Environmental Assessment for
PROPOSED AMENDMENT TO REGULATIONS FOR GEOLOGICAL EXPLORATION OF THE COASTAL PLAIN 1002 AREA

U.S. Fish and Wildlife Service
Arctic National Wildlife Refuge, Alaska

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U.S. Fish & Wildlife Service

Environmental Assessment
For the
Proposed Regulation Change for Management of the Coastal Plain 1002 Area of the Arctic National Wildlife Refuge, Alaska

This Environmental Assessment (EA) was prepared in accordance with the U.S. Department of the Interior (DOI) Departmental Manual 516, and is in compliance with the National Environmental Policy Act and the Council on Environmental Quality Regulations (40 CFR 1500-1508).

This EA serves as a public document to briefly provide sufficient evidence and analysis for determining the need to prepare an Environmental Impact Statement (EIS) .

This EA concisely describes the potential environmental impacts of the proposed action and the alternatives. The EA provides a list of the agencies and persons consulted during EA preparation.

Glossary	
1002 area	identified as such in the map entitled *Arctic National Wildlife Refuge*, dated August 1980 [ANILCA § 1002(b)] (See Figure 1).
ANCSA	Alaska Native Claims Settlement Act
ANILCA	Alaska National Interest Lands Conservation Act of 1980
BLM	Bureau of Land Management, U.S. Department of the Interior
CCP	Comprehensive Conservation Plan for National Wildlife Refuges, required by ANILCA
coastal plain	defined as that area shown on the map entitled Arctic National Wildlife Refuge dated August 1980 [ANILCA § 1002(b)], and legally described in 50 CFR Part 37 Appendix I-Legal Description of the Coastal Plain, Arctic National Wildlife Refuge, Alaska [see also 50 CFR § 37.2(d)] (See Figure 1).
cultural resource	defined as any district, site, building, structure, or object significant in American history, architecture, archeology, engineering or culture, as determined in accordance with 36 CFR § 60.6 [see 50 CFR § 37.2(e)]
DOE	U.S. Department of Energy
DOI	U.S. Department of the Interior; including BLM, USFWS, USGS
EA	Environmental Assessment, as stipulated under NEPA
EIS	Environmental Impact Statement, as stipulated under NEPA
exploratory activity	defined as surface geological exploration or seismic exploration or both of the coastal plain and all related activities and logistics required for either or both, and any other type of geophysical exploration of the coastal plain which involves or is a component of an exploration program for the coastal plain involving surface use of refuge lands and all related activities and logistics required for such exploration [see 50 CFR § 37.2(i)]
FONSI	Finding of No Significant Impact; Federal agency decision that concludes an EA

NEPA	National Environmental Policy Act of 1970 [40 CFR §§ 1500-1508]
NRC	National Research Council, National Academy of Sciences
NWR	National Wildlife Refuge
ROD	Record of Decision, Federal agency decision that concludes an EIS
USFWS	Fish and Wildlife Service, U.S. Department of the Interior
USGS	Geological Survey, U.S. Department of the Interior

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1 Introduction & Overview

1.1 PURPOSE AND NEED

The U.S. Fish and Wildlife Service (Service), proposes to amend the regulations at 50 CFR Part 37 - *Geological and Geophysical Exploration of the Coastal Plain, Arctic National Wildlife Refuge, Alaska*, regarding the dates when an application may be submitted for a permit for a geological and geophysical exploration plan on the Arctic National Wildlife Refuge (Arctic Refuge) lands described in the Alaska National Interest Lands Conservation Act (ANILCA). This action is an update to our regulations to allow opportunities for applicants to conduct seismic exploration. he ability to collect new information on oil and gas resources will better inform public policy decisions. We are taking this action in support of Executive Order 13783, Promoting Energy Independence and Economic Growth.

1.2 KEY ENVIRONMENTAL REQUIREMENTS & INTEGRATION OF OTHER ENVIRONMENTAL STATUTES & REGULATIONS

The *National Environmental Policy Act of 1969* (NEPA) requires federal agencies to integrate environmental values into their decision-making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions, including a no action alternative. This Environmental Assessment (EA) addresses the administrative action by the Service to permit new exploration plans in the Arctic Refuge. This EA does not evaluate decisions to issue special use permits for specific exploration plans as the details of those plans are unknown at this time. Any analysis by the Service at this time would be speculative in regards to methods, location and timing of specific exploration activities that may occur if the current regulations are amended to provide for additional geological and geophysical exploration.

Section 7 of the *Endangered Species Act* (16 U.S.C. 1536) requires the DOI Secretary to ‘‘review other programs administered by him (or her) and utilize such programs in furtherance of the purposes of the Act’’ and to ‘‘insure that any action authorized, funded, or carried out is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of [critical] habitat . . . .’’ Prior to issuance of these regulations, we would consult under section 7 of the Endangered Species Act of 1973, as amended (Act; 16 U.S.C. 1531 et seq.), to ensure that any applications for exploration in the 1002 area of the coastal plain of Arctic Refuge is not likely to jeopardize the continued existence of any species designated as endangered or threatened, or modify or destroy its critical habitat, and that the regulations are consistent with conservation programs for those species. Similar to the NEPA analysis, plan-specific section 7 reviews would be completed when explorations plans are submitted for review and processing.

ANILCA is integral to how this proposed regulation change will be evaluated. When ANILCA was passed in 1980 the Act re-designated Arctic Refuge and required the writing of a Comprehensive Conservation Plan (CCP) for the Arctic Refuge (Title III), required the identification of federal actions which could have the potential to significantly restrict subsistence users (Title VIII), and required the DOI “to provide for a comprehensive and continuing inventory and assessment of the fish and wildlife resources of the coastal plain of the Arctic Refuge; an analysis of the impacts of oil and gas exploration, development, and production, and to authorize exploratory activity within the coastal plain in a manner that avoids significant adverse effects on the fish and wildlife and other resources” (Title X). The “coastal plain” was defined by a map entitled “Arctic National Wildlife Refuge”, dated August 1980 (Figure 1).

Section 106 of the *National Historic Preservation Act of 1966* requires that federal agencies identify and assess the effects its actions may have on historic properties. “Properties” is broadly defined and does not just include built infrastructure. Prior to issuance of any permit given under these regulations, we would ensure that any applications for exploration in the coastal plain of Arctic Refuge are not likely to jeopardize historic properties.

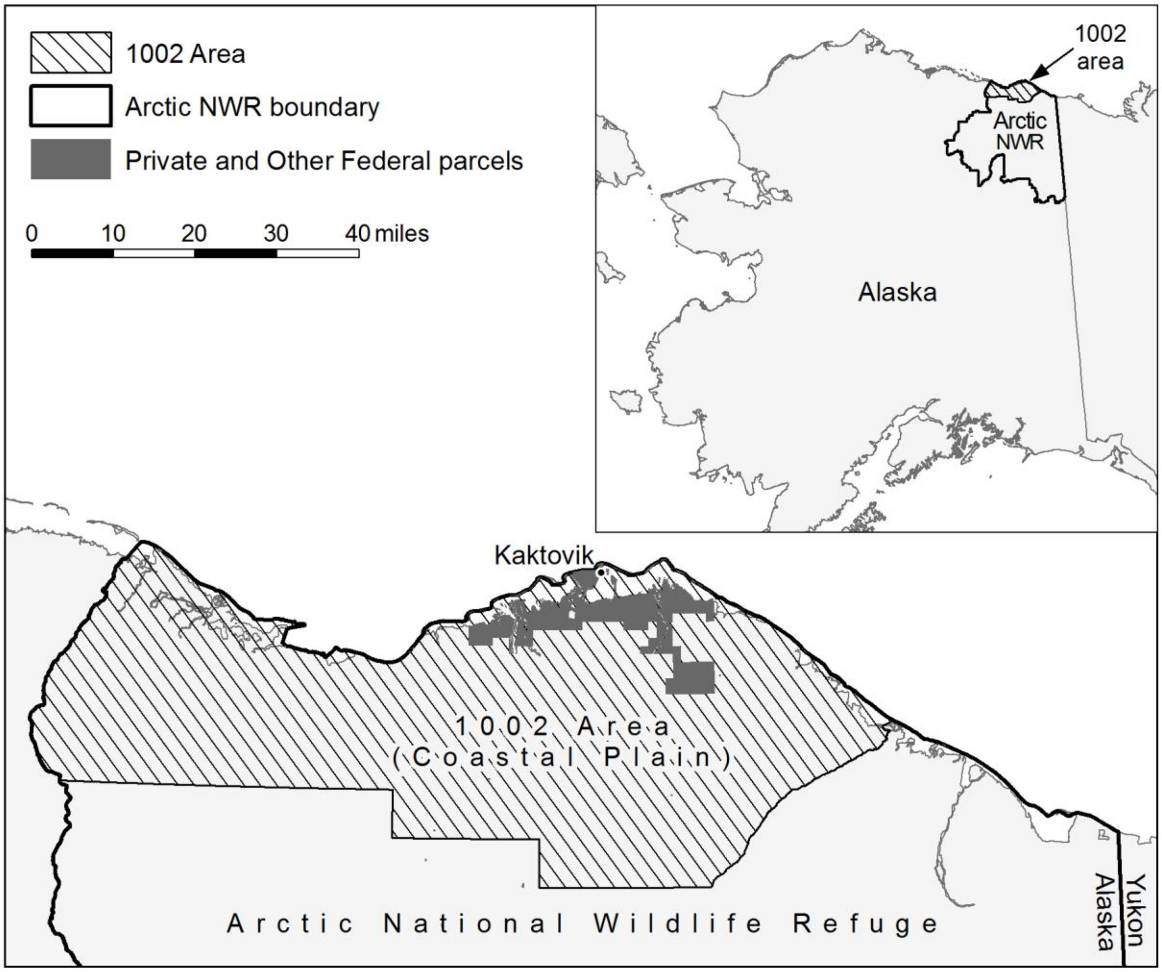


Figure 1. Arctic National Wildlife Refuge showing the coastal plain 1002 area.

The Arctic Refuge was first established in 1960 through Public Land Order 2214, for the purpose of preserving unique wildlife, wilderness, and recreational values. The original 8.9-million acre Arctic National Wildlife "Range" was withdrawn from all forms of appropriation under public land laws, including mining but not from mineral leasing.

In ANILCA Title III, the Arctic Refuge was expanded to 19-million acres (Figure 1). Under ANILCA § 303(2) the "purposes for which the Arctic National Wildlife Refuge was established and shall be managed include –

(i) to conserve fish and wildlife populations and habitats in their natural diversity including, but not limited to, the Porcupine caribou herd (including participation in coordinated ecological studies and management of this herd and the Western

Arctic caribou herd), polar bears, grizzly bears, muskox, Dall sheep, wolves, wolverines, snow geese, peregrine falcons and other migratory birds and Arctic char and grayling;

(ii) to fulfill the international treaty obligations of the United States with respect to fish and wildlife and their habitats;

(iii) to provide, in a manner consistent with the purposes set forth in subparagraphs (i) and (ii), the opportunity for continued subsistence uses by local residents; and

(iv) to ensure, to the maximum extent practicable and in a manner consistent with the purposes set forth in paragraph (i), water quality and necessary water quantity within the refuge."

In Title VIII of ANILCA, § 810, Congress recognized the importance of federal lands to local residents of Alaska who had been using those lands to support their subsistence lifestyle for generations. As a result, federal land managers are required to identify whether a proposed land management action has the potential to significantly restrict subsistence opportunities. If so, then the manager is required to consult with local subsistence users and to seek to minimize such restrictions. In Title X of ANILCA, § 1002, Congress provided for a "comprehensive and continuing inventory and assessment of the fish and wildlife resource of the coastal plain of the Arctic Refuge; an analysis of the impacts of oil and gas exploration, development, and production, and to authorize exploratory activity within the coastal plain in a manner that avoids significant adverse effects on the fish and wildlife and other resources."

1.3 BACKGROUND

With the passage of ANILCA, three primary actions were required of the Service and DOI in relation to administration of the Arctic Refuge: (1) a CCP for the Arctic Refuge was to be written; (2) the DOI Secretary was to assess wildlife values and oil reserves in an area described in ANILCA § 1002; and, (3) the DOI Secretary was to authorize exploratory activity within the coastal plain "in a manner that avoids significant adverse effects on the fish and wildlife and other resources."

First, ANILCA § 304(g) directed the preparation of a CCP for each refuge in Alaska. Each plan is based on an identification and description of resources of the refuge, including fish and wildlife resources and wilderness values, and must "designate areas within the refuge according to their respective resources and values; specify programs for conserving fish and wildlife and the programs relating to maintaining the identified values proposed to be implemented within each such area; and specify uses within each area which may be compatible with the major purposes of the refuge."

An initial CCP and related EIS were prepared for Arctic Refuge. The Record of Decision (ROD) implemented the minimal management alternative (FWS 1988a, 1988b) which emphasized managing for natural, unaltered landscapes and natural processes. This decision was reiterated in 2015 when the CCP was revised. In this updated CCP and EIS, recommendations for Congressionally-designated Wilderness and four additional Wild and Scenic River designations were also included (FWS 2015a).

Second, under ANILCA § 1002 the DOI Secretary was required to assess the petroleum and wildlife values for a 1.5 million-acre portion of Arctic Refuge coastal plain referred to as the "1002" area (Figure 1). The assessment of the 1002 area of the coastal plain was essential to identifying potential oil and gas reserves and whether development activities would significantly and adversely affect fish, wildlife, habitats or the environment.

Biological studies and geological exploration coordinated by the Service, U.S. Geological Survey (USGS), and Bureau of Land Management (BLM) over a 2-year period on the coastal plain were initiated shortly after the enactment of ANILCA. Studies were to conclude 5 years after enactment of the Act, with final results and recommendations submitted to Congress 9 months later.

In April 1982, the Service completed the initial report summarizing current information regarding fish and wildlife, and their habitats occurring on the Arctic Refuge coastal plain (FWS 1982). Between 1982 and 1987 over 50 separate biological field studies in the 1002 area of the coastal plain documented baseline conditions, most summarized in annual reports (Garner and Reynolds 1983, 1984, 1985, 1986, 1987). The baseline assessment period ended in 1987 with the submittal of the *Arctic National Wildlife Refuge, Alaska, Coastal Plain Resources Assessment: Report and Recommendation to the Congress of the United States and Final legislative Environmental Impact Statement* (hereafter, *Coastal Plain Report*) (Clough and others 1987). The recommendation to Congress at the time was to open the entire 1002 area of the coastal plain to an orderly oil and gas leasing program and in such circumstances as warranted, avoid unnecessary adverse effects on the environment (DOI Secretary Recommendation pp. 182-192 in Clough and others 1987).

Baseline biological and water resource assessment in or near the 1002 area of the coastal plain continued from 1988 through 2002, coordinated among the USFWS, USGS, BLM, Alaska Department of Fish and Game, Canadian Wildlife Service, Yukon Department of Renewable Resources, Northwest Territories Department of Resources, Wildlife, and Economic Development, and academic institutions (Truett 1990; McCabe and others 1992; FWS 1994; Douglas and others 2002). Since 2002, biological studies have become increasingly landscape oriented, focusing on ecosystem processes and functions (Martin and others 2009).

Concurrent with the biological studies, oil and gas resource exploration and assessment were ongoing in the 1002 area of the coastal plain but ended with the submission of the 1987 *Coastal*

Plain Report (Bird and Magoon 1987; Clough and others 1987; FWS 1990; GAO 1993). The Coastal Plain Report concluded that the 1002 area of the coastal plain was potentially rich in oil and gas resources. Based on the findings, there is a 95 percent chance the 1002 area of the coastal plain contains more than 4.8 billion barrels of oil and 11.5 trillion cubic feet of gas in-place (Clough and others 1987). There is a 19 percent chance that economically recoverable oil occurs on the 1002 area of the coastal plain. The average of all estimates of conditional economically recoverable oil resources is 3.2 billion barrels (Clough and others 1987).
Finally, in order to conserve the wildlife resources of the area Congress outlined guidance in § 1002(d) for DOI to authorize exploration plans and to develop regulatory guidelines for these geological exploratory activities to ensure these activities do not significantly adversely affect fish and wildlife and their habitats, or the environment. Some of the requirements included a prohibition on the carrying out of exploratory activity during caribou calving and immediate post-calving seasons or during any other period in which human activity may have adverse effects; temporary or permanent closing of appropriate areas to such activity; specification of the support facilities, equipment and related manpower that is appropriate in connection with exploratory activity; and, requirements that exploratory activities be coordinated in such a manner as to avoid unnecessary duplication.

In April 1983, DOI published the final 50 CFR Part 37 guidelines (DOI 1983; FWS 1983). This regulation defines the general provisions for geological and geophysical exploration within the coastal plain of Arctic Refuge, including: purpose and definitions [Subpart A]; general requirements for exploratory activities [Subpart B]; exploration plans and the application process [Subpart C]; environmental protection to avoid significant adverse impacts to natural and cultural resources [Subpart D]; general administration [Subpart E]; and, reporting and data management to preclude unnecessary duplication [Subpart F].

In that rule, three permit application openings were established as described in Table 1. Each application opening allowed either continued work from a previous work session or new work to begin in the upcoming work session. All exploration work, regardless of when it was initiated, was to be completed by May 31, 1986. No new exploration plans have been accepted since 1984 and no new exploration work has occurred since 1986.

Table 1-1. Exploration Work Sessions and Their Respective Application Due Dates as Stipulated in 50 CFR 37.21.

Type of Exploration Work	**Exploration Work Sessions as Allowed in 50 CFR 37.21**	**Applications Due**
Any exploration plans	April 19, 1983 – May 31, 1986	May 20, 1983

Exploration plans other than seismic exploration	June 1, 1984 – May 31, 1986	April 2, 1984
Any exploration plans	October 1, 1984 – May 31, 1986	June 4, 1984

1.4 AGENCY AND PUBLIC INVOLVEMENT

The Service is the lead agency in the development of this EA. For a 60-day period following the publication of the proposed rule in the Federal Register, the public may submit comments on both this draft EA and the proposed rule. After considering the comments received, the Service will issue a final EA and if it determines that the proposed action will not result in significant impacts it would issue a Finding of No Significant Impact (FONSI) for the EA, thus completing the NEPA analysis for the proposed action.

1.5 CONSULTATION WITH FEDERALLY-RECOGNIZED TRIBES AND NATIVE CORPORATIONS

In compliance with Executive Order 13175, Consultation and Coordination with Indian Tribal Governments, federal agencies are required to consult with federally recognized tribal governments during the NEPA process for certain proposed actions, including the development of regulations, that may have a substantial direct effect on the tribes. Pursuant to Public Law 108-199, the Executive Order also applies to Native corporations established under the Alaska Native Claims Settlement Act. Within the Service and DOI the Executive Order is implemented by the Department of the Interior policies on Consultation with Indian Tribes (December 2011) and Consultation with ANCSA Corporations (August 2012). The Service has identified tribal governments and ANCSA Corporations potentially substantially affected by the proposed rule change, who are being invited to consult with the Service on this proposed regulation change. Additional consultation opportunities will be provided prior to issuance of permits for exploration activities on the refuge.

1.6 SUMMARY OF ISSUES

In order to clarify the issues of greatest concern, the following two tables describe the issues being dismissed and further considered in this EA. If an issue has been considered but dismissed from further evaluation, a reason is given in Table 1-3 and the issue will not be discussed further in this EA. Issues being further evaluated are listed in Table 1-4. These issues will be further evaluated in Chapter 3 Affected Environment and Chapter 4 Environmental Consequences.

Table 1 - 3: Issues Dismissed from Further Evaluation

AFFECTED ENVIRONMENT	REASON FOR NOT-EVALUATING FURTHER
Geology	Neither the change in regulation nor the resulting exploration activities, which are non-extractive, will change the geology of the area.
Air Quality	With anticipated use of low sulfur fuel it is not expected that emissions concentrations or ice fog from motorized vehicles and equipment would ever reach levels that pose an environmental hazard or cause any significant degradation in air quality.
Steller and spectacled eiders	As migratory birds, neither of these threatened eiders would occupy breeding habitat during the period of winter exploration. Even if there were temporal overlap, only the very NW corner of the 1002 area of the coastal plain is within the breeding range of the spectacled eider, and they only occur there as a rare breeder at very low densities. Steller's eiders do not breed in the 1002 area of the coastal plain and are rare visitors along the coast.

Table 1 - 4: Issues Considered for Further Evaluation

AFFECTED ENVIRONMENT	REASON FOR FURTHER EVALUATION
Soils	Although the overall geology of the coastal plain would not be affected, the development of ice roads and ice pads and other associated infrastructure may expose areas to erosion. There is also a risk of fuel spills from equipment being used.
Hydrology	In any proposed winter exploration activity on Arctic Refuge, water withdrawals would be necessary to construct ice roads and other infrastructure that would potentially impact hydrology, aquatic habitats, wetlands and species that depend on them. There is also a risk of fuel spills and release of other contaminants that could impact water quality.
Climate	Although climate will not be affected by either of the alternatives directly, a description of past and present climate is useful in considering cumulative effects of the proposed action to other resources. For this reason a description of climate trends is included in Chapter 3.
Vegetation	In any proposed industrial activity on Arctic Refuge, there is a concern that invasive species will be introduced. We are also concerned about the effects of the development ice roads and ice pads and other associated infrastructure may create.
Wetlands	Depending on the amount of water needed for the development of ice roads and pads, water available for healthy wetlands may be affected.
Fish	Water needed for the development of ice roads and pads could be withdrawn from aquatic habitat impacting fish populations. Seismic testing over water bodies may also

	impact fish.
Bald and Golden Eagles	Golden Eagles are rare breeders on the coastal plain and initiate nesting very early in the spring on the North Slope (earliest of 23 March, with three annual mean initiation dates of 5 April, 14 April, and 22 April); thus, could be affected by "winter" seismic exploration. Bald Eagles are probable, but very rare, breeders on the coastal plain.
Resident Birds	Gyrfalcons are rare breeders on the coastal plain, and initiate nesting very early in the spring; thus, could be affected by seismic exploration. Their primary late winter/early spring prey is rock and willow ptarmigan which are uncommon and common permanent residents, respectively, on the coastal plain.
Migratory Birds	Water needed for the development of ice roads and pads could be withdrawn from aquatic habitat impacting migrating waterfowl and shorebird populations.
Caribou	The coastal plain is within the territory of the Porcupine Caribou Herd which travels north and south and is a primary subsistence resource for many of the Native people who live in and around the Refuge.
Terrestrial Mammals, Not Including Caribou	Both muskox and moose are now rare on the coastal plain; their populations have declined in recent years. Muskox may be particularly sensitive to late winter disturbance given nutritional challenges and calving beginning in mid-April. Bears, wolves, and wolverines all occur on the coastal plain, although they are more abundant in the foothills and mountains. Brown bears emerge from their dens from late March through May; this period could well overlap seismic exploration periods.
Polar Bears	A majority of female polar bears of the Southern Beaufort Sea population now den on the Refuge coastal plain. As a result much of the area has been designated critical habitat.
Bowhead Whale	Now that there is limited sea ice during much of the year, exploration equipment could be transported to the area via barges through a known bowhead whale migration corridor.
Ringed and Bearded Seals	Now that there is limited sea ice during much of the year, exploration equipment could be transported to the area via barges through known bearded and ringed seal habitat.
Cultural Resources	The reverberation created by seismic exploration is known to damage buried artifacts.
Socioeconomic	Exploration activities have the potential to create employment opportunities within communities neighboring the Refuge and may also affect subsistence resource availability.
Environmental Justice	Under EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, federal agencies are required to develop strategies to address environmental justice concerns in their approach to operations.
Subsistence	Exploration activities have the potential to affect resource availability by creating disturbances that change caribou and polar bear movements.
Noise	Noise from vehicles, generators, aircraft, and human presence has the potential to

	change the natural soundscape during seismic exploration.
Visual	Due to the relatively flat nature of the landscape, equipment associated with seismic exploration will be noticeable to recreationalists and residents in the vicinity.
Wilderness Values	The resulting exploration activities will require a significant level of industrial activity during the exploration work season in limited areas.

2 Proposed Action and Alternatives

2.1 ALTERNATIVE 1 (NO ACTION ALTERNATIVE)

Under the no action alternative, the existing regulation would not be amended or updated. Management of the Coastal Plain, Arctic Refuge, would continue as stipulated in the ROD for the Arctic Refuge CCP (FWS 2015). There would continue to be no oil and gas exploration on Arctic Refuge.

2.2 ALTERNATIVE 2 - PROPOSED ACTION

The Service proposes to allow opportunities for submission of applications to conduct seismic exploration by amending and updating the regulatory language of 50 CFR Part 37 - *Geological and Geophysical Exploration of the Coastal Plain, Arctic National Wildlife Refuge, Alaska*, specifically § 37.21(b) and (c) as follows:

PART 37 – GEOLOGICAL AND GEOPHYSICAL EXPLORATION OF THE COASTAL PLAIN, ARCTIC NATIONAL WILDLIFE REFUGE, ALASKA

Subpart C – Exploration Plans

§ 37.21 Application Requirements.

(a) Prior to submitting an exploration plan, applicants may meet with the Regional Director to discuss their proposed plans and exploratory activities and the requirements of this part.

(b) Any person wanting to conduct exploratory activities may apply for a special use permit by submitting for approval one or more written exploration plans, in triplicate, to the Regional Director, Region 7, U.S. Fish and Wildlife Service, 1011 East Tudor Road, Anchorage, Alaska 99503.

(c) In addition to containing the information required in paragraph (d) of this section, any exploration plan submitted shall describe the applicant's plan for carrying out an integrated program of exploratory activities in such a manner as will satisfy the objective and limitations stated in § 37.1. If an applicant submits an exploration plan in any given year with the intention of submitting another exploration plan the following year, the applicant shall describe in its initial plan how its future exploratory activities will be integrated with those proposed under its initial plan. Each exploration plan submitted must be published and be the subject of a public hearing in accordance with requirements of § 37.22(b).

(d) An exploration plan shall set forth in general terms such information as is required by this part and by the Regional Director in determining whether the plan is consistent with this part, including, but not limited to:

(1) The name and address of any person who will conduct the proposed exploratory activities, i.e., the applicant/permittee, and, if that person is an agency, firm, corporation, organization, or association, the names and addresses of the responsible officials, or, if a partnership, the names and addresses of all partners;

(2) The names and addresses of all persons planning at the time of plan submittal to participate in the proposed exploratory activities or share in the data and information resulting therefrom through a cost-sharing or any other arrangement;

(3) Evidence of the applicant's technical and financial ability to conduct integrated and well-designed exploratory activities in an arctic or subarctic environment and of the applicant's responsibility in complying with any exploration permits previously held by it;

(4) A map at a scale of 1:250,000 of the geographic areas in which exploratory activities are proposed and of the approximate locations of the applicant's proposed geophysical survey lines, travel routes to and within the refuge, fuel caches, and major support facilities;

(5) A general description of the type of exploratory activities planned, including alternate exploratory methods and techniques if proposed, and the manner and sequence in which such activities will be conducted;

(6) A description of how various exploratory methods and techniques will be utilized in an integrated fashion to avoid unnecessary duplication of the applicant's own work;

(7) A schedule for the exploratory activities proposed, including the approximate dates on which the various types of exploratory activities are proposed to be commenced and completed;

(8) A description of the applicant's proposed communication techniques;

(9) A description of the equipment, support facilities, methods of access and personnel that will be used in carrying out exploratory activities;

(10) A hazardous substances control and contingency plan describing actions to be taken to use, store, control, clean up, and dispose of these materials in the event of a spill or accident;

(11) A general description of the anticipated impacts that the proposed exploratory activities may have on the refuge's wildlife, its habitat, the environment, subsistence uses and needs, and cultural resources, and a description of mitigating measures which will be implemented to minimize or avoid such impacts;

(12) A description of the proposed procedures for monitoring the environmental impacts of its operation and its compliance with all regulatory and permit requirements;

(13) A statement that, if authorized to conduct exploratory activities, the applicant shall comply with this part, its special use permit, its approved exploration plan, plan of operation, and all reasonable stipulations, demands and orders issued by the Regional Director;

(14) A description of the applicant's proposed data quality assurance and control program; and

(15) Such other pertinent information as the Regional Director may reasonably require.

If this alternative is selected, it is assumed that the Service will receive and possibly approve applications for seismic exploration activities on the 1002 area of the coastal plain. Proposed 3-D seismic exploration activities in the nearby National Petroleum Reserve - Alaska (NPRA) and analyzed in the BLM EA, DOI-BLM-AKF01000-2017-001-EA and the NPRA Integrated Activity Plan/EIS (2012), give us an understanding of what these activities would generally entail.

Seismic exploration maps the subsurface structure of rock formations by sending energy waves into the ground or water and then recording the reflected energy waves. One of the most common methods for creating these energy waves in the arctic is via vibroseis seismic operations which use truck-mounted vibrators that systematically put variable frequency energy into the earth. Several of these truck-mounted vibrators are located along a line and vibrate in synchrony in order to record energy along a transect. The reflected energy is recorded and the whole line moves ahead.

3-D seismic activities generally occur in the winter with crews beginning to mobilize and build ice roads and pads in December. Full crews arrive in January and commence seismic operations if the ice infrastructure has been completed. Seismic operations continue through most of April, with demobilization finishing by the first part of May. Crews may include 40–160 people depending on the planned activity with operations occurring 24 hours a day. The camp facility often includes sled-mounted units for preparing and eating meals, sleeping areas, washrooms, offices, shops, medical facilities, generator rooms, and any other support needed. The camp moves along with the exploration work. Any ice roads or pads built during this time are left to melt in place. Any ice bridges built across rivers are removed in order to decrease the chance of ice damming during the melt season. Frozen lakes are often used for landing strips.

Without a specific exploration plan to evaluate, it is not possible to determine exact locations and timing of all the seismic work and staging. Although we can predict that seismic exploration activities will happen in the winter months, it is less clear what the timing of staging and pre-survey work would be. We can predict that ice roads may be used to stage and transport equipment and materials into the west end of the 1002 area of the coastal plain. Exploration activities further to the east would likely require barge transportation during the summer and fall before the sea ice freezes. Also, unlike the western side of the area, there is no nearby infrastructure on the eastside from which to build, possibly changing the kind and quantity of equipment used.

2.3 ALTERNATIVES CONSIDERED BUT DISMISSED FROM DETAILED ANALYSIS

No other alternatives were analyzed in detail in this EA, because the proposed change of regulation will allow opportunities for submission of applications to conduct seismic exploration. The Service considered updating the environmental protection requirements of 50 CFR §§ 37.31 and 37.32, but determined that the regulations as currently written provide adequate and appropriate protection of refuge resources and allow the Regional Director to impose additional stipulations to ensure that permittees' activities are conducted in a manner which avoids significant adverse effects on the refuge's wildlife, its habitat, and environment.

3 Affected Environment

Per ANILCA § 1002(c), resource assessment baseline studies within the 1002 area of the coastal plain began shortly after its enactment and, as stipulated, are "continuing." Special emphasis was placed on caribou, wolves, wolverines, grizzly bears, migratory waterfowl, muskox, and polar bears of the coastal plain and their habitats. The purpose of the studies was to "assess the size, range, and distribution of populations of fish and wildlife; determine the extent, location, and carrying capacity of the habitats of the fish and wildlife; assess the impacts of human activities and natural processes on the fish and wildlife and their habitats; analyze the potential impacts of oil and gas exploration, development, and production on such wildlife and habitats; and analyze the potential effects of such activities on the culture and lifestyles (including subsistence) of affected Native and other people."

The environmental setting, flora and fauna, water resources, cultural resources, and rural lifestyles (including subsistence) of the 1002 area of the coastal plain, Arctic Refuge, are generally defined and described in the *Final EIS and Preliminary Final Regulations: Proposed Oil and Gas Exploration within the Coastal Plain of the Arctic NWR* (DOI 1983), and *Coastal Plain Report* (Clough and others 1987).

Additional natural, water and cultural resource data and assessments are provided in the numerous studies conducted under the Arctic Refuge Coastal Plain Resource Assessment over the past 30 years (FWS 1982; Garner and Reynolds 1983, 1984, 1985, 1986, 1987; McCabe and others 1992; Douglas and others 2002; among others). Cumulative effects of oil and gas activities on the Alaska North Slope were reviewed by the National Research Council, as these effects were not adequately integrated into ongoing studies up to that point (NRC 2003).

Since 1988, the natural and cultural resources, water resources, and lifestyles (including subsistence) in the Arctic Refuge, including the 1002 area of the coastal plain, have been minimally managed by human influence or intrusion, and administered for their wilderness values and natural processes (FWS 1988a, 1988b, 2015a, 2015b).

3.1 PHYSICAL ENVIRONMENT

3.1.1 Soils

Soils in the coastal plain are described in the 2015 Arctic Refuge CCP as including low terraces and floodplains of streams draining the North Slope of the Brooks Range. Materials underlying soils in this region consist of fluvial sands and silts, with increasing amounts of interstratified marine sediments near the coast. Generally, soils thaw less than 18 inches in summer and are poorly drained. Loamy textures are common on terraces and floodplains, and organic soils occur in depressions. Locally, peaty materials are buried beneath windblown sand deposits.

3.1.2 Hydrology

Water resources on the coastal plain of the Arctic National Wildlife Refuge consist of streams, lakes, and springs. Streams of the Arctic coastal plain flow north, several forming large alluvial fans as they flow into the Beaufort Sea where they contribute substantial volumes of water and sediment to coastal ecosystems (Arctic Refuge CCP). Like other areas of the Arctic, the coastal plain is underlain by continuous permafrost limiting infiltration of surface water and limiting groundwater resources (Lyons and Trawicki 1994). Groundwater that may exist below permafrost is thought to be saline or brackish (Williams 1970). While ninety-nine percent of the 1002 area is classified as wetlands, freshwater is limited and confined to the shallow zone above permafrost (Clough et al. 1987). Lakes are not evenly distributed across the coastal plain with concentrations occurring near the mouth of the Canning River and in the region of the Sadlerochit and Jago Rivers with very few lakes occupying the central Katakturuk River region (Trawicki et al. 1991). At Barter Island mean annual precipitation which includes the water equivalent of snow averages 6.3 inches per year, in Umiat east of the 1002 area on the North Slope it is 5.7 inches (Searby and Hunter 1971) emphasizing that climate and permafrost are dominant factors that limit water availability. The non-frozen water found on the coastal plain during the winter months is located in small isolated pools beneath ice hummocks associated with stream drainages , lakes with depths greater than 7 feet, and flowing surface waters associated with springs (Lyons and Trawicki 1994).

<u>Streams and Rivers</u>

The 1002 area has a relatively high density of streams and rivers compared to other areas of the North Slope (Brackney 2008). These habitats support thirteen species of fish, including Dolly Varden, an important subsistence fish. The hydrography of these systems is strongly influenced by the climate which is characterized by extremely low winter temperatures and short, cool summers with low, desert-like levels of precipitation. Streamflow rapidly declines in most systems shortly after freeze up in September and ceases in most streams by December when they are generally frozen to the stream bed resulting in no flow or flow so low as to not be measureable (Lyons and Trawicki 1994). A few exceptions to this occur where springs result in open reaches and aufeis areas that develop providing important fish overwintering habitat (Arcone 1989). Break up on the Arctic coastal plain occurs during a brief period in late May or early June. Snowmelt begins in the mountains and foothills progressing towards the coastal plain. Rapidly melting water runs over the ground as sheetflow with infiltration limited by permafrost (Lyons and Trawicki 1994). Water in drainages rises rapidly, often flowing over ice covered stream channels. More than half of the annual discharge for these streams can occur during a period of several days to a few weeks (Clough et al. 1987, Sloan 1987). Based on origin, hydrologic regime, and chemical and biological characteristics, Craig and McCart (1975) classified North Slope streams into three categories: mountain, spring-fed, and tundra. Mountain streams are typically fast flowing and fed by varying proportions of snowmelt, glacier meltwater, and spring-fed tributaries. Waters are cold (usually less than 50 °F), occasionally turbid, moderately hard, and support low invertebrate densities. The most common species of fish in mountain streams is Dolly Varden. Mountain streams that receive glacial inputs are unique to the eastern North Slope, in the Jago, Hulahula, and Okpilak watersheds, discharge from glacial sources is the dominant source of flow when precipitation is low and air temperatures are high and transport large volumes of water, sediment and nutrients to downstream ecosystems (Arctic CCP). Spring-fed streams are often tributaries of mountain streams and have relatively stable flows and temperatures throughout the year. Spring-fed waters are characterized by low levels of dissolved solids and very high densities of macroinvertebrates. Many spring-fed streams provide critical spawning and overwintering habitat for Dolly Varden. Tundra streams originate in the Brooks Range Foothills and coastal plain ecoregions, are fed by surface runoff, tend to be meandering systems, and have low to moderate invertebrate densities. Waters are typically warmer and exhibit lower pH and conductivity relative to mountain and spring-fed streams (Arctic CCP). Huryn et al. (2004) found that gradients in freezing probability, nutrient concentrations, and substratum instability control invertebrate communities in these systems. Some projections indicate that glacial inputs could disappear within the next 50 years altering hydrology by reducing instream connectivity and negatively impacting fish migrating to critical overwintering habitat (Nolan et al. 2011). Surface water availability and instream connectivity will potentially be adversely impacted by deepening of the active layer on the coastal plain, increasing duration of the summer season, and increased evapotranspiration rates (Arctic CCP).

Springs and Aufeis Areas

Six springs are located on the Arctic coastal plain identified through reconnaissance investigation by Childers et al. (1977): Sadlerochit Spring, Red Hill Spring, Katakturuk River tributary Spring, Hulahula River Spring, Okerokovik River Spring, and Aichilik River Spring. During the winter months pressurized water discharges from a spring pushing up through the ice to the surface where it spreads out and freezes forming aufeis areas that can become extensive. These formations melt more slowly than snow, generally persist into the summer and may provide a temporary source of freshwater (Kane and Slaughter 1973). Open water associated with springs provides important winter habitat particularly once surface water runoff ceases due to freezing (Lyons and Trawicki 1994). Most springs in Arctic Refuge have survived since the last glacial maximum (Yoshikawa et al. 2007), suggesting that they will continue to flow and be refugia for aquatic biota in a changing climate.

Lakes

The density of lakes in the Arctic coastal plain is low compared to the rest of the North Slope and as noted earlier their distribution is not uniform, nor is their size and depth (Arctic CCP). Jorgenson and Shur (2007) classified the coastal plain into regions based on lake origin: thaw, depression, riverine, and delta. Depression lake basins are formed in undulating sandy, alluvial marine or eolian deposits, and are the majority found on the coastal plain concentrated in the depression lakes region between the Hulahula and Niguanak rivers. Riverine lakes include oxbow and floodplain lakes along sinuous channels and thaw lakes formed in ice-rich abandoned channels. Riverine lakes are most concentrated along the Jago and Niguanak rivers. Delta lakes include thaw, riverine, and tidal lakes and most are found in deltas of the Hulahula, Jago, Aichilik, and Canning rivers (Arctic CCP). The majority of lakes on the coastal plain are shallow lakes with surface areas ranging from 1,500 acres to less than 10 acres (Trawicki et al. 1991). Recharge of these systems is generally limited to snow melt and direct precipitation in the immediate vicinity of the lake (Lyons and Trawicki 1994). When not connected to larger drainage networks, evaporation has a strong influence on water chemistry and plays an important role in regulating lake water balance (Arctic CCP). Maximum winter ice thickness on lakes in the Arctic is between 6–7 feet (Bilello and Bates 1969, 1971, 1972, and 1975). Clough et al. (1987) reported that most lakes have basins less than 7 feet deep and thus freeze to the substrate. These shallow lakes generally melt from the surface downward in spring. Deeper lakes that do not freeze to substrate may have ice present on the surface well into July. Due to the level of winter freezing, the depth of lakes restricts the presence of fish, Hobbie (1984) found fish present only in lakes with depths greater than 5.6 feet. Shallow lakes generally lack fish because they usually freeze solid but they provide important habitat to emergent vegetation, invertebrates, and migratory birds due to the earlier availability of ice-free areas. Trawicki et al. (1991) identified fish presence in lakes on the coastal plain to be more frequent and widespread than previously suspected. Ninespine stickleback (*Pungitius puingitus*) was found in 34 of 52 lakes surveyed (65%) in 1989. In the past half a century, the duration of ice cover, thermal regimes, and rates of primary productivity have likely changed. In the future, changes in temperature, active layer depth, fire frequency and severity, and erosion rates could affect lake distribution, water quality, water levels, size, and connectivity to other habitats (Arctic CCP).

Winter Specific Hydrologic Data

Hydrologic data for the 1002 area are limited, the Service collected short-term (less than five years) of data over two decades ago at 11 stream gage sites on five drainage systems across the coastal plain and conducted an inventory of 119 lake basins to create lake contour maps, water volume calculations and estimates of winter water volume beneath ice cover. These lake basins constituted the majority of larger lake basins found in the 1002 area. These data were collected in large part to address questions regarding winter water availability in the 1002 area in the event of exploration activities. The USGS has collected some additional hydrography data on the Canning and Hulahula Rivers. In the Service stream studies winter water was found to occur over a wide area in most of the major river drainages but it was restricted to small isolated pools beneath ice hummocks scattered throughout the braided portions of these rivers. The volume of water available was estimated to be small, 9 million gallons over the 237 miles of inventoried area (Elliot and Lyons 1990). Total estimated volume of water in the study lakes ranged from 55,382 acre-feet (18 billion gallons) when free of ice to a low of 3,366 acre-feet (1.1 billion gallons) beneath a maximum ice thickness of seven feet. Ninety percent of the available water was contained in just nine of the 119 surveyed lakes, the majority of these were found in the Canning River delta area (up to eighty percent of the total volume), and only two of these lakes were located in the region between the Katakturuk and Sadlerochit rivers (Trawicki et al. 1991).

Climate Change Effects

Historically, in the nearby NPR-A the coastal regions have not thawed until after the second week of June (BLM 2012). By mid-century, these areas are projected to thaw the first week of June. By late century these areas are expected to thaw as early as June 1st. Changes in freeze-up date are predicted to be even greater. Historic data indicates NPR-A water bodies freeze by mid-September. Models indicate freeze-up will not occur until late September in southern regions and early October along the coast. By the end of the century, coastal waterbodies may not freeze until the end of October. These changes will result in a six-week increase in the length of the ice-free season.

Landscape drying trends have been observed in northeastern Alaska (ACIA 2004). Increased temperatures and an extended growing season could increase the evapotranspiration rate, increasing the water deficit (defined as the amount by which evapotranspiration exceeds precipitation) and potentially affecting the annual water balance. The annual water balance represents the water available for plants and animals, streamflow, and groundwater recharge. Shallow water systems, including lakes and wetlands, could decrease in number and extent as the annual water balance experiences an ongoing deficit. Permafrost loss on the Refuge could also result in draining of many shallow water systems; the thawing of ice wedges and ice lenses could create more connections between surface water and groundwater systems. If wetlands and lakes continue to dry, an increase in vegetative cover can be expected eventually transitioning to dry meadows and shrublands. This would reduce the amount of habitat available for wetland-dependent species, such as waterfowl.

3.1.3 Climate

The North Slope is defined as the area north of the Brooks Range, including the Beaufort Sea Coastal Plain and the Brooks Range Foothills ecoregions. The climate of the North Slope is classified as arctic: summers are short and cool, and winters are long and cold. The growing season lasts from June to August. Subfreezing temperatures and snow may occur at any time during the year.

The Arctic coast experiences more frequent cloudiness and fog with higher winds; inland, clear skies are more common, winds are variable, and summers are warmer and less cloudy with increasing distance from the coast. At Barter Island on the coast, temperatures average 40 °F in July (warmest month) and -20 °F in February (coldest month) (Table 4–2). Temperatures on the coastal plain and in the northern foothills of the Brooks Range are more similar to those measured at weather stations at Kuparuk and Toolik Lake, ranging from means of 47 to 53 °F in July and -18 to -6 °F in February.

North of the Brooks Range, the Refuge receives little precipitation. The average annual water equivalent precipitation is less than 10 inches (in), most of which falls as summer rainfall, but it includes 32 to 46 in of snowfall. Evaporation rates are low due to low temperatures and a short growing season; the land is underlain by continuously frozen soil, which restricts soil drainage. Therefore, available soil moisture is considerably greater than the low annual precipitation would produce in a more temperate climate, and soils are usually saturated during summer.

Surface winds along the Arctic coast average 9 to 15 miles per hour (mph), with occasional intense storms generating winds exceeding 70 mph. Winds are predominantly from the northeast, although the strongest winds come from the west. September and October are the windiest months on the coast, probably due to maximum amounts of open water (Wendler et al. 2010). During winter, winds are a major force affecting the distribution and amount of snow cover on the coastal plain. Higher, rolling terrain is often blown clear, or nearly so, while dense snow drifts accumulate in sheltered areas along stream banks.

The Arctic is particularly sensitive to warming due to the historically extensive snow and ice cover, where the freezing point marks a critical threshold for stability of the landscape and thus both habitat and infrastructure sustainability. Accelerated melting of multiyear sea ice, reduction of terrestrial snow cover, and permafrost degradation are examples of the observed rapid Arctic-wide response to global warming.

Annual average near-surface air temperatures across Alaska and the Arctic have increased over the last 50 years at a rate more than twice as fast as the global average temperature (Taylor et al. 2017). There is limited meteorological monitoring on the North Slope, and no long term, continuous monitoring in the Arctic Refuge. Thus, long term trends are derived primarily from Utqiagvik (formerly Barrow). Especially strong warming has occurred over Alaska's North

Slope during autumn. For example, Utqiagvik's warming since 1979 exceeds 7°F (3.8°C) in September, 12°F (6.6°C) in October, and 10°F (5.5°C) in November (Wendler et al. 2014).

Our understanding of precipitation trends are limited on the North Slope, in part because the difficulty of collecting rain and snow in windy sites makes historical precipitation data less reliable than temperature data. Overall, the 2016 May Alaska statewide snow coverage was the lowest on record dating back to 1967; the snow coverage of 2015 was the second lowest, and 2014 was the fourth lowest (Taylor et al. 2017). The length of the snow season impacts the timing available for winter exploration activities as well as the timing of wildlife activities, including occupancy of migration and birthing habitats. Snowpack in the Brooks Range, and glacier mass, affect water availability in rivers and lakes for fish and wildlife habitat.

Negative trends in precipitation were observed between 1950 and 1988 at Barter Island, on the Beaufort Sea coast in the center of the Arctic Refuge (Curtis et al. 1998; L'Heureux et al. 2004). Across six decades (1950–2010), researchers also observed a consistent decrease in winter precipitation at Utqiagvik (McAfee et al. 2013), which supported earlier analyses (L'Heureux et al. 2004). The Barter Island station, however, has not reported continuously since the late 1980s, so it cannot confirm recent trends at Utqiagvik. At Bettles, south of the Brooks Range, there appears to be an increase in winter precipitation, with the difference from the Arctic Coastal Plain resulting from the Brooks Range acting as a barrier to moisture transport.

3.2 Biological Environment

3.2.1 Vegetation

North of the Brooks Range, the coastal plain is treeless tundra, composed mainly of hardy dwarf shrubs, sedges, and mosses. Habitats on the North Slope can be grouped into four broad categories: coastal lagoons, lowland wet tundra and lakes, upland moist tundra, and river floodplains with willow shrub thickets. The geography of the 1002 Area differs from the coastal plain further west in that there is generally less low, flat, wet tundra and a greater proportion of rolling, drier terrain. A detailed description of all the habitats on the Refuge can be found in the 2015 Refuge CCP. The following is a summary of the information found there as it pertains to the Refuge coastal plain.

Shrub thicket habitat can be categorized into two types: dry and moist prostrate dwarf shrub. Dry prostrate dwarf shrub occupies dry areas of the coastal plain tundra and on dry, infrequently-flooded river terraces or alluvial fans throughout the refuge. Moist habitats on slightly elevated microsites of the coastal plain are often drier as a result of greater exposure to wind and lack of water from surrounding terrain. Lichen are more common than mosses in these drier habitats. Bare soil as a result of frost action is common in this habitat type. Moist prostrate dwarf shrub contains similar shrub species as dry, but greater winter snow cover and summer soil moisture allows grasses, sedges, and mosses to thrive in the understory.

The riparian shrub type develops on gravels along rivers and is dominated by the willows *Salix planifolia* and *S. alaxensis*. On the North Slope, this is the tallest vegetation type. Species composition and density is controlled by frequency of flooding, water velocity, and the size of particles deposited during flooding

The very wet graminoid vegetation type occurs on aquatic habitats surrounding large, open bodies of fresh water, very wet habitats that contain numerous small bodies of open water; and coastal marshes frequently inundated with salt water. Surface forms includ low-centered polygons with abundant standing water, thaw lake basins, edges of lakes, and lowbank coastline. There is usually little shrub, forb, or moss cover, except on drier microsites such as polygon rims.

3.2.2 Wetlands

Although the density is low compared to the rest of the North Slope, there are over four thousand lakes covering over 37,000 ac in the Refuge. Most (73 percent) of the lakes are in the coastal plain ecoregion. Most lakes in this region are shallow, freeze to the bottom during winter (Trawicki et al. 1991), and are recharged by snowmelt, overbank flooding, and precipitation. When not connected to larger drainage networks, evaporation has a strong influence on water chemistry and plays an important role in regulating lake water balance. Jorgenson and Shur (2007) classified the coastal plain into regions based on lake origin: thaw, depression, riverine, and delta. Thaw lakes are formed by the degradation of ice-rich sediments and, in the Refuge, are only in great abundance in a small thaw lake plain east of Demarcation Bay. Depression lake basins are formed in undulating sandy, alluvial marine or eolian deposits. Most of the lakes in the Refuge are in the depression lakes region between the Hulahula and Niguanak rivers. Riverine lakes include oxbow and floodplain lakes along sinuous channels and thaw lakes formed in ice-rich abandoned channels. Riverine lakes are most concentrated along the Jago and Niguanak rivers. Delta lakes include thaw, riverine, and tidal lakes and most are found in deltas of the Hulahula, Jago, Aichilik, and Canning rivers. Up to 80 percent of the winter water volume is in lakes in the Canning River delta (Trawicki et al. 1991).

Over 25 percent of the lakes on the North Slope of the Refuge are in the mountains and foothills. Most mountain lakes are of glacial origin and tend to be deeper, have larger surface areas, and store much greater volumes of water than coastal plain Lakes. The largest mountain lakes include Lake Peters (3,226), Lake Schrader (1,689 ac), Elusive Lake (772 ac), and Porcupine Lake (333 ac). With the exception of studies on two large deep glacial lakes, Lakes Peters and Schrader, the limnology of mountain lakes in the Refuge has not been well studied. In the late 1950s, Hobbie (1961) found that Lake Schrader was at the northern limit of thermally stratified lakes; Hobbie (1964) found that 50 percent of the annual primary productivity in Lake Peters occurred when the lake was still covered by ice. In the past half a century, the duration of ice cover, thermal regimes, inputs from glacial meltwater, and rates of primary productivity have likely changed. In the future, changes in temperature, active layer depth, fire frequency and severity, and erosion rates could affect lake distribution, water quality, water levels, size, and connectivity to other habitats.

Landscape drying trends have been observed in northeastern Alaska. Riordan et al. (2006) reported a reduction in wetland extent and the number and surface area of lakes on parts of the Yukon Flats between 1980 and 2002. Many wetlands on the Yukon Flats Refuge that were once aquatic habitats, such as lakes, now are shrub and wet meadow habitats. Historical aerial photographs from the boreal forest part of Arctic Refuge also show lakes shrinking or disappearing in the past 60 years.

Increased temperatures and an extended growing season could increase the evapotranspiration rate, increasing the water deficit (defined as the amount by which evapotranspiration exceeds precipitation) and potentially affecting the annual water balance. The annual water balance represents the water available for plants and animals, stream flow, and groundwater recharge. Shallow water systems, including lakes and wetlands, would decrease in number and extent as the annual water balance experiences an ongoing deficit. Permafrost loss on the Refuge could also result in draining of many shallow water systems on the Refuge; the thawing of ice wedges and ice lenses could create more connections between surface water and groundwater systems. If wetlands and lakes continue to dry, an increase in vegetative cover can be expected; and they could eventually transition to dry meadows and shrublands. This would reduce the amount of habitat available for wetland-dependent species, such as waterfowl.

3.2.3 Fisheries

Two types of fish habitat dominate the Arctic coastal plain: streams and lakes. Lake habitats may be isolated and without upstream or downstream connections, and may be further defined as deep or shallow. Environmental extremes also dominate fish habitats, between freezing, i.e., below 0°C/32°F during the long winter and flowing waters (above 0°C/32°F) during the short summer months. This combination, along with size, location, and morphology, including chemical and physical characteristics of the numerous lakes and tributaries of the Arctic coastal plain determine the distribution, densities and diversity of fish species (see Affected Environment - Hydrology 3.1.2).

Fish species may be categorized into freshwater residents, diadromous (both marine and freshwater) and marine. About 62 marine and diadromous fish occur in in the Beaufort Sea adjacent to the coastal plain and these species include Arctic char, Arctic cisco, Arctic flounder, boreal smelt, Pacific salmon (pink and chum), and fourhorn sculpin (Craig 1984; Clough and others 1987; Gallaway and Fechhelm 2000; BLM 2012). Nearshore marine environments provide important foraging and spawning habitats while the moving waters of river deltas provide overwintering habitat for some species. About 21 species of freshwater fish, including diadromous species that are predominantly freshwater, occur in the coastal plain and include Arctic lamprey, Arctic grayling, round whitefish, broad whitefish, ninespine stickleback, and burbot (Clough and others 1987; Moulton and George 2000; BLM 2012).

The 3- to 4-month Arctic summer is a critical period for fish to find quality foraging habitats and food resources and reproduce. It may be safely assumed that any fresh waters deeper than 2–2.5 meters (6-7 feet) deep, or alternatively below the maximum winter ice depth of the coastal plains environs may be suitable wintering habitat for fish (Bilello and Bates 1969, 1971, 1972, 1975 in Lyons and Trawicki 1994; Schmidt and others 1989; Moulton and George 2000). This type of habitat is considered restricted and a limiting factor to overwintering fish survival (Reynolds 1997). Large lakes are generally uncommon in the 1002 area of the coastal plain, and particularly those with overwintering capacity; do not freeze to the bottom during winter months, provide sufficient dissolved oxygen, and/or without salt water intrusion (Clough and others 1987).

Springs are important for spawning, rearing, and overwintering and these sites are generally more abundant and diverse than other waters for aquatic invertebrates as food resources (Glesne and Deschermeier 1984; Clough and others 1987).

The integrity of riparian areas is important for maintenance of water quality and fish populations on the coastal plain, more so at higher elevations where stream meandering during spring snowmelt or summer storm events is less prevalent than at lower elevations (Clough and others 1987).

Grayling are not as tolerant of brackish waters and occur more in riverine systems than char but are in large concentrations are only a few locations. Grayling make extensive migrations to and from spawning, rearing, foraging, and overwintering locations (West and Wiswar 1985; Mecklenburg and others 2002). Major Arctic grayling populations occur in the Canning, Tamayariak, Sadlerochit, Hulahula, Okpilak, and Aichilik Rivers. Arctic char (Dolley Varden) are primarily anadromous but rely on freshwater habitats for spawning, early rearing, and wintering. Therefore, char also migrate with primary movement corridors in the Canning, Aichilik and Hulahula Rivers. The Canning River has the largest char run and the Hulahula is the most important for subsistence purposes.

Smaller fish species which have little interest for sport or subsistence, are important food resources for birds, mammals and other fish.

Seventeen of the most commonly occurring fish species in the coastal plain are important subsistence resources (NRC 2003). Due to difficulty of access and seasonal restrictions, sport fishing may be considered minimal in the coastal plain (Clough and others 1987; BLM 2012). Arctic char is the most important subsistence freshwater fish species followed by Arctic grayling.

3.2.4 Bald and Golden Eagles

Bald eagles are considered a casual visitor on the coastal plain (Arctic Refuge CCP) but recent observations suggest that they may be more accurately considered a very rare possible breeder in the 1002 area of the coastal plain (T. Swem, pers. comm.). Golden eagles, on the other hand are fairly common visitors on the coastal plain, and rare breeders on the inland coastal plain (Arctic Refuge CCP). Across the entire Arctic Coastal Plain, overall golden eagle numbers in spring increased significantly between 1986 and 2012 at an annual rate of 7%; over the last decade of that period the increase was significant at an annual rate of 37% (Stehn et al. 2013). The mean annual index for golden eagles over the entire period was 118 birds, but in 2012, the index reached an all-time high of 522 (Stehn et al. 2013).

The 1002 area of the coastal plain is very important for non-breeding golden eagles, particularly subadults, which both scavenge and prey upon caribou during the calving and post-calving period of the Porcupine herd (Mauer 1985). Although none of the nest sites visited by Mauer (1985) and his colleagues were within the 1002 area of the coastal plain, subsequent observations have confirmed them as a breeding species there, including at nest sites within core calving areas (T. Swem, pers.comm.).

Within the refuge, golden eagles breeding north of the crest of the Brooks Range begin nesting early in spring. Based on a three-year study (1988–1990), nest initiation dates in those golden eagles ranged from 23 March to 11 May, with annual mean nest initiation dates of 22 April, 14 April, and 5 April in 1988, 1989, and 1990, respectively (Young et al. 1995). Those dates would include the last third of the operations phase and the entirety of the demobilization phase of a recently-proposed winter seismic exploration project farther west on the North Slope (BLM CPAI-NPR- A Final Seismic Environmental Assessment, 2016). Elsewhere, disturbance and development correlated with reduction in golden eagle nest success (Kochert et al. 2002); winter seismic activity could have similar result.

3.2.5 Resident Birds

Four species of birds are considered permanent residents of the coastal plain: Willow Ptarmigan, Rock Ptarmigan, Gyrfalcon, and Common Raven (Arctic Refuge CCP). Gyrfalcons are an uncommon resident of the inland coastal plain (Arctic Refuge CCP); eyries are known in the 1002 area of the coastal plain (T. Swem, pers. comm.). Even in the middle of winter, gyrfalcons may be present on their nesting territories; in the coastal Northwest Territories of Canada (at latitudes comparable to, or greater than, those of the 1002 area of the coastal plain), gyrfalcons have been found on territory as early as February (Booms et al. 2008). Both species of ptarmigan are important components of the gyrfalcon diet, particularly in winter and early spring when other prey types are either absent or scarce (Watson et al. 2012). Nest initiation dates range from early April to early June.

3.2.6 Migratory Birds

In the northern foothills of the Brooks Range, Arctic coastal plain and adjacent marine waters, 158 species have been recorded, including 79 breeding species and 79 species that are migrants, visitors, or vagrants. Birds that use the Refuge have ranges that include all 50 U.S. states and six continents. Thirty-five species of waterfowl have been observed on the Refuge. The geese, except Canada geese, and tundra swans primarily breed on the coastal plain (Arctic CCP 2015).

Red-throated loons have been identified as a species of Conservation Concern by the Service (2008a), Audubon Alaska (Stenhouse and Senner 2005) and the ADFG (2006). Its highest densities are found on the coastal plain and adjacent marine areas, but a few also breed in the Brooks Range and on the south side of the Refuge.

Twenty-six species of shorebirds breed on the Arctic Refuge, of which 22 breed on the coastal plain. Another species, the red knot, occurs as a migrant only. Of these 27 species, 21 are identified as species of Moderate or High Conservation Concern by the U.S. Shorebird Conservation Plan (Brown et al. 2001), Alaska Shorebird Conservation Plan (Alaska Shorebird Group 2008), the Service (2008a), and/or Audubon Alaska (Stenhouse and Senner 2005) because of small or declining populations.

3.2.7 Terrestrial Mammals other than Caribou

As established by ANILCA, the first purpose of the Arctic Refuge is to "conserve fish and wildlife populations and habitats in their natural diversity." Among the wildlife species specifically listed in ANILCA under this purpose are several species of large terrestrial mammals including caribou, Dall sheep, muskox, moose, brown bear, wolf, and wolverine. Caribou will be considered in the next section; Dall sheep do not occur on the coastal plain. Among the five species which do occur in that region, both muskox and moose have experienced marked population declines over the last few decades. After muskoxen were reintroduced to the North Slope in the Arctic Refuge in 1969 and 1970, the population grew steadily and rapidly from 1978 to 1985 and then remained relatively stable until nearly the end of the century. Beginning in 1998, however, numbers within the refuge dropped dramatically for the next half decade and have remained very low ever since. The overall muskox population in northeast Alaska and northwest Canada peaked in 1993, declined through 2006, and has remained relatively stable since then. Most of that decline was due to losses from the Arctic Refuge. Today, most of the muskox in the area are either west or east of the Arctic Refuge (Arctic Refuge CCP).

Moose populations in northeast Alaska, including the Arctic Refuge, increased rapidly in the third quarter of the 20^{th} century. From 1989–1994, however, moose in this region declined by at least 50%, leading to harvest closures on state lands. By the early 21^{st} century, moose populations west of the refuge had started to increase, and by 2015 there was some indication that moose were beginning to increase within the refuge.. However moose continue to occur at low density east of the Canning River on the coastal plain and in the northern foothills of the refuge. Because of concerns about the small population size, harvest restrictions have been implemented (Arctic Refuge CCP).

Of the two species, muskox may be more vulnerable to potential disturbance on the coastal plain. Female muskox don't breed until they are four or five years old, most only breed every other year (or less frequently), and produce just a single calf. They subsist on generally poor quality forage in the winter time, and to compensate, they conserve energy by reducing their winter activity. In addition, calves are born between mid-April and mid-May, 4–6 weeks before snowmelt and subsequent green-up produce nutritious forage. As a result, late winter is a time of high vulnerability, and if any muskox were in the vicinity of seismic exploration camps and activity, disturbance could dangerously impact their energy balance (Arctic Refuge CCP).

Grizzly bears, wolves, and wolverines all occur on the coastal plain, but are more common inland in the foothills and mountains of the Brooks Range. Among the three, bears may be the most vulnerable to disturbance. Throughout the Arctic, brown bears have low rates of reproduction. They exhibit a delayed age at first reproduction (nine years of age in the Arctic Refuge), mean litter size of two, high first-year mortality, and an interval between successful litters of greater than three years. In addition, they emerge from their dens from late March through May; females with cubs usually emerge later than adult males (Arctic Refuge CCP). The den emergence period overlaps the late operation and entire demobilization phases of hypothetical winter seismic exploration. Human-bear conflicts would be possible at this time as recently-emerged and hungry bears are ranging widely in search of early spring food.

3.2.8 Caribou

Caribou are the most abundant large mammal in Arctic Refuge and are an important subsistence species for Iñupiat and Athabascan (Gwich'in) hunters. Caribou are also hunted and viewed by other visitors to the Refuge and are prey for brown bears and wolves.

Caribou have been present in northeastern Alaska and the northern Yukon since the early Pleistocene. Human use of caribou in the region may date back thousands of years. Remnants of caribou fences and corral structures used by the Gwich'in people are found throughout the current southern range of the Porcupine caribou herd (Warbelow et al. 1975).

Large caribou herds tend to migrate over long distances using seasonally available forage resources that are often widely distributed. Caribou move in response to changing weather conditions, biting and parasitic insect harassment, and predators. In arctic areas, caribou reproduction is highly synchronous and the majority of calving occurs in a two- to three-week period. Most adult females give birth to a single calf. Caribou calves are precocious, being able to stand and nurse within one hour after birth and follow their mothers within a few hours. The first 24 hours of life are critical, when a behavioral bond is formed between the calf and its mother. Disturbance of maternal groups on the calving grounds may interfere with bond formation and can increase calf mortality. After calving, small bands of cows with newborn calves gradually merge into larger groups and are joined by yearlings, barren females, and bulls arriving from wintering areas.

Summer weather conditions promote the emergence of mosquitoes, nose bots, warble flies, and other biting insects. Insect harassment drives caribou into densely packed groups. These post-calving aggregations often move toward the Arctic coast or to higher elevations in the mountains to find relief from insects.

By August, large aggregations gradually dissolve into widely dispersed small groups that move slowly toward winter ranges. Breeding takes place en route, and by mid-November, caribou arrive in areas where they will spend the winter.

Four caribou herds live in northern Alaska. Two of these, the Porcupine and Central Arctic herds, consistently use Arctic Refuge seasonally or throughout the year. Caribou would be most susceptible to interaction and potential disturbance from winter exploration activities during their spring migration to calving grounds within the 1002 area of the coastal plain and for those that overwinter in that area, including members of the Teshekpuk Herd.

Porcupine Caribou Herd

An iconic symbol of Arctic Refuge, this herd migrates hundreds of miles from wintering grounds to give birth on the coastal plain and northern foothills of Arctic Refuge and nearby Yukon Territory in Canada. Residents of Arctic Village and, to a lesser extent, Kaktovik, hunt Porcupine caribou. Many visitors come to Arctic Refuge during early summer with hopes of seeing large numbers of caribou.

During the 1960s and 1970s, the Porcupine caribou herd was relatively stable at about 100,000 animals. Numbers steadily increased after 1978, peaked at 178,000 in 1989, and declined to 123,000 caribou in 2001 (Lenart 2007). Between 2002 and 2009, no estimates of abundance were available. During this period, caribou left the coastal plain and northern foothills of Arctic Refuge earlier and did not form large post-calving aggregations, or weather conditions precluded flights to photograph groups (E. Lenart, wildlife biologist, ADFG, pers. comm.). In 2010, 169,000 caribou were counted in a photocensus of the Porcupine caribou herd (Caikoski 2011). Between 2001 and 2013 the herd increased to levels not seen since monitoring began in 1977, with an estimated population of 197,000 (ADFG 2017b).

The Porcupine caribou herd ranges over 130,000 square mi (337,000 square km) of wild lands in northeastern Alaska and northwestern Canada (Lenart 2007). The entire Arctic Refuge coastal plain is key calving and post-calving habitat for Porcupine caribou (Griffith et al. 2002). Foothills and mountains of Arctic Refuge are also important summer, fall, and winter habitats, as well as spring and fall migration routes. As the summer progresses and willows (Salix sp.) emerge, caribou also use riparian habitats. The Porcupine caribou herd generally overwinters south of the Brooks Range in Arctic Refuge and in the Richardson and Ogilvie mountains of the

Yukon Territory, Canada. Winter distribution varies by year but is primarily south of the Brooks Range (Caikoski 2011).

Spring migration to calving grounds begins in mid-April and continues through May. Pregnant caribou move northward from wintering areas toward calving grounds, where they give birth during the first week in June. Timing and routes of migration vary annually depending on where they overwintered, snow conditions, and timing of the onset of spring weather. Caribou wintering in Alaska often follow a northeasterly route to calving grounds, crossing the southern flanks and valleys of the Brooks Range, and eventually entering Canada near the Firth River. Caribou wintering in Canada also converge in this region. Some caribou wintering in Alaska move in a more northerly direction, crossing the eastern Brooks Range and traveling more directly toward calving grounds. As snowmelt progresses, caribou in the foothills spread northwestward along a broad front, primarily following the major river corridors and associated terraces where snow melt has advanced.

For the past few decades, the Porcupine caribou herd has calved in a region encompassed by the Arctic foothills and the coastal plain from the Canning River in Arctic Refuge to the Babbage River in Canada, an area of nearly 8.9 million ac (3.6 million ha) (Griffith et al. 2002). During the calving season in early June, Porcupine caribou selected areas of wet sedge, herbaceous tussock tundra and riparian vegetation types (Griffith et al. 2002). Emerging tussock cotton grass (*Eriophorum vaginatum*) flowers were an important source of high quality forage in areas used by calving caribou (Jorgenson et al. 2002). This plant species had greater biomass and forage quality in tussock tundra compared with other vegetation types. The distribution of tussock tundra and moist sedge-willow tundra was greater in calving areas in the Arctic Refuge 1002 area of the coastal plain than in areas further south and east (Jorgenson et al. 2002).

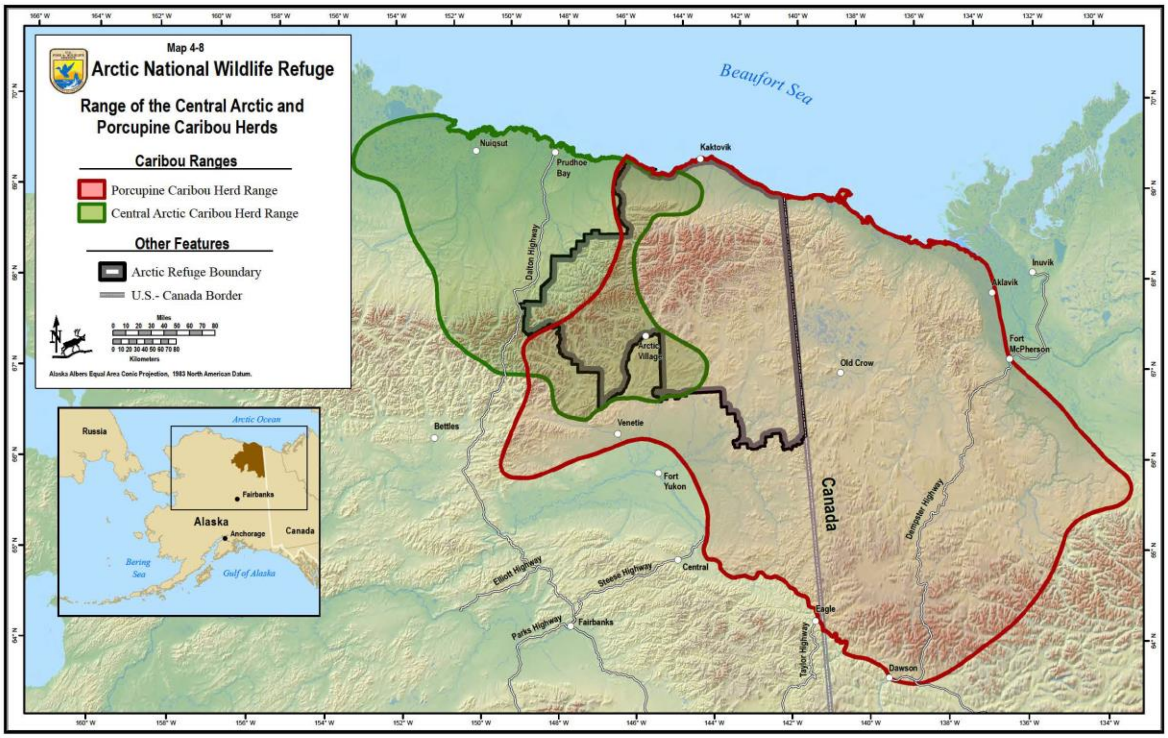
Central Arctic Caribou Herd

The annual range of the Central Arctic caribou herd overlaps that of the Porcupine caribou herd. Two main calving concentration areas have been identified for the Central Arctic caribou herd: a western area between the Kuparuk and Colville rivers, and an eastern area between the Sagavanirktok and Canning rivers. The eastern area includes the Canning River delta region in northwest Arctic Refuge.

During most winters, scattered groups of animals range throughout the coastal plain west of the Katakturuk River and adjacent uplands to the south. Between 2002 and 2009, the winter distribution of the Central Arctic caribou was north and south of the Brooks Range in Arctic Refuge. In some years, they mixed with Porcupine caribou wintering in the same region. In 2010, almost all Central Arctic caribou wintered on the south side of the Brooks Range in Alaska, as did Porcupine caribou.

This herd had about 5,000 caribou in the mid-1970s when it was first identified as a distinct herd (Cameron and Whitten 1979). By the early 1980s, it had grown to almost 13,000 and by the late

1990s, when net calf production was greater than 70 percent calves per female, it increased to over 25,000 (Cameron et al. 2002). A photo census in 2010 counted more than 70,000 caribou in the Central Arctic herd, but a late spring in 2013 resulted in high mortality and the population dropped to 50,000 animals (ADFG 2017a). A 2016 estimate showed further dramatic declines, and the population estimate decreased an additional 50% and is at less than 23,000 caribou. The declines are attributed to both high adult female mortality and mixing of the Central, Teshekpuk and Porcupine herds.



3.2.9 Polar Bear

Of the two polar bear subpopulations (or stocks) found in the United States, polar bears in the Southern Beaufort Sea (SBS) subpopulation are the most likely to occur in the 1002 area of the coastal plain. The subpopulation is shared by the U.S. and Canada and is listed as Threatened under the Endangered Species Act. Critical habitat was established in 2010. The boundary of the SBS subpopulation, as recognized by the Polar Bear Specialists Group, is Icy Cape, Alaska to the west and south of Banks Island and east of the Baillie Islands, Canada to the east (Obbard et al. 2010). The SBS subpopulation had an estimated population size of approximately 900 bears in 2010 (Bromaghin et al. 2015). This estimate represents a significant reduction from previous estimates of approximately 1,800 in 1986 (Amstrup et al. 1986), and 1,526 in 2006 (Regehr et al.

2006). Although there was some evidence in the 2010 estimate that the population might be showing signs of the subpopulation beginning to increase (Bromaghin et al. 2015). Analyses of over 20 years of data on the size and body condition of bears in this subpopulation demonstrated declines for most sex and age classes (Rode et al. 2010, 2014).

Population declines and the size and body condition of bears in the SBS subpopulation have been linked to declining sea ice conditions in the Beaufort Sea (Regehr et al. 2006; Rode et al. 2010, 2014, in press; Bromaghin et al. 2015). Declining sea ice conditions in the Beaufort Sea have also led to an increase in the proportion of the subpopulation coming on shore in summer and autumn (from 5.8% during 1986–1999 to 20% during 2000–2014) and a 30 day increase in time spent on land (Atwood et al. 2016). While on land, polar bears typically do not feed (Rode et al. 2015), although bears in the SBS subpopulation are drawn to bowhead whale remains from subsistence harvest, particularly adjacent to the community of Kaktovik, Alaska (Wilson et al. 2017). These whale remains may be helping offset lost hunting opportunities for bears in the SBS subpopulation due to sea ice loss (Herreman and Peacock 2013, Atwood et al. 2016).

In addition to a higher proportion of the SBS subpopulation occurring on shore during summer and autumn, there is also an increasing trend towards more bears denning on land (Olson et al. 2017). Denning substrate (i.e., sea ice or mainland) is significantly related to where bears occur in autumn. Pregnant polar bears in the SBS subpopulation that spent >25 days on land in autumn all subsequently denned on land (Olson et al. 2017). Between 1985–2013 the percent of bears denning on land in the SBS subpopulation increased from 34 to 55% and is linked to sea ice declines. Designated Critical Denning Habitat overlaps with 77% of the 1002 area of the coastal plain (U.S. Fish and Wildlife Service 2010). There is also 38% more denning habitat available in the coastal plain of the Arctic Refuge than in the region immediately west of the refuge (Durner et al. 2006). Polar bears have been shown to den in the 1002 area of the coastal plain with greater frequency than expected based on available habitat (Amstrup 1993). Based on known den locations from 2000–2010, 22% of dens for bears in the SBS subpopulation occurred within the 1002 area of the coastal plain (Durner et al. 2010). Thus, the 1002 area of the coastal plain has been documented to be an important area for denning by polar bears and will likely increase in importance as the percent of bears denning on land increases with sea ice loss (Olson et al. 2017).

The mean dates of den entrance and emergence for polar bears that den on land in the SBS subpopulation is 11 November and 3 March, respectively (Rode et al. in review). Females observed with cubs in spring emerged 15 days later than females observed without cubs (Rode et al. in review). Land-based denning also appears to be important for polar bears, as bears that den on land have significantly higher reproductive success (Rode et al. in review).

3.2.10 Bowhead Whale

The bowhead whale is classified as endangered under the ESA and as depleted under the Marine Mammal Protection Act. It was listed in 1970, but no critical habitat has been designated. A detailed discussion of the bowhead whale migration and population history is included in the BLM Integrated Action Plan/EIS (2012). The Bering-Chukchi-Beaufort Seas stock of whale is important to the Inupiat peoples of the northern arctic for subsistence. If barging of materials to Kaktovik, Alaska, is required to support exploration of the eastern 1002 area, this population may be affected.

The size of the Bering-Chukchi-Beaufort Seas stock was estimated at 10,400 to 23,000 animals in 1848, before commercial whaling decreased the stock to between 1,000 and 3,000 animals by 1914 (Woodby and Botkin 1993). This stock has slowly increased since 1921 when commercial whaling ended, and in 2001 estimates indicated a population size of about 10,500 whales (George et al. 2004, Zeh and Punt 2005). Separate analyses suggest the mean annual rate of increase from 1978 to 2001 to be between 3.4 and 3.5 percent (George et al. 2004, Brandon and Wade 2004).

Bowhead whales migrate through the Beaufort Sea while traveling between wintering areas in the Bering Sea and summer feeding grounds in the Canadian Beaufort Sea, although some animals may remain in areas offshore in the Beaufort and Chukchi seas throughout the summer. The spring migration typically begins in the Bering Sea in mid-March to early April, depending on ice conditions. During the spring migration, bowhead whales follow somewhat predictable leads that form along the coast of western Alaska to Point Barrow. From Point Barrow eastward to Amundsen Gulf, the leads and the migration occur farther from shore based largely on satellite telemetry tracks (Alaska Department of Fish and Game, unpublished data19). From April to June, most bowhead whales are distributed along a migration corridor that extends from their Bering Sea wintering grounds to their feeding grounds in the eastern Beaufort Sea (Moore and Reeves 1993). Some bowhead whales migrate westward to feeding grounds in the western Chukchi Sea (Bogoslovskaya et al. 1982, Mel'nikov et al. 1997, Alaska Department of Fish and Game satellite telemetry data). Bowhead whales arrive on their primary summer feeding grounds in the eastern Beaufort Sea from mid-May through June and remain in the Canadian Beaufort Sea and Amundsen Gulf until late August or early September. Some whales may occur regularly in the western Beaufort Sea, particularly near Barrow Canyon, and in the Chukchi Sea along the northwestern Alaskan coast in late summer. These animals may be summer residents but may also be "early autumn" migrants. However, it should be noted that recent telemetry data has suggested that bowhead movements are far more labile within their range than formerly thought (Quakenbush et al. 2010) and 'reverse' migratory behavior has been documented.

Bowhead whales that have summered in the eastern (Canadian) Beaufort Sea begin the fall migration in late August to September and are usually out of the Beaufort Sea by late October (Treacy 1988−1997, 2000, 2002a, 2000b; Moore and Reeves 1993). The fall migration route extends from the eastern Beaufort Sea, along the continental shelf across the Chukchi Sea, and down the coast of the Chukotka Peninsula (Moore and Reeves 1993, Quakenbush et al. 2010b) The extent of ice cover may influence the route, timing, or duration of the fall migration. Moore et al. (2000) noted that bowheads in the U.S. Beaufort Sea tended to be distributed closer to shore during their westward migration in light ice years. Miller et al. (1996) also observed that whales moving from 147° to 150° West longitude in the central Beaufort Sea, migrated closer to shore in light and moderate ice years (median distance offshore 18 to 25 miles), and farther offshore in heavy ice years (median distance offshore 35 to 45 miles).

3.2.11 Ringed and Bearded Seals

Ringed seals (*Phoca hispida*) are the smallest and most abundant of the Arctic ice seals (seals that use ice to carry out important life history traits) (Smith and Hammill 1981, Kingsley 1986). Ringed seals have a circumpolar distribution, occurring in all areas of the Arctic Ocean north of approximately 35° north latitude (Kelly et al. 2010, King 1983). A detailed discussion of the ringed seal population and life history is included in the BLM Integrated Action Plan/EIS (2012).

Bearded seals (*Erignathus barbatus nauticaus*) are a pagophilic (ice-associated) seal present in the Chukchi and Beaufort seas year round. They are generally considered to inhabit areas of shallow water (less than 200 meters) that are at least seasonally ice covered (Burns 1970, Kelly 1988b, Cameron et al. 2010). A detailed discussion of the bearded seal population and life history is included in the BLM Integrated Action Plan/EIS (2012).

3.3 Social Environment

3.3.1 Cultural Resources & Historic Background

The Arctic Refuge CCP (2015) describes in detail the known cultural and historic context of the Refuge. When considering development within the Refuge's coastal plain, it is important to note that cultural resources on the North Slope and coastal plain are on or near the surface of the tundra and tend to be oriented along river corridors and coastal beaches. This means that many cultural resource sites on the Refuge are vulnerable to erosion and other natural forces, and to a lesser extent, from public use of Refuge lands and waters. Human use has occurred in the area for more than 10,000 years (Reanier 2003).

Communities surrounding the Arctic coastal plain or that rely on resources, such as caribou, from the coastal plain include Arctic Village, Chalkyitsik, Coldfoot, Deadhorse, Fort Yukon, Kaktovik, Prudhoe Bay,Venetie, and Wiseman. Details of the histories of all communities, except Deadhorse and Prudhoe Bay, are included in the Arctic Refuge CCP (2015). Deadhorse and Prudhoe Bay were not included in the CCP because their residents do not generally use Refuge wildlife resources. These communities fundamentally support infrastructure for the operational oil fields.

Prudhoe Bay and Deadhorse
Prudhoe Bay was named in 1828 for Baron Prudhoe by British explorer Sir John Franklin. In the

1970s the site was extensively developed to support oil drilling operations. The 800-mile Trans Alaska Pipeline, constructed to transport crude oil from Prudhoe Bay to Valdez, has its northern terminus here. At Valdez oil is loaded into marine tankers for shipment throughout the U.S. Prudhoe Bay is also the unofficial northern terminus of the Pan-American Highway. Deadhorse is a small community which is absorbed into Prudhoe Bay for statistical purposes. Prudhoe Bay is a large work camp for the oil industry. All residents are employees of oil-drilling or oil-production and support companies and work long consecutive shifts. Living quarters and food are provided to the workforce, and there are a number of recreational facilities. There are no permanent residents of Prudhoe Bay.

3.3.2 Socioeconomic

Although the communities of Arctic Village, Chalkyitsik, Coldfoot, Fort Yukon, Kaktovik, Venetie, Wiseman, and Prudhoe Bay surround the Refuge, generally only economies of Kaktovik, Coldfoot, Wiseman, and Prudhoe Bay would be directly affected by oil and gas exploration as they are located either in locations where infrastructure could be staged or along the Haul Road, the only developed land route into the area. All of the communities would be indirectly affected if caribou, a valuable subsistence resource, was affected due to their proximity to and use of the Porcupine caribou herd.

Table 3 – 2: Demographic Characteristics of the Communities Near Arctic Refuge

Demographic Characteristics	**Arctic Village**	**Chalkyitsik**	**Cold-foot**	**Fort Yukon**	**Kaktovik**	**Venetie**	**Wiseman**	**Prudhoe Bay**
Overall 2010 Census Population	152	69	10	583	239	166	14	2174
American Indian and Alaska Native	135	59	1	45	212	152	0	163
White	7	10	9	520	24	3	13	1804
Two or more races	10	0	0	10	3	10	1	41
Other races	0	0	0	8	0	1	0	166

Median age	29	27.5	43	33.7	30.5	30.5	28.5	50
Median household income	$27,250 +/- $9,667	$38,750 +/- $16,617	Not Available	$33,194 +/- $7,432	$58,125 +/- $33,478	$28,333 +/- $21,379	Not Available	94,906 +/- 11,207
Employment in 2016								
Employed (#)	87	48	11	266	125	103	5	1978
Employed in the Private Sector (#)	14	6	9	113	41	23	5	1978
Employed in local and/or state government (#)	73	42	2	153	84	80	0	0
Employed in all 4 Quarters (#)	31	27	9	138	93	40	0	1891

3.3.3 Environmental Justice

Some of the communities potentially affected by the Proposed Action are predominantly Alaska Native, with lower incomes than Alaska and U.S. averages. As a result of these socioeconomic characteristics, the analysis of environmental consequences of the Proposed Action and Alternatives in Chapter 4 will determine whether there are disproportionate adverse impacts on these communities as a result of the proposed project.

3.3.4 Subsistence

Section 803 of ANILCA defines subsistence uses as: The customary and traditional uses by rural Alaska residents of wild, renewable resources for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation; for the making and selling of handicraft articles out of inedible byproducts of fish and wildlife resources taken for personal or family consumption; for barter or sharing for personal or family consumption; and for customary trade (16 U.S.C. § 3113).

One of the purposes of the Arctic Refuge is to provide the opportunity for continued subsistence uses by local residents in a manner consistent with the purposes of conserving fish and wildlife populations and habitats and fulfilling international treaty obligations with respect to fish and wildlife (USFWS 2015). With the exception of Prudhoe Bay, each of the affected communities within the proposed project area is characterized by active participation in subsistence fishing, hunting, and trapping on federal, state, and Native corporation lands.

Subsistence Harvest Practices In or Near the Refuge

According to the Arctic Refuge CCP (2015) Arctic Village, Chalkyitsik, Fort Yukon, Kaktovik, Venetie, and Wiseman use the Refuge for subsistence purposes. Due to their close proximity Arctic Village, a Gwich'in community, and Kaktovik, a Inupiat community, use the Refuge most frequently. The subsistence way of life encompasses much more than just a way of obtaining food or natural materials. It involves traditions that are important mechanisms for maintaining cultural values, family traditions, kinships, and passing on those values to younger generations. It is considered a way of life, rather than just an activity. (Alaska Federation of Natives 2010).

Not only are subsistence opportunities critical to the cultural identities of these communities, the resources gained provide needed sustenance for residents. There are very few year-round employment opportunities and food costs are high due to the cost of air transportation.

Although both Arctic Village and Kaktovik rely heavily on the Refuge for subsistence resources, the resources used are significantly different. Subsistence harvest in Arctic Village was 10,000 to 21,000 pounds with moose and caribou constituting 90 percent of the harvest in each year, according to the State of Alaska's Community Subsistence Information System (1993–1997) and data collected by the Council of Athabascan Tribal Governments in 2001 and 2002. The harvested caribou from these surveys come primarily from the migrating Porcupine caribou herd. Because of this, the Gwich'in people consider the Porcupine caribou herd's calving grounds on the coastal plain as sacred ground, a birthing place for thousands of caribou each year (Gwich'in National 1988).

Kaktovik is an Inupiat community located on Barter Island on the shore of the Beaufort Sea. The Kaktovikmiut's way of life continues to be heavily dependent on subsistence harvest of marine and terrestrial animals and fish. Caribou hunting occurs throughout most of the year, while bowhead whaling occurs from late August to early October. When the community harvests a whale, marine resources composed 59 to 68 percent of their total subsistence harvest (Minerals Management Service 2003). In addition to whales, Kaktovik residents also harvest a considerable number of Dall's sheep and caribou, contributing 17 to 30 percent of the annual harvest by weight.

3.3.5 Recreation

The coastal plain is located on lands within ADF&G Game Management Unit (GMU) 26C. ADF&G regulates the seasons, licenses, and bag limits (ADF&G 2015h). Access to prime hunting areas is typically by chartered aircraft, boat, or foot. Two guide use areas could be affected by exploration activities. Nonresident brown bear and Dall sheep hunters must be accompanied in the field by a big game guide authorized to operate in the area (USFWS 2014a).

There are two registration brown bear hunting seasons in GMU 26C. They are held from January 1 to May 31 and August 25 to May 31. In 2016, of the 27 permits issued 12 people reported going hunting (ADF&G website 2017). Caribou hunting is also popular and the hunt is open year round. No permit statistics were available to quantify caribou hunting pressure.

3.3.6 Noise

Sound is defined as a particular auditory effect produced by a given source, for example the sound of rain on the roof, and is measured in decibels (dB). A-weighted sound level measurements (dBA) are a measure of how the human ear hears sound and is used to characterize sound levels. Table 3–4 shows dBA levels for sounds associated with the area and equipment being proposed for use in the action alternatives.

Table 3 - 4: dBA Levels

Source of Noise	dBA Level
Ambient sound without human influence	20 – 30 dBA
Ground wind 5–10 miles per hour	35 – 45 dBA
Ground wind 20 – 30 miles per hour	55 – 65 dBA
Single engine plane fly over at 1,000 ft	88 dBA
Cessna 206	79 dBA
Bell Huey 204	88 dBA
R-66	82 dBA
Propane generator at 500 ft away	30–35 dBA

(Bolin 2006, Illingworth and Rodkin 2006, Schulten 1997, ICAO Annex 2006, US Coast Guard 2010)

Currently there is no source of non-ambient noise on the coastal plain, aside from ground wind and the occasional aircraft, high overhead. Generally, noise levels on the Refuge are expected to be between 20 and 30 dBA in calm winds and up to 40 to 50 dBA in moderate to strong winds.

3.3.7 Visual

Visual resources are often described in relation to landscape character or the overall impression created by an area's unique combination of features, such as land, vegetation, water, and existing structures (cultural modification). Viewsheds are the geographical areas that are visible from given locations. They include all surrounding points that are in line-of-sight with a given location and exclude points that are beyond the horizon or obstructed by terrain and other features.

The landscape character of the coastal plain is of a landscape that is relatively flat, yet interspersed with low ridges and depressions. Tall, linear lined objects would be an unusual characteristic. Viewsheds on the coastal plain are virtually free from indications of human activities except where subsistence structures are located.

3.3.8 Wilderness Values

The Arctic Refuge, including the coastal plain, was initially proposed as "The Last Great Wilderness" and wilderness values were highly prominent in its initial establishment as the Arctic National Wildlife Range. The Refuge's 2015 CCP recommended the 1002 area for Wilderness designation because it exemplifies the wilderness qualities of natural condition, natural quiet, scenery, wild character, and ecological wholeness. The area's diverse wildlife species are particularly valued because they exist in a wilderness context, with their natural behaviors, interactions, movements, and cycles continuing.

The area offers exceptional opportunities for wilderness oriented recreation—adventure, exploration, solitude, and emersion in the natural world. As well, the area holds high symbolic and existence value for millions of people who don't visit, but find satisfaction, inspiration, even hope in just knowing it exists.

4 Environmental Consequences

NEPA requires the disclosure of environmental impacts associated with the alternatives including the No Action Alternative. This chapter presents the anticipated environmental impacts of Alternative 1 (No Action) and Alternative 2. These analyses provide the basis for comparing the effects of the alternatives on the Affected Environment. The exploration activities described in Alternative 2 are general in nature. If Alternative 2 is selected, the regulations are updated, and applications are received, the Service would complete additional NEPA analysis based on the specifics of each proposal at that time.

4.1 DEFINITIONS OF TERMS

Direct Effects – Direct effects are impacts that are caused by the alternatives at the same time and in the same place as the action.

Indirect Effects – Indirect effects are impacts caused by the alternatives that occur later in time or farther in distance than the action.

Long-term Effects – Long-term effects are impacts that would occur throughout the life of the project.

Short-term Effects- Short-term effects are impacts that would occur during only the construction phase of this project.

Cumulative Effects ——The Council on Environmental Quality (CEQ) defines cumulative effects as impacts on the environment which result from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative effects can result from individually minor, but collectively significant actions taking place over a period of time (40 CFR 1508.7). Informed decision making is served by consideration of cumulative effects resulting from projects that are proposed, under construction, recently completed, or anticipated to be implemented in the reasonably foreseeable future.

CEQ guidance in considering cumulative effects states that the first steps in assessing cumulative effects involve defining the scope of the other actions and their interrelationship with a proposed action. The scope must consider other projects whose effects coincide with the location and timetable of a proposed action and other actions. Cumulative effects analyses must also evaluate the nature of interactions among these actions (CEQ 1997). The cumulative effects assessment is based on available information at the time of development of this EA.

To identify cumulative effects, the analysis needs to address two fundamental questions.

1. Does a relationship exist such that affected resource areas of the Proposed Action or alternatives might interact with the affected resource areas of past, present, or reasonably foreseeable future actions?
2. If such a relationship exists, then does an EA reveal any potentially significant effects not identified when the Proposed Action is considered alone?

Mitigation — Mitigation includes special procedures and minimization measures that are implemented to avoid, reduce, or compensate for effects caused by an action. Some mitigation measures are already incorporated into the Proposed Action to avoid and reduce the potential for adverse effects. Other mitigation measures could be characterized as Best Management Practices that further reduce or compensate for adverse effects.

4.2 SIGNIFICANCE CRITERIA

Summaries of the effects on the resources synthesize information about context, intensity, and duration, which are weighed against each other to produce a final assessment. While each summary reflects a determination using best professional judgment regarding the relative importance of the various factors involved, Table 4–1 provides a general guide for how summaries are reached.

Table 4 - 1: Descriptions of Final Assessment Categories

Assessment	**Description**
Beneficial	Resource improvements would occur and would have a perceptible change to the resource.
Adverse: Negligible	Impacts are generally extremely low in intensity (often they cannot be measured or observed), are temporary, and do not affect unique resources.
Adverse: Minor	Impacts tend to be low intensity or of short duration, although common resources may have more intense, longer-term impacts.
Adverse: Moderate	Impacts can be of any intensity or duration, although common resources are affected by higher intensity, longer impacts while unique resources are affected by medium or low intensity, shorter-duration impacts.
Adverse: Significant	Impacts that in their context and due to their intensity (severity) have the potential to meet the thresholds for significance set forth in CEQ regulations and therefore, warrant heightened attention and examination for potential mitigation in order to fulfill the policies set forth in NEPA.

4.4 ALTERNATIVE 1 – NO ACTION

Direct and Indirect Effects: Implementation of the No Action Alternative would result in no direct or indirect impacts to any of the considered resources. There would be no new exploration activities allowed on the coastal plain; and therefore no effects due to this project would occur.

Cumulative Effects: No direct or indirect effects to the existing condition of the resources considered would occur under the No Action Alternative; therefore, no cumulative effects would occur on the resources.

4.5 ALTERNATIVE 2 – PHYSICAL ENVIRONMENT

4.5.1 Soils

It is difficult to fully describe potential environmental consequences when the scope and nature of activities has not been fully outlined. The BLM Integrated Action Plan/EIS (2012) for the NPRA describes general consequences to soils as a result of seismic exploration activities.

Seismic surveys to collect geological data would occur during the winter months. Frozen ground and sufficient snow cover, along with the requirement for low-pressure ground vehicles, would prevent most disturbances to vegetation or compaction of the soils. A majority of seismic surveys create minor, short-term disturbance to soils and vegetation (Jorgenson et al. 2003). However, even with protective measures in place, some small areas of disturbance to soils and vegetation would be expected to occur from seismic surveys and overland moves. In some instances, past overland moves and seismic surveys have disturbed vegetation (the insulating layer), altered the thermal balance, and increased the risk of thermokarsting (Jorgenson et al. 1996). Areas of soil disturbance could be caused at streambank crossings from damage to the vegetative mat, which could be scraped away, leaving exposed soil. Disturbance could also be caused, damaging the tops of tussocks in dryer areas, reducing the insulating abilities, and hastening loss of permafrost. Water-saturated areas show less damage to vegetation and soils from large-tired vehicles (USDOI 2005). The potential for soil erosion would increase with an increase in disturbance to soil and vegetation. Best management practices and other measures are designed to keep areas and severity of disturbance as small as possible.

4.5.2 Hydrology

It is difficult to fully describe potential environmental consequences when the scope and nature of activities has not been fully outlined. This section is developed to address very general potential activities limited to seismic exploration of unknown scope and attendant infrastructure to accomplish this including development of ice roads. It is clear that because unfrozen water is limited in winter on the Arctic coastal plain, negative effects of water withdrawals on overwintering fish populations, benthic invertebrates, and birds and mammals that feed on those organisms seem likely (West et al. 1992). Water withdrawal and its direct influence on reducing available habitat (wetted space) probably impacts fish populations more than any other winter alteration (Cunjak 1996). Since the distribution of adult and juvenile fish is extremely restricted during the long arctic winter when most of a drainage is frozen solid (Craig and Poulin 1975), water removal , leading to reduced groundwater flow or altering baseflow, ice and temperature regimes has the potential to affect all life stages of some populations. Seismic activity could potentially reduce fish populations, divert fish from their normal locations, or adversely affect fish populations and habitat. Exploration activities bring the potential for fuel spills or other releases of contaminants that could affect water quality.

Seismic Exploration and Thermokarst Activity

Seismic exploration can cause thermokarst, especially when snow is insufficient to protect soil and vegetation (WesternGeco 2003). Removal or damage of the organic mat exposes soils to erosion by wind and water, which could deposit sediment into water bodies resulting in higher turbidity and concentrations of suspended sediment. To cause high turbidity, the peat mat must be sufficiently eroded to expose underlying mineral soils, and the mineral soils must be fine grained (BLM 2012).

Effects of seismic exploration on water resources and aquatic habitats

Seismic surveys can be conducted using dynamite (or other explosives), air guns, or Vibroseis to generate acoustical energy pulses necessary to locate subsurface geological formations that might contain oil or gas (BLM 2012). Research has demonstrated that high-intensity acoustic energy can lead to damaged auditory sensory hair cells in fish, effectively reducing the ability to hear (McCauley et al. 2003; Popper 2003; Smith et al. 2004; Popper et al. 2005). The extent of damage and the ability to regenerate these cells is dependent on the intensity and duration of noise and the species of fish. Underwater shock waves can also cause injury to the swim bladder and other organs and tissue (Wright 1982), which could result in a sub-lethal or lethal effects. Fleeing behavior is also a well-documented response by fish to anthropogenic sounds (Popper 2003; Popper et al. 2004). Because of a lack of information regarding the impacts on fish from Vibroseis specifically, winter field tests on the North Slope were conducted in 2000, to measure the sound pressure levels in water that were generated by Vibroseis rigs operating on the ice overhead (Greene 2000; Nyland 2002). The results indicated that these sound pressures were great enough 10 meters from the source to cause avoidance behavior, but no measurements were made directly below the Vibroseis equipment. Fish fleeing behavior was the most obvious effect of Vibroseis during the 2003 Alaska Department of Natural Resources/BLM study (Morris and Winters 2005). Because exploration using Vibroseis occurs in the winter when physiological stress is the greatest for most fish species, a flight response could potentially be detrimental. (BLM 2012)

Use of Explosives

Use of explosives is a major disturbance to fish and wildlife. These are particularly stressful to fish that are captive in overwintering habitats and would likely have a negative impact on terrestrial and aquatic animals that congregate near spring-fed oases during winter as well as presenting potential contamination issues.

Effects of Water Withdrawal from Lakes

In other areas of the North Slope the primary source of water during the winter months for exploration activities is unfrozen water that lies beneath the ice cover of both shallow and deep lakes. This water is somewhat saline because of the exclusion of ions during the freezing of the upper part of the lake. Water from lakes may be used for ice roads, pads and airstrips, and potable water for field crews. Typically the volume of water taken from an individual lake depends on the depth of the lake, volume of unfrozen water in the lake, and the presence and type of fish documented (BLM 2012).

Water withdrawal affects the available habitat for fish species if they are present, macroinvertebrates and can otherwise impact aquatic habitat by further altering water quality and reducing the water available when breakup occurs potentially affecting spring recharge and lake levels.

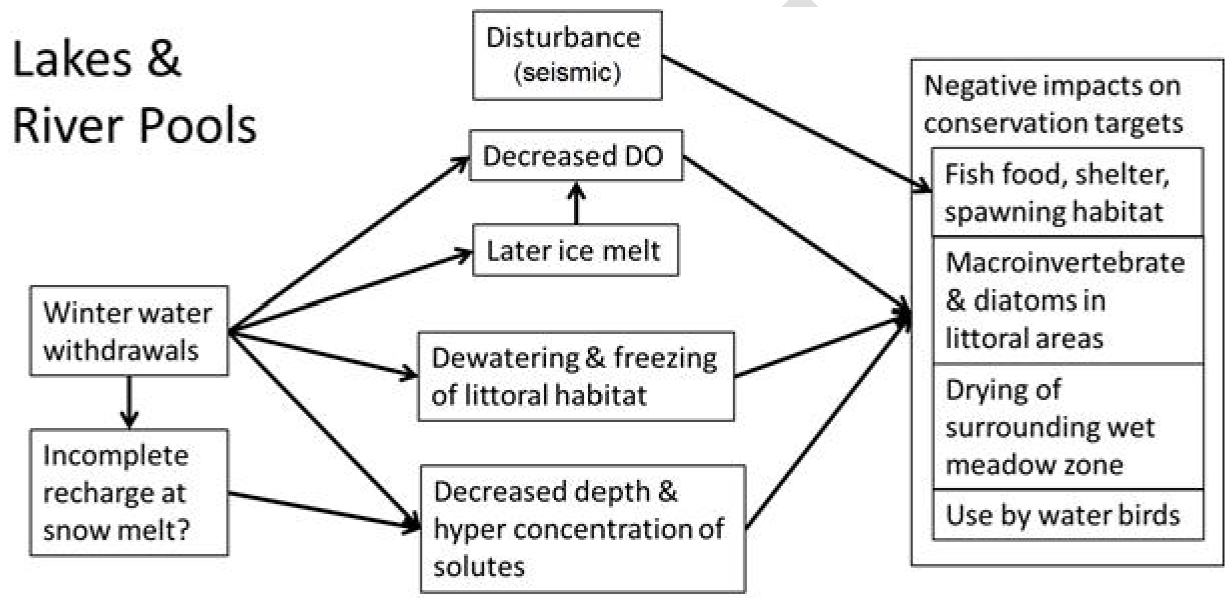


Figure 1. Potential impacts of seismic exploration on lakes and rivers

Removal or compaction of snow can increase the depth of freezing on lakes, sometimes by one foot or more. As a result, the water quantity available in a lake during the winter months can be greatly reduced, and the salinity of the water beneath the ice can be increased further. Maintaining the natural hydrologic regime may not be possible under various pumping scenarios. To reduce impacts to the natural hydrologic regime, regulations typically prohibit snow compaction on fish-bearing lakes, but snow compaction is unavoidable when ice aggregates are removed from lakes (BLM 2012).

There are no studies assessing the effects of permitted withdrawals on lake water chemistry on the North Slope of Alaska. Hinzman et al. (2006) conducted a study to assess the effects of what turned out to be relatively small water withdrawals on water chemistry and lake-recharge. This work was funded by the Department of Energy and oil field companies, and did not undergo a standard peer-review process, yet it is widely cited by the BLM and DOE. Unfortunately, only a small fraction of the permitted withdrawal volume was actually pumped from the study lakes, the study design had almost no ability to detect change, and the researchers were unable to get their dissolved oxygen sensors functioning to conduct any relevant measurements in pumped lakes.

Thus, we have no information on potential impacts of heavy pumping that is currently allowed by water withdrawal permits on the North Slope of Alaska. Despite the low ability to detect change, Hinzman et al. (2006) did find that one of four pumped lakes did not fully recharge at snow melt. This suggests that water withdrawals far less than permitted volumes can have significant impacts on lake hydrology and the availability of wetted habitat. Canadian studies on ice-covered lakes have found that water withdrawals have a substantial and wide range of negative impacts on aquatic ecosystems (Cott et al. 2008). These include reduction of habitat for fish, waterfowl, and furbearers; reduction in oxygen available to overwintering fish; and dewatering and freezing of littoral habitats which kills plants, invertebrates, and fish eggs. Isolated lakes may be particularly vulnerable as they may not recharge at snowmelt. Organisms in small isolated lakes are particularly sensitive to water withdrawals. The effects of water withdrawals on wet meadow zones surrounding lakes are unknown, but would likely be great if lakes are not fully recharged at snowmelt. This would result in a reduction in habitat for waterfowl and shorebirds that use these lakes during the summer.

Effects during exploration on water chemistry from water withdrawals could be short term if lakes are fully recharged during spring. Impacts to overwintering fish and littoral zone communities will likely be more substantial and longer-term, especially in isolated lakes.

Effects of Ice Roads, Ice Pads and Ice Bridges

Ice roads and ice pads are used extensively during the winter season for access and for seismic exploration. Ice roads require about 1 million to 1.5 million gallons of water per linear mile and generally can be built at a rate of about 1.5 inches of thickness per day (BLM 1998). Ice pads can require up to 5 million gallons of water to build and range in size from 3 to 10 acres. Floating ice bridges may be necessary to cross large rivers and must be of sufficient thickness to handle heavy truck traffic. Smaller rivers require ice bridges, which are often constructed of aggregate chips and water and placed on grounded ice. Ice roads and bridges can cause additional freeze-down, reducing the already limited overwinter water volume available for fish habitat and affecting water quality. During snow melt ice bridges can create ice dam flooding if not removed properly.

4.6 ALTERNATIVE 2 - BIOLOGICAL ENVIRONMENT

4.6.1 Vegetation

Similar to the effect to soils, we expect seismic surveys to create minor, short-term disturbance. Vegetation near stream banks may be particularly at risk as the soil they grow in may be more be disturbed by the movement of equipment uncross uneven ground. In the NPRA EIS (2012) they found that in general, construction of ice roads, pads, and airstrips would have only localized impacts on vegetation, usually limited in wetter areas to compression of the tundra vegetation under the roads and pads and a shortened growing season for the plants in the following summer due to delayed melting of the ice in the spring. However, ice roads and pads could also cause breakage of shrubs and scuffing and crushing of tussocks in moist or drier habitats, and localized areas of plant death (Jorgenson 1999; Pullman et al. 2005; Yokel et al. 2007). Recovery from most impacts to vegetation would be expected within a few years.

4.6.2 Wetlands

The BLM Integrated Action Plan/EIS (2012) for the NPRA describes general consequences to wetlands as a result of seismic exploration activities and similar to the NPR-A, the vast majority of the 1002 area of the coastal plain is considered wetlands, according to the Service National Wetlands Inventory database. As such, we can assume that any ground-disturbing actions to vegetation will also be impacting wetlands. Once a specific exploration plan has been developed a full analysis can be completed in order to develop site specific mitigations.

4.6.3 Fisheries

Direct impacts would include mortality to fish or alterations to habitat by geophysical exploration that make these unacceptable or suboptimal for life history requirements and/or long-term survival, including contaminant spills, failure of sewage or waste-water disposal, blasting, channelization, culverts or barriers to movement, increased turbidity from construction, toxic effects of drilling muds or depletion of dissolved oxygen levels. Over-harvesting of selected fish species may occur if not stipulated as a prohibition to the increased human workforce during exploration or development.

Indirect impacts would fish swept into storage reservoirs during high flows (storm events, spring snowmelt or construction activities) where fish are trapped when water levels return to normal or are pumped out. Such events occur naturally. Additionally, such artificial impoundments may provide alternative overwintering habitat for some species in a region where such habitats are scarce. Access to and from the larger population would be necessary for this to be an effective benefit to fish species. Abandoned deep-water reservoirs have been beneficial for several fish species (Moulton and George 2000).

Early pipeline and development in the Prudhoe Bay area reduced some fish populations due to locations of road crossings, undersized or undercut culverts prior to understanding species-specific swimming needs (Moulton and George 2000).

Those species that do not migrate are not as likely to be affected by impacts related to barriers and some habitat changes. However, wintering areas are essential. Therefore, any factor linked with exploration or development that reduces adequate open water depths during winter months may have the potential to reduce populations at specific locations.

Each Arctic grayling river-population is distinct from others. Therefore, geophysical impacts could have a larger footprint on a landscape scale than a single site. However, the distribution of the Arctic grayling has increased in Prudhoe Bay environs since the development of the the oil-field (NRC 2003).

Direct, indirect, and cumulative effects of geophysical exploration and oil-field development pose little risks to freshwater fisheries and their habitats based on recent evaluations and using best management practices that have evolved since the late 1970s to late 1980s (Moulton and George 2000; NRC 2003; BLM 2012). The use of vibration equipment in lieu of blasting has reduced overpressure mortalities in fish and less intrusive to habitats. Low ground-bearing pressure vehicles reduce soil disturbances and potential for sediment mobilization and associated accumulation to lakes and streams. Capping the amount of water withdrawal from any natural waters may minimize overwinter mortalities or reduction of overwintering habitat for fish.

4.6.4 Bald and Golden Eagles

Although we do not anticipate significant effects to bald eagles, as they are not common within the 1002 of the coastal plain; further analysis of project specific plans will be required to analyze possible effects and needed mitigation measures for golden eagles. We know the golden eagles feed on caribou calves being born in the 1002 area and that they are within their nesting season during the time of winter exploration. Elsewhere, disturbance and development correlated with reduction in golden eagle nest success (Kochert et al. 2002) and we expect winter seismic activity could have similar result.

4.6.5 Resident Birds

Ptarmigan and gyrfalcon are known to be present within the 1002 area of the coastal plain during the winter. Gyrfalcon, like golden eagles, are early-nesting birds that could be disturbed by winter seismic exploration during both the late operation and demobilization phases. Gyrfalcons are known to be disturbed by both fixed-wing aircraft and helicopter overflights; disturbed birds are less likely to use the same site in subsequent year (Booms et al. 2008). Further analysis of project specific plans will be required to analyze possible effects and needed mitigation measures for bird species present during any proposed seismic activities.

4.6.6 Migratory Birds

Many species of migratory birds use the coastal plain for nesting or for feeding in preparation for fall migration. These include a variety of waterfowl and shorebirds that are dependent on aquatic and lakeshore habitats for nesting or feeding. If winter water withdrawals impact shoreline vegetation and/or aquatic plants, fish, and invertebrates, these effects could negatively impact waterfowl and shorebirds.

4.6.7 Terrestrial Mammals (Caribou, Muskox, Wolverine, Grizzly Bears)

Impacts to habitat used by terrestrial mammals would be minor, as most seismic activities would occur during the winter on frozen tundra or ice. Potential causes of disturbance to terrestrial mammals from seismic activities would include surface vehicular traffic on frozen tundra or ice and fixed-wing aircraft traffic. In most cases, these activities would cause short-term displacements of and/or disturbance to terrestrial mammals. Where 3-D seismic exploration survey lines are located only 660 to 1,200 feet apart, localized displacement of terrestrial mammals could last for several days or lead to complete abandonment of localized habitat.

Effects on caribou and moose could include temporary habitat displacement and increased energy expenditure associated with increased disturbance movement. Caribou overwintering on the coastal plain would likely be encountered during seismic surveys. It is possible that displacement of caribou by seismic exploration activities during winter could have a negative effect on their energy balance (intake versus expenditure). Because these animals are mobile and the operation would be short in duration (e.g., 2 to 3 days in one area), it is not anticipated that any lasting adverse impacts to caribou would result under most circumstances. However, this assumption has not been scientifically tested and conditions for winter survival vary from year to year. It is possible that this disturbance could have an additive effect on natural winter mortality and could disproportionately impact young of the year and pregnant cows. Caribou have been shown to exhibit panic or violent, running reactions to aircraft flying at elevations of approximately 160 feet and to exhibit strong escape responses (animals trotting or running) to aircraft flying at 150 to 1,000 feet (Calef et al. 1976). Additional effects on caribou nutrition during the calving and post calving periods could occur as a result of delayed green up of vegetation underlying ice roads and pads or areas of compacted snow. The severity of these impacts would be dependent on the extent of the affected areas and by timing of snowmelt during a particular year.

Previous studies of the effects of oil and gas exploration on muskoxen in Alaska and Canada focused on disturbances associated with winter seismic operations. Some muskoxen reacted to seismic activities at distances up to 2.5 miles from the operations; however, reactions were highly variable among individuals (Reynolds and LaPlant 1985). Responses varied from no change in behavior to becoming alert, forming defense formations, or running away (Winters and Shideler 1990). The movements of muskoxen away from the seismic operations did not exceed 3 miles and had no apparent effect on muskox distribution (Reynolds and LaPlant 1986). Unlike caribou, muskoxen are not able to travel and dig through snow easily. In the winter, they search out sites with shallow snow, and greatly reduce movements and activity to conserve energy (USDOI U.S. Fish and Wildlife Service 1999). Muskoxen survive the winter by using stored body fat and reducing movement to compensate for low forage intake (Dau 2001). Because of this strategy, muskoxen may be even more susceptible to disturbances during the winter. It is possible that repeated disturbances of the same animals during winter could result in increased energetic costs that could increase mortality rates. Depending upon the location of the seismic exploration, impacts on muskox populations would be non-existent to minor.

Seismic camps could result in localized disturbance and/or displacement of terrestrial mammals for up to a few days. Bears and foxes could also be attracted to camps and conflict could result. Since seismic camps generally move at least once a week and proper handling of wastes would be regulated through permitting, the potential for bears or foxes to be attracted to human food sources would be minor. In addition, most seismic activity would occur when bears were hibernating and not attracted to scents. However, grizzly bears denning on the coastal plain, including females with dependent cubs, would be exposed to disturbance from seismic activities. Disturbance during winter can cause bears to abandon their dens, which increases winter mortality. Mitigations measures, such as those employed in existing oil fields west of the refuge will be required to minimize this disturbance.

The potential effects of seismic activities on wolverines would include disturbance from air and surface vehicle traffic, and increased human presence. Wolverines are considered a shy and secretive species that is present at very low densities and may be sensitive to disturbance.

4.6.8 Caribou

Addressed in previous section

4.6.9 Polar Bears

Terrestrial oil and gas industry seismic survey activities on the North Slope of Alaska typically require between 80 and 160 personnel. Substantial logistical support is required for a seismic survey operation, and also to support the personnel camps, vehicles, security, aircraft operations, restocking of the explosive magazine (if explosives are used), medical support, scientists, marine mammal observers, ice road construction, barge traffic, and many other logistical and support functions.

Polar bears present in the Arctic Refuge 1002 area may be affected by seismic survey activities in various ways. Noise, vibrations, sights, and smells produced by seismic survey activities may elicit a wide range of responses from polar bears. Polar bears respond to the sights and sound of snowmachines, vehicles, vessels, and aircraft; especially helicopters (Watts and Ratson 1989; Dyck 2001; Dyck and Baydack 2004; Andersen and Aars 2005). Polar bear responses to disturbance are highly variable and are influenced by an individual bear's previous experiences and tolerance level. Polar bears are most likely to respond to the majority of seismic survey activities with short-term behavioral and physiological responses such as avoidance, increased vigilance, increased heart rate, and other stress responses. Disturbance during resting may result in increased energy expenditure or adverse physiological responses (Watts et al. 1991), but short-term reactions like these will rarely affect the health or survival of individual animals or the population. The effects of fleeing from aircraft may be minimal if the event is short and the animal is otherwise healthy and unstressed. However, on a warmer day, a short run may be enough to overheat a well-insulated polar bear. The effect of fleeing an aircraft or ground vehicle on polar bear cubs, particularly cubs of the year, would likely be the use of energy that otherwise would be needed for survival during a critical time in a polar bear's life, and potentially separation from the female. If the exposure and separation, or both, were brief and singular then the effect would most likely be minimal. Chronic disturbances, extreme reactions, disruption of key behaviors such as feeding or denning, or separation of dependent cubs from the female are more likely to affect health or survival. Polar bears directly interacting with seismic survey activities increase the risk of human-bear encounters, conflicts, and injury or death of polar bears.

Seismic survey activities disturbing female polar bears at maternal den sites are of great concern. Minimizing disturbance while bears are in dens is important because timing of den emergence is significantly related to cub survival (Rode et al. in review). Female polar bears entering dens and females in dens with cubs are more sensitive to noises than other age and sex groups. Disturbance during the early stages of denning may cause a female polar bear to abandon the den site in search of another one. A female polar bear may locate another suitable den site and continue her reproductive process Denning female bears may abandon their dens early in response to stress (Amstrup 1993). Amstrup (1993) reported most polar bears in dens continue to occupy the dens after close approaches by aircraft. Although the snow attenuates some aircraft noise (Blix and Lentfer 1992), repeated overflights may cause polar bears to abandon or depart their dens. Premature den site abandonment after the birth of cubs, or if the female abandons the cubs after they emerge from the den, will result in cub mortality. The potential for disturbance increases once the female emerges from the den. She is more vigilant against perceived threats and easier to disturb.

Though human activities (e.g. industrial, subsistence) are expected to exert a smaller influence on polar bear populations than the loss of sea ice habitat (Atwood et al. 2015; Regehr et al. 2015), the cumulative effects of seismic survey activity and climate change are not well understood. Habitat loss due to changes in Arctic sea ice is the primary cause of decline in polar bear populations, and the decline of sea ice is expected to continue throughout the polar bear's range for the foreseeable future (73 FR 28212, May 15 2008). Under both stabilized and unabated greenhouse gas emissions models, polar bears are expected to have greatly decreased persistence throughout the region (Atwood et al. 2015). The effects of seismic survey activity in the Arctic Refuge 1002 area combined with the effects of climate change could have unknown effects on the Southern Beaufort Sea population of polar bears.

The requirements of incidental take authorizations under the Marine Mammal Protection Act, such as polar bear interaction plans, training, monitoring, and mitigation measures have proven effective at reducing the effects of oil and gas industry activities, including seismic surveys, on polar bears in other areas of northern Alaska. Mitigation measures, including a pre-activity den survey and a 1.6-km (1-mi) operational exclusion zone around known dens help to limit disturbance of denning female polar bears. The current incidental take regulations for oil and gas industry activity in the Beaufort Sea and adjacent areas of northern Alaska, published in the Federal Register on August 5, 2016 (81 FR 52276), include a comprehensive analysis of the effects of oil and gas industry activity to polar bears, as well as mitigation, monitoring, and reporting requirements. A detailed description of mitigation measures that limit the effects of seismic surveys on polar bears is available at title 50 of the Code of Federal Regulations, part 18, subpart J, section 18.128.

4.6.10 Bowhead Whale

Bowhead whales would generally only be affected if offshore ice roads are developed or if project infrastructure will be shipped to the project site via barge through the Beaufort and Chukchi Sea. Further analysis, in conjunction with the National Marine Fisheries Service, of project specific plans will be required to analyze possible effects and needed mitigation measures for bowhead whales.

4.6.11 Bearded and Ringed Seals

Similar to bowhead whales, bearded and ringed seals would generally only be affected if offshore ice roads are developed or if project infrastructure will be shipped to the project site via barge through the Beaufort and Chukchi Sea. Further analysis, in conjunction with the National Marine Fisheries Service, of project specific plans will be required to analyze possible effects and needed mitigation measures for these ice seals.

4.7 ALTERNATIVE 2 - SOCIAL ENVIRONMENT

4.7.1 Cultural Resources

Very little cultural resource investigations or inventories have occurred within the 1002 area. Therefore, pursuant to Section 106 of the National Historic Preservation Act, applications for exploration within the 1002 would be required to include sufficient identification and evaluation of cultural resources to ensure that potential adverse effects could be avoided, minimized or mitigated.

4.7.2 Socioeconomic

Impacts to socioeconomic resources would be considered to be significant if an action resulted in a substantial change in the local or regional population; and housing, community general services, or social conditions from the demands of additional population/population shifts. Impacts would also be considered major if there were a substantial change in the local or regional economy, employment, or spending or earning patterns.

We would expect minor direct and indirect effects in Coldfoot and Wiseman during transport of equipment and personnel. Communities used for staging, likely Prudhoe Bay and/or Kaktovik could expect to see increases in activity during the project. They would see increases in air traffic as equipment and personnel are transshipped to the field. Staging communities would also experience increased activity in hoteling and restaurants to support personnel. Project personnel would be experienced operators from outside the area.

4.7.3 Environmental Justice

A Federal agency is required to identify and address, as appropriate, any disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations (Executive Order 12898, February 11, 1994, amended January 30, 1995, by Executive Order 12948). This includes health risks and other impacts for people who rely principally on fish or wildlife for subsistence. Subsistence activities are a way of obtaining food or natural materials and an important mechanism for maintaining cultural values, family traditions, kinships, sharing practices, and relationships to the land. We do not expect direct or indirect effects to the

4.7.4 Subsistence

The Alaska National Interest Lands Conservation Act (ANILCA) Section 810 requires an evaluation of the effects on subsistence uses for any action to withdraw, reserve, lease, or otherwise permit the use, occupancy, or disposition of public lands. This analysis will be done as part of the final environmental assessment.

4.7.5 Recreation and sport hunting

On-shore seismic surveys in the winter would likely be conducted using mobile seismic camps comprised of ski-mounted trailers that are moved every few days to once a week (BLM 2012). Such activities could displace species being sought by hunters in the area, having an impact on their success if they were unable to locate animals due to the disturbance. Any ice roads, ice pads or snow trails would be temporary. Disturbance lasts only while the survey or camp train is passing through. Lighting at the facilities would be visible to any hunters or recreationalists passing nearby. Persistence of compacted snow or ice structures may be encountered by recreationalists in the spring and are unlikely to be a barrier to recreation by foot or boat travel.

4.7.6 Noise/Soundscape

Noise from vehicles, generators, aircraft and human presence has the potential to affect both humans and wildlife within the vicinity of seismic survey activities. The disturbance distance depends on the source and strength of noise, but should be negligible outside the immediate vicinity and is only temporary in nature.

4.7.7 Visual

On-shore seismic surveys on the North Slope are only collected in the winter; therefore, the colors of structures and equipment would be in contrast with the white color of the snow-covered landscape. Lights on equipment would be visible when the equipment is passing through an area. Few travelers would be expected on the Arctic Coastal Plain during the winter, minimizing the numbers of the public that would be affected by localized visual disturbance. Local subsistence users could be traveling on the tundra and observe the seismic activity. The BLM's NPRA EIS (2012) determined that "visual resources could be minimally impacted from the moving camps, aircraft, and human presence. The seismic operations would have a moderate contrast on the landscape character element of line."

4.7.8 Wilderness Values

Wilderness characteristics consist of size, naturalness, wildness, and outstanding opportunities for solitude or primitive and unconfined recreation. They may also include supplemental and symbolic values.

Seismic surveys would be conducted in winter, when there are fewer visitors seeking a wilderness experience come to the Arctic Coastal Plain. Ice roads, ice pads, airstrips, and snow trails would be used for staging winter seismic activities and are temporary in nature. The BLM's NPRA EIS (2012) describes seismic activity as consisting of low-ground-pressure vehicles to minimize potential impacts to the tundra. The typical survey lasts about 100 days. Seismic camps, which generally consist of six camp strings of five ski-mounted trailers, are typically moved every few days to once a week. The presence of this equipment on the Arctic Coastal Plain would have a significant but temporary impact on the wilderness value of the area where seismic surveys are being conducted during the time period of the activity. Impacted wilderness values would include naturalness, outstanding opportunities for solitude or primitive and unconfined recreation, and scenic values resulting from moving camps and associated noise from generators, aircraft, vehicles/trailers and human presence (BLM 2012). Impacts to wilderness values should be negligible once the activity is completed.

Longer lasting impacts to vegetation could result from seismic surveys, which could impact wilderness values of naturalness and scenic values. The color contrast would be minimal from ground view and almost nonexistent from more than a few hundred feet away (BLM 2012). After 8 to 9 years, the evidence of use would be minimal (BLM 2012). Seismic operations by their nature do not follow the same routes every year and the number of miles of survey line run can vary greatly from year to year.

5 Cumulative Effects

<u>Past, Present or Reasonably Foreseeable Actions</u>

Across the larger landscape of the North Slope (North Slope Borough), the coastal plain from Point Barrow to Point Demarcation (approximately the U.S. and Canadian border) is increasingly developed. This is especially true of the western end with the National Petroleum Reserve-Alaska (NPRA), Prudhoe Bay and adjoining oilfield from Tarn and Kuparuk on the western end to Point Thompson on the eastern end at the western-most boundary of the Arctic Refuge and 1002 area. With the discovery of oil in the late 1960s came the first explorations, developments and finally production. Following the international oil crisis of 1973, the Trans-Alaska Pipeline Systems (TAPS) was build and spanned Alaska from north to south, Prudhoe Bay to Valdez. The TAPS has been moving oil from the oilfield to transports for 40 years and likely to continue for the long term. Lateral pipelines are under construction or proposed to connect with the TAPS in the near future. The TAPS is approved to operate via DOE permit through 2032.

To accommodate development and infrastructure construction, a road was constructed from Fairbanks to Deadhorse to convey personnel and material necessary to build and maintain the oilfields, pipeline and support services and allowed overland access to the North Slope year-round. Initially constructed with private funds and for industrial purposes only, the road was eventually turned over to the State of Alaska to maintain. In addition to still be maintained largely for industrial purposes, it is now a popular for vacationers and sport hunter access (FWS 2010).

The oil and gas industry continue to expand with one of the most recent developments, the Liberty Project on the Alaska outer continental shelf (BOEM 2017) and the NPRA being opened for oil and gas lease sales, as announced in September 2017. The development of the North Slope, including the coastal plain environs is likely to continue into the foreseeable future (Clement and others 2013; NRC 2014, 2015; Alaska Arctic Policy Commission 2015).

Increasing mean annual summer temperatures concurrent with projections for less snow cover during winter months will greatly facilitate development of industry, infrastructure, and public access to the North Slope.

The proposed full build-out oil and gas development scenario footprint projected to be 2,000 acres or 0.13 percent of the total 1.5 million acre 1002 area as described in the 1987 *Coastal Plain Report/EIS* (Clough and Christiansen 1987). This includes 8 large pads for housing storage, drilling with a heavy-duty large airstrip (estimated 82 acres each); 19 medium-size pads for drilling with light-duty airstrip (estimated 37 acres each); and, 26 small pads for drilling (estimated 11 acres each). Also, 8 gravel pits would established, each about 150 acres. Additionally about 275 miles of pipeline corridor (average 100-foot wide) would be developed with associated construction widths reduced to maintenance and operation, estimated at 3,330 acres. Note that the total footprint based on the estimated acreage annotated here is about 6,175 acres which vastly exceeds the 2,000 acre full build scenario described in the 1987 *Coastal Plain Report/EIS* (Clough and Christiansen 1987) and still does not include road infrastructure, water pumping sites, dock facilities or seawater treatment plants.

It is possible that the differences in the 1987 scenario build-out acreages may be accounted for in the area *directly affected* by oil and gas development, which is estimated at 12,650 acres, or 0.84 percent of the total 1.5 million acre 1002 area (Clough and Christiansen 1987). This would include the actual footprints of scattered pads and all associated construction and maintenance and operation phases of development through production. Improvements in industry technology since development of the 1987 may greatly reduce pad size or consolidation of separate pads into pads facilitating multiple drilling operations. However, pipelines, gravel pits, and other supporting infrastructure footprint will remain constant.

Advances in the oil and gas state-of-the-industry since the late 1970s through late 1980s include: increasing directional drilling capacities; reduced pad sizes; multiple drillings from a single pad; low ground-bearing pressure vehicles; winter site development; buffer zones around critical resources; among other features or best management practices (BMPs), the scope and scape of the exploration, development and production may be expected to be reduced from the initial estimate. All these considerations serve to mitigate direct, indirect and cumulative effects through avoiding, minimizing, rectifying, reducing, and/or compensating the significance of context and intensity for the proposed oil and gas exploration, development, and production activities.

Concurrently, there have been advances in understanding of mitigation technologies and cumulative effects for many Arctic species and habitats. The 29 listed mitigation recommendations of the 1987 *Coastal Plain Report/EIS* (Clough and Christiansen 1987), although now largely dated, provide a basis for updating and augmenting state-of-the-industry advances since (Clough and Christiansen 1987). Specifically, this includes the changes for threatened, endangered and sensitive (TES) species: arctic pennycress (*Noccaea arctica*, formerly *Thlaspi arcticum*), more common than initially determined; the delisting of the American Peregrine Falcon (*Falco peregrinus anatum*) and Arctic Peregrine Falcon (*F.p. tundrius*); and, listing of the polar bear (*Ursus maritimus*), among other considerations.

Cumulative effects including some aspects of climate change, not adequately considered in the 1987 *Coastal Plain Report/EIS* (Clough and Christiansen 1987) are addressed at least up to the time of publication in *Cumulative Environmental Effects of Oil and Gas Activities on the Alaska's North Slope* (NRC 2003). Additionally, biological resources in relation to oilfield developments including: vegetation and biotic communities; caribou, grizzly bear; polar bear; Arctic fox; Pacific Loon; Tundra Swan; Lesser Snow Goose; Common Eider (Pacific Eider); shorebirds; freshwater invertebrates; freshwater fish; anadromous fish; and benthic marine communities are discussed in *The Natural History of an Arctic Oil Field: Development and the Biota* (Truett and Johnson 2000). Finally, parallels from exploration, development and production of oil and gas on the North Slope may be National Petroleum Reserve – Alaska EIS (BLM 2012), which are directly comparable to the coastal plain 1002 area. Additional information relative to wildlife and water resources and the oil and gas industry may be found in a variety of environmental evaluations, principally through NEPA, and other permitting conditions, for example, the recent Liberty Development Project (BOEM 2017).

As examples of advances in state-of-the-industry, oil and gas environmental impacts can be significantly reduced if these activities occur during winter months, when the tundra is frozen and protected by snow cover, and most wildlife are absent (Gliders and Cronin 2000). In summer, the thawing snow and lengthening days bring millions of shorebirds and waterfowl in search of nesting sites along with caribou migrating from wintering locations in the interior. The oil exploration and production process involves multiple stages that may require several years or even decades to complete for each oil field. New technologies involving reduced well spacing, elimination of reserve pits, directional drilling, winter maintenance and construction from ice pads and roads, aerial support, and the use of baseline and ongoing biological monitoring programs to facilitate decision making have reduced the areal impacts of development. The incorporation of baseline biological studies and monitoring of exploration and field development assists in minimizing impacts to high-value habitats and species. In this manner the oil and gas industry reduces encroachment on wildlife habitat and avoids disturbance to wildlife during critical periods (Gliders and Cronin 2000).

As a specific example, denning bears and particularly denning females with young were susceptible to seismic blasting during exploration surveys. Rousing bears, emerging and resettling, required energy reserves that might place individual bears at risk for long-term survival and especially cubs-of-the-year. In part this was because field crews were unaware of denning sites. Bear dens are now more closely monitored due to the threatened status of the polar bear, typically via radio-telemetry. Additionally, traditional blasting has been replaced by vibrators and sensor lines which are far less intrusive to denning bears. As a consequence, the disturbance threat has been greatly reduced through advances in technology (Reynolds and others 1986; McLellan and Shackleton 1988, 1989; Mattson 1990; Blix and Lentfer 1992; Linnell and others 2000).

However, cumulative effects of oil and gas exploration, development and production become problematic for long-term recovery and restoration. Some sites abandoned and rehabilitated to various degrees still show evidence of impacts 40 to 60 years following the activity (Walker and others 1987; Felix and Raynolds 1989; Gliders and Cronin 2000; Kemper and MacDonald 2009; Jorgenson and others 2010; McCarter and others 2017).

As an example of unknowns and uncertainty of climate change in relation to oil and gas exploration, development and production are water resources and their use for industry. While the creation of impoundments for water storage and subsequent use for drilling operations has created habitat and expanded the distribution of such species as the Arctic char (Moulton and George 2000; NRC 2003), it is only with the provision that pumping capacity is capped so that sufficient overwintering habitat is available below the maximum ice depth and large enough to contain dissolved oxygen for the longest period of ice coverage. This is important in a landscape where overwintering habitat for fish is limited (Reynolds 1997).

Climate projections for the North Slope indicate not only warming but drying through the summer months and less precipitation through the winter (ACIA 2004). This situation may lead to lower minimum depths in natural lakes or artificial impoundments where entrapments may increase that may ultimately affect fish species populations, invertebrate food resources and possibly trophic cascade effects (Ims and Fuglei 2005). As aquatic invertebrates are a primary food resource for migratory shorebirds, and reduction in this energy-rich, seasonal resource could greatly affect the survival of adults and nesting efforts (Bart and others 2012; Hof and others 2017).

Even using the largest footprint estimated for development from 1987 *Coastal Plain Report/EIS* (Clough and Christiansen 1987), this may be scattered across the landscape of 1.5 million acres of the coastal plain 1002 area. As mean annual summer temperature increase, as they have to the present, migrating caribou will seek out the coolest remaining sites, including patches of snow which are used to avoid or reduce biting insects. Oil and gas developments have been demonstrated to affect movement and foraging behavior previously (Ballard and others 2000; Cameron and others 1979, 1989, 2005; Cronin and others 2000; among others). While behavioral responses may be individually or herd specific, and have not affected the overall health of North Slope caribou to this time, the point is that with future environmental change, a threshold may be crossed at some point in the future where wildlife resource requirements may come in direct conflict with industry.

<u>Fragmentation</u>
A reconsideration of the full build-out of the proposed 1987 action, with allowances for reductions due to advances in technology, is best considered at a landscape scale. The placement of about 60 drill pads and other facilities across the length and depth of the 1.5 million acres 1002 area, amounting to a total consolidated footprint of less than 1 percent, is minimal. However, additive to this is the pipeline connections for each well, which if not a barrier to movement, at a minimum an encumbrance to species movement for specie that depend on landscape mobility such as caribou and bears.

Further, there is operation and maintenance activities along roadways by vehicles, facility activity and human presence, fixed and rotor-wing aircraft traffic conveying personnel and materiel or conducting surveys among widely distributed sites, and other noise or visual distractions (Gliders and Cronin 2000; Pepper and others 2003). These disturbances may affect the quality of habitat immediately adjacent for foraging or reproduction or other life history events thereby reducing value to wildlife. Some species, while tolerant of period disturbances may eventually abandon areas if the disturbance is continuous. Alternatively, some species are less tolerant or intolerant during specific life history events such as nesting or calving. For example, increased human activity and industrial development are also implicated in the declines of many caribou herds throughout the circumpolar region (CAFF 2010). Compounding these considerations are changes to resources, some naturally-occurring with or without climate change, and others aggravated through human activities. For example, the siting of pads along the coastal plain places caribou seeking cooler, wind-blown areas for insect relief, and/or polar bear movements along shorelines and river deltas may increase the potential for wildlife-human conflict, not limited to life-threatening situations. All of the above may be collectively embraced in the concept of habitat fragmentation, with the result that despite the widely spaced placement of oil and gas activities, the combination of a suite of human-made feature and activities reduces the value of the overall landscape (Franklin and others 2002; Lindenmayer and Fischer 2006).

When wildlife have no other options available, individuals may remain in poor-quality habitat that may lead to higher predation or mortality or low reproduction rates and these types of habitats situations are primarily modified by human activities (Batten 2004). Further, such situations may occur in relatively pristine areas (Batten 2004). By definition, a source population is that which has sufficient numbers in excess over mortality to maintain itself or increase indefinitely, and a sink population is that which has insufficient excess or net loss (mortality) which over time, may decline to eventual extinction at that location. Sources and sinks are increasingly important considerations in human-altered environments. An ecological trap is a situation in which wildlife settle in seemingly optimal habitat, but conditions were either deceptive or change rapidly to suboptimal, threatening survival if the individual remains at that site, or, upon departure if it was unable to gain sufficient body energy reserves for movement or survival. A factor contributing to population sink conditions are subsidized predators – those predators that are tolerant of human presence and tend to increase in association with humans, specifically gulls (*Larus* spp.), Common Raven, and red fox (Truett et al. 1997; Mitchell and Pihl 2005).

For the 1002 area, even slight alterations to water availability and hydrology, species nutrient uptake, survival rates, increased predation, habitat fragmentation, flock/herd social structure, or behavioral stress could contribute to conditions creating a population sink or ecological trap situation (Van Horne 1983; Pulliam 1988; Pulliam and Danielson 1991; Franklin et al. 2002; Battin 2004; Lindenmayer and Fischer 2006; Beale 2007).

As a cautionary note, monitoring of wildlife and their habitats will certainly occur throughout the lifespan of the project. One of the simplest and cost-effective measures is the counting of individuals for density or abundance. This is typically interpreted as an indicator of habitat quality but caution is recommended as other factors need to be validated to confirm the effects and their significance for the proposed oil and gas exploration, development and production (Van Horne 1983).

<u>Climate Change</u>
As noted in the discussion here, climate changes are difficult address or isolate as a single subject due to its effect on nearly every aspect of Arctic biology, ecology, and physics. Climate change are affecting the Arctic and boreal ecosystems twice as fast as any other region on earth (ACIA 2004; IPCC 2007; NRC 2008; Clement et al. 2013). Using climate projections (ALFRESCO – Alaska Frame-based Ecosystem Code sponsored by Scenarios Network for Alaska Planning – SNAP; http://www.snap.uaf.edu), for 33-, 66-, and 99-year futures based upon temperature and precipitation, ecosystems are likely to change through 3 general avenues: (1) no

change, i.e., refugia; (2) jump from existing climax to new (and potentially novel) climax community; or (3) progress through a series of successional seral stages to a new (and potentially novel) climax community (SNAP/EWHALE 2012).

More to the point, future climate projections for the North Slope include increasing mean high summer temperature, increasing mean low winter temperatures, less precipitation, and landscape drying (ACIA 2004; Martin and others 2009; SNAP/EWHALE 2012). This may be translated to less water for drilling operations including the risk of over-pumping water resources in a landscape with relatively limited open water despite the appearance of abundance. Such drying will affect wetland functions and values for wildlife resources and water quality. Less water and higher temperatures will place some species at risk for continued occupation of preferred habitats, such as overwintering habitat for freshwater fish, freshwater invertebrates, waterfowl and shorebird production (ACIA 2004; Tulp and Schekkerman 2008).

Additionally, the projected drying may create conditions conducive for invasive species (vascular and nonvascular plants, invertebrates and vertebrates, and pathogens) to pioneer and establish populations (NRC 2002, 2008; Carlson and Shephard 2007; Crowl and others 2008; Bella 2009; Conn and others 2010; Lassuy, D.R., and P.N. Lewis. 2013). As an example the red fox is just now entering the Arctic Refuge which will ultimately compete with native Arctic fox and is a far more plastic and effective predator than native fox or equivalent mesocarnivores. Declines in waterfowl production have been demonstrated in multiple locations where red fox were not previous present. Increasing soil disturbances for development and infrastructure may create pathways for invasive plants and the increased movement of personnel and materiel may create human-subsidized transport of seeds or propagules.

Loss of sea ice will create the potential for increased shore zone erosion during storm or tide surge events. Sea level rise is already causing dislocation and relocation of traditional village sites to higher grounds if available elsewhere in Alaska.

<u>Uncertainty</u>
As expressed by local residents and subsistence resource users during scoping for numerous development projects is the fear of displacement of those resources due to increasing fragmentation of the landscape for traditional lifestyles (North Slope Borough 2009). Equal with this concern is the fear of catastrophic spills that will affect subsistence resources, particularly long-term incidents that may require years (or generations) to restore and rehabilitate to achieve pre-incident conditions (North Slope Borough 2009).

While the oil and gas industry may take every precaution and opportunity to prevent accidental spills or toxic exposure to humans and the environment, the potential risks will remain throughout the lifespan of exploration, development and production, and until the coastal plain is restored and rehabilitated. Due to the concentration of some species in the coastal plain, which for a few species may include significant proportions of global populations, an inland or marine spill could have significant consequences (Brown and others 2007; CAFF 2010; Dickson and Smith 2013; among others).

Remoteness and weather are compounding factors for incident assessment, control and cleanup, in addition to the general lack of water as noted previously. The oil and gas industry mitigation and BMPs have evolved based on experience, knowledge and technology. Similarly, understanding and knowledge of biological and water resources has increased over time and with technology. However, foreseeable changes may be acknowledged but uncertainty and lack of knowledge make management of oil and gas exploration, development, and production or natural resources management tenuous in many respects for the long-term (Wilson and others 2013).

Some cumulative effects of exploration, development and production may be avoided through careful monitoring and permit stipulations. Therefore, strict adherence to those stipulations will be critically important. Other effects may be mitigated via collaborative and cooperative effort, particularly through adaptive management that is modified as new information or technology becomes available. Industry and agency monitoring must therefore work together so that evolving approaches may be fully explored to meet the needs of natural and physical resources and industry needs.

6 List of Preparers, Contributors, and Advisors

This EA was developed by U.S. Fish and Wildlife Service (Service) staff. The Service holds final responsibility for all content. Personnel for each contributing party are listed in Table 6-1.

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