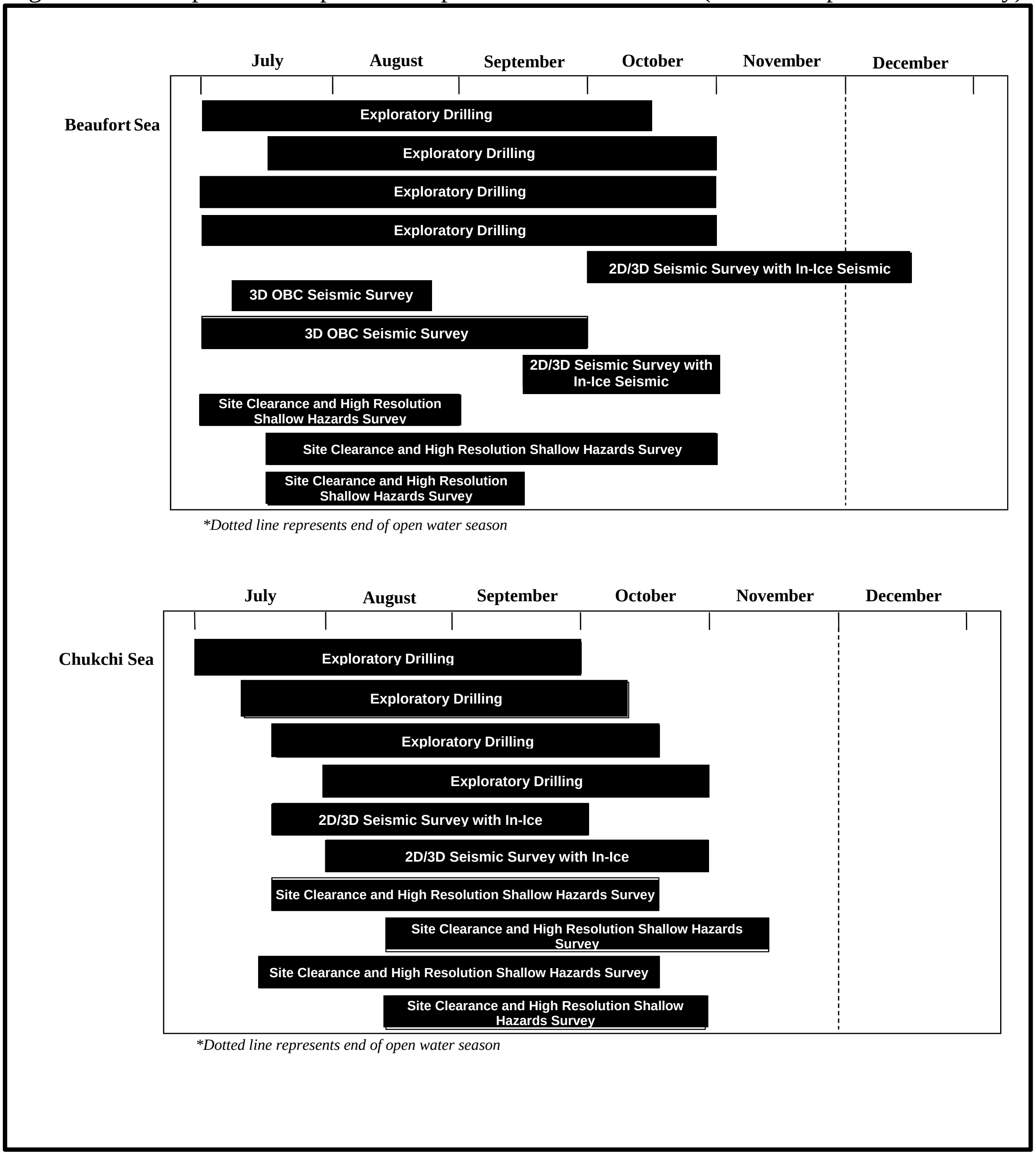


Figure 4.6-1 Example of dose-response curve used for Navy mid-frequency active sonar (Finneran and Jenkins 2012)

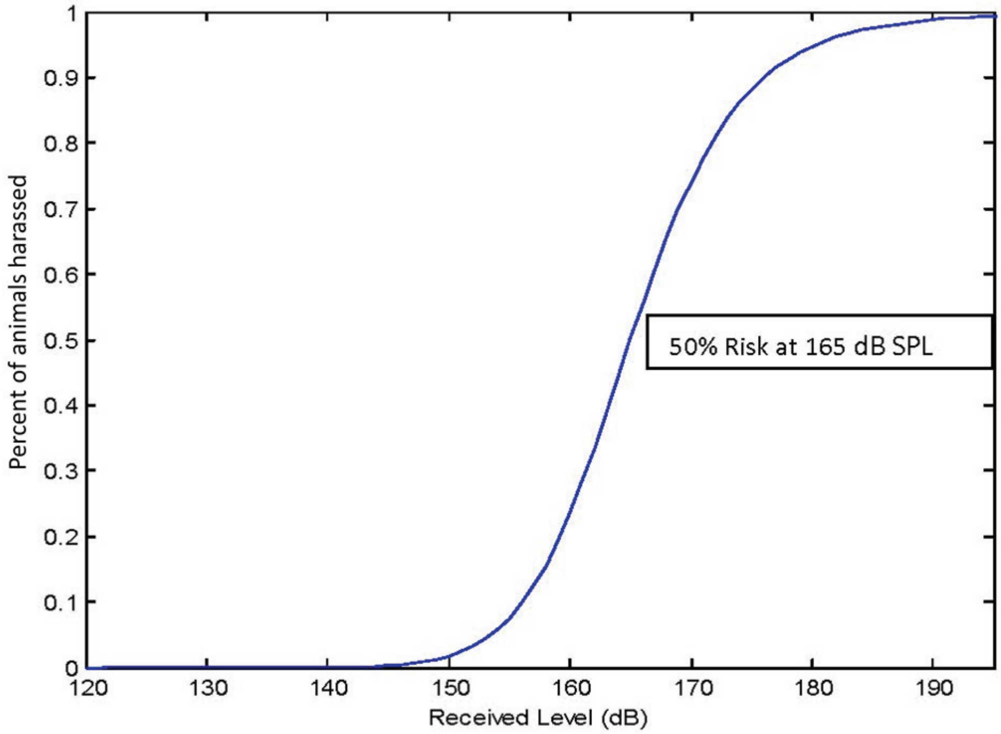


Figure 4.6-2 This graph illustrates proposed weighting functions that could be applied to cetaceans for the thresholds outlined above, if the methods outlined in Finneran and Jenkins (2012) were used. Note, in graphic LF = low frequency hearing specialists, MF = mid frequency hearing specialists, and HF = high frequency hearing specialists.

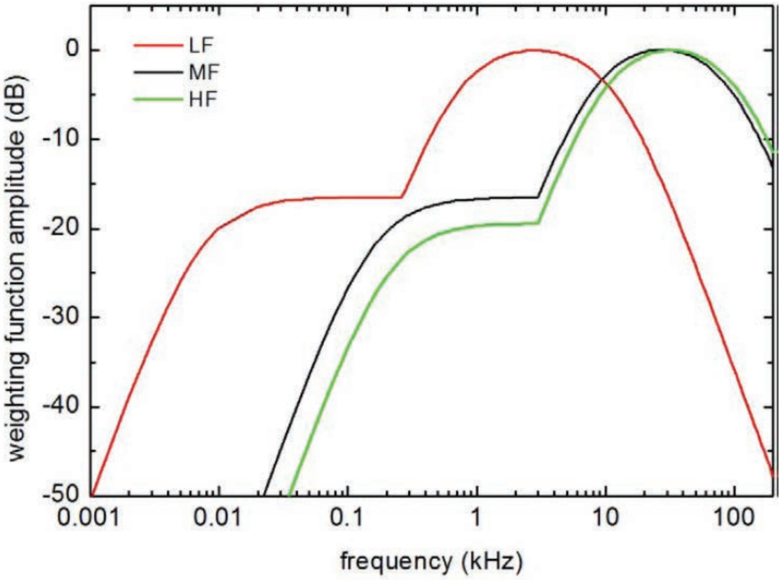


Figure 4.6-3 This graph illustrates the weighting functions that could be applied to pinnipeds for the thresholds outlined above (m-weighting, Southall et al., 2007, Finneran and Jenkins (2012)).

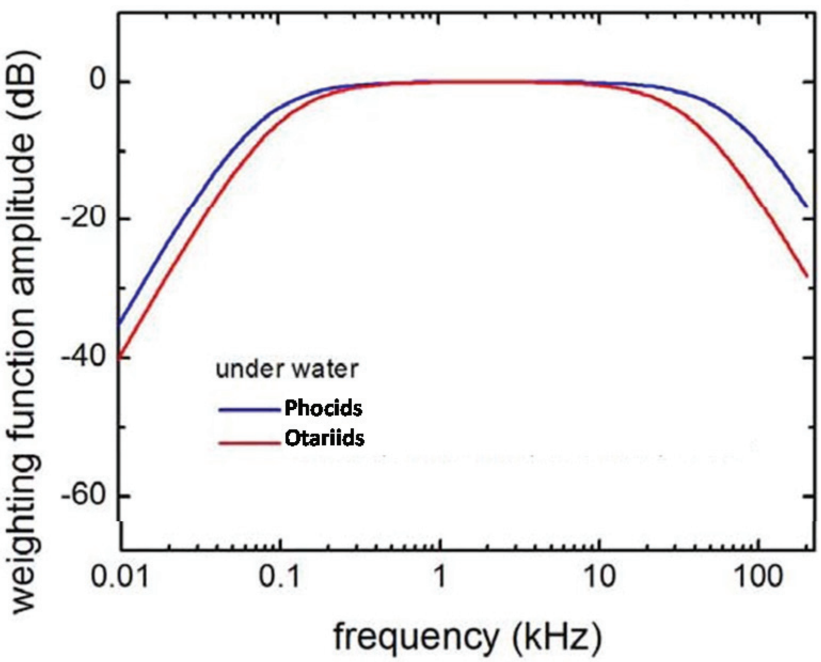


Figure 4.7-1 Dispersion and fate of water-based drill cuttings and drilling fluids discharged to the ocean. About 90% of the discharged solids settle rapidly and form a mud/cuttings pile within several hundred meters of the point of discharge.

Source: Neff 2005

This mud/cuttings pile would affect water depths near the drilling activity. The remaining 10% of the discharged solids remain suspended and drift with prevailing currents away from the drilling site to settle elsewhere.

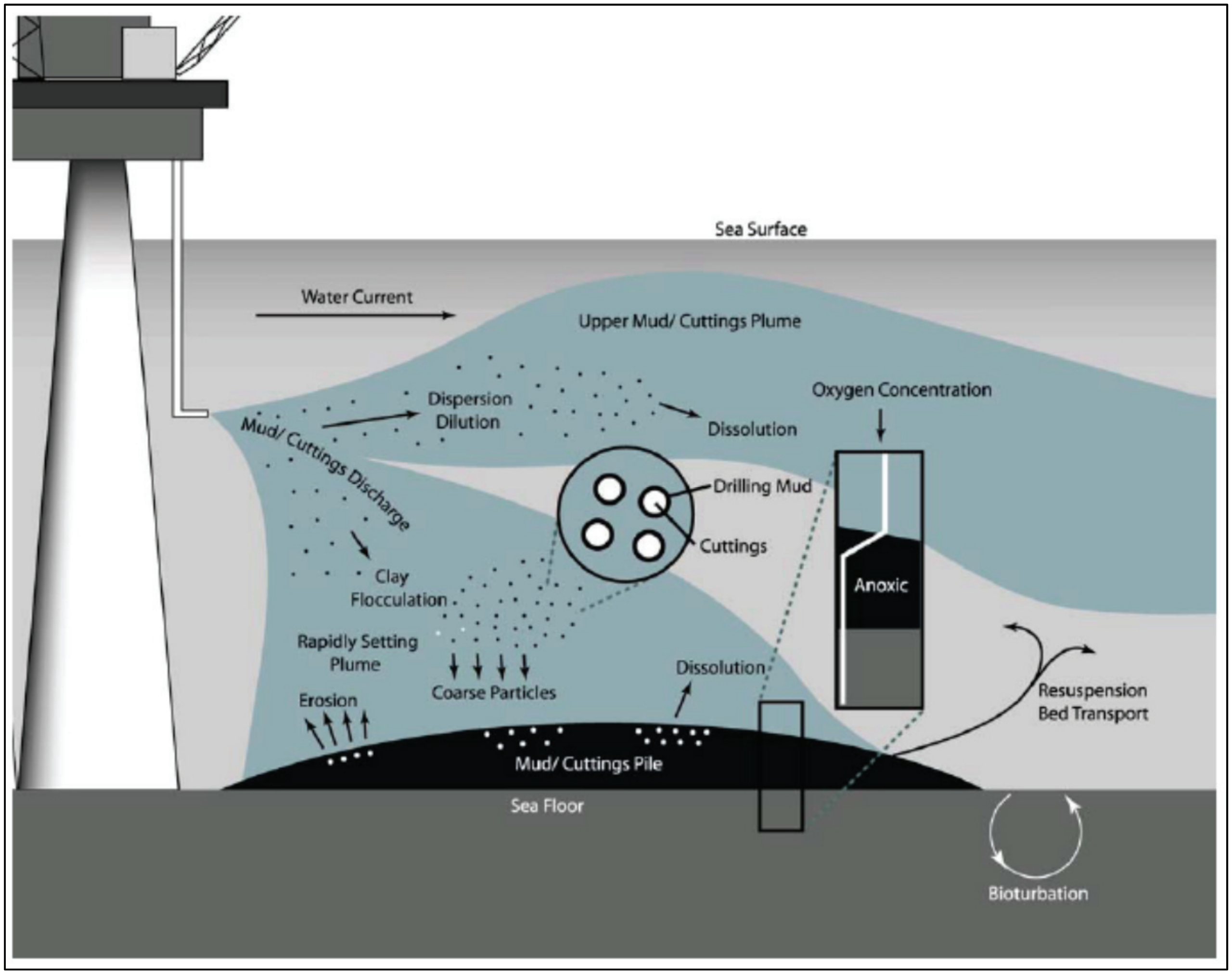
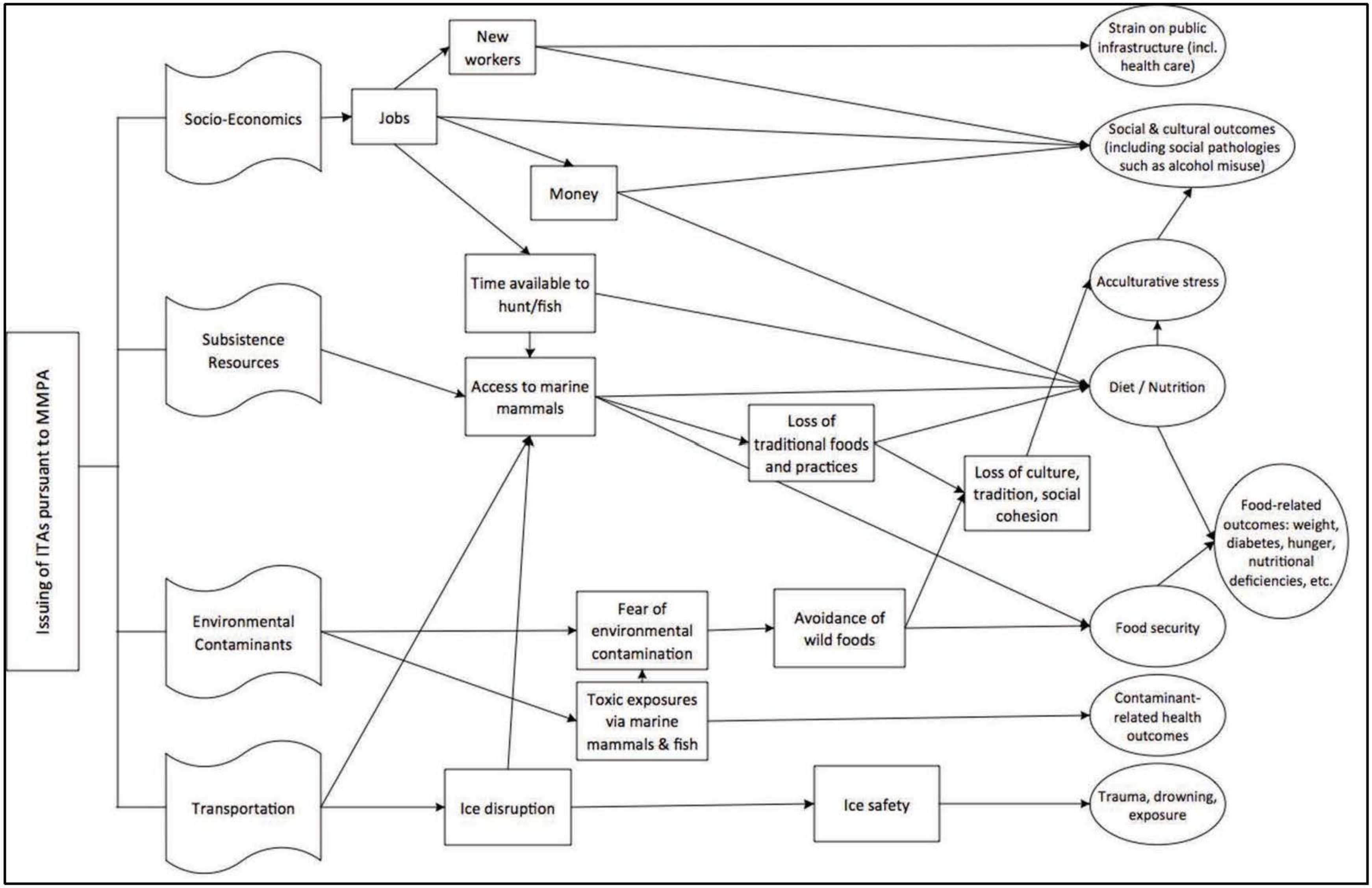


Figure 4.7-2 Logic framework for potential impacts to human health.



APPENDIX A

Standard and Additional Mitigation Measures

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Appendix A: Standard and Additional Mitigation Measures Addressing Impacts to Marine Mammals and Subsistence Activities

NMFS Standard Mitigation Measures

The mitigation measures[1] (and the identified mitigation monitoring needed to support them) listed below are planned for inclusion as a requirement under every MMPA ITA issued for the type of activity identified.

A. DETECTION-BASED MEASURES INTENDED TO REDUCE NEAR-SOURCE ACOUSTIC EXPOSURES AND IMPACTS ON MARINE MAMMALS WITHIN A GIVEN DISTANCE OF THE SOURCE

2D/3D and in-ice seismic surveys and site clearance and high resolution shallow hazards surveys

Mitigation Measure A1. Establishment and execution of 180 dB shutdown/power down radius for cetaceans and 190 dB shutdown/power down radius for ice seals.

NMFS has established acoustic thresholds that identify the received sound levels above which hearing impairment or other injury could potentially occur; these thresholds are 180 and 190 dB re 1 µPa (rms) for cetaceans and pinnipeds, respectively (NMFS 1995, 2000). All further received sound level criteria reported in this appendix will be re 1 µPa (rms). The established 180- and 190-dB re 1 µPa (rms) criteria are the received levels above which, in the view of a panel of bioacoustics specialists convened by NMFS before direct data on temporary threshold shift (TTS) (from which PTS is primarily extrapolated) for marine mammals became available, one could not be certain that there would be no injurious effects, auditory or otherwise, to marine mammals. Since the establishment of these acoustic criteria, NMFS has recommended and included shutdown/powerdown zones at the 180/190 dB isopleths as standard required mitigation measures in MMPA authorizations for seismic surveys. Typical language in past ITAs includes:

- Establish and have trained Protected Species Observers (PSOs) monitor a preliminary exclusion zone for cetaceans surrounding the airgun array on the source vessel where the received level would be 180 dB or greater. The radius for the zone will vary based on the airgun array used, water depth, and numerous other factors related to the water and seafloor properties. This final distance of the radius will be established by modeling and/or a sound source verification test.
- Establish and monitor a preliminary exclusion zone for pinnipeds surrounding the airgun array on the source vessel where the received level would be at or above 190 dB with trained PSOs. The radius for the zone will vary based on the airgun array used, water depth, and numerous other factors related to the water and seafloor properties. The final distance of the radius will be established by modeling and/or a sound source verification test.
- Immediately power-down the seismic airgun array and/or other acoustic sources, whenever any cetaceans or walrus are sighted approaching close to or within the area

[1] These measures have been included in past ITAs issued by NMFS in the Arctic Ocean.

delineated by the 180 dB, or pinnipeds or polar bears are sighted approaching close to or within the area delineated by the 190 dB isopleth.

- If the power-down operation cannot reduce the received sound pressure level at the cetacean or pinniped to less than 180 dB or 190 dB, respectively, then the holder of the ITA must immediately shutdown the seismic airgun array and/or other acoustic sources.
- The seismic airgun array cannot be powered up unless the marine mammal exclusion zones are visible and no marine mammals are detected within the appropriate safety zones for a minimum of 15 minutes (small odontocetes, pinnipeds) or 30 minutes (for mysticetes). The seismic array can be ramped up once the PSOs have no further visual detection of the animal(s) within the exclusion zone, and they are confident that no marine mammals remain within the appropriate exclusion zone.

Mitigation Measure A2. Specified ramp-up procedures for airgun arrays.

Ramp-up is the gradual introduction of sound to deter marine mammals from potentially damaging sound intensities and from approaching the exclusion zone. This technique involves the gradual increase (usually approximately 5-6 dB per 5-minute increment) in emitted sound levels, beginning with firing a single airgun and gradually adding airguns over a period of 20 to 40 minutes, until the desired operating level of the full array is obtained. Ramp-up procedures are instituted based on the assumption that any marine mammals in the vicinity of seismic operations will become aware of the noise source before it rises to potentially harmful levels and to leave the area. The 180- and 190-dB exclusion zones described in the previous measure are used for the ramp-up procedures as well. Typical language in past ITAs includes:

- Conduct a 30-minute period of marine mammal observations by at least two trained PSOs to verify that the exclusion zone is clear prior to commencing ramp-up at the commencement of seismic operations and at any time the airgun array has been shut down for a certain period of time. The period of shutdown requiring a full ramp-up is based on the size of the airgun array but is typically between 8 and 10 minutes.
- Do not commence ramp-up if the entire exclusion zones are not visible for at least 30 minutes prior to ramp-up in either daylight or nighttime and do not commence ramp-up at night unless the seismic source has maintained a sound pressure level at the source of at least 180 dB during the interruption of full seismic survey operations. If a sound source of at least 180 dB has been maintained during the interruption of seismic operations, then the 30 minute pre-ramp-up visual survey is waived.
- Ramp-up the airgun arrays at no greater than 6 dB per 5-minute period starting with the smallest airgun in the array and then adding additional guns in sequence until the full array is firing if no marine mammals are observed in the safety zones and periods specified above. Ramp-up procedures should be used at the commencement of seismic operations and any time after the airgun array has been shut down for a certain period of time.

Mitigation Measure A3. Protected Species Observers (PSOs) required on all seismic source vessels and ice breakers, as well as on dedicated monitoring vessels.

PSOs are a key component both for the purposes of implementing mitigation measures, such as shutdowns and ramp-ups, and for gathering information pursuant to the monitoring requirements of the ITA (latter addressed separately). Some of the mitigation monitoring requirements in past ITAs include:

- The holder of the ITA must designate trained, NMFS-approved, individuals (PSOs) to be onboard the source vessel to conduct the visual monitoring programs required under this Authorization and to record the effects of seismic surveys and the resulting noise on marine mammals.
- To the extent possible, PSOs should be on duty for four consecutive hours or less, although more than-one four-hour shift per day is acceptable. PSOs will not work more than three shifts in a 24-hour period (i.e. 12 hours total per 24-hour period).
- Monitoring is to be conducted by the PSOs onboard the active seismic vessel (including in-ice surveys), to (A) ensure that no marine mammals enter the appropriate exclusion zone whenever the seismic sources are on, and (B) to record marine mammal activity. At least two observers must be on watch the 30 minutes prior to full ramp up, during ramp ups, and for as much of the other operating hours as possible. At all other times, at least one observer must be on active watch (1) whenever the seismic source is operating during the daytime; (2) during any nighttime power-ups of the airguns; and (3) at night, whenever one or more power-down situations the preceding day were due to marine mammal presence.
- At all times, the crew must be instructed to keep watch for marine mammals. If any are sighted, the bridge watch-stander must immediately notify the PSO(s) on-watch. If a marine mammal is within or closely approaching its designated exclusion zone, the seismic acoustic sources must be immediately powered down or shutdown.
- Monitoring will consist of recording: (A) the species, group size, age/size/sex categories (if determinable), the general behavioral activity, heading (if consistent), bearing and distance from seismic vessel, sighting cue, behavioral pace, and apparent reaction of all marine mammals seen near the seismic vessel and/or its airgun array (e.g. none, avoidance, approach, paralleling, etc.); (B) the time, location, heading, speed, and activity of the vessel (shooting or not), along with sea state, visibility, cloud cover and sun glare at (1) any time a marine mammal is sighted, (2) at the start and end of each watch, and (3) during a watch (whenever there is a change in one or more variable); and, (C) the identification of all vessels that are visible within 5 km (3.1 mi) of the seismic-vessel whenever a marine mammal is sighted, and the time observed, bearing, distance, heading, speed and activity of the other vessel(s).

On-ice Seismic Surveys

Mitigation Measure A4. All activities must be conducted at least 152 m (500 ft) from any observed ringed seal lair.

- This measure requires survey crews to be trained in seal detection and to search for ringed seal lairs around intended seismic survey operation sites and prohibits seismic activities within a 152 m (500 ft) radius of ringed seal lairs. Additionally, while traveling on ice roads, the area shall be monitored for marine mammals, especially ringed seal lairs.
- No ice roads may be built between the mobile camp and work site. Travel between mobile camp and work site shall also be monitored for marine mammals and be done by vehicles driving through on a snow road. Vehicles must avoid any pressure ridges, ice ridges, and ice deformation areas where seal structures are likely to be present.

Mitigation Measure A5. No energy source may be placed over a ringed seal lair.

- A 152 m (500 ft) exclusion zone must be established around all located active subnivean seal structures, within which no seismic or impact work may be conducted.

Exploratory Drilling Activities

Mitigation Measure A6. PSOs required on all drill ships (including rigs and ships) and ice management vessels.

- PSO requirements would be the same as those identified for Standard Mitigation Measure A3. PSOs are required on all types of drilling units and all support vessels. PSOs will watch during active drilling operations and transits.

B. NON-DETECTION-BASED MEASURES INTENDED TO MORE BROADLY LESSEN THE SEVERITY OF ACOUSTIC IMPACTS ON MARINE MAMMALS OR REDUCE OVERALL NUMBERS TAKEN BY ACOUSTIC SOURCE

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

Mitigation Measure B1. Specified flight altitudes for all support aircraft except for take-off, landing, and emergency situations.

- Aircraft shall not operate below 457 m (1,500 ft) unless the aircraft is engaged in approaching, landing or taking off, or unless engaged in providing assistance to a whaler or in poor weather (low ceilings) or any other emergency situations. Aircraft shall not operate below 305 m (1,000 ft) during marine mammal monitoring when operating outside of active subsistence areas. Aircraft engaged in marine mammal monitoring shall not operate below 457 m (1,500 ft) in areas of active subsistence use; such areas are to be identified through communications with the Communication Centers.
- Except for airplanes engaged in marine mammal monitoring, aircraft shall use a flight path that keeps the aircraft at least five miles inland until the aircraft is directly (south) of its offshore destination, then at that point it shall fly directly to its destination. This is applicable to the Beaufort Sea only.
- Helicopters shall not hover or circle above groups of marine mammals or within 457 m (1,500 ft) of such groups.

C. MEASURES INTENDED TO REDUCE/LESSEN NON-ACOUSTIC IMPACTS ON MARINE MAMMALS

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

Mitigation Measure C1. Specified procedures for changing vessel speed and/or direction to avoid collisions with marine mammals.

General operation conditions include:

- Reduce vessel speed when within 274 m (900 ft) of whales and those vessels capable of steering around such groups should do so. Vessels may not be operated in such a way as to separate members of a group of whales from other members of the group.
- Avoid multiple changes in direction and speed when within 274 m (900 ft) of whales. In addition, operators should check the waters immediately adjacent to a vessel to ensure that no whales will be injured when the vessel's propellers (or screws) are engaged.
- Do not operate support vessels (including small boats), to the extent that they are being used, at a speed that would make collisions with whales likely. Vessel speeds shall be less than 10 knots in the proximity of feeding whales or whale aggregations.
- When weather conditions require, such as when visibility drops, adjust vessel speed accordingly to avoid the likelihood of injury to whales. Vessel speeds should be reduced to at least 10 knots.

D. MEASURES INTENDED TO ENSURE NO UNMITIGABLE ADVERSE IMPACT TO SUBSISTENCE USES

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

Mitigation Measure D1. Shutdown of exploration 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. The following includes typical language from recent IHAs that required shutdown in the Beaufort Sea to account for fall bowhead whaling.

- No geophysical activity from the Canadian Border to the Canning River (146 deg. 4 min. W) beginning on or around August 25 to close of the Kaktovik's and Nuiqsut's fall bowhead whale.
- The bowhead whale subsistence hunt will be considered closed for a particular village when the village Whaling Captains' Association declares the hunt ended or the village quota has been exhausted (as announced by the village Whaling Captains' Association or the Alaska Eskimo Whaling Commission [AEWC]), whichever occurs earlier.
- From Pt. Storkerson (~148 deg. 42 min. W) to Thetis Island (~150 deg. 10.2 min. W);
    - Inside the Barrier Islands: No geophysical activity prior to August 5. Geophysical activity is allowed from August 5 until completion of operations. Geophysical activity allowed in this area after August 25 shall include a source array of no more than 12 airguns, a source layout no greater than 8 m x 6 m (26.2 ft x 19.7 ft), and a single source volume no greater than 14.4 liters (880 in^3).
    - Outside the Barrier Islands: No geophysical activity from August 25 to close of fall bowhead whale hunting in Nuiqsut. Geophysical activity is allowed at all other times.
- From Canning River (~146 deg. 4 min. W) to Pt. Storkerson (~148 deg. 42 min. W), no geophysical activity from August 25 to the close of bowhead whale subsistence hunting in Nuiqsut.
- Around Barrow, no geophysical activity 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.

Mitigation Measure D2. Establishment and utilization of Communication Centers in subsistence communities to address potential interference with marine mammal hunts on a real-time basis throughout the season.

To address potential interference with marine mammal hunts on a real-time basis, exploration companies have been required to participate in the establishment and interaction with Communication Centers in affected subsistence communities. The Communication Centers are to be operated on a 24-hour basis during the fall bowhead whale hunt.

- Upon notification by a Communication Center operator of an at-sea emergency, the holder of the ITA shall provide such assistance as necessary to prevent the loss of life, if conditions allow the holder of the ITA to safely do so.
- Upon request for emergency assistance made by a subsistence whale hunting organization, or by a member of such an organization, in order to prevent the loss of a whale, the holder of the ITA shall assist towing of a whale taken in a traditional subsistence whale hunt, if conditions allow the holder of the ITA to safely do so.

Mitigation Measure D3. Required flight altitudes and paths for all support aircraft in areas where subsistence occurs, except during take-off, landing, and emergency situations.

Aircraft shall avoid concentrations or groups of whales. Operators shall, at all times, conduct their activities at a maximum distance from such concentrations of whales.

- Aircraft shall not operate below 457 m (1,500 ft) unless the aircraft is engaged in, approaching, landing or taking off, or unless engaged in providing assistance to a whaler or in poor weather (low ceilings) or any other emergency situations.
- Aircraft engaged in marine mammal monitoring shall not operate below 457 m (1,500 ft).
- Except for airplanes engaged in marine mammal monitoring, aircraft operating in the Beaufort Sea shall use a flight path that keeps the aircraft at least five miles inland until the aircraft is directly (south) of its offshore destination, then at that point it shall fly directly (north) to its destination.
- When weather conditions do not allow a 457 m (1,500 ft) flying altitude, such as during severe storms or when cloud cover is low, aircraft may be operated below the 457 m (1,500 ft) altitude. However, when aircraft are operated at altitudes below 457 m (1,500 ft) because of weather conditions, the operator must avoid whale concentrations and concentration areas and should take precautions to avoid flying directly over or within 1,372 m (4,501 ft) of groups of whales.

BOEM Standard Mitigation Measures

The following measures are typically required by BOEM in G&G permits issued under the OCS Lands Act. These measures are not standardized in regulations. However, they have typically been required in recent years and are adjusted periodically, as needed.

- No solid or liquid explosives shall be used without specific approval.
- Permittee operations shall be conducted in a manner to ensure that they will not cause pollution, cause undue harm to aquatic life, create hazardous or unsafe conditions, or unreasonably interfere with other uses of the area. If any difficulties are encountered with other uses of the area or any of

the above mentioned scenarios occur during operations under this permit, they shall be reported to the Regional Supervisor, Resource Evaluation. Serious or emergency conditions shall be reported without delay.

- The Permittee shall maintain a minimum spacing of 15 miles between their deep penetration seismic-source vessels and any other concurrently operating deep penetration seismic-source vessel. If there is not 15 miles between seismic-source vessels, one source vessel must cease operations. The BOEM must be notified by means of the weekly report whenever a shutdown of operations occurs in order to maintain this minimum distance.
- Permittee operators shall use the lowest sound levels feasible to accomplish their data-collection needs.
- When any operator becomes aware of the potentially harassing effects of operations on whales, or when any operator is unsure of the best course of action to avoid harassment of whales, every measure to avoid further harassment shall be taken until NMFS is consulted for instructions or directions. However, human safety shall take precedence at all times over the guidelines and distances recommended herein for the avoidance of disturbance and harassment of whales.
- The Permittee shall notify BOEM, NMFS, and U.S. Fish and Wildlife Service (USFWS) in the event of any loss of cable, streamer, or other equipment that could pose a danger to marine mammals and other wildlife resources.
- To help avoid causing bird collisions with seismic survey and support vessels, seismic and surface support vessels will minimize the use of high-intensity work lights, especially within the 20-meter-bathymetric contour. High-intensity lights will be used only as necessary to illuminate active, on-deck work areas during periods of darkness or inclement weather (such as rain or fog), otherwise they shall be turned off. Deck lights, interior lights, and lights used during navigation could remain on for safety. Nothing in this mitigation measure is intended to reduce personnel safety or prevent compliance with other regulatory requirements (e.g., U.S. Coast Guard or Occupational Safety and Health Administration) for marking or lighting of equipment and work areas.
- All bird collisions (with vessels and aircraft) shall be documented and reported within 3 days to BOEM. Minimum information shall include species, date, time, location and weather, identification of the vessel or aircraft involved, and its operational status when the strike occurred. Bird photographs are not required, but would be helpful in verifying species. Permittees/operators are advised that the USFWS does not recommend recovery or transport of dead or injured birds due to avian influenza concerns.

Additional Mitigation Measures

The following mitigation measures (and mitigation monitoring needed to support them) will be evaluated in Chapter 4 and may be required by NMFS in ITAs or by BOEM in G&G permits or ancillary activity notices to make the necessary findings under the MMPA and OCS Lands Act, respectively, for the type of activity identified.

A. DETECTION-BASED MEASURES INTENDED TO REDUCE NEAR-ARRAY ACOUSTIC EXPOSURES AND IMPACTS ON MARINE MAMMALS WITHIN A GIVEN DISTANCE OF THE SOURCE

Additional Mitigation Measure A1. Prior to conducting the authorized survey, the seismic array operator shall conduct SSV tests for their airgun array configurations in the area in which the survey is proposed to occur.

This measure would be implemented for seismic, including in-ice, and site clearance and high resolution shallow hazards surveys. Before conducting the activity, the operators shall conduct sound source verification (SSV) tests to verify the radii of the safety and monitoring zones within real-time conditions in the field, providing for more accurate radii to be used. When moving an operation into a new area, the operator shall re-verify the new radii of the exclusion zones. The purpose of this mitigation measure is to establish and monitor more accurate safety zones based on empirical measurements, as compared to the zones based on modeling and extrapolation from different datasets. Using a hydrophone system, the vessel operator is required to conduct SSV tests for all airgun arrays and vessels and, at a minimum, report the following results to NMFS within five days of completing the test:

- The empirical distances from the airgun array and other acoustic sources utilized during the effectiveness of the ITA to broadband received levels of 190 dB down to 120 dB in 10 dB increments and the radiated sounds vs. distance from the source vessel.
- Measurements are to be made at the beginning of the survey for locations not previously modeled in the Arctic Seas.

Additional Mitigation Measure A2. All PSOs shall be provided with and use appropriate 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 in order to detect marine mammals within the exclusion zones.

- This measure would be required for all activities requiring the use of PSOs.
- All PSOs could be provided with and use appropriate night-vision devices, Big Eyes, and reticulated and/or laser range finding binoculars in order to detect marine mammals within the Exclusion Zone.

Additional Mitigation Measure A3. Operators shall limit seismic airgun operations in situations of low visibility when the entire safety radius cannot be observed (e.g., nighttime or bad weather). These limitations could mean cease airgun operations entirely, reduce the time that operations are conducted in this limited visibility situation, or reduce the number of airguns operating so that the exclusion radius is entirely visible.

- This measure would be implemented for seismic, including in-ice, and site clearance and high resolution shallow hazards surveys.

Additional Mitigation Measure A4. Seismic operators shall use passive (or active) acoustic monitoring systems, in addition to visual monitoring, to detect marine mammals approaching or within the exclusion zone and trigger the shutdown of airguns.

- This measure would be implemented for seismic, including in-ice, and site clearance and high resolution shallow hazards surveys.

Additional Mitigation Measure A5. Enhancement of monitoring protocols and mitigation shutdown zones to minimize impacts in specific biologic situations (e.g. expansion of shutdown zone to 120 dB or 160 dB when cow/calf groups and feeding or resting aggregations are detected, respectively).

This measure would be implemented for any activity that implements standard shutdown zones. Some characteristic mitigation language that has been used in past ITAs for these measures include:

- For seismic activities (including shallow hazards and site clearance and other marine surveys where active acoustic sources will be employed) in the Beaufort Sea after August 25, a 120-dB monitoring zone for bowhead whales will be established and monitored for the next 24 hours if four or more bowhead whale cow/calf pairs are observed at the surface during an aerial monitoring program within the area where an ensonified 120-dB zone around the vessel's track is projected. To the extent practicable, such monitoring should focus on areas upstream (eastward) of the bowhead migration. No seismic surveying shall occur within the 120-dB safety zone around the area where these whale cow-calf pairs were observed, until two consecutive surveys (aerial or vessel) indicate they are no longer present within the 120-dB safety zone of seismic-surveying operations.
- A 160-dB vessel monitoring zone for bowhead and gray whales will be established and monitored in the Chukchi Sea and after August 25 in the Beaufort Sea during all seismic surveys. Whenever an aggregation of bowhead whales or gray whales (12 or more whales of any age/sex class that appear to be engaged in a non-migratory, significant biological behavior (e.g. feeding, socializing)) are observed during an aerial or vessel monitoring program within the 160-dB safety zone around the seismic activity, the seismic operation will not commence or will shut down, until two consecutive surveys (aerial or vessel) indicate they are no longer present within the 160-dB safety zone of seismic-surveying operations.

B. NON-DETECTION-BASED MEASURES INTENDED TO MORE BROADLY LESSEN THE SEVERITY OF ACOUSTIC IMPACTS ON MARINE MAMMALS OR REDUCE OVERALL NUMBERS TAKEN BY ACOUSTIC SOURCE

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

Additional Mitigation Measure B1. Temporal/spatial limitations to minimize impacts in particular important habitats, including Kaktovik, Barrow Canyon, Hanna Shoal, the shelf break of the Beaufort Sea, Kasegaluk Lagoon, and Ledyard Bay.

All, or a subset of, oil and gas activities would be limited (e.g., either completely prohibited, or the overall time reduced) in the areas specified here during the listed timeframes. 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 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 do not propagate into the area. In the event that a buffer zone of this size was impracticable, a buffer zone avoiding the ensonification of the important habitat above 180 dB could be used. Table A-1 below outlines the time/area closure locations, dates, and species or subsistence hunts that would be protected by the closures.

2D/3D Seismic Surveys, Including In-Ice Surveys ONLY

Additional Mitigation Measure B2. 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).

- Require industry to organize a way to interact with one another to identify when and if duplicative surveys are likely to occur (survey type to gather same type of data within five years) and outline efforts to avoid or describe justification.

Additional Mitigation Measure B3. Separate seismic surveys are prohibited from operating within 145 km (90 mi) of one another.

C. MEASURES INTENDED TO REDUCE/LESSEN NON-ACOUSTIC IMPACTS ON MARINE MAMMALS

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

Additional Mitigation Measure C1. Vessels and aircraft avoidance of concentrations of groups of ice seals by 0.8 km (0.5 mi).

- Seismic survey and associated support vessels shall observe a 0.8 km (0.5 mi) safety radius around ice seal or Pacific walrus groups hauled out onto land or ice.
- Vessels must reduce speed when walruses are observed in the water. Vessels capable of steering around these animals must do so. Vessels may not be operated in such a manner as to separate members of a group of ice seals or walruses from other members of a group. Vessels should avoid multiple changes in direction and speed when ice seals or walruses are present.
- Under no circumstances, other than an emergency, should aircraft be operated at an altitude lower than 457 m (1,500 ft) when within 0.8 km (0.5 mi) of ice seal or Pacific walrus groups.
- Helicopters may not hover or circle above such areas or within 762 m (2,500 lateral ft) of such areas.

- Seismic survey operators shall adhere to any mitigation measures identified by the USFWS to protect polar bears from being harassed and/or injured.
- Vessels must reduce speed when polar bears are observed in the water. Vessels capable of steering around these animals must do so. Vessels may not be operated in such a manner as to separate members of a group of polar bears from other members of a group. Vessels should avoid multiple changes in direction and speed when polar bears are present.
- Currently, proposed polar bear critical habitat mitigation includes a 1.6 km (1 mi) no disturbance zone around the barrier islands, and sea ice habitat.

Additional Mitigation Measure C2. Specified shipping or transit routes to avoid important habitat in areas where marine mammals may occur in high densities.

Exploratory Drilling Activities ONLY

Additional Mitigation Measure C3. 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.

Discharge streams identified with potential impacts to marine mammals or marine mammal habitat include the following:

- Drill cuttings;
- Drilling fluids;
- Sanitary waste;
- Bilge water;
- Ballast water; and
- Domestic waste (i.e. gray water).

Additional Mitigation Measure C4. Operators are required to recycle drilling muds.

- Operators are required to recycle drilling muds (e.g. use those muds on multiple wells) based on operational considerations to reduce discharges.

On-ice Seismic Surveys

Additional Mitigation Measure C5. Use trained seal-lair sniffing dogs for areas with water deeper than 3 m (9.8 ft) depth contour to locate seal structures under snow in the work area and camp site before initiation of activities.

- Seal lairs are to be avoided by 152 m (500 ft).

Additional Mitigation Measure C6. Use trained seal-lair sniffing dogs to survey the ice road and establish a route where no ringed seal structures are present.

D. MEASURES INTENDED TO ENSURE NO UNMITIGABLE ADVERSE IMPACT TO SUBSISTENCE USES

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

Additional Mitigation Measure D1. No transit of exploration vessels into the Chukchi Sea prior to July 15 or until the beluga hunt is completed at Point Lay.

- Any vessel conducting geophysical work in the Chukchi Sea should remain at least 8 km (5 mi) offshore during transit except for emergencies or human/navigation safety.
- Geophysical activity shall not be conducted within 96.5 km (60 mi) of any point on the Chukchi Sea coast.

Additional Mitigation Measure D2. Vessels transiting east of Bullen Point to the Canadian border should remain at least 8 km (5 mi) offshore during transit along the coast, except for emergencies or human/navigation safety.

Additional Mitigation Measure D3. 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.

Additional Mitigation Measure D4. Shutdown of exploration activities in the Beaufort Sea for the Barrow bowhead whale hunts from Pitt Point on the east side of Smith Bay to a location about half way between Barrow and Peard Bay from September 15 to the close of the fall bowhead whale hunt in Barrow.

Additional Mitigation Measure D5. 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.

Additional Mitigation Measure D6. Shutdown of exploration activities in the Chukchi Sea for the Point Hope and Point Lay bowhead whale hunts based on real-time reporting of whale presence and hunting activity rather than a fixed date.

Additional Mitigation Measure D7. Transit restrictions into the Chukchi Sea modified to allow offshore travel under certain conditions (e.g. 32 km [20 mi] from the coast) if beluga whale, fall bowhead whale (Barrow and Wainwright), and other marine mammal hunts would not be affected.

Exploratory Drilling Activities ONLY

Additional Mitigation Measure D8. For exploratory drilling operations in the Beaufort Sea west of Cross Island, no drilling equipment or related vessels used for at-sea oil and gas operations shall be moved onsite at any location outside the barrier islands west of Cross Island until the close of the bowhead whale hunt in Barrow.

Table A-1. Proposed Time/Area closure locations under Additional Mitigation Measure B1. This table identifies the species and subsistence hunts that would be mitigated by implementing these closures.

	Kaktovik	Barrow Canyon and the Western Beaufort Sea	Beaufort Sea Shelf Break	Hanna Shoal	Kasegaluk Lagoon and Ledyard Bay
Proposed closure period	August 25 - September 15	Mid-July - October	Mid-July - late September	September 15 - early October	Mid-June - mid-July for the Lagoon and July 1 – November 15 for the LBCHU
Bowhead Whale	Migrating and feeding: late August - October	Migrating and feeding: late August - October	Migrating: late August - October	Part of migratory corridor: September - October	Do not occur (migrate offshore)
Beluga Whale	Uncommon	Migrating and feeding: mid-July - late August	Feeding: mid-July - late September	Unknown	Feeding, molting, calving: June and July
Spotted Seal	Present	Present	Present	Present	Present; Some feeding habitat
Walrus	Not present	Not present	Not Present	Feeding: July - August	Resting habitat: Spring and early winter
Whaling Hunts	bowheads: late August - mid-September	bowheads: September - October	Uncommon	None	belugas: mid-June - mid-July in the Lagoon only
Sealing Hunts	Mostly October - June	Mostly November - January and spring	Uncommon	None	Mostly October - June

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APPENDIX B

Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis

April 2012

Criteria and Thresholds for U.S. Navy Acoustic and Explosive Effects Analysis

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ACKNOWLEDGMENTS

This technical report relies heavily upon two prior documents:

OPNAV Recommended Phase II Threshold Criteria, dated 20 January 2012.

Marine Mammal and Sea Turtle Criteria and Thresholds for Navy Effects Analyses, dated August 2010

We wish to thank the following individuals whom contributed to the aforementioned documents and to the completion of this technical report: Chip Johnson, Julie Rivers and Roy Sokolowski (COMPACFLT); Sean Hanser (NAVFAC Pacific); Dorian Houser, Sarah Kotecki, and Jason Mulsow (Navy Marine Mammal Program); Danielle Buonantony, Anurag Kumar, and Mandy Shoemaker (NAVFAC Atlantic), Amy Farak, Peter Hulton, and Stephanie Watwood (NUWC Newport); Robert Gisiner and Heather Havens (OPNAV N45); Jene Nissen (USFF).

CONTENTS

ACRONYMS AND ABBREVIATIONS

dB	decibel
dB re 1 μPa	decibels referenced to 1 microPascal
dB re 1 $\mu Pa^2 \cdot s$	decibels referenced to 1 microPascal- squared – seconds
GI	gastrointestinal
HF	high-frequency
Hz	hertz
kHz	kilohertz
LF	low-frequency
MF	mid-frequency
psi	pounds per square inch
PTS	permanent threshold shift
SEL	sound exposure level
SPL	sound pressure level
TM	tympanic membrane
TTS	temporary threshold shift

1 INTRODUCTION

The U.S. Navy is required to assess the potential impacts to marine species from training and testing activities to remain in compliance with a suite of Federal environmental laws and regulations including, but not limited to, the Marine Mammal Protection Act, Endangered Species Act, and the National Environmental Policy Act. In cases where these activities introduce high-levels of sound or explosive energy into the marine environment, an effects analysis must be conducted. The acoustic effects analysis begins with mathematical modeling to predict the sound transmission patterns from Navy sources. These data are then coupled with marine species distribution and abundance data to determine the sound levels likely to be received by various marine species. Finally, criteria and thresholds are applied to estimate the specific effects that animals exposed to Navy-generated sound may experience.

Sounds produced from naval activities can be divided into seven categories: (1) Sonars and other active acoustic sources; (2) Explosive detonations; (3) Ship noise; (4) Aircraft noise; (5) Gunfire and other launch noise; (6) Pile driving; and (7) Airguns. This report summarizes the criteria and thresholds for marine mammals and sea turtles exposed to underwater explosive detonations and sonars and other acoustic sources. Pile driving and seismic airguns, although impulsive sources, lack the potential for shock wave generation and are therefore not treated as explosives, but rather rely on unique criteria and thresholds agreed upon by Navy and NMFS. The criteria and thresholds for pile driving and airguns are therefore not included in this document.

2 CRITERIA AND THRESHOLDS FOR MARINE MAMMALS

2.1 INTRODUCTION

The criteria and thresholds for marine mammals are similar to those proposed by Southall et al. (2007): Marine mammal species are divided into a number of functional hearing groups, with all species in the same group assumed to be equally susceptible to noise. Within each functional hearing group, auditory weighting functions are used to emphasize frequencies where sensitivity to noise is high and de-emphasize frequencies where sensitivity is low. Individual criteria and thresholds are defined for explosive and (non-explosive) acoustic sources. The criteria and thresholds presented here for explosive sources are similar to those proposed by Southall et al. (2007) for impulsive sources, and the criteria and thresholds presented here for acoustic sources are similar to the Southall et al. (2007) non-impulsive criteria.

2.2 FUNCTIONAL HEARING GROUPS

To facilitate the acoustic and explosive effects analyses, marine mammals are divided into eight functional hearing groups, and the same criteria and thresholds are used for all species within a group. Species were grouped by considering their known or suspected auditory sensitivity, ear anatomy, and acoustic ecology (i.e., how they use sounds), as has been done previously (e.g., Ketten, 2000; Southall *et al.*, 2007). Appendix A summarizes the specific families and subfamilies contained in each functional hearing group.

2.2.1 Low-frequency (LF) cetaceans

Low-frequency cetaceans include all of the mysticetes.

No direct measurements of hearing sensitivity in any LF cetacean are available. Sensitivity to LF sound by baleen whales has been inferred from observed vocalization frequencies, observed reactions to playback of sounds, and anatomical analyses of the auditory system (Houser et al., 2001; Parks et al., 2007). Baleen whales are estimated to hear from 15 Hz – 20 kHz, with good sensitivity from 20 Hz – 2 kHz (Ketten, 1998). Mathematical models of the humpback whale's ear developed from anatomical features and optimization techniques (Houser *et al.*, 2001) suggest that humpbacks are sensitive to frequencies between 40 Hz and 16 kHz, but best sensitivity is likely to occur between 100 Hz and 8 kHz. Based on these data, functional hearing limits for LF cetaceans are defined as 7 Hz – 22 kHz.

2.2.2 Mid-frequency (MF) cetaceans

Mid-frequency cetaceans include most delphinid species (e.g., bottlenose dolphin, common dolphin, killer whale, pilot whale; see high-frequency cetacean list for exceptions), beaked whales, bottlenose whales, and sperm whales (but not pygmy and dwarf sperm whales of the genus *Kogia*, which are treated as high-frequency species).

Hearing sensitivity has been directly measured for a number of species within this group, including Atlantic bottlenose dolphins (Johnson, 1967), belugas (Finneran et al., 2005; White, 1977), Indo-Pacific bottlenose dolphins (Houser et al., 2008), Black Sea bottlenose dolphins

(Popov et al., 2007), striped dolphins (Kastelein et al., 2003), white-beaked dolphins (Nachtigall et al., 2008), Risso's dolphins (Nachtigall et al., 2005), killer whales (Szymanski et al., 1999), false killer whales (Yuen et al., 2005), common dolphins (Touhey-Moore et al., unpublished), Atlantic white-sided dolphins (Touhey-Moore et al., unpublished), Gervais' beaked whales (Finneran et al., 2009), Blainville's beaked whale (Pacini et al., 2011), short-finned pilot whales (Schlundt et al., 2011), and long-finned pilot whales (Pacini et al., 2010). All audiograms exhibit the same general U-shape, with a nominal hearing range between approximately 150 Hz and up to 160 kHz; these two frequencies were used as the lower and upper cutoff frequencies for the functional hearing limits.

2.2.3 High-frequency (HF) cetaceans

High-frequency cetaceans include the porpoises (genus *Phocoena*, *Neophocaena*, *Phocoenoides*), river dolphins, *Kogia* species, and *Cephalorhynchus* species.

Hearing has been tested for harbor porpoises (Kastelein et al., 2002a), Yangtze finless porpoises (Popov et al., 2005), Amazon River dolphins (Popov and Supin, 1990b), and Tucuxi dolphins (Popov and Supin, 1990a). All audiograms exhibit the same general U-shape with nominal hearing range between 200 Hz and 180 kHz; these two frequencies were used as the lower and upper cutoff frequencies for the functional hearing limits.

2.2.4 Phocids

Phocids include all earless seals or "true seals," including the ice seals (harp, hooded, bearded, ringed, ribbon, spotted, Weddell, leopard, Ross, and crabeater seals); harbor or common seals; gray seals; inland seals (e.g., Caspian and Baikal seals); elephant seals (northern and southern); and monk seals (Hawaiian and Mediterranean). Since these animals are amphibious, separate criteria and thresholds are included for airborne and underwater exposure.

Phocid hearing limits are estimated to be 75 Hz – 30 kHz and 75 Hz – 75 kHz in air and water, respectively (Kastak and Schusterman, 1999; Kastelein et al., 2009; Møhl, 1968; Reichmuth, 2008; Terhune and Ronald, 1971; 1972).

2.2.5 Otariids and Odobenids

Otariids include all eared seals (fur seals and sea lions) and odobenids are walruses (the only extant species). Separate criteria/thresholds are included for airborne and underwater exposure. Since these animals are amphibious, separate criteria and thresholds are included for airborne and underwater exposure.

Otariid hearing limits are estimated to be 100 Hz – 35 kHz and 100 Hz – 50 kHz in air and water, respectively (Babushina et al., 1991; Kastak and Schusterman, 1998; Kastelein et al., 2005b; Moore and Schusterman, 1987; Mulsow and Reichmuth, 2007; Mulsow et al., 2011a; Mulsow et al., 2011b; Schusterman et al., 1972).

The ear morphology of the walrus is intermediate between the otariid and phocid ear; however, current data indicate that the hearing of the walrus is more similar to that of otariids (Kastelein et al., 2002c). Therefore, the hearing limits defined for otariids are also applied to walruses.

2.2.6 Mustelids

Mustelids include sea otters (in air and under water). Since these animals are amphibious, separate criteria and thresholds are included for airborne and underwater exposure.

Like the pinnipeds, sea otters are amphibious mammals in the order Carnivora. No published data are available for sea otter hearing, though it is reasonable to expect hearing ability similar to other mustelids (otters). Behavioral measures of hearing in air for two North American river otters indicate a functional hearing of approximately 450 Hz – 35 kHz (Gunn, 1988), which is similar to the in-air hearing range of otariids. Based on the limited available information and the fact that the otariid ear is very similar to the ear of other carnivores (Nummela, 2008), the functional hearing limits for otariid are used for sea otters.

2.2.7 Ursids

Ursids include polar bears (in air and under water). Since these animals are amphibious, separate criteria and thresholds are included for airborne and underwater exposure.

Like the pinnipeds and sea otters, polar bears are amphibious mammals in the order Carnivora. Hearing threshold measurements of polar bears (in air) have shown good sensitivity up to approximately 20 kHz, with a rapid decline in sensitivity above 20 kHz (Bowles et al., 2008; Nachtigall et al., 2007). Based on the limited available information and the fact that the otariid ear is very similar to the ear of other carnivores (Nummela, 2008), the functional hearing limits for otariid are used for polar bears.

2.2.8 Sirenians

Sirenians contain manatees and dugongs.

Gerstein et al. (1999) obtained behavioral audiograms for two West Indian manatees and found an underwater hearing range of approximately 400 Hz – 76 kHz, with best sensitivity around 16 – 18 kHz. Mann et al. (2009) obtained masked behavioral audiograms from two manatees; sensitivity was shown to range from 250 Hz – 90 kHz, although the detection level at 90 kHz was 80 dB above the manatee’s frequency of best sensitivity (16 kHz). This audible frequency range is similar to that of phocids (Gerstein *et al.*, 1999; Southall *et al.*, 2007), therefore the functional hearing range for phocids (75 Hz – 75 kHz) was applied to the Sirenians.

2.3 AUDITORY WEIGHTING FUNCTIONS

Human occupational noise exposure guidelines rely on numeric thresholds based on “weighted” noise levels. Weighted noise levels are calculated by applying frequency-dependent filters, or “weighting functions,” to the noise sound pressure measured in the workplace. The weighting functions are designed to emphasize frequencies (i.e., to add “weight”) where people are sensitive to noise and to de-emphasize frequencies (i.e., subtract weight) where people are not very sensitive. The weighted noise levels at each frequency are then combined to generate a single, weighted exposure value. This technique allows the use of a single, weighted threshold value, regardless of the noise frequency. The alternative would be to have a large number of individual threshold values, one for every frequency that might be encountered.

Weighting functions for humans were derived from equal loudness contours — graphs representing the sound pressure levels (SPLs) that give rise to a sensation of equal loudness magnitude in a human listener as a function of sound frequency (Suzuki and Takeshima, 2004). Equal loudness contours are in turn derived from subjective loudness experiments, where human listeners are asked to judge the relative loudness of two tones with different frequencies (e.g., Fletcher and Munson, 1933; Robinson and Dadson, 1956). For humans, the most commonly encountered weighting functions are the “A-weighting” and “C-weighting” functions. A-weighting resembles the human auditory sensitivity curve, and is the most common weighting function prescribed in noise regulations. The C-weighting curve is flatter, subtracts less energy at the extreme high and low frequencies, and better matches human sensitivity to louder sounds.

For marine mammals, several approaches have been used to define auditory weighting functions. See Appendix B for a summary of weighting functions and parameters specific for each functional hearing group.

2.3.1 Development of marine mammal auditory weighting functions

The first broadly applied marine mammal weighting functions were developed by Southall et al. (2007). Cetaceans and pinnipeds were divided into five functional hearing groups: LF cetaceans, MF cetaceans, HF cetaceans, pinnipeds in air, and pinnipeds in water. At the time, there were no equal loudness data for marine mammals. Although the use of species’ hearing sensitivities as weighting functions seems logical, existing audiograms for odontocetes typically possessed a much steeper reduction in sensitivity at low-frequencies compared to the dolphin and beluga temporary threshold shift (TTS) data, which showed little variation between 3 and 20 kHz. For these reasons, Southall et al. based their proposed weighting functions on the shape of the human “C-weighting” network, with the parameters adjusted so the weighting function shape better matched the known or suspected hearing range for each species group. The group of resulting weighting functions was referred to as the “M-weighting” functions (Southall *et al.*, 2007).

The “M-weighting” functions are described by the equation:

$$W(f) = K + 20\log_{10}\left[\frac{b^2 f^2}{(a^2 + f^2)(b^2 + f^2)}\right], \qquad (1)$$

where *f* is the frequency (Hz), $W(f)$ is the weighting function amplitude (dB) at each frequency, *a* and *b* are constants related to the upper and lower hearing limits, respectively, and *K* is a constant used to normalize the equation at a particular frequency. Specific values for the constants *a* and *b* are given in Table 1 (Southall *et al.*, 2007). Figure 1 shows the resulting weighting functions. The M-weighting functions are nearly flat between the lower and upper cutoff frequencies (*a* and *b*, respectively) specified in Table 1. For this reason, they were believed to over-estimate the effects of noise at high and low frequencies and thus to be protective (Southall *et al.*, 2007).

Table 1. Parameters for the "M-weighting" functions defined by Southall et al. (2007).

Species Group	*K*	*a* (Hz)	*b* (Hz)
LF cetaceans	0	7	22,000
MF cetaceans	0	150	160,000
HF cetaceans	0	200	180,000
Pinnipeds in water	0	75	75,000
Pinnipeds in air	0	75	30,000

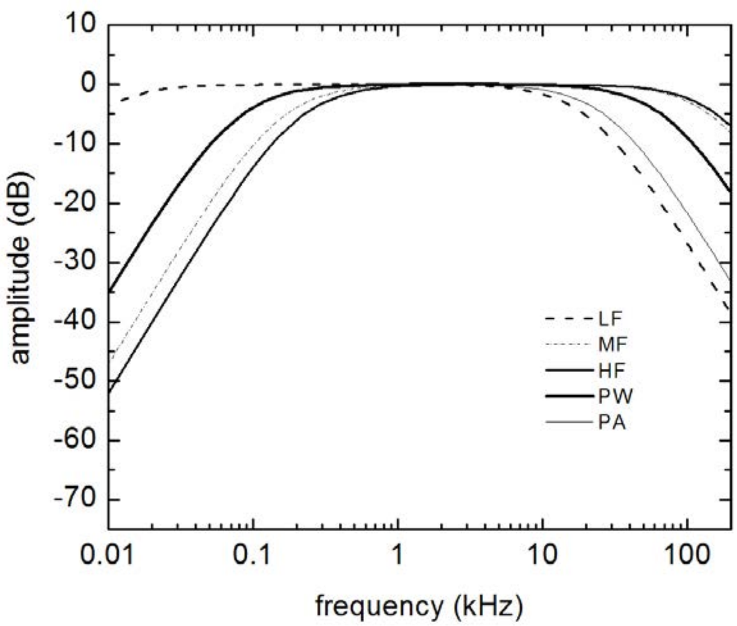

Figure 1. Marine mammal auditory weighting functions proposed by Southall et al. (2007). LF – low-frequency cetacean, MF – mid-frequency cetacean, HF – high-frequency cetacean, PW – pinnipeds in water, PA – pinnipeds in air.

The next advancement of marine mammal weighting functions occurred in 2011, when subjective loudness measurements were made with a bottlenose dolphin, the first time such an experiment has been conducted with a non-human animal (Finneran and Schlundt, 2011). From the subjective loudness data, equal loudness contours were derived, using the same procedures as those used to derive human equal loudness contours (e.g., Suzuki and Takeshima, 2004). Finally, Eq. (1) was fit to the equal loudness contour data, providing a set of auditory weighting functions. Three weighting functions based on equal loudness contours (the “EQL weighting functions”) were presented by Finneran and Schlundt (2011); the functions were based on the equal loudness contours passing through 90, 105, and 115 dB re 1 µPa at 10 kHz.

Figure 2 compares the Finneran and Schlundt (2011) bottlenose dolphin EQL weighting functions with the Southall et al. (2007) M-weighting function for MF cetaceans. Also shown in Fig. 2 is the relative susceptibility to noise, based on the TTS onset data for dolphins (Finneran, 2010; Finneran and Schlundt, 2009). In contrast to the onset of TTS, which represents an exposure threshold, the hazardousness of a noise exposure can also be described by the *susceptibility* of the listener, which represents the listener’s sensitivity to noise. The *relative susceptibility* is obtained by negating the onset TTS levels (in dB), then normalizing these data at some frequency. High values of susceptibility therefore indicate frequencies where noise is more hazardous. The susceptibility data can be directly compared to auditory weighting functions, which preferentially emphasize (apply larger weight to) frequencies where noise is more hazardous and de-emphasize those frequencies where noise is less hazardous. In Fig. 2, the EQL weighting functions, M-weighting function, and susceptibility data are all normalized at 3 kHz.

At frequencies above 3 kHz, the dolphin susceptibility to TTS increases (the TTS onset is lower); however, the MF cetacean weighting function proposed by Southall et al. (2007) is flat between 3 and 20 kHz and does not reflect the dependence of TTS on exposure frequency. In contrast, the EQL weighting functions predict larger effects from noise than the MF cetacean M-weighting function above 3 kHz, and better match the susceptibility data. The best fit to the susceptibility data is found with the EQL weighting function based on the 90-dB re 1 µPa equal loudness contour (adjusted $R^2 = 0.831$). Below 3 kHz, the EQL weighting functions are similar and predict increasingly lower effects compared to the MF cetacean M-weighting function. No MF cetacean TTS data exist for frequencies below 3 kHz and the equal loudness data only extend down to 2.5 kHz, therefore the accuracy of the EQL weighting functions at lower frequencies is unknown.

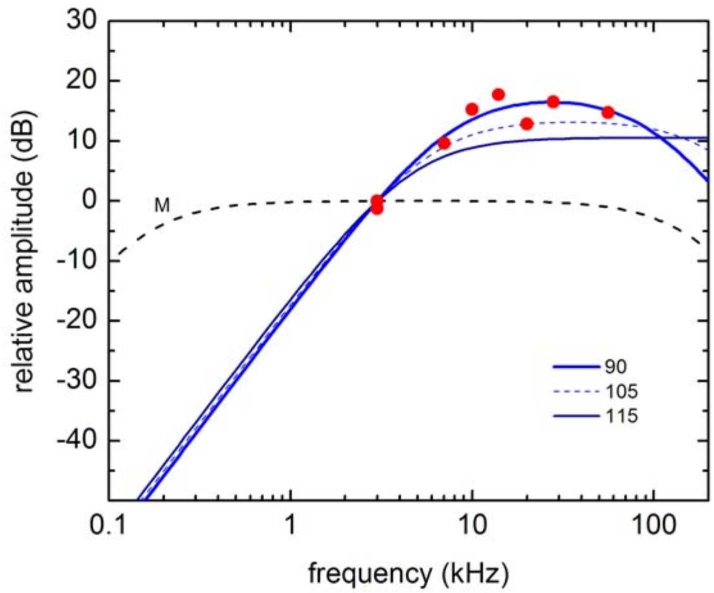

Figure 2. Comparison of dolphin auditory weighting function (solid lines), relative susceptibility to noise measured in a bottlenose dolphin (symbols), and Southall et al. mid-frequency cetacean “M-weighting” (dashed line).

2.3.1.1 Estimating EQL weighting functions for LF and HF cetaceans

Although equal loudness data only exist for bottlenose dolphins, EQL weighting functions can be estimated for other species by adjusting the parameters for Eq. (1), on a relative basis, to fit the known or suspected hearing range of each species group. This process can only be used for functional hearing groups that are closely related to the MF cetaceans (the group for whom the EQL functions exist) — the LF and HF cetaceans.

Because the frequency excitation pattern within the mammalian ear is organized logarithmically, not linearly (Ketten, 2000), the adjustment of the parameters *a* and *b* is done on a logarithmic basis. Specifically, the parameters *a* and *b* are adjusted so that the relationship, in terms of octaves, between *a* and *b* for the EQL weighting function and the functional hearing limits is preserved between the MF cetacean group and the other species groups. The extrapolation is performed using:

$$\frac{\log_2 a' - \log_2 f'_L}{\log_2 f'_U - \log_2 f'_L} = \frac{\log_2 a - \log_2 f_L}{\log_2 f_U - \log_2 f_L}, \tag{2}$$

and

$$\frac{\log_2 b' - \log_2 f'_L}{\log_2 f'_U - \log_2 f'_L} = \frac{\log_2 b - \log_2 f_L}{\log_2 f_U - \log_2 f_L}, \tag{3}$$

where a and b are the EQL weighting function parameters for MF cetaceans, a' and b' are the (extrapolated) parameters for the LF or HF species group, f_L and f_U are the lower and upper frequency limits for MF cetaceans (150 Hz and 160 kHz, respectively), and f'_L and f'_U are the lower and upper frequency limits for LF cetaceans or HF cetaceans. Taking the logarithm to the base 2 ($\log_2$) converts each frequency to octave spacing (re 1 Hz); this is done because the frequency organization of the inner ear is logarithmically spaced, not linearly (Ketten, 2000).

For low-frequency cetaceans, f'_L = 7 Hz and f'_U = 22 kHz, so application of Eqs. (2) and (3) yields a' = 674 Hz and b' = 12,130 Hz. A value of K = 0.94 is needed to normalize the peak of the curve to 0 dB.

For high-frequency cetaceans, f'_L = 200 Hz and f'_U = 180 kHz, so application of Eqs. (2) and (3) yields a' = 9,480 Hz and b' = 108,820 Hz. A value of K = 1.4 is needed to normalize the peak of the curve to 0 dB.

Parameters used to generate the LF, MF, and HF cetacean EQL weighting functions from Eq. (1) are given in Table 2. Graphs of the EQL weighting functions for the LF, MF, and HF cetaceans are shown in Fig. 3.

Table 2. Parameters for the EQL weighting functions for the LF, MF, and HF cetaceans. The MF cetacean function is based on the 90 dB re 1 µPa equal loudness contour for dolphins (Finneran and Schlundt, 2011). The LF and HF functions were extrapolated form the MF function based on the functional hearing limits for the LF and HF cetacean groups. The value of K was adjusted for each function to set the peak amplitude to 0 dB.

Functional Hearing Group	*K*	*a* (Hz)	*b* (Hz)
LF cetacean (extrapolated)	0.9	674	12,130
MF cetacean (based on dolphin 90-dB re 1 µPa equal loudness function)	1.4	7,829	95,520
HF cetacean (extrapolated)	1.4	9,480	108,820

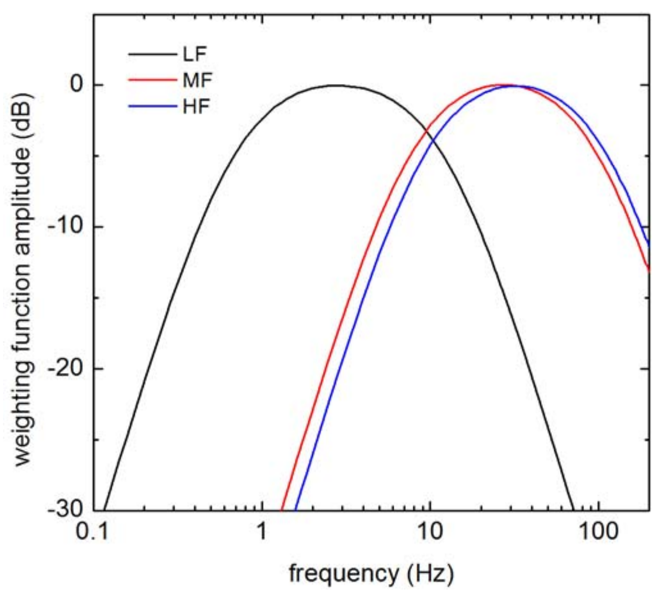

Figure 3. EQL weighting functions for the LF, MF, and HF cetaceans. The MF cetacean function is based on the 90 dB re 1 µPa equal loudness contour for dolphins (Finneran and Schlundt, 2011). The LF and HF functions were extrapolated form the MF function based on the functional hearing limits for the LF and HF cetacean groups.

2.3.2 Navy marine mammal weighting functions

Auditory weighting functions developed for Navy acoustics effects analyses utilize features of both the M-weighting functions and the EQL weighting functions. Two types of Navy weighting functions are defined: Type I weighting functions and Type II weighting functions.

Type I weighting functions are similar to the M-weighting functions and have two parameters (*a*, *b*) that define the lower and upper frequencies where the amplitude begins to decline (the “rolloff” or “cutoff” frequencies), and one parameter (*K*) that defines the amplitude of the flat portion of the curve. Type I functions are flat over a broad range of frequencies. As with the M-weighting functions, the cutoff frequencies are based on the known or estimated hearing range for each functional hearing group. The equation for the Type I weighting function is

$$W_I(f) = K + 20\log_{10}\left[\frac{b^2 f^2}{\left(a^2 + f^2\right)\left(b^2 + f^2\right)}\right], \quad (4)$$

where $W_I(f)$ is the weighting function amplitude (in dB) at the frequency f (in Hz), and *a*, *b*, and *K* are constants defining the shape of the function for each functional hearing group.

Table 3 lists the parameters used to generate the Type I weighting functions from Eq. (4) for each functional hearing group defined in Section 2-2. The weighting functions are displayed in Fig. 4. The Navy Type I weighting functions for the cetaceans are identical to the Southall et al. (2007) M-weighting functions. The Type I weighting functions (in air and underwater) for the phocids are identical to the Southall et al. (2007) M-weighting functions for pinnipeds (the pinniped M-weighting functions were based on the hearing ranges for phocids seals). The Type I functions for otariids, odobenids, mustelids, ursids, and sirenians are based on the estimated functional hearing limits for these functional groups as defined in Section 2.2.

Table 3. Parameters for the Navy marine mammal Type I weighting functions.

Functional Hearing Group	*K*	*a* (Hz)	*b* (Hz)
LF cetaceans	0	7	22,000
MF cetaceans	0	150	160,000
HF cetaceans	0	200	180,000
Phocids (in water), Sirenians	0	75	75,000
Phocids (in air)	0	75	30,000
Otariids, Odobenids, Mustelids, Ursids (in water)	0	100	40,000
Otariids, Odobenids, Mustelids (in air)	0	100	30,000

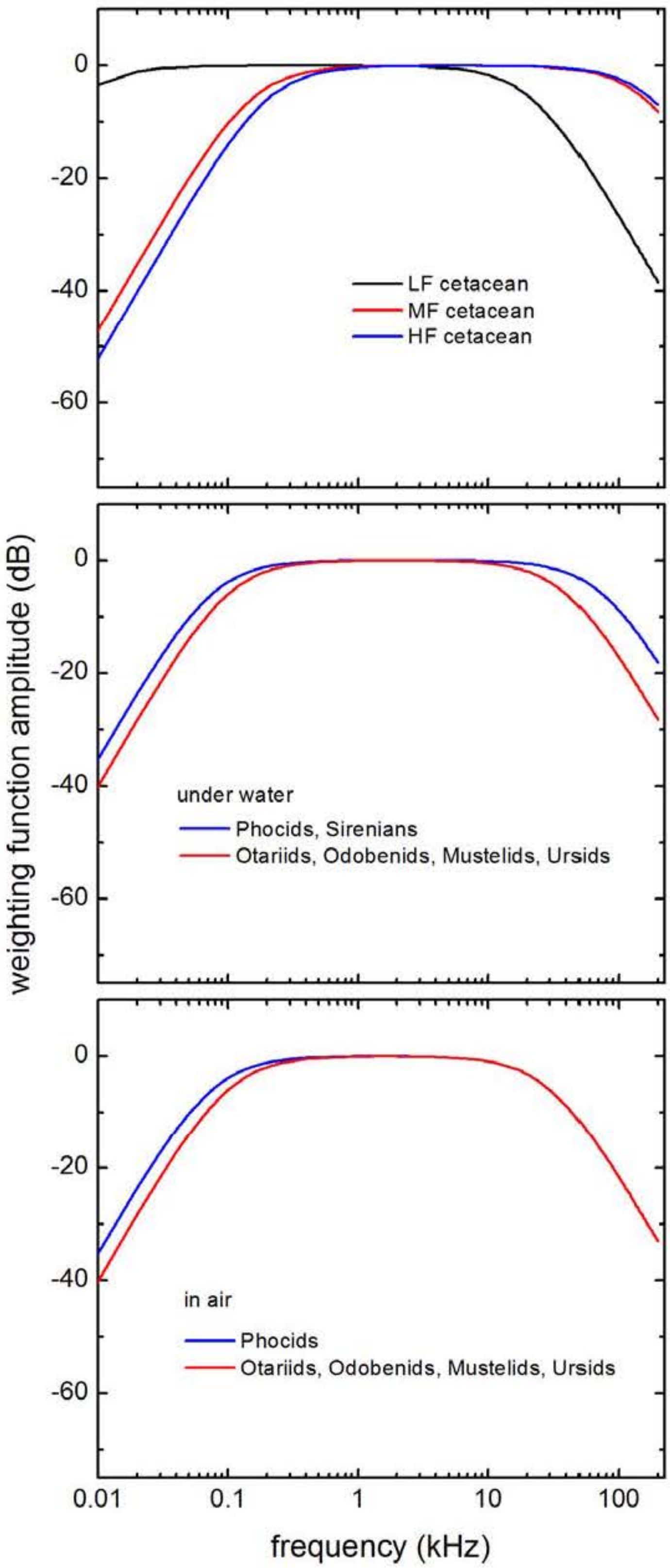

Figure 4. Navy Type I weighting functions.

Type II weighting functions modify the Type I functions (or M-weighting functions) by including a region of increased amplitude (increased susceptibility) based on the EQL weighting functions. Type II functions are only derived for the cetaceans, because the underlying data necessary for the functions are only available for bottlenose dolphins (MF cetaceans). Although TTS data exist for three pinniped species (harbor seal, California sea lion, northern elephant seal), most exposures consisted of octave band noise centered at 2.5 kHz, thus data are insufficient to either derive weighting functions in a manner analogous to that used for MF cetaceans or to verify the effectiveness of extrapolations from the MF cetacean group.

Type II functions are defined using two component curves: one based on the Type I weighting function and the other based on the EQL weighting function. At each frequency, the amplitude of the weighting function is defined using the larger value from the two component curves, as illustrated in Fig. 5. In practice, the Type I component will dominate below some frequency, denoted as the “inflection point” frequency, and the EQL component will dominate above the inflection point. The idea behind the Type II function is to enhance the Type I weighting function by accounting for the increased susceptibility to noise seen in the bottlenose dolphin TTS data at frequencies above 3 kHz. The EQL weighting functions are not used by themselves because of the uncertainty regarding the weighting function amplitude at low frequencies, below the range of the TTS and equal loudness data. The Type I function is used at lower frequencies as a protective approach since there are no TTS or equal loudness data below 2.5 – 3 kHz. The Type II weighting function represents a way to incorporate new data showing increased susceptibility to noise at higher frequencies with the broad, protective weighting functions proposed by Southall et al. (2007).

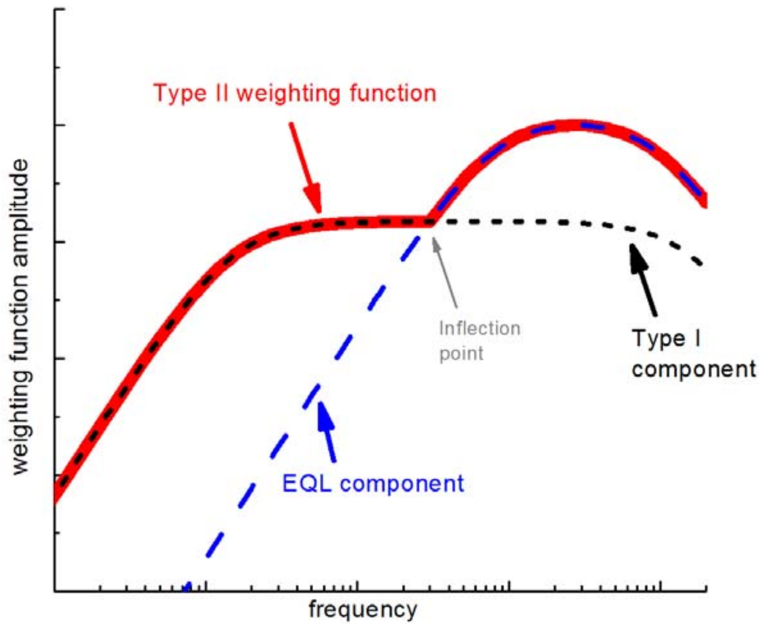

Figure 5. Illustration of the Type II weighting function concept. Below the inflection point frequency, the Type II weighting function matches the shape of the Type I function. Above the inflection point, the Type II function matches the EQL-based weighting function.

The Type II weighting functions are mathematically defined as:

$$W_{II}(f) = \text{maximum}\{G_1(f), G_2(f)\}, \tag{5}$$

where $W_{II}(f)$ is the weighting function amplitude (dB) at the frequency f (Hz),

$$G_1(f) = K_1 + 20\log_{10}\left[\frac{b_1^2 f^2}{(a_1^2 + f^2)(b_1^2 + f^2)}\right], \tag{6}$$

$$G_2(f) = K_2 + 20\log_{10}\left[\frac{b_2^2 f^2}{(a_2^2 + f^2)(b_2^2 + f^2)}\right], \tag{7}$$

the parameters a_1, b_1, and K_1 define the Type I component of the function and a_2, b_2, and K_2 define the EQL component of the function. The specific parameters for the LF, MF, and HF cetaceans are given in Table 4. Note that the values for a_1, b_1 match the parameters *a* and *b* for the Type I (and M-weighting) functions and a_2, b_2 match the parameters for the EQL weighting functions. The values for K_2 match the values for *K* for the EQL weighting function, so the Type II functions also have their peak amplitudes at 0 dB. The values for K_1 are adjusted from the Type I functions so that the MF and HF cetaceans have the inflection point at 3 kHz. For the LF cetaceans, *K* is adjusted so that the flat portion of the Type I component is 16.5 dB below the peak, identical to the value for the MF cetaceans. This places the inflection point for the LF cetacean function at 267 Hz. The Type II weighting functions are shown graphically in Fig. 6.

Table 4. Marine mammal Type II weighting function parameters for use in Eq. (5).

Functional Hearing Group	K_1 (dB)	a_1 (Hz)	b_1 (Hz)	K_2 (dB)	a_2 (Hz)	b_2 (Hz)	Inflection point (Hz)
LF cetaceans	-16.5	7	22,000	0.9	674	12,130	267
MF cetaceans	-16.5	150	160,000	1.4	7,829	95,520	3,000
HF cetaceans	-19.4	200	180,000	1.4	9,480	108,820	3,000

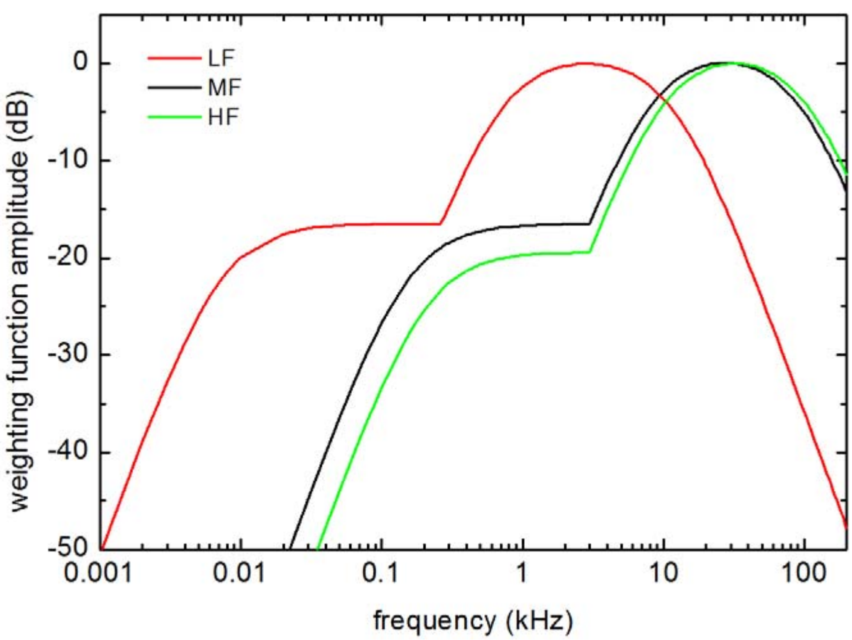

Figure 6. Navy Type II weighting functions for LF, MF, and HF cetaceans.

2.4 CRITERIA AND THRESHOLDS FOR SONARS AND OTHER ACTIVE ACOUSTIC SOURCES

2.4.1 Introduction

Criteria for marine mammals exposed to sonars and other active acoustic sources are divided into physiological effects and behavioral effects. Physiological effects criteria and thresholds are based on temporary and permanent threshold shift (TTS and PTS). Behavioral thresholds are based on observational data documenting the reactions of various marine mammal species to sound. For TTS, PTS, and behavioral responses, criteria and thresholds are provided for each functional hearing group. A summary of the various criteria and thresholds is provided in Appendix C.

2.4.2 Criteria and thresholds for TTS

TTS criteria and thresholds are based on TTS onset values obtained from representative species of MF and HF cetaceans and pinnipeds. The data obtained from MF and HF cetaceans and pinnipeds were then extrapolated to the other functional hearing groups.

Criteria for TTS are based on the sound exposure level (SEL) received by the animal. SEL is used, rather than sound pressure level (SPL), because SEL includes the effect of the exposure duration, which is a key factor is the likelihood that a noise exposure will produce TTS.

The threshold value for TTS for each functional hearing group is defined in terms of the *weighted* SEL. This means that the SEL corresponding to the onset of TTS is “weighted” by the appropriate weighting function. For cetaceans, Type II weighting functions are used for sonars and other active acoustic sources, since the EQL portion of the Type II functions are based on tonal noise exposures most closely related to sonars. For the other functional hearing groups, where Type II weighting functions do not exist, Type I functions are used instead.

For meaningful comparison to the weighted SEL threshold value, the SEL received by an animal must also be weighted by the same function. To determine if a TTS occurs, the frequency content of the SEL is first determined. The appropriate weighting function is then used to weight each frequency band. Then, the total, weighted SEL is calculated by integrating the weighted frequency content. Finally, the weighted exposure is compared to the weighted threshold value for TTS. If the weighted exposure SEL meets or exceeds the weighted SEL threshold value, then TTS is assumed to occur.

2.4.2.1 Low-Frequency Cetaceans

No direct measurements of TTS are available for any LF cetaceans. For this reason, the MF criteria and thresholds are also applied to LF cetaceans; however, exposures and threshold SEL values are weighted using the Type II LF cetacean weighting function rather than the MF cetacean function. This provides higher susceptibility to low frequency sound, consistent with the inferred frequencies of best hearing for LF cetaceans. The resulting (Type II) weighted exposure SEL for LF cetaceans is 178 dB re 1 $\mu Pa^2 \cdot s$.

2.4.2.2 Mid-Frequency Cetaceans

To date, TTS data has been collected for bottlenose dolphins and belugas, two diverse odontocetes. Both species had similar TTS thresholds (Schlundt et al., 2000). Due to the similarity in the known audiograms and TTS thresholds, the TTS thresholds for dolphins and belugas are applied to all MF cetaceans.

A number of studies have shown that an SEL of 195 dB re 1 µPa^2·s is a reasonable threshold for TTS in dolphins and belugas exposed to 3 kHz tones (Finneran, 2005; Finneran et al., 2010; Mooney et al., 2009; Nachtigall et al., 2004; Schlundt *et al.*, 2000). This threshold was also supported by Southall et al. (2007) as the best estimate of onset-TTS for non-impulsive noise exposure in cetaceans. For the MF cetacean Type II weighting function, the weighting function amplitude at 3 kHz is -16.5 dB. This means that the (Type II) weighted exposure SEL for MF cetaceans is 178 dB re 1 µPa^2·s.

2.4.2.3 High-Frequency Cetaceans

At the time the Navy criteria were developed, no direct measurements of TTS were available for any HF cetacean exposed to non-impulsive sound (such as that produced by sonars). TTS thresholds for HF cetaceans were therefore based on data published by Lucke et al. (2009), who measured TTS in a harbor porpoise exposed to impulses produced by a small seismic air gun. The TTS threshold for impulsive noise obtained from the airgun TTS data was adjusted to estimate the TTS threshold for sonars and other active acoustic sources (which are non-impulsive sources) using the method outlined by Southall et al. (2007) (Type II weighted SEL = 146 dB re 1 µPa^2·s). This method relies on the relationship between impulsive and non-impulsive TTS onset values for MF cetaceans, which means that the non-impulsive threshold is 6 dB higher than the impulsive threshold (Southall *et al.*, 2007). For the harbor porpoise, this results in a non-impulsive, (Type II) weighted TTS threshold of 152 dB re 1 µPa^2·s.

Due to the similarities in the known audiograms, the TTS threshold derived for harbor porpoises is used for all HF cetaceans. Newly published TTS data for the Yangtze finless porpoise (Popov et al., 2011) were not directly used to derive threshold values, although this study supports the concept that the HF cetacean thresholds are significantly lower than those for the MF cetaceans. Kastelein et al. (2011) have also presented results of TTS experiments with harbor porpoise, though, at present, these data have not been published.

2.4.2.4 Phocids (in water)

TTS thresholds for phocids exposed to underwater sonars and other active acoustics are based on data reported by Kastak et al. (2005), who provided estimates of the average SEL for onset-TTS for a harbor seal, sea lion, and Northern elephant seal exposed to underwater, octave-band noise centered at 2.5 kHz. The most sensitive of the two phocids was the harbor seal, with a TTS onset threshold of 183 dB re 1 µPa^2·s. For phocids, only a Type I weighting function is used; the weighting function amplitude at 2.5 kHz is 0 dB. This means the (Type I) weighted exposure SEL for harbor seals under water is 183 dB re 1 µPa^2·s.

Due to the similarities in the known audiograms, and the fact that the only other phocid for whom TTS data are available had a higher TTS onset threshold (Northern elephant seal, with

TTS onset 204 dB SEL), the underwater TTS threshold for the harbor seal is used for all phocids seals. Recently, Kastelein et al. (2011) have presented results of TTS experiments with harbor seals exposed to underwater noise, though, at present, these data have not been published.

2.4.2.5 Phocids (in air)

TTS thresholds for phocids exposed to acoustic sources in-air are based on data reported by Kastak et al. (2004), who provided estimates of the average SEL for onset-TTS for a harbor seal, sea lion, and Northern elephant seal exposed to in-air, octave-band noise centered at 2.5 kHz. The most sensitive of the two phocids was the harbor seal, with a TTS onset threshold of 131 dB re $(20\ \mu Pa)^2 \cdot s$. For phocids, only a Type I weighting function is used; the weighting function amplitude at 2.5 kHz is 0 dB. This means the (Type I) weighted exposure SEL for harbor seals in air is 131 dB re $(20\ \mu Pa)^2 \cdot s$.

Due to the similarities in the known audiograms, and the fact that the only other phocid for whom TTS data are available had a higher TTS onset threshold [northern elephant seal, with TTS onset 163 dB re $(20\ \mu Pa)^2 \cdot s$], the in-air TTS threshold for the harbor seal is used for all phocids seals.

2.4.2.6 Otariids and odobenids (in water)

TTS thresholds for otariids exposed to underwater sonars and other active acoustics are based on data reported by Kastak et al. (2005), who provided estimates of the average SEL for onset-TTS for a harbor seal, sea lion, and Northern elephant seal exposed to underwater, octave-band noise centered at 2.5 kHz. The California sea lion TTS onset threshold was 206 dB SEL. For otariids, only a Type I weighting function is used; the weighting function amplitude at 2.5 kHz is 0 dB. This means the (Type I) weighted exposure SEL for California sea lions exposed under water is 206 dB re 1 $\mu Pa^2 \cdot s$.

As the only otariid species for whom TTS data are available, the California sea lion TTS threshold is used for all otariids. No TTS data exist for the walrus; however, underwater audiograms (Kastelein et al., 2002b) for the walrus show a strong similarity to those of other otariids, therefore, the otariid TTS threshold is also used for odobenids.

2.4.2.7 Otariids and odobenids (in air)

TTS thresholds for otariids exposed to acoustic sources in-air are based on data reported by Kastak et al. (2007; 2004), who provided estimates of the average SEL for onset-TTS for a California sea lion exposed to in-air, octave-band noise centered at 2.5 kHz. The California sea lion TTS onset threshold was 154 dB re $(20\ \mu Pa)^2 \cdot s$. For otariids, only a Type I weighting function is used; the weighting function amplitude at 2.5 kHz is 0 dB. This means the (Type I) weighted exposure SEL for California sea lions exposed in air is 154 dB re $(20\ \mu Pa)^2 \cdot s$.

As the only otariid species for whom TTS data are available, the California sea lion TTS threshold is used for all otariids. No TTS data exist for the walrus; however, underwater audiograms (Kastelein *et al.*, 2002b) for the walrus show a strong similarity to those of other otariids, therefore, the otariid TTS threshold is also used for odobenids.

2.4.2.8 Mustelids

Based on the limited data available for sea otters and the similarities between these species and pinnipeds, the otariid TTS criteria and thresholds are used for mustelids.

2.4.2.9 Ursids

Based on the limited data available for polar bears and the similarities between these species and pinnipeds, the otariid TTS criteria and thresholds are used for polar bears.

2.4.2.10 Sirenians

No TTS data for manatees and dugongs exist; however, because the hearing ranges of phocids and sirenians are roughly equivalent, the phocid TTS threshold (the lowest of any of the pinnipeds), is used for sirenians.

2.4.3 Criteria and thresholds for PTS

In contrast to TTS, which represents a temporary reduction of hearing sensitivity, PTS represents tissue damage that does not recover and leads to a permanent reduced sensitivity to sounds over specific frequency ranges. Since no studies have been designed to intentionally induce PTS in marine mammals, onset-PTS levels for marine mammals must be estimated using available information. TTS data are available for some marine mammal species, and a large amount of TTS and PTS data exist for terrestrial mammals. Differences in auditory structures and sound propagation and interaction with tissues prevent direct application of numerical thresholds for PTS in terrestrial mammals to marine mammals. However, the inner ears of marine and terrestrial mammals are analogous and certain relationships are expected to relate to both groups of mammals. Experiments with marine mammals have revealed similarities between marine and terrestrial mammals with respect to features such as TTS, age-related hearing loss, ototoxic drug-induced hearing loss, masking, and frequency selectivity (e.g., Finneran, 2012; Finneran *et al.*, 2005; Nachtigall et al., 2000). For this reason, relationships between TTS and PTS from human and terrestrial mammal data can be used, along with TTS onset values for marine mammals, to estimate exposures likely to produce PTS in marine mammals (Southall *et al.*, 2007).

A variety of terrestrial and marine mammal data sources indicate that threshold shifts up to 40 to 50 dB may be induced without PTS, and that 40 dB is a reasonable upper limit for threshold shift to prevent PTS (e.g., Kryter et al., 1966; Miller et al., 1963; Ward, 1960; Ward et al., 1958; Ward et al., 1959). A conservative assumption is that 40 dB of TTS is an upper limit for reversibility and that any additional exposure will result in some PTS. This means that 40 dB of TTS essentially defines the onset of PTS. To estimate the exposure necessary to induce 40 dB of TTS (and thus PTS), TTS growth rates from marine and terrestrial mammals are used to estimate the additional exposure required to “grow” TTS from the onset value (6 dB of TTS) to the point of the onset of PTS (40 dB of TTS) — a 34 dB difference.

Data from Ward et al. (1958) reveal a linear relationship between TTS and SEL with growth rates of 1.5 to 1.6 dB TTS per dB increase in SEL. This value for the TTS growth rate is larger than those experimentally measured in a dolphin exposed to 3 and 20 kHz tones (Finneran and Schlundt, 2010), and so appears to be a protective value to use for cetaceans. The additional exposure above onset-TTS that is required to reach PTS is therefore 34 dB divided by 1.6 dB, or approximately 20 dB. For cetaceans, exposure to sonars and other active acoustics sources with an SEL 20 dB above that producing TTS may be assumed to produce a PTS. For example, an onset-TTS threshold of 195 dB re 1 μPa^2·s would have a corresponding onset-PTS threshold of 215 dB re 1 μPa^2·s. This extrapolation process is identical to that recently proposed by Southall et al. (2007).

Kastak et al. (2007) reported a TTS growth rate of 2.5 TTS per dB increase in SEL for a California sea lion. This growth rate results in a 14 dB difference between TTS onset and PTS onset. Since this results in a more protective approach, this value is used for all pinnipeds, not just the otariids. The same 14 dB difference is also used for the functional groups that utilize the same thresholds as the pinnipeds: the odobenids, mustelids, ursids, and sirenians..

2.4.3.1 LF Cetaceans

PTS onset for LF cetaceans is defined as the exposure 20 dB above TTS onset: a (Type II) weighted SEL of 198 dB re 1 μPa^2·s.

2.4.3.2 MF Cetaceans

PTS onset for MF cetaceans is defined as the exposure 20 dB above TTS onset: a (Type II) weighted SEL of 198 dB re 1 μPa^2·s.

2.4.3.3 HF Cetaceans

PTS onset for HF cetaceans is defined as the exposure 20 dB above TTS onset: a (Type II) weighted SEL of 172 dB re 1 μPa^2·s.

2.4.3.4 Phocids (in water)

PTS onset for phocids seals is defined as the exposure 14 dB above TTS onset: a (Type I) weighted SEL of 197 dB re 1 μPa^2·s.

2.4.3.5 Phocids (in air)

PTS onset for phocids seals is defined as the exposure 14 dB above TTS onset: a (Type I) weighted SEL of 145 dB re (20 μPa)^2·s.

2.4.3.6 Otariids and odobenids (in water)

PTS onset for otariids and odobenids is defined as the exposure 14 dB above TTS onset: a (Type I) weighted SEL of 220 dB re 1 μPa^2·s.

2.4.3.7 Otariids and odobenids (in air)

PTS onset for otariids and odobenids is defined as the exposure 14 dB above TTS onset: a (Type I) weighted SEL of 168 dB re (20 μPa)^2·s.

2.4.3.8 Mustelids

Based on the limited data available for sea otters and the similarities between these species and pinnipeds, the otariid PTS criteria and thresholds are used for mustelids: a (Type I) weighted SEL of 220 dB re 1 $\mu Pa^2 \cdot s$ in water and 168 dB re $(20\ \mu Pa)^2 \cdot s$ in-air.

2.4.3.9 Ursids

Based on the limited data available for polar bears and the similarities between these species and pinnipeds, the otariid PTS criteria and thresholds are used for polar bears: a (Type I) weighted SEL of 220 dB re 1 $\mu Pa^2 \cdot s$ in water and 168 dB re $(20\ \mu Pa)^2 \cdot s$ in-air.

2.4.3.10 Sirenians

Because the hearing ranges of the phocids and sirenians are roughly equivalent, the phocid PTS threshold (the lowest of any of the pinnipeds), is used for sirenians: a (Type I) weighted SEL of 197 dB re 1 $\mu Pa^2 \cdot s$.

2.4.4 Criteria and thresholds for behavioral effects

Marine animals are likely to exhibit any of a suite of potential behavioral responses or combinations of behavioral responses upon exposure to sonars and other active acoustic sources. Potential behavioral responses include, but are not limited to, avoiding exposure or continued exposure, behavioral disturbance (including distress or disruption of social or foraging activity), habituation to the sound, becoming sensitized to the sound, or not responding to the sound.

In Navy acoustic impact analyses, two types of criteria/thresholds are utilized to estimate behavioral effects of noise:

(1) In cases where a specific taxonomic group's behavioral responses to sound have been well documented, a single sound pressure level (SPL) threshold has been provided to predict the number of behavioral disturbances. As an example, for harbor porpoises (but not other HF cetaceans), a behavioral response threshold of 120 dB SPL (no weighting function) is used for sonars and other active acoustic sources because of the demonstrated high behavioral sensitivity of harbor porpoises to these types of sounds.

(2) For all other taxa, the likelihood of behavioral effects is based on a probabilistic function (termed a behavioral response function – BRF), that relates the likelihood (i.e, probability) of a behavioral response to the received SPL. The BRF is used to estimate the percentage of an exposed population that is likely to exhibit altered behaviors or behavioral disturbance at a given exposure SPL. The BRF relies on the assumption that sound poses a negligible risk to marine mammals if they are exposed to SPL below a certain "basement" value. Above the basement exposure SPL, the probability of a response increases with increasing SPL.

Two BRFs are used in Navy acoustic impact analyses: BRF_1 for LF cetaceans and BRF_2 for all other functional hearing groups (i.e., MF and HF cetaceans, pinnipeds, mustelids, ursids, and sirenians). The BRF functions are based on three sources of data: behavioral observations during TTS experiments conducted at the US Navy Marine Mammal Program (Finneran and Schlundt, 2004); reconstruction of sound fields produced by the USS Shoup associated with the behavioral responses of killer whales observed in Haro Strait (Department of the Navy, 2003; Fromm, 2009); and observations of the behavioral response of North Atlantic right whales exposed to alert stimuli containing mid-frequency components (Nowacek et al., 2004). For a detailed discussion of the derivation of the BRFs, see Department of the Navy (2008a).

The BRFs are calculated using:

$$R(L) = \frac{1 - \left(\frac{L-B}{K}\right)^{-A}}{1 - \left(\frac{L-B}{K}\right)^{-2A}}, \qquad (8)$$

where $R(L)$ is the probability of a response, L is the received SPL, and B and K are parameters that define the shape of the curve. For both BRFs, the "basement" parameter B = 120 dB re 1 μPa and the factor K = 45. For the BRF_1, A = 8; for BRF_2, A = 10. Both functions are illustrated in Fig. 7. Note that the received SPL is weighted using the Type I weighting functions when applying the BRFs.

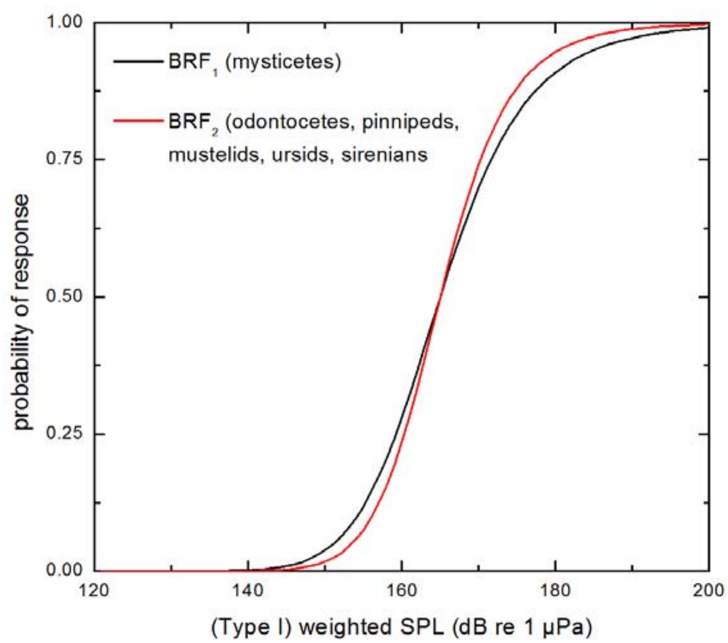

Figure 7. Navy Behavioral response functions (BRFs).

2.4.4.1 LF cetaceans

BRF_1 is used to assess behavioral effects from sonars and other active acoustic sources for all LF cetaceans. The LF cetacean Type I weighting function is used when determining the received SPL to use with the BRF.

2.4.4.2 MF cetaceans

To assess behavioral effects from sonars and other active acoustic sources to all MF cetaceans *except beaked whales*, BRF_2 is used, with the exposure weighted using the Type I weighting function for MF cetaceans.

Data obtained from *Mesoplodon densirostris* suggest greater responsiveness of beaked whales to a variety of sonars and active acoustic sources compared to other species exposed to the same or similar sounds (Tyack et al., 2011). For this reason, an (unweighted) SPL of 140 dB re 1µPa is used for beaked whales as a threshold to predict behavioral disturbance when exposed to sonars or other active acoustic sources.

2.4.4.3 HF cetaceans

To assess behavioral effects from sonars and other active acoustic sources to all HF cetaceans *except harbor porpoises*, BRF_2 is used, with the exposure weighted using the Type I weighting function for HF cetaceans.

For harbor porpoises, the information currently available suggests a very low threshold level of response for both captive and wild animals. Threshold levels at which both captive (Kastelein et al., 2005a; Kastelein et al., 2000) and wild harbor porpoises (Johnston, 2002) responded to sound (e.g. acoustic harassment devices, acoustic deterrent devices, or other non-impulsive sound sources) is very low (e.g. an SPL of approximately 120 dB re 1 µPa), although the biological significance of the disturbance is uncertain. Therefore, an (unweighted) SPL of 120 dB re 1µPa is used for harbor porpoises as a threshold to predict behavioral disturbance.

2.4.4.4 Phocids (in water)

To assess behavioral effects from sonars and other active acoustic sources to all phocids in water, BRF_2 is used, with the exposure weighted using the Type I weighting function for phocids.

2.4.4.5 Phocids (in air)

A number of investigators have studied pinniped reactions to rocket launches (Berg et al., 2004; Berg et al., 2002; Berg et al., 2001; Holst et al., 2005; Thorson et al., 2000a; b; Thorson et al., 1999; Thorson et al., 1998). In some cases severe reactions such as stampeding were recorded by pinnipeds exposed to rocket launch noise with SPLs of approximately 110–120 dB re 20 µPa. Distant rocket launches with received SPLs of approximately 60-70 dB re 20 µPa tended to be ignored by hauled-out pinnipeds. Southall et al. (2007) reviewed these studies and recommended an (unweighted) SEL of 100 dB re $(20\ \mu Pa)^2\cdot s$ as the threshold to predict effects to pinnipeds in air. Despite this threshold being based on reactions to launch noise, not sonars or other active acoustics, Navy uses this threshold as a protective measure for pinnipeds exposed to in-air acoustic sources. Therefore, the behavioral response threshold for phocids exposed to acoustic sources in-air is an (unweighted) SEL of 100 dB re (20 µPa)^2·s.

2.4.4.6 Otariids and odobenids (in water)

To assess behavioral effects from sonars and other active acoustic sources to all otariids and odobenids in water, BRF_2 is used, with the exposure weighted using the Type I weighting function for otariids.

2.4.4.7 Otariids and odobenids (in air)

Similar to phocids seals, the behavioral response threshold for otariids and odobenids exposed to acoustic sources in-air is an (unweighted) SEL of 100 dB re (20 µPa)^2·s.

2.4.4.8 Mustelids

Due to a lack of specific data regarding sea otter reactions to sound, and the phylogenetic and audiometric similarities between these amphibious carnivores and pinnipeds, the pinniped behavioral thresholds are also used to assess the potential behavioral effects to mustelids.

Therefore, to assess behavioral effects from in-water sonars and other active acoustic sources on sea otters, BRF_2 is used, with the exposure weighted using the Type I weighting function for mustelids. For in-air sounds, an (unweighted) SEL of 100 dB re (20 µPa)^2·s is used as a threshold for behavioral reactions in sea otters.

2.4.4.9 Ursids

Due to a lack of specific data regarding polar bear reactions to sound, and the phylogenetic and audiometric similarities between these amphibious carnivores and pinnipeds, the pinniped behavioral thresholds are also used to assess the potential behavioral effects to ursids.

Therefore, to assess behavioral effects from in-water sonars and other active acoustic sources on polar bears, BRF_2 is used, with the exposure weighted using the Type I weighting function for ursids. For in-air sounds, an (unweighted) SEL of 100 dB re (20 µPa)^2·s is used as a threshold for behavioral reactions in polar bears.

2.4.4.10 Sirenians

Due to a lack of specific data regarding sirenian reactions to sound, and the audiometric similarities between these animals and phocid pinnipeds, the phocid behavioral thresholds are also used to assess the potential behavioral effects to sirenians.

Therefore, to assess behavioral effects from in-water sonars and other active acoustic sources on sirenians (manatees and dugongs), BRF_2 is used, with the exposure weighted using the Type I weighting function for sirenians.

2.5 CRITERIA AND THRESHOLDS FOR EXPLOSIVE SOURCES

2.5.1 Introduction

Criteria and thresholds for predicting physical and behavioral effects to marine mammals exposed to underwater explosive detonations were initially developed for the U.S. Navy shock trials of the SEAWOLF submarine (Department of the Navy, 1998) and WINSTON S. CHURCHILL guided missile destroyer (Department of the Navy, 2001). After the SEAWOLF and CHURCHILL shock trials, additional data became available regarding the auditory effects of impulsive sounds, similar to underwater detonations, on marine mammals (e.g., Finneran, 2002). These data were incorporated into the analysis for the shock trial of the MESA VERDE amphibious transport dock ship (Department of the Navy, 2008b). The present US Navy criteria and thresholds for explosive sources follow the a similar approach to that used for the MESA VERDE acoustic impact analysis (Department of the Navy, 2008b).

Similarly to the criteria and thresholds for marine mammals exposed to sonars and other active acoustic sources, criteria and thresholds for explosive sources are divided into physiological effects and behavioral effects. Because of the increased hazardousness of the shock wave associated with underwater detonations, physiological effects not only include auditory effects (PTS and TTS), but also mortality and direct (i.e., non-auditory) tissue damage known as primary blast injury. Criteria and thresholds for physiological effects are presented in order of decreasing severity (i.e., mortality and most serious injuries first). These are followed by criteria and thresholds for PTS, TTS, and behavioral reactions for each functional hearing group. A summary of the various criteria and thresholds is provided in Appendix D.

2.5.2 Mortality and primary (non-auditory) blast injury

A considerable body of laboratory data exist on injuries from impulsive sound exposure, usually from explosive pulses, obtained from tests with a variety of lab animals (mice, rats, dogs, pigs, sheep and other species). Primary blast injuries from explosive detonations are the result of differential compression and rapid re-expansion of adjacent tissues of different acoustic properties (e.g., between gas-filled and fluid-filled tissues or between bone and soft tissues). These injuries usually manifest themselves in the gas-containing organs (lung and gut) and auditory structures (e.g., rupture of the eardrum across the gas-filled spaces of the outer and inner ear). This section describes criteria and thresholds for primary blast injury to non-auditory tissues such as the lungs and gastrointestinal (GI) tract.

2.5.2.1 Mortality

An analysis of potential mortality of submerged terrestrial mammals exposed to small explosive charges has been conducted and used to define Navy thresholds for mortality for marine mammals exposed to underwater detonations (U.S. Navy, 2001; Yelverton, 1981). These analyses found the most common injuries to submerged mammals exposed to underwater detonations to be hemorrhaging in the fine structure of the lungs, and that lung damage is governed by the magnitude of the acoustic impulse (the time integral of the instantaneous sound pressure) of the underwater blast, not the peak pressure or sound exposure level (Richmond et al., 1973; Yelverton, 1981; Yelverton et al., 1973; Yelverton et al., 1975). Therefore, Navy analyses use the value of the acoustic impulse to determine if mortality or slight lung injury occurs. This approach is consistent with other efforts to predict the effects of underwater detonations (Department of the Navy, 1998; 2001; 2008b).

Mortality thresholds resulting from studies of injuries to submerged terrestrial mammals exposed to underwater blasts were based on the occurrence of "extensive lung injury" resulting in "1% Mortality," defined as an exposure where most animals may have moderate blast injuries to the lungs but 99% would survive. The minimum acoustic impulse for predicting the onset of mortality (I_M) is defined as:

$$I_M(M,D) = 91.4M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/2}, \qquad (9)$$

where M is the animal mass (kg), D is the animal depth (m), and the units of I_M are Pa·s. This equation is based on the Goertner injury model (Goertner, 1982), corrected for atmospheric and hydrostatic pressures and based on the cube root scaling of body mass (Richmond *et al.*, 1973; U.S. Navy, 2001). The impulse required for mortality is assumed to increase proportionally to the square root of the ratio of the combined atmospheric and hydrostatic pressures at a specific depth to the atmospheric pressure at the surface. The critical value is assumed to be delivered during a time period that is the lesser of the positive pressure duration, or 20% of the natural period of the assumed-spherical lung adjusted for the size and depth of the animal. As depth increases, the impulse delivery time decreases (Goertner, 1982).

The impact analyses completed for the SEAWOLF and CHURCHILL shock trials (Department of the Navy, 1998; 2001) and other Navy compliance documents used a single body mass, that of a dolphin calf (12.2 kg), to represent all marine mammals for the derivation of the mortality threshold; however, thresholds based on the mass of a dolphin calf may underestimate mortality in smaller marine mammals and may overestimate mortality in larger marine mammals. Species-specific masses are therefore used for determining mortality thresholds because they most closely represent effects to individual species. Table D-2, in Appendix D, provides a nominal body mass for each species based on newborn individuals, a protective approach since the impulse threshold is lower for smaller masses and only a small percentage of a marine mammal population would consist of newborns (i.e., most would be larger and therefore have a higher threshold for mortality). In some cases, body masses were not available for the listed species and were therefore extrapolated from similar species.

2.5.2.2 Slight lung injury

Thresholds for slight lung injury to marine mammals exposed to underwater blasts were based on the occurrence of "slight lung injury" resulting in "0% Mortality," defined as an exposure where most animals may have slight blast injuries to the lungs but all would survive. The minimum acoustic impulse for predicting the onset of slight lung injury (I_S) is defined as:

$$I_S(M,D) = 39.1M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/2}, \quad (10)$$

where M is the animal mass (kg), D is the animal depth (m), and the units of I_S are Pa·s. This equation is based on the Goertner injury model (Goertner, 1982), corrected for atmospheric and hydrostatic pressures and based on the cube root scaling of body mass (Richmond *et al.*, 1973; U.S. Navy, 2001). The impulse required for a slight lung injury is assumed to increase proportionally to the square root of the ratio of the combined atmospheric and hydrostatic pressures at a specific depth to the atmospheric pressure at the surface. As with the mortality thresholds, species-specific masses (see Table D-2, in Appendix D) are used for determining thresholds for slight lung injury.

In-air mortality and slight lung injury criteria and thresholds for pinnipeds (i.e., otariids, phocids, and odobenids) were not developed. Navy explosive training and testing activities do not normally coincide with pinniped, polar bear, or sea otter terrestrial habitat and therefore exposure to explosive energy on land that could cause mortality and slight lung injury is unlikely.

2.5.2.3 GI tract injury

Slight injury to the GI tract appears to be better correlated with the peak sound pressure of the shock wave rather than the acoustic impulse and is independent of the animal's size and mass (Goertner, 1982). Slight contusions to the GI tract were reported during small charge tests (Richmond *et al.*, 1973), when the (unweighted) peak SPL was 237 dB re 1µPa, therefore an unweighted peak SPL of 237 dB re 1 µPa is used as a threshold for slight injury to the GI tract for all marine mammals exposed to underwater explosions.

In-air GI tract injury criteria and thresholds for pinnipeds (i.e., otariids, phocids, and odobenids) were not developed. Navy explosive training and testing activities do not normally coincide with pinniped, polar bear, or sea otter terrestrial habitat and therefore exposure to explosive energy on land that could cause GI tract injury is unlikely.

2.5.3 Auditory Effects (TTS and PTS)

Navy environmental analyses for auditory effects (TTS and PTS) from underwater detonations follow the approach proposed by Southall et al. (2007) and used in the MESA VERDE acoustic impact analysis (Department of the Navy, 2008b), where a weighted SEL threshold is used in conjunction with an unweighted peak SPL threshold. The threshold producing the greater range for effect is then used because it is the more protective of the dual thresholds. In most cases, a total weighted SEL is more conservative than the largest SEL in any single 1/3-octave band, which was used for some earlier ship shock trials (e.g., Department of the Navy, 2001). Type II weighting functions for each functional hearing group are used, when available, to determine the auditory effects of explosions. If a Type II weighting function is not available for a functional hearing group, the Type I function for the group is used.

SEL and peak SPL thresholds for TTS are based on TTS data from impulsive sound exposures when available. If impulsive TTS data are not available, but TTS data from non-impulsive exposures are available, the onset of TTS is estimated from the TTS onset for non-impulsive sound and the relationship between impulse and non-impulse TTS observed in dolphins and belugas. For those species for whom no TTS data exist, TTS onset thresholds are based on the most closely related species for whom TTS data exist.

Since marine mammal PTS data from impulsive noise exposures do not exist, onset-PTS levels for these animals are estimated by adding 15 dB to the SEL-based TTS threshold and adding 6 dB to the peak pressure based thresholds. These relationships were derived by Southall et al. (2007) from impulse noise TTS growth rates in chinchillas. The appropriate frequency weighting function (i.e., Type II when available, otherwise Type I) for each functional hearing group is applied when using the SEL-based thresholds to predict PTS. The peak SPL thresholds are not weighted.

The specific thresholds for TTS and PTS for each marine mammal functional hearing group are detailed below and summarized in Appendix D.

2.5.3.1 LF Cetaceans

No TTS data are available for LF cetaceans, so the MF cetacean TTS onset values are used for LF cetaceans as well. The dual TTS thresholds for LF cetaceans therefore consist of a (Type II) weighted SEL of 172 dB re 1 $\mu Pa^2 \cdot s$ and a peak SPL of 224 dB re 1 μPa.

The PTS thresholds for LF cetaceans consist of a total (Type II) weighted SEL of 187 dB re 1 $\mu Pa^2 \cdot s$ and a peak SPL of 230 dB re 1 μPa.

2.5.3.2 MF Cetaceans

The TTS onset thresholds for MF cetaceans are based on TTS data from a beluga exposed to an underwater impulse produced from a seismic watergun (Finneran et al., 2002). These thresholds were also recommended by Southall et al. (2007). The numeric thresholds for MF cetaceans consist of a (Type II) weighted SEL of 172 dB re 1 $\mu Pa^2 \cdot s$ and a peak SPL of 224 dB re 1 μPa.

The PTS thresholds for MF cetaceans consist of a total (Type II) weighted SEL of 187 dB re 1 $\mu Pa^2 \cdot s$ and a peak SPL of 230 dB re 1 μPa.

2.5.3.3 HF Cetaceans

The TTS onset thresholds for HF cetaceans are based on TTS data from a harbor porpoise exposed to an underwater impulse produced from a seismic airgun (Lucke *et al.*, 2009). The numeric thresholds for HF cetaceans consist of a (Type II) weighted SEL of 146 dB re 1 $\mu Pa^2 \cdot s$ and a peak SPL of 195 dB re 1 μPa are used for HF cetaceans.

The PTS thresholds for HF cetaceans consist of a (Type II) weighted SEL of 161 dB re 1 $\mu Pa^2 \cdot s$ and a peak SPL of 201 dB re 1 μPa.

2.5.3.4 Phocids (in water)

Criteria for predicting TTS in phocid seals exposed to underwater pulses were based on underwater TTS data from a harbor seal exposed to octave band noise (Kastak *et al.*, 2005) and the extrapolation procedures described by Southall et al. (2007). The resulting TTS threshold values are: a (Type I) weighted SEL of 177 dB re 1 μPa^2·s and a peak SPL of 212 dB re 1 μPa.

The PTS thresholds for phocid seals exposed to underwater explosives consist of a total (Type I) weighted SEL of 192 dB re 1 μPa^2·s and a peak SPL of 218 dB re 1 μPa.

2.5.3.5 Phocids (in air)

The only known data regarding TTS in pinnipeds exposed to in-air impulse noise are from an unpublished report [Bowles et al. (unpublished data), as cited by Southall et al. (2007)] of TTS in harbor seals exposed to simulated sonic booms. The report cites onset-TTS at a peak SPL of 143 dB re 20 μPa or 129 dB re (20 μPa)^2·s. Southall et al. 2007 also reported that Bowles tested other pinnipeds whose TTS thresholds were higher, but actual numeric thresholds were not reported. Based on the only available TTS data for pinnipeds exposed to in-air impulsive noise, TTS thresholds for phocid seals exposed to in-air blasts consist of a (Type I) weighted SEL of 129 dB re (20 μPa)^2·s and a peak SPL of 143 dB re 20 μPa.

The PTS thresholds for phocid seals exposed to in-air explosives consist of a (Type I) weighted SEL of 144 dB re (20 μPa)^2·s and a peak SPL of 149 dB re 20 μPa.

2.5.3.6 Otariids and odobenids (in water)

Criteria for predicting TTS in otariids and odobenids exposed to underwater pulses were based on underwater TTS data from a California sea lion exposed to octave band noise (Kastak *et al.*, 2005) and the extrapolation procedures described by Southall et al. (2007). The resulting threshold values are: a (Type I) weighted SEL of 200 dB re 1 μPa^2·s and a peak SPL of 212 dB re 1 μPa.

The PTS thresholds for otariids and odobenids exposed to underwater explosives consist of a (Type I) weighted SEL of 215 dB re 1 μPa^2·s and a peak SPL of 218 dB re 1 μPa.

2.5.3.7 Otariids and odobenids (in air)

Based on the only available TTS data for pinnipeds exposed to in-air impulsive noise [Bowles et al., as cited by Southall et al. (2007)], TTS thresholds for otariids and odobenids exposed to in-air blasts consist of a (Type I) weighted SEL of 129 dB re (20 μPa)^2·s and a peak SPL of 143 dB re 20 μPa.

The PTS thresholds for otariids and odobenids exposed to in-air explosives consist of a (Type I) weighted SEL of 144 dB re (20 μPa)^2·s and a peak SPL of 149 dB re 20 μPa.

2.5.3.8 Mustelids

The explosive TTS and PTS thresholds for otariids are also used for sea otters because of the close taxonomic relationships and the similarities between audiograms. Therefore, for underwater exposures, the TTS threshold values for explosives consist of a (Type I) weighted

SEL of 200 dB re 1 µPa^2·s and a peak SPL of 212 dB re 1 µPa. For in-air exposures, a (Type I) weighted SEL of 129 dB re (20 µPa)^2·s and a peak SPL of 143 dB re 20 µPa are used.

The PTS threshold values for mustelids exposed to underwater explosives consist of a (Type I) weighted SEL of 215 dB re 1 µPa^2·s and a peak SPL of 218 dB re 1 µPa. For in-air exposures, mustelid PTS thresholds consist of a (Type I) weighted SEL of 144 dB re (20 µPa)^2·s and a peak SPL of 149 dB re 20 µPa.

2.5.3.9 Ursids

The explosive TTS and PTS thresholds for otariids are also used for polar bears because of the close taxonomic relationships and the similarities between audiograms. Therefore, for underwater exposures, the TTS threshold values for explosives consist of a (Type I) weighted SEL of 200 dB re 1 µPa^2·s and a peak SPL of 212 dB re 1 µPa. For in-air exposures, a (Type I) weighted SEL of 129 dB re (20 µPa)^2·s and a peak SPL of 143 dB re 20 µPa are used.

Similarly, the PTS threshold values for ursids exposed to underwater explosives consist of a (Type I) weighted SEL of 215 dB re 1 µPa^2·s and a peak SPL of 218 dB re 1 µPa. For in-air exposures, ursid PTS thresholds consist of a (Type I) weighted SEL of 144 dB re (20 µPa)^2·s and a peak SPL of 149 dB re 20 µPa.

2.5.3.10 Sirenians

The explosive TTS and PTS thresholds for phocid seals are also used for sirenians because of the similarities between the hearing ranges of phocids and manatees/dugongs. Therefore, for underwater exposures, the TTS threshold values for explosives consist of a (Type I) weighted SEL of 177 dB re 1 µPa^2·s and a peak SPL of 212 dB re 1 µPa.

The PTS thresholds for sirenians exposed to underwater explosives consist of a total (Type I) weighted SEL of 192 dB re 1 µPa^2·s and a peak SPL of 218 dB re 1 µPa.

2.5.4 Behavioral Effects

For single detonations, behavioral disturbance is likely to be limited to a short-lived startle reaction; therefore, Navy does not use any unique behavioral disturbance thresholds for marine mammals exposed to single explosive events.

For multiple, successive detonations (i.e., detonations happening at the same location within a 24-hour period), the threshold for behavioral disturbance is set 5 dB below the SEL-based TTS threshold, unless there are species or group specific data indicating that a lower threshold should be used. This is based on observations of behavioral reactions in captive dolphins and belugas occurring at exposure levels ~ 5 dB below those causing TTS after exposure to pure tones (Finneran and Schlundt, 2004; Schlundt *et al.*, 2000). The appropriate frequency weighting function (i.e., Type II when available, otherwise Type I) for each functional hearing group is applied when using the SEL-based disturbance thresholds.

The specific behavioral disturbance thresholds for the marine mammal functional hearing groups are detailed below and summarized in Appendix D.

2.5.4.1 LF Cetaceans

Specific data are lacking on the levels of sound that may illicit a behavioral reaction in LF cetaceans. Therefore, the disturbance threshold for LF cetaceans exposed to multiple, successive detonations is the TTS SEL-based threshold minus 5 dB: a (Type II) weighted SEL of 167 dB re 1 $\mu Pa^2 \cdot s$.

2.5.4.2 MF Cetaceans

The disturbance threshold for MF cetaceans exposed to multiple, successive detonations is a (Type II) weighted SEL of 167 dB re 1 $\mu Pa^2 \cdot s$, based on observations of behavioral reactions in captive dolphins and belugas occurring at exposure levels ~ 5 dB below those causing TTS after exposure to pure tones (Finneran and Schlundt, 2004; Schlundt *et al.*, 2000).

2.5.4.3 HF Cetaceans

Specific data are lacking on the levels of sound that may illicit a behavioral reaction in HF cetaceans. Therefore, the disturbance threshold for HF cetaceans exposed to multiple, successive detonations is the TTS SEL-based threshold minus 5 dB: a (Type II) weighted SEL of 141 dB re 1 $\mu Pa^2 \cdot s$.

2.5.4.4 Phocids (in water)

Specific data are lacking on the levels of sound that may illicit a behavioral reaction in phocid seals. Therefore, the disturbance threshold for phocids exposed to multiple, successive detonations is the TTS SEL-based threshold minus 5 dB: a (Type I) weighted SEL of 172 dB re 1 $\mu Pa^2 \cdot s$.

2.5.4.5 Phocids (in air)

As described in Section 2.4.4.5, a (Type I) weighted SEL of 100 dB re $(20\ \mu Pa)^2 \cdot s$ as the behavioral disturbance threshold for phocids exposed to multiple, successive, in-air blasts.

2.5.4.6 Otariids/odobenids (in water)

As with the phocids, the Navy the disturbance threshold for otariids and odobenids exposed to multiple, successive underwater detonations is the TTS SEL-based threshold minus 5 dB: a (Type I) weighted SEL of 195 dB re 1 $\mu Pa^2 \cdot s$.

2.5.4.7 Otariids/odobenids (in air)

As with the phocids, the Navy thresholds for otariids/odobenids exposed to multiple, successive explosive detonations in-air follows the Southall et al. (2007) recommendations: a (Type I) weighted SEL of 100 dB re $(20\ \mu Pa)^2 \cdot s$.

2.5.4.8 Mustelids

Specific data are lacking on the levels of sound that may illicit a behavioral reaction in sea otters. In light of the close taxonomic relationships and the similarities between the audiograms of otariids and mustelids, the behavioral disturbance thresholds for otariids exposed to multiple detonations are also used for sea otters. Therefore, the Navy the disturbance threshold for mustelids exposed to multiple, successive underwater detonations is a (Type I) weighted SEL of 195 dB re 1 $\mu Pa^2 \cdot s$.

For in-air exposures, the disturbance thresholds for mustelids exposed to multiple, successive explosive detonations consists of a (Type I) weighted SEL of 100 dB re (20 μPa)^2·s.

2.5.4.9 Ursids

Specific data are lacking on the levels of sound that may illicit a behavioral reaction in polar bears. In light of the close taxonomic relationships and the similarities between the audiograms of otariids and ursids, the behavioral disturbance thresholds for otariids are also used for polar bears. Therefore, the Navy the disturbance threshold for ursids exposed to multiple, successive underwater detonations is a (Type I) weighted SEL of 195 dB re 1 μPa^2·s.

For in-air exposures, the disturbance thresholds for ursids exposed to multiple, successive explosive detonations consists of a (Type I) weighted SEL of 100 dB re (20 μPa)^2·s.

2.5.4.10 Sirenians

The behavioral disturbance thresholds for phocid seals exposed to multiple, successive detonations are also used for sirenians because of the similarities between the hearing ranges of phocids and manatees/dugongs. Therefore, the disturbance threshold for sirenians exposed to multiple, successive detonations consists of a (Type I) weighted SEL of 172 dB re 1 μPa^2·s.

3 CRITERIA AND THRESHOLDS FOR SEA TURTLES

3.1 INTRODUCTION

The criteria and thresholds for sea turtles are similar to those proposed by Southall et al. (2007) for marine mammals: All sea turtles are placed into a single functional hearing group, and an auditory weighting function is used to emphasize frequencies where sensitivity to noise is high and de-emphasize frequencies where sensitivity is low. Individual criteria and thresholds are defined for sonars and other active acoustic sources and explosives.

3.2 FUNCTIONAL HEARING GROUP

To facilitate the acoustic and explosive effects analyses, animals are divided into functional hearing groups, and the same criteria and thresholds used for all species within a group. Several studies using green, loggerhead, and Kemp's ridley turtles suggest sea turtles are most sensitive to low-frequency sounds (Bartol and Ketten, 2006; Bartol et al., 1999; Lenhardt, 1994; Ridgway et al., 1969). Although hearing sensitivity varies slightly by species and age class, because of the similarities across the available data, all sea turtles are placed into a single functional hearing group.

3.3 AUDITORY WEIGHTING FUNCTION

Auditory weighting functions are used to emphasize frequencies where sensitivity to noise is high and to de-emphasize frequencies where sensitivity is low. The weighted noise levels at each frequency are then combined to generate a single, weighted exposure value. This technique allows the use of a single, weighted threshold value, regardless of the noise frequency.

For humans, weighting functions are based on subjective loudness data. Analogous data for dolphins was used to derive the Type II weighting functions for MF cetaceans, and by extrapolation, for the other cetaceans. For the other marine mammal functional groups, only Type I weighting functions, based on functional hearing limits, are used. Since there are no equal loudness data for sea turtles and the differences between turtles and cetaceans preclude extrapolation to derive a Type II function for turtles, only a Type I weighting function is used for sea turtles.

The sea turtle weighting function amplitude is calculated using Eq. (4). The parameters for the weighting function are provided in Table 5; these are based on the functional hearing range for sea turtles of approximately 100 Hz to 1 kHz, with an upper frequency limit of 2 kHz (Bartol and Ketten, 2006; Bartol *et al.*, 1999; Lenhardt, 1994; Ridgway *et al.*, 1969). Figure 8 shows the sea turtle weighting function. The sea turtle (Type I) weighting function is used with all sea turtle SEL-based thresholds.

Table 5. Parameters for the Navy sea turtle (Type I) weighting function.

Functional Hearing Group	*K*	*a* (Hz)	*b* (Hz)
Sea turtles	0	10	2,000

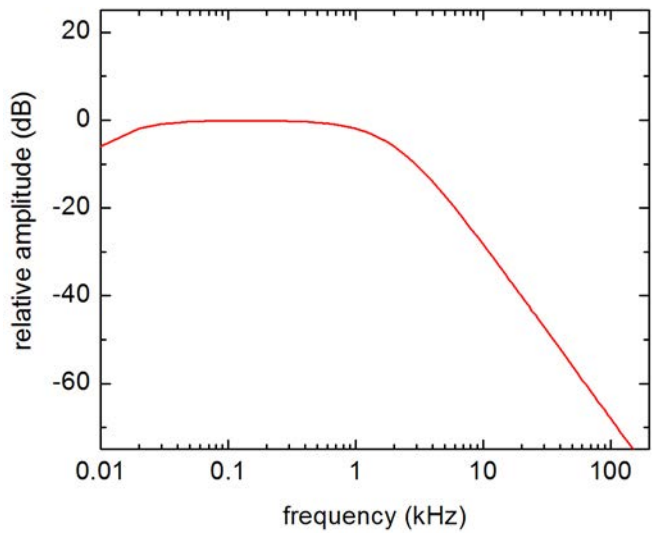

Figure 8. Auditory weighting function for sea turtles.

3.4 CRITERIA AND THRESHOLDS FOR SONARS AND OTHER ACTIVE ACOUSTIC SOURCES

3.4.1 Introduction

Criteria for sea turtles exposed to sonars and other active acoustic sources are divided into physiological effects and behavioral effects. Physiological effects criteria and thresholds are based on temporary and permanent threshold shift (TTS and PTS). Behavioral thresholds are based on experimental and observational data documenting the reactions of sea turtles to sound. A summary of the various criteria/thresholds and the sea turtle weighting function is provided in Appendix C.

3.4.2 Criteria and thresholds for TTS

To date, no known data are available on potential hearing impairments (i.e., TTS and PTS) in aquatic turtles. Sea turtles, based on their auditory anatomy (Bartol and Musick, 2003; Lenhardt et al., 1985; Wartzok and Ketten, 1999; Wever, 1978; Wyneken, 2001), are believed to have lower absolute sensitivity (i.e., higher thresholds) compared to cetaceans. Because of this, and the lack of data specific to sea turtles, previous Navy environmental analyses (e.g., Department of the Navy, 1998; 2001; 2008b), used the cetacean TTS threshold to define the sea turtle threshold. Since sea turtles have best sensitivity at low frequencies, similar to the LF cetaceans, the LF cetacean TTS threshold is applied to sea turtles. Therefore, the TTS threshold for sea turtles exposed to sonars and other active acoustic sources is a (Type I) weighted SEL of 178 dB re 1 $\mu Pa^2 \cdot s$.

3.4.3 Criteria and thresholds for PTS

As with the marine mammals, the PTS threshold for sea turtles exposed to sonars and other active acoustic sources is estimated as being 20 dB above the TTS threshold. This results in a PTS threshold consisting of a (Type I) weighted SEL of 198 dB re 1 $\mu Pa^2 \cdot s$.

3.4.4 Criteria and thresholds for behavioral effects

Potential behavioral changes could include a startle reaction, avoiding the sound source, increased swimming speed, increased surfacing time, and decreased foraging. No known studies have examined the reactions of sea turtles to sonars or other active acoustic sources. However, several studies have investigated the behavioral responses of sea turtles to impulsive sounds produced by seismic airguns. O’Hara and Wilcox (1990) reported that loggerhead turtles kept in a 300 × 45 m enclosure in a 10 m deep canal maintained a standoff range of 30 m from three small airguns fired simultaneously at 15-s internals (O'Hara and Wilcox, 1990). Although O’Hara and Wilcox did not report the actual received sound levels, McCauley et al. (2000) have estimated the received SPL for avoidance to be 175–176 dB re 1 μPa.

Moein et al. (1994) investigated the use of airguns to repel juvenile loggerhead sea turtles from hopper dredges. The results from all turtles tested (11 individuals, six trials each) indicated avoidance was seen during the first presentation of the air gun exposure at a mean range of 24 m; however, details of the airgun, its operational pressure, deployment depth, and the sound levels received by the turtles throughout the cage were not provided.

McCauley et al. (2000) measured behavioral responses in captive green and loggerhead turtles exposed to airgun impulses. The results showed that above a received SPL of 166 dB re 1 μPa the turtles noticeably increased their swimming activity compared to non airgun operation periods. Above 175 dB re 1 μPa, behavior became more erratic possibly indicating the turtles were in an agitated state (McCauley *et al.*, 2000). The authors noted that the point at which the turtles showed the more erratic behavior would be expected to approximately equal the point at which avoidance would occur for unrestrained turtles (McCauley *et al.*, 2000).

Cumulatively, these studies indicate that behavioral disturbance may occur in sea turtles exposed to impulsive noise with SPLs greater than 166 dB re 1 μPa and that more erratic behavior and avoidance may begin at SPLs of 175–179 dB re 1 μPa, with 175 dB re 1 μPa more likely to be the point at which avoidance may occur in unrestrained turtles (McCauley *et al.*, 2000). Navy effects analyses use the lower range of SPLs that caused avoidance as the behavioral disturbance threshold for sea turtles: a (Type I) weighted SPL of 175 dB re 1 μPa.

3.5 CRITERIA AND THRESHOLDS FOR EXPLOSIVE SOURCES

3.5.1 Introduction

Similarly to the marine mammal criteria and thresholds for sonars and other active acoustic exposures, criteria and thresholds for explosive sources are divided into physiological effects and behavioral effects. Because of the increased hazardousness of the shock wave associated with underwater detonations, physiological effects not only include auditory effects (PTS and TTS), but also mortality and direct (i.e., non-auditory) tissue damage known as primary blast injury. Criteria and thresholds for physiological effects are presented in order of decreasing severity (i.e., mortality and most serious injuries first). These are followed by criteria and thresholds for PTS, TTS, and behavioral reactions. A summary of the various criteria and thresholds is provided in Appendix D.

3.5.2 Mortality and primary (non-auditory) blast injury

Very little information exists regarding the impacts of underwater detonations on sea turtles. Impacts to sea turtles from explosive removal operations have ranged from non-injurious effects (e.g., acoustic annoyance, mild tactile detection or physical discomfort) to varying levels of injury (i.e., non-lethal and lethal injuries). Often, effects of explosive events on turtles must be inferred from documented effects to other vertebrates with lungs or other-gas containing organs, such as mammals and fish (Viada et al., 2008). As with marine mammals, primary blast injury almost exclusively affects the gas-containing organs: the lung and the ear. For this reason, the general principles of the Goertner injury model are applicable; however, since it is not known what degree of protection from a shock wave is provided by a turtle's shell, application of the Goertner injury model is believed to be protective (Viada *et al.*, 2008). Therefore, Eqs. (9) and (10) are used to calculate the mortality and slight lung injury thresholds, respectively, for sea turtles exposed to underwater detonations. Sea turtle body masses for use in Eqs. (9) and (10) are provided in Table D-2, in Appendix D. Since sea turtle hatchlings can weigh less than 0.5% of their adult mass, juvenile masses are used to avoid greatly over-estimating the potential effects of detonations.

Although the lungs and auditory system are considered to be the most likely site of injury to sea turtles exposed to underwater detonations, as a protective measure, the GI tract injury threshold used for marine mammals is also applied to sea turtles: an (unweighted) SPL of 237 dB re 1 μPa.

3.5.3 Auditory Effects (TTS and PTS)

No data exist to correlate the sensitivity of the sea turtle tympanum and middle and inner ear to trauma associated with the shock waves associated with underwater explosions (Viada *et al.*, 2008). Thus, similar to the turtle sonar and other active acoustic thresholds, sea turtle thresholds for TTS and PTS after exposure to underwater detonations are identical to the values for LF cetaceans.

Therefore, the dual TTS thresholds for sea turtles consist of a (Type I) weighted SEL of 172 dB re 1 $\mu Pa^2 \cdot s$ and a peak SPL of 224 dB re 1 μPa.

The PTS thresholds for sea turtles consist of a (Type I) weighted SEL of 187 dB re 1 μPa^2·s and a peak SPL of 230 dB re 1 μPa.

3.5.4 Behavioral Effects

As discussed in Section 3.4.4, several authors have investigated the behavioral responses of sea turtles to impulsive sounds produced by airguns (McCauley et al., 2000; Moein et al., 1994; O'Hara and Wilcox, 1990). Cumulatively, these studies indicate that a behavioral reaction to a sound may occur with SPLs greater than 166 dB re 1 μPa, and that more erratic behavior and avoidance, which may be indicative of a behavioral disturbance in wild animals, may occur at SPLs of 175–179 dB re 1 μPa. McCauley et al. determined that these SPLs would result in an SEL 11.4–14.6 dB lower than the SPL. For an SPL of 175 dB re 1 μPa, the comparable SEL would therefore be 163.6–160.4 dB re 1 μPa^2·s.

For Navy environmental documents, the sea turtle behavioral disturbance threshold after exposure to multiple, successive underwater impulses therefore consists of a (Type I) weighted SEL of 160 dB re 1 μPa^2·s.

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APPENDIX A. FUNCTIONAL HEARING GROUPS

Table A-1. Functional hearing groups used in Navy acoustic impact analyses.

Functional Hearing Group	Description
LF cetaceans	Suborder Mysticeti (baleen whales)
MF cetaceans	Family Ziphiidae (beaked whales) Family Physeteridae (Sperm whale) Family Monodontidae (Irrawaddy dolphin, beluga, narwhal) Subfamily Delphininae (white-beaked/white-sided/ Risso's/bottlenose/spotted/spinner/striped/common dolphins) Subfamily Steninae (rough-toothed/humpback dolphins) Subfamily Globicephalinae (melon-headed whales, false/pygmy killer whale, killer whale, pilot whales) Subfamily Lissodelphinae (right whale dolphins)
HF cetaceans	Family Phocoenidae (porpoises) Family Platanistidae (Indus/Ganges river dolphins) Family Iniidae (Amazon river dolphins) Family Pontoporiidae (Baiji/ La Plata river dolphins) Family Kogiidae (Pygmy/dwarf sperm whales) Subfamily Cephalorhynchinae (Commersen's, Black, Heaviside's, Hector's dolphins)
Phocids	Family Phocidae (earless seals)
Otariids and Odobenids	Family Otaridae (fur seals/sea lions) Family Odobenidae (walrus)
Mustelids	Family Mustelidae (sea otters)
Ursids	Family Ursidae (polar bears)
Sirenians	Order Sirenia (mantees/dugongs)
Sea turtles	Family Cheloniidae (loggerhead, green, hawksbill, Kemp's ridley, olive ridley, flatback sea turtle) Family Dermochelyidae (leatherback sea turtle)

APPENDIX B. AUDITORY WEIGHTING FUNCTIONS

B.1 TYPE I WEIGHTING FUNCTIONS

$$W_I(f) = K + 20\log_{10}\left[\frac{b^2 f^2}{(a^2 + f^2)(b^2 + f^2)}\right] \tag{B-1}$$

$W_I(f)$ weighting function amplitude (dB)

f sound frequency (Hz)

a lower cutoff frequency (Table B-1)

b upper cutoff frequency (Table B-1)

K gain (Table B-1)

Table B-1. Parameters for the Navy Type I weighting functions.

Functional Hearing Group	*K* (dB)	*a* (Hz)	*b* (Hz)
LF cetaceans	0	7	22,000
MF cetaceans	0	150	160,000
HF cetaceans	0	200	180,000
Phocids (in water), Sirenians	0	75	75,000
Phocids (in air)	0	75	30,000
Otariids, Odobenids, Mustelids, Ursids (in water)	0	100	40,000
Otariids, Odobenids, Mustelids, Ursids (in air)	0	100	30,000
Sea turtles	0	10	2,000

B.2 TYPE II WEIGHTING FUNCTIONS

$$W_{II}(f) = \text{maximum}\{G_1(f), G_2(f)\}, \quad \text{(B-2)}$$

$W_{II}(f)$ weighting function amplitude (dB)

f sound frequency (Hz)

$$G_1(f) = K_1 + 20\log_{10}\left[\frac{b_1^2 f^2}{(a_1^2 + f^2)(b_1^2 + f^2)}\right] \quad \text{(B-3)}$$

$G_1(f)$ amplitude of Type I function component (dB)

a_1 Type I component lower cutoff frequency (Table B-2)

b_1 Type I component upper cutoff frequency (Table B-2)

K_1 Type I component gain (Table B-2)

$$G_2(f) = K_2 + 20\log_{10}\left[\frac{b_2^2 f^2}{(a_2^2 + f^2)(b_2^2 + f^2)}\right] \quad \text{(B-4)}$$

$G_2(f)$ amplitude of EQL function component (dB)

a_2 EQL component lower cutoff frequency (Table B-2)

b_2 EQL component upper cutoff frequency (Table B-2)

K_2 EQL component gain (Table B-2)

Table B-2. Parameters for the Navy (cetacean) Type II weighting functions.

Functional Hearing Group	K_1 (dB)	a_1 (Hz)	b_1 (Hz)	K_2 (dB)	a_2 (Hz)	b_2 (Hz)	Inflection point (Hz)
LF cetaceans	-16.5	7	22,000	0.9	674	12,130	267
MF cetaceans	-16.5	150	160,000	1.4	7,829	95,520	3,000
HF cetaceans	-19.4	200	180,000	1.4	9,480	108,820	3,000

APPENDIX C. CRITERIA AND THRESHOLDS FOR SONARS AND OTHER ACTIVE ACOUSTIC SOURCES

Table C-1. Navy criteria and thresholds for marine mammals and sea turtles exposed to sonars and other active acoustic sources

Functional Hearing Group or Species	PTS Threshold (all weighted SEL)	TTS Threshold (all weighted SEL)	Behavioral Threshold
LF Cetaceans	(Type II) SEL: 198 dB re 1 μPa^2·s	(Type II) SEL: 178 dB re 1 μPa^2·s	(Type I) SPL: BRF_1
MF Cetaceans (*except beaked whales*)	(Type II) SEL: 198 dB re 1 μPa^2·s	(Type II) SEL: 178 dB re 1 μPa^2·s	(Type I) SPL: BRF_2
Beaked whales	(Type II) SEL: 198 dB re 1 μPa^2·s	(Type II) SEL: 178 dB re 1 μPa^2·s	(unweighted) SPL: 140 dB re 1 μPa
HF Cetaceans (*except harbor porpoises*)	(Type II) SEL: 172 dB re 1 μPa^2·s	(Type II) SEL: 152 dB re 1 μPa^2·s	(Type I) SPL: BRF_2
Harbor porpoises	(Type II) SEL: 172 dB re 1 μPa^2·s	(Type II) SEL: 152 dB re 1 μPa^2·s	(unweighted) SPL: 120 dB re 1 μPa
Phocids Sirenians (in water)	(Type I) SEL: 197 dB re 1 μPa^2·s	(Type I) SEL: 183 dB re 1 μPa^2·s	(Type I) SPL: BRF_2
Phocids (in air)	(Type I) SEL: 145 dB re (20 μPa)^2·s	(Type I) SEL: 131 dB re (20 μPa)^2·s	(unweighted) SEL: 100 dB re (20 μPa)^2·s
Otariids Odobenids Mustelids Ursids (in water)	(Type I) SEL: 220 dB re 1 μPa^2·s	(Type I) SEL: 206 dB re 1 μPa^2·s	(Type I) SPL: BRF_2
Otariids Odobenids Mustelids Ursids (in air)	(Type I) SEL: 168 dB re (20 μPa)^2·s	(Type I) SEL: 154 dB re (20 μPa)^2·s	(unweighted) SEL: 100 dB re (20 μPa)^2·s
Sea Turtles	(Type I) SEL: 198 dB re 1 μPa^2·s	(Type I) SEL: 178 dB re 1 μPa^2·s	(Type I) SPL: 175 dB re 1 μPa

APPENDIX D. CRITERIA AND THRESHOLDS FOR EXPLOSIVES

Table D-1. Navy criteria and thresholds for marine mammals and sea turtles exposed to explosive detonations.

Functional Hearing Group or Species	Mortality	Slight Lung Injury	GI tract injury	PTS Threshold	TTS Threshold	Behavioral Threshold
LF Cetaceans	Modified Goertner model, Eq. (D-1) Mass from Table D-2	Modified Goertner model, Eq. (D-2) Mass from Table D-2	(unweighted) SPL: 237 dB re 1 μPa	(Type II) SEL: 187 dB re 1 $\mu Pa^2 \cdot s$ (unweighted) peak SPL: 230 dB re 1 μPa	(Type II) SEL: 172 dB re 1 $\mu Pa^2 \cdot s$ (unweighted) peak SPL: 224 dB re 1 μPa	(Type II) SEL: 167 dB re 1 $\mu Pa^2 \cdot s$
MF Cetaceans	Modified Goertner model, Eq. (D-1) Mass from Table D-2	Modified Goertner model, Eq. (D-2) Mass from Table D-2	(unweighted) SPL: 237 dB re 1 μPa	(Type II) SEL: 187 dB re 1 $\mu Pa^2 \cdot s$ (unweighted) peak SPL: 230 dB re 1 μPa	(Type II) SEL: 172 dB re 1 $\mu Pa^2 \cdot s$ (unweighted) peak SPL: 224 dB re 1 μPa	(Type II) SEL: 167 dB re 1 $\mu Pa^2 \cdot s$
HF Cetaceans	Modified Goertner model, Eq. (D-1) Mass from Table D-2	Modified Goertner model, Eq. (D-2) Mass from Table D-2	(unweighted) SPL: 237 dB re 1 μPa	(Type II) SEL: 161 dB re 1 $\mu Pa^2 \cdot s$ (unweighted) peak SPL: 201 dB re 1 μPa	(Type II) SEL: 146 dB re 1 $\mu Pa^2 \cdot s$ (unweighted) peak SPL: 195 dB re 1 μPa	(Type II) SEL: 141 dB re 1 $\mu Pa^2 \cdot s$
Phocids Sirenians (in water)	Modified Goertner model, Eq. (D-1) Mass from Table D-2	Modified Goertner model, Eq. (D-2) Mass from Table D-2	(unweighted) SPL: 237 dB re 1 μPa	(Type I) SEL: 192 dB re 1 $\mu Pa^2 \cdot s$ (unweighted) peak SPL: 218 dB re 1 μPa	(Type I) SEL: 177 dB re 1 $\mu Pa^2 \cdot s$ (unweighted) peak SPL: 212 dB re 1 μPa	(Type I) SEL: 172 dB re 1 $\mu Pa^2 \cdot s$

Functional Hearing Group or Species	Mortality	Slight Lung Injury	GI tract injury	PTS Threshold	TTS Threshold	Behavioral Threshold
Phocids (in air)	See Note 1	See Note 1	See Note 1	(Type I) SEL: 144 dB re (20 µPa)^2·s (unweighted) peak SPL: 149 dB re 20 µPa	(Type I) SEL: 129 dB re (20 µPa)^2·s (unweighted) peak SPL: 143 dB re 20 µPa	(Type I) SEL: 100 dB re (20 µPa)^2·s
Otariids Odobenids Mustelids Ursids (in water)	Modified Goertner model, Eq. (D-1) Mass from Table D-2	Modified Goertner model, Eq. (D-2) Mass from Table D-2	(unweighted) SPL: 237 dB re 1 µPa	(Type I) SEL: 215 dB re 1 µPa^2·s (unweighted) peak SPL: 218 dB re 1 µPa	(Type I) SEL: 200 dB re 1 µPa^2·s (unweighted) peak SPL: 212 dB re 1 µPa	(Type I) SEL: 195 dB re 1 µPa^2·s
Otariids Odobenids Mustelids Ursids (in air)	See Note 1	See Note 1	See Note 1	(Type I) SEL: 144 dB re (20 µPa)^2·s (unweighted) peak SPL: 149 dB re 20 µPa	(Type I) SEL: 129 dB re (20 µPa)^2·s (unweighted) peak SPL: 143 dB re 20 µPa	(Type I) SEL: 100 dB re (20 µPa)^2·s
Sea Turtles	Modified Goertner model, Eq. (D-1) Mass from Table D-2	Modified Goertner model, Eq. (D-2) Mass from Table D-2	(unweighted) SPL: 237 dB re 1 µPa	(Type I) SEL: 187 dB re 1 µPa^2·s (unweighted) peak SPL: 230 dB re 1 µPa	(Type I) SEL: 172 dB re 1 µPa^2·s (unweighted) peak SPL: 224 dB re 1 µPa	(Type I) SEL: 160 dB re 1 µPa^2·s

1 - In-air GI tract injury, slight lung injury, and mortality criteria and thresholds for pinnipeds (i.e., otariids, phocids, and odobenids) were not developed. Navy explosive training and testing activities do not normally coincide with pinniped, polar bear, or sea otter terrestrial habitat and therefore exposure to explosive energy on land that could cause these injuries is unlikely.

$$I_M(M,D) = 91.4 M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/2} \qquad \text{(D-1)}$$

$I_M(M,D)$	mortality threshold, expressed in terms of acoustic impulse (Pa·s)
M	Animal mass (Table D-1)
D	Water depth (m)

$$I_S(M,D) = 39.1 M^{1/3}\left(1+\frac{D}{10.1}\right)^{1/2} \qquad \text{(D-2)}$$

$I_S(M,D)$	slight lung injury threshold, expressed in terms of acoustic impulse (Pa·s)
M	Animal mass (Table D-1)
D	Water depth (m)

Table D-2. Representative animal masses for use in Eqs. (D-1) and (D-2).

Species Name	Common Name	Newborn Calf / Pup Mass (kg)	Reference
Cetaceans			
Family Balaenidae			
Eubalaena glacialis	North Atlantic right whale	910	Reeves et al. (2002)
Eubalaena japonica	North Pacific right whale	910	Reeves et al. (2002)
Family Balaenopteridae			
Balaenoptera acutorostrata	Minke whale	200	Mann et al. (2000)
Balaenoptera borealis	Sei whale	650	Gambell (1985)
Balaenoptera edeni	Bryde's whale	680	Reeves et al. (2002)
Balaenoptera musculus	Blue whale	2,000	Reidenberg and Laitman (2002)
Balaenoptera physalus	Fin whale	1,750	Reidenberg and Laitman (2002)
Megaptera novaeangliae	Humpback whale	680	Reeves et al. (2002)
Family Delphinidae			
Delphinus capensis	Long-beaked common dolphin	7	Surrogate: striped dolphin
Delphinus delphis	Short-beaked common dolphin	7	Surrogate: striped dolphin
Feresa attenuata	Pygmy killer whale	7	Surrogate: striped dolphin
Globicephala macrorhynchus	Short-finned pilot whale	37	Reeves et al. (2002)
Globicephala melas	Long-finned pilot whale	70	Reidenberg and Laitman (2002)
Grampus griseus	Risso's dolphin	47	Nachtigall et al. (2005)
Lagenodelphis hosei	Fraser's dolphin	19	Reeves et al. (2002)
Lagenorhynchus acutus	Atlantic white-sided dolphin	20	Reeves et al. (2002)
Lagenorhynchus albirostris	White-beaked dolphin	40	Reidenberg and Laitman (2002)
Lagenorhynchus obliquidens	Pacific white-sided dolphin	12	Heise (1997)
Lissodelphis borealis	Northern right whale dolphin	15	Surrogate: bottlenose dolphin/melon-headed whale
Orcinus orca	Killer whale	160	Reeves et al. (2002)
Peponocephala electra	Melon-headed whale	15	Reeves et al. (2002)
Pseudorca crassidens	False killer whale	80	Mann et al. (2000)
Stenella attenuata	Pantropical spotted dolphin	7	Surrogate: striped dolphin
Stenella clymene	Clymene dolphin	7	Surrogate: striped dolphin
Stenella coeruleoalba	Striped dolphin	7	Reeves et al. (2002)
Stenella frontalis	Atlantic spotted dolphin	7	Surrogate: striped dolphin
Stenella longirostris	Spinner dolphin	7	Surrogate: striped dolphin
Steno bredanensis	Rough-toothed dolphin	14	Surrogate: humpbacked dolphin
Tursiops aduncus	Indo-Pacific bottlenose dolphin	9	Reeves et al. (2002)
Tursiops truncatus	Common bottlenose dolphin	14	Reeves et al. (2002)
Family Eschrisctiidae			

Species Name	Common Name	Newborn Calf / Pup Mass (kg)	Reference
Eschrichtius robustus	Gray whale	500	Reidenberg and Laitman (2002)
Family Kogiidae			
Kogia breviceps	Pygmy sperm whale	23	Reeves et al. (2002)
Kogia sima	Dwarf sperm whale	14	Plön (2004)
Family Monodontidae			
Delphinapterus leucas	Beluga whale	80	Reeves et al. (2002) and Reidenberg and Laitman (2002)
Monodon monoceros	Narwhal	80	Reeves et al. (2002)
Family Phocoenidae			
Phocoenoides dalli	Dall's Porpoise	6	Ferrero and Walker (1999)
Phocoena phocoena	Harbor porpoise	5	Reeves et al. (2002) and Reidenberg and Laitman (2002)
Family Physeteridae			
Physeter macrocephalus	Sperm whale	1000	Reeves et al. (2002) and Reidenberg and Laitman (2002)
Family Ziphiidae			
Berardius arnouxii	Arnoux's beaked whale	250	Surrogate: Cuvier's beaked whale
Berardius berardii	Baird's beaked whale	250	Surrogate: Cuvier's beaked whale
Hyperoodon ampullatus	Northern bottlenose whale	250	Surrogate: Cuvier's beaked whale
Indopacetus pacificus	Longman's beaked whale	228	Dalebout et al (2003)
Mesoplodon bidens	Sowerby's beaked whale	170	Reeves et al. (2002)
Mesoplodon carlhubbsi	Hubb's beaked whale	170	Surrogate: Sowerby's beaked whale
Mesoplodon densirostris	Blainville's beaked whale	60	Reeves et al. (2002) and Reidenberg and Laitman (2002)
Mesoplodon europaeus	Gervais' beaked whale	49	Reidenberg and Laitman (2002)
Mesoplodon ginkgodens	Ginkgo-toothed beaked whale	170	Surrogate: Sowerby's beaked whale
Meosplodon hectori	Hector's beaked whale	60	Surrogate: Blainville's beaked whale
Mesoplodon layardii	Strap-toothed whale	136	Surrogate: True's beaked whale
Mesoplodon mirus	True's beaked whale	136	Reidenberg and Laitman (2002)
Mesoplodon perrini	Perrin's beaked whale	60	Surrogate: Blainville's beaked whale
Mesoplodon peruvianus	Pygmy beaked whale	49	Surrogate: Gervais' beaked whale
Mesoplodon stejnegeri	Stejneger's beaked whale	60	Surrogate: Blainville's beaked whale

Species Name	Common Name	Newborn Calf / Pup Mass (kg)	Reference
Tasmacetus shepherdi	Shepherd's beaked whale	250	Surrogate: Cuvier's beaked whale
Ziphius cavirostris	Cuvier's beaked whale	250	Reeves et al. (2002)
Carnivores			
Family Mustelidae			
Enhydra lutris	Sea otter	2	Reeves et al. (2002)
Family Phocidae			
Cystophora cristata	Hooded seal	11	Reeves et al. (2002)
Erignathus barbatus	Bearded seal	29	Lydersen et al. (2002)
Halichoerus grypus	Gray seal	13	Iverson et al. (1993)
Histriophoca fasciata	Ribbon seal	9	Reeves et al. (2002)
Mirounga angustirostris	Northern elephant seal	22	Le Boeuf et al. (1972)
Monachus schauinslandi	Hawaiian monk seal	10	Wirtz (1968)
Pagophilus groenlandicus	Harp seal	7	Reeves et al. (2002)
Phoca vitulina	Harbor seal	7	Ellis et al. (2000)
Pusa hispida	Ringed seal	4	Reeves et al. (2002)
Family Otariidae			
Arctocephalus townsendi	Guadalupe fur seal	2	Reeves et al. (2002)
Callorhinus ursinus	Northern fur seal	4	Reeves et al. (2002)
Eumetopias jubatus	Steller sea lion	16	Reeves et al. (2002)
Zalophus californianus	California sea lion	6	Reeves et al. (2002)
Family Ursidae			
*Ursinus maritimus**	Polar bear	10	DeMaster and Stirling (1981)
Sirenians			
Family Dugonginae			
Dugong dugong	Dugong	25	Reeves et al. (2002)
Family Trichechidae			
Trichechus manatus	West Indian manatee	27	Caldwell and Caldwell (1985)
Sea Turtles			
Family Cheloniidae			
Caretta caretta	Loggerhead turtle	8.7	Southwood, Higgins et al. (2007)
Chelonia mydas	Green turtle	8.7	Wood and Wood (1993)
Eretmochelys imbricata	Hawksbill turtle	7.4	Okuyama, Shimizu et al. (2010)
Lepidochelys kempii	Kemp's ridley turtle	6.25	McVey and Wibbels (1984) and Caillouet, Koi et al. (1986)
Lepidochelys olivacea	Olive ridley turtle	7.15	Rajagopalan (1984)
Family Dermochelyidae			
Dermochelys coriacea	Leatherback turtle	35.18	Jones (2009)

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