U.S. Department of the Interior
Bureau of Land Management

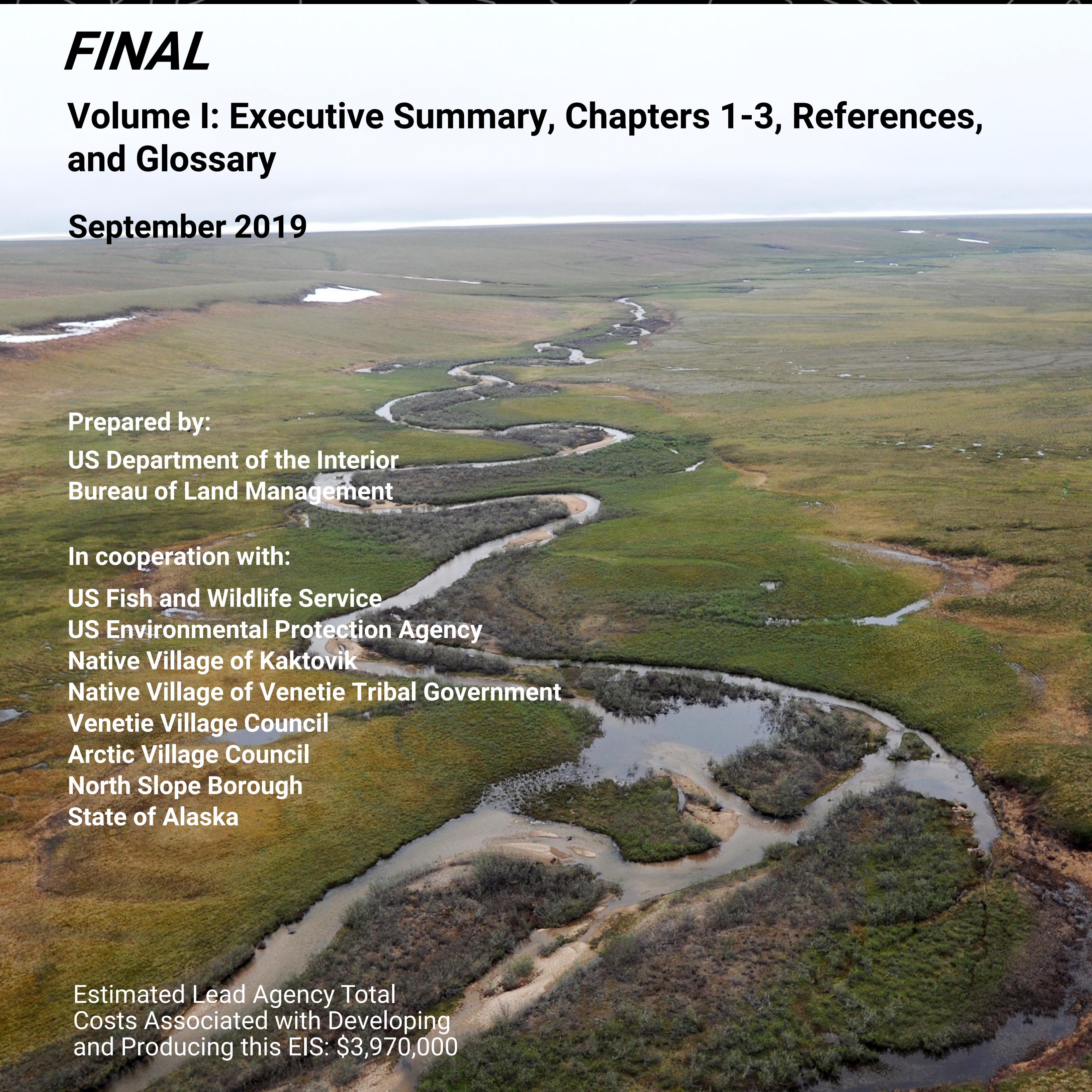
Coastal Plain Oil and Gas Leasing Program

Environmental Impact Statement

FINAL

Volume I: Executive Summary, Chapters 1-3, References, and Glossary

September 2019



Prepared by:

US Department of the Interior
Bureau of Land Management

In cooperation with:

US Fish and Wildlife Service
US Environmental Protection Agency
Native Village of Kaktovik
Native Village of Venetie Tribal Government
Venetie Village Council
Arctic Village Council
North Slope Borough
State of Alaska

Estimated Lead Agency Total Costs Associated with Developing and Producing this EIS: $3,970,000

Mission

To sustain the health, diversity, and productivity of the public lands for the use and enjoyment of present and future generations.

Cover Photo: Northward view in central coastal plain area near the Sadlerochit River showing gently rolling topography typical of the area. Natural oil indications are visible of an oil seep that occurs along the coast (Barter Island). Photo by David Houseknecht (USGS).

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United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Alaska State Office
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September 2019

Dear Reader:

The Bureau of Land Management (BLM) has completed a Final Environmental Impact Statement (EIS) for the Coastal Plain Oil and Gas Leasing Program (Leasing EIS). The Final EIS addresses potential impacts associated with the BLM's implementation of an oil and gas leasing program in the Coastal Plain of the Arctic National Wildlife Refuge (Arctic Refuge). This program is required by the Tax Cuts and Jobs Act of 2017, Public Law 115-97 (PL 115-97). The BLM prepared this document in consultation with cooperating agencies, and in accordance with the National Environmental Policy Act of 1969 (NEPA), as amended, the BLM's NEPA Handbook (H-1790-1), and other applicable laws and policies.

The Coastal Plain is within the political boundary of the North Slope Borough and is predominantly managed by the US Fish and Wildlife Service as part of the Arctic Refuge. The decisions to be made as part of this Final EIS concern which areas of the Coastal Plain would be offered for oil and gas leasing and the terms and conditions of the leases, and authorizations for oil and gas activities.

The alternatives discussed in the Final EIS include stipulations and required operating procedures designed to mitigate impacts on resources and their uses. The decisions evaluated would not authorize any activity associated with the exploration or development of oil and gas resources in the Coastal Plain. Future actions requiring BLM approval, including proposed exploration plans and development proposals, would require further NEPA analysis.

The analysis of the preferred alternative and other alternatives was conducted based on public input gathered from the 60-day public scoping period and the extended 75-day comment period of the Draft EIS. In February 2019, the BLM held public comment meetings on the Draft EIS in Anchorage, Arctic Village, Fairbanks, Fort Yukon, Kaktovik, Utqiagvik, Venetie, and Washington, DC. The BLM received written comments by mail, fax, email, online comments from ePlanning, as well as handwritten and verbal testimony at public meetings. Modifications to the Draft EIS were made based on public comment, cooperating agency coordination, tribal and Alaska Native Claims Settlement Act corporation consultation, and the BLM's internal review of the Draft EIS.

Consistent with 43 CFR 1503.4, the BLM has responded to substantive comments provided during the public comment period and prepared this Final EIS. This Final EIS provides the scientific basis for BLM's implementation of PL 115-97, including the requirement for BLM to hold multiple oil and gas lease sales.

The BLM has identified Alternative B as the preferred alternative. This alternative offers the opportunity to lease the entire program area while providing protections for the many important resources and uses identified through scoping and public comments within the program area. In addition to applicable lease stipulations, over 40 required operating procedures would be applied to post-lease oil and gas activities to reduce potential impacts.

You may access the Final EIS on the internet at www.blm.gov/alaska or make a request for a CD to Ms. Nicole Hayes, Project Manager, BLM Alaska State Office, 222 West 7th Avenue, Anchorage, AK 99513. Persons who use a telecommunications device for the deaf (TDD) may call the Federal Relay Service (FRS) at 1 (800) 877-8339 to contact Ms. Hayes during normal business hours. The FRS is available 24 hours a day, 7 days a week, to leave a message or question. You will receive a reply during normal business hours.

A record of decision will be signed no sooner than 30 days after publication of the Notice of Availability in the Federal Register of the Final EIS.

Thank you for your continued interest in the Coastal Plain Oil and Gas Leasing Program EIS. We appreciate the information and suggestions you contributed to the planning process. For additional information or clarification regarding this document, please contact Ms. Nicole Hayes at (907) 271-4354.

Sincerely,

Chad B. Padgett
State Director

Coastal Plain Oil and Gas Leasing Program
Final Environmental Impact Statement

Lead Agency: United States (US) Department of the Interior, Bureau of Land Management (BLM)

Cooperating Agencies: US Fish and Wildlife Service, US Environmental Protection Agency, State of Alaska, North Slope Borough, Native Village of Kaktovik, Native Village of Venetie Tribal Government, Venetie Village Council, and the Arctic Village Council

Proposed Action: In accordance with Section 20001 of Public Law 115-97 (PL 115-97), establish and administer a competitive oil and gas program for leasing, developing, producing, and transporting oil and gas in and from the Coastal Plain in the Arctic National Wildlife Refuge (Arctic Refuge).

Abstract: The BLM will establish and administer an oil and gas leasing program for the Coastal Plain in the Arctic Refuge, as required by PL 115-97. This Coastal Plain Oil and Gas Leasing Program Environmental Impact Statement (Leasing EIS) will inform the BLM's implementation of PL 115-97, Section 20001(c)(1), which requires the BLM to hold multiple oil and gas lease sales.

In the Leasing EIS, the BLM considered three action alternatives. Alternatives B, C, and D propose a range of the extent of the Coastal Plain that would be available for lease sale—from 51 to 100 percent of the 1.56 million-acre Coastal Plain—while balancing biological, ecological, and social concerns. These alternatives also include lease stipulations and required operating procedures designed to mitigate impacts on resources and their uses. Alternative B offers the opportunity to lease the entire program area, and there would be the fewest acres with no surface occupancy (NSO) stipulations; Alternative B is the BLM's preferred alternative. Alternative C offers the opportunity to lease the entire program area, but a large portion of it would be subject to NSO stipulations. Under Alternative D, portions of the Coastal Plain would not be offered for lease sale, to protect biological and ecological resources; two sub-alternatives, Alternatives D1 and D2, would use different approaches to mitigate impacts on resources through lease stipulations. The No Action Alternative, Alternative A, is included for comparison only; it does not meet the purpose and need of the EIS.

In the Leasing EIS, the BLM considered and analyzed the environmental impact of these various leasing alternatives, including the areas to offer for sale, and the indirect impacts that could result in consideration of the hypothetical development scenario. These include potential effects from future on-the-ground post-lease activities on climate and meteorology, air quality, noise, physiography, geology and minerals, petroleum resources, paleontological resources, sand and gravel, soil, water, solid and hazardous waste, vegetation and wetlands, wildlife, landownership and uses, cultural resources, subsistence uses and resources, sociocultural systems, environmental justice, recreation, visual resources, special designations (including marine protected areas, water bodies eligible and suitable for designation as Wild and Scenic Rivers, and wilderness characteristics, qualities, and values), transportation, public health, and the economy.

For further Information: Contact Nicole Hayes of the BLM at (907) 271-4354 or visit the Leasing EIS website at https://goo.gl/HVo5Mj.

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FIGURES:

MAPS AND FIGURES *(see Appendix A) (continued)*

ACRONYMS AND ABBREVIATIONS

Acronyms and Abbreviations	Full Phrase
μg/m3	micrograms per cubic meter
μPa	micro Pascal
AAAQS	Alaska Ambient Air Quality Standards
AAC	Alaska Administrative Code
ACCS	Alaska Center for Conservation Science
ACP	Arctic Coastal Plain
ACRC	Alaska Climate Research Center
ADEC	Alaska Department of Environmental Conservation
ADFG	Alaska Department of Fish and Game
ADNR	Alaska Department of Natural Resources
ADOLWD	Alaska Department of Labor and Workforce Development
AFFF	aqueous film-forming foam
AHRS	Alaska Heritage Resources Survey
ANCSA	Alaska Native Claims Settlement Act
ANILCA	Alaska National Interest Lands Conservation Act of 1980
APD	Application for Permit to Drill
APDES	Alaska Pollutant Discharge Elimination System
AQRV	air quality related value
ARCP	Arctic Refuge Coastal Plain
ARPA	Archaeological Resources Protection Act of 1979
[Arctic] Refuge	Arctic National Wildlife Refuge
asl	above sea level
ASRC	Arctic Slope Regional Corporation
ASTAR	Arctic Strategic Transportation and Resources
AWOS	automated weather observing system
bbl	blue barrel
BBO	billion barrels of oil
BLM	Bureau of Land Management
BMP	best management practice
BOEM	Bureau of Ocean Energy Management
BOPD	barrels of oil per day
BS	Beaufort Sea stock
BSEE	Bureau of Safety and Environmental Enforcement
CAA	conflict avoidance agreement
CAH	Central Arctic Herd
CASTNET	Clean Air Status and Trends Network
CCP	Comprehensive Conservation Plan
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CH_4	methane
CI	confidence interval

CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
CPF	central processing facility
CSU	controlled surface use
dB	decibels
dBA	A-weighted decibel
DEW	Distant Early Warning
DOD	Department of Defense
DOI	Department of the Interior
DPS	distinct population segment
dv	deciview
ECS	Eastern Chukchi Sea stock
EFH	Essential Fish Habitat
EIS	environmental impact statement
EO	executive order
EPA	US Environmental Protection Agency
ESA	Endangered Species Act of 1973
°F	Fahrenheit
FAA	Federal Aviation Administration
FLIR	forward-looking infrared radiometry
FY	fiscal year
GFUR	general fund unrestricted revenue
GHG	greenhouse gas
GIS	Geographic Information System
GMT1	Greater Mooses Tooth 1
GMT2	Greater Mooses Tooth 2
GMU	Game Management Unit
GWP	global warming potential
HCP	hydrocarbon potential
IAP	Integrated Activity Plan
IHLC	Iñupiat History, Language, and Cultural Division
IMPROVE	Interagency Monitoring for the Protection of Visual Environments
ITR	Incidental Take Regulation
kg/ha-yr	kilograms per hectacre per year
kHz	kilohertz
KIC	Kaktovik Iñupiat Corporation

Leasing EIS	Coastal Plain Oil and Gas Leasing Program Environmental Impact Statement
LOA	Letter of Authorization
LRRS	long-range radar sites
M	magnitude
MMPA	Marine Mammal Protection Act
MMT	million metric tons
MPA	Marine Protected Area
mya	millions of years ago
NAAQS	National Ambient Air Quality Standards
NDVI	Normalized Difference Vegetation Index
NEPA	National Environmental Policy Act of 1969
NHPA	National Historic Preservation Act of 1966
NMFS	National Marine Fisheries Service
N_2O	nitrous oxide
NO_2	nitrogen dioxide
NOAA	National Oceanographic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPR-A	National Petroleum Reserve-Alaska
NRHP	National Register of Historic Places
NSB	North Slope Borough
NSO	no surface occupancy
NWI	National Wetland Inventory
NWS	National Weather Service
NWT	Northwest Territory
O_3	ozone
ORV	outstandingly remarkable value
Pb	lead
PCH	Porcupine Caribou Herd
PDO	Pacific decadal oscillation
PFYC	Potential Fossil Yield Classification
PL	Public Law
PM_{10}	particulate matter less than 10 microns in diameter
$PM_{2.5}$	particulate matter less than 2.5 microns in diameter
POC	Plan of Cooperation
Ppb	parts per billion
ppm	parts per million
PRPA	Paleontological Resources Protection Act of 2009
PSO	protected species observer

ROD	record of decision
ROP	required operating procedure
ROW	right-of-way
RS	Revised Statute
SAR	stock assessment report
SBS	Southern Beaufort Sea
SCC	social cost of carbon
SEIS	Supplemental Environmental Impact Statement
SHPO	State Historic Preservation Office
SO	Secretarial Order
SO_2	sulfur dioxide
STP	seawater treatment plant
3D	three-dimensional
TAPS	Trans-Alaska Pipeline System
TCF	trillion cubic feet
TCP	Traditional Cultural Property
TL	timing limitation
TLUI	Traditional Land Use Inventory
UIC	Underground injection control
US	United States
USACE	US Army Corps of Engineers
USC	United States Code
USFWS	US Fish and Wildlife Service
USGS	US Geological Survey
VOC	volatile organic compound
VRI	Visual Resource Inventory
VSM	vertical support member
WSR	wild and scenic river

Executive Summary

Introduction

The United States (US) Department of the Interior (DOI), Bureau of Land Management (BLM), Alaska State Office, has prepared this environmental impact statement (EIS) in accordance with the National Environmental Policy Act of 1969, as amended (NEPA), to implement an oil and gas leasing program in the Arctic National Wildlife Refuge (Arctic Refuge) Coastal Plain. Congress identified the Coastal Plain in Section 1002 of the Alaska National Interest Lands Conservation Act of 1980 (ANILCA) for its oil and natural gas potential; legislation was passed in December 2017 lifting a prohibition on oil and gas development imposed by Section 1003 of ANILCA and requiring the BLM to implement an oil and gas leasing program. The Coastal Plain program area is composed of approximately 1,563,500 acres in the approximately 19.3-million-acre Arctic Refuge (**Map 1-1**, Program Area, in **Appendix A**). The oil and gas leasing program must also consider the Arctic Refuge purposes set out in Section 303(2)(B) of ANILCA, as amended, and modified by Section 20001 of Public Law (PL) 115-97 (Dec. 22, 2017) (PL 115-97).

Purpose and Need

Section 20001 of PL 115-97 requires the Secretary of the Interior, acting through the BLM, to establish and administer a competitive oil and gas program for the leasing, development, production, and transportation of oil and gas in and from the Coastal Plain area within the Arctic Refuge. Further, Section 20001 of PL 115-97 requires that at least two lease sales be held by December 22, 2024, and that each sale offer for lease at least 400,000 acres of the highest hydrocarbon potential (HCP) lands within the Coastal Plain, allowing for up to 2,000 surface acres of Federal land to be covered by production and support facilities.

The BLM has undertaken this Coastal Plain Oil and Gas Leasing Program Environmental Impact Statement (Leasing EIS) to implement the leasing program consistent with PL 115-97. The Leasing EIS will serve to inform the BLM's implementation of PL 115-97, Section 20001(c)(1), which is the requirement to hold multiple lease sales. It may also inform post-lease activities, including seismic and drilling exploration, development, and transportation of oil and gas in and from the Coastal Plain. Specifically, the Leasing EIS considers and analyzes the environmental impact of various leasing alternatives, including the areas to offer for sale, and the indirect impacts that could result in consideration of the hypothetical development scenario. All action alternatives are designed to meet Section 20001 of PL 115-97 and to account for all purposes of the Arctic Refuge. The alternatives analyze various terms and conditions (i.e., lease stipulations and required operating procedures [ROPs]) to be applied to leases and associated oil and gas activities, to properly balance oil and gas development with protection of surface resources.

This Leasing EIS evaluates which lands to offer to lease and what terms and conditions to apply to those leases; it does not in itself authorize on-the ground exploration or development. Future on-the-ground actions requiring BLM approval, including potential exploration and development proposals, would require further NEPA analysis based on the site-specific proposal. For example, before drilling on any lease, an operator would be required to submit an application for permit to drill, which would require appropriate NEPA analysis (as well as compliance with other applicable laws) before any drilling could be authorized. Potential applicants would be subject to the terms of the lease; however, the BLM Authorized Officer may require additional site-specific terms and conditions before authorizing any oil and gas activity based on the project-level NEPA analysis.

DECISIONS TO BE MADE

The BLM's decisions will include which tracts of land to offer for lease and the terms and conditions to be applied to such leases and subsequent authorizations for oil and gas activities. The decisions evaluated in this Leasing EIS and its record of decision (ROD) would not authorize any on-the-ground activity associated with the exploration or development of oil and gas resources on the Coastal Plain.

The US Fish and Wildlife Service (USFWS) continues managing all federal lands in the Coastal Plain as part of the Arctic Refuge, including both leased and unleased areas; however, the BLM manages all aspects of the oil and gas program, including issuing and administering oil and gas leases and issuing permits for all oil and gas activities. Although the BLM intends to consult with the USFWS, as noted in **Table 2-3** (footnote 1) when making oil and gas program decisions, Section 20001(a)(2) and (b)(2)(A) of the Tax Act assigns the BLM the sole responsibility for making such decisions.

PROGRAM AREA

The USFWS is the predominant land manager in the program area. Other lands in the Coastal Plain include Alaska Native lands conveyed pursuant to the Alaska Native Claims Settlement Act (ANCSA) and Native allotments (see **Table ES-1** and **Map 1-1** in **Appendix A**). The program area excludes a northern coastal portion of Air Force-administered lands near Kaktovik. Lands outside the BLM's oil and gas leasing authority are those excluded from the definition of the Coastal Plain in PL 115-97, Native conveyed, and Native selected lands.

Table ES-1
Land Administration Included in PL 115-97 Coastal Plain

Subject to the BLM's Oil and Gas Leasing Authority	Acres	Outside the BLM's Oil and Gas Leasing Authority	Acres
USFWS-managed lands, including submerged lands	1,562,600	Native-conveyed	24,400
Native allotment	900	Native-selected	4,400
Total	**1,563,500**	**Total**	**28,800**

Source: BLM Geographic Information Systems (GIS) 2018
Note: Acreages are rounded to the nearest 100.

SCOPING AND ISSUES

As part of the scoping process, the BLM considered public comments provided during scoping meetings held in Anchorage, Arctic Village, Fairbanks, Kaktovik, Utqiaġvik, and Venetie, Alaska, and in Washington, DC, during May and June 2018, when developing the alternatives for analysis in the Leasing EIS. It also considered input from cooperating agencies, tribes, and ANCSA corporations. For more information on the scoping process, see the final scoping report on the BLM's project website: https://goo.gl/HVo5Mj.

Issues such as fish and wildlife, including the Porcupine caribou herd (PCH), special status species, including polar bear, analysis of oil and gas activities, and subsistence use and traditional ways of life, were identified during scoping and addressed in this Leasing EIS. The full list of issue summaries is available in the final scoping report.

DRAFT EIS PUBLIC COMMENTS

The US Environmental Protection Agency (EPA) published the Notice of Availability of the Draft EIS in the *Federal Register* on December 28, 2018, initiating a 45-day public comment period. The Draft EIS comment period was extended to March 13, 2019, for a total of 75 days. In February 2019, the BLM held public meetings to receive comments on the Draft EIS in Anchorage, Arctic Village, Fairbanks, Fort Yukon, Kaktovik, Utqiagvik, and Venetie, Alaska, and Washington, DC. The BLM received written comments by mail, fax, email, online comment form via ePlanning, and handwritten and verbal testimony at public meetings. Comments received covered a wide spectrum of thoughts, opinions, ideas, and concerns. A total of 1,066,803 comment letter submissions were received; 3,709 of these were considered unique submissions and 1,063,094 were part of form letter campaigns.

ALTERNATIVES

Alternative A—No Action Alternative

Under Alternative A (No Action Alternative), no federal minerals in the Coastal Plain would be offered for future oil and gas lease sales after the ROD for this EIS is signed. Alternative A would not comply with the directive under PL 115-97 to establish and administer a competitive oil and gas program for leasing, developing, producing, and transporting oil and gas in and from the Coastal Plain. It also would not meet the purpose of the Arctic Refuge to provide for an oil and gas program on the Coastal Plain, set out in Section 303(2)(B)(v) of ANILCA. Under this alternative, current management actions would be maintained, and resource trends are expected to continue, as described in the Arctic National Wildlife Refuge Revised Comprehensive Conservation Plan (CCP) (USFWS 2015a).

Alternative A would not meet the purpose and need of the action, which is the BLM's implementation of PL 115-97, including the requirement to hold multiple lease sales and to permit associated post-lease oil and gas activities; however, Alternative A is being carried forward for analysis to provide a baseline for comparing impacts under the action alternatives, in accordance with the Council on Environmental Quality (CEQ) NEPA regulations.

Alternative B (Preferred Alternative)

Alternative B is the BLM's preferred alternative. It offers the opportunity to lease the entire program area, and there would be the fewest acres with no surface occupancy (NSO) stipulations. In addition to applicable lease stipulations, several ROPs would apply to post-lease oil and gas activities to reduce potential impacts. Approximately 1,563,500 acres would be offered for lease, of which 359,400 acres would be subject to NSO stipulations, and 585,400 acres would be subject to timing limitations (TLs). Standard terms and conditions only would apply to approximately 618,700 acres.

Alternative C

The entire program area could also be offered for lease sale under Alternative C; however, a large portion of the program area would be subject to NSO. The BLM would rely on the same ROPs as under Alternative B to reduce potential impacts from post-lease oil and gas activities. Approximately 1,563,500 acres would be offered for lease, of which 932,500 acres would be subject to NSO, and 317,100 acres would be subject to TLs. Standard terms and conditions only would apply to approximately 313,900 acres.

Alternative D

Under Alternative D, portions of the Coastal Plain would not be offered for lease sale. In addition, a large portion of the remaining area would be subject to NSO. In some instances, more prescriptive ROPs are analyzed under Alternative D, than under Alternatives B and C.

Alternative D contains two sub-alternatives, Alternatives D1 and D2, which use different approaches to mitigate impacts on resources through lease stipulations. Under Alternatives D1, approximately 1,037,200 acres would be offered for lease, of which 708,600 acres would be subject to NSO, and 123,900 acres would be subject to controlled surface use (CSU). Alternative D1 would have no areas subject to TLs but would have approximately 204,700 acres subject to only standard terms and conditions.

Under Alternative D2, 800,000 acres would be offered for lease. Of those acres, 505,800 acres would be subject to NSO, 105,200 acres would be subject to controlled surface use (CSU), 189,000 acres would be subject to TLs, and no areas subject to standard terms and conditions. The BLM reduced the amount of land available for leasing under Alternative D2, based on public comments received on the Draft EIS. This revision prioritizes high potential areas available for lease, while providing additional consideration for caribou calving and post-calving habitat (areas along the coast of Camden Bay and east of the mouth of the Niguanak River), expansion of existing buffers, and expansion of lands adjacent to springs and aufeis[1] habitats. Alternative D2 reflects the total minimum acreage that PL 115-97 requires to be offered in two mandated lease sales.

The complete list of lease stipulations and ROPs under each alternative is presented in **Table 2-3** in **Chapter 2**.

HYPOTHETICAL DEVELOPMENT SCENARIO

The BLM developed a hypothetical development scenario for oil and gas exploration, development, production, and abandonment in the PL 115-97 Coastal Plain. This hypothetical development scenario projects the reasonably foreseeable oil and gas exploration, development, production, and abandonment/reclamation over the expected life of the program. Of the approximately 1,563,500 acres of federal land in the Coastal Plain, an estimated 427,900 acres are projected to have high potential for petroleum resources, 658,400 acres have medium potential, and 477,200 acres have low potential. The hypothetical baseline scenario assumes all potentially productive areas can be open under standard lease terms and conditions, except those areas outside the BLM's oil and gas leasing authority. This unconstrained scenario represents the maximum level of development that could occur in the program area with no management restrictions except those mandated by law. **Appendix B** contains a more detailed description of these activities and the resources that would be required under each phase.

The BLM used the unconstrained hypothetical development scenario for each alternative, based on differing terms and conditions relating to environmental protection. It did this so that it could analyze a range of impacts on resources. Section 20001(c)(3) of PL 115-97 states that the Secretary shall authorize up to 2,000 surface acres of federal land on the Coastal Plain to be covered by production and support facilities during the term of the leases (see **Section 1.9.1**). **Table ES-2**, below, shows the hypothetical projected facilities and the associated surface disturbance estimates by alternative that would occur after applying discretionary management decisions.

The program area contains an estimated mean of 7.687 billion barrels of technically recoverable oil and 7.04 trillion cubic feet (TCF) of technically recoverable natural gas (Attanasi 2005). Due to high costs associated with operating in the Arctic, it is extremely unlikely that all technically recoverable resources would be produced. The US Energy Information Administration estimated that a total mean of approximately 3.4 billion barrels of oil (BBO) would be produced in the Arctic Refuge by 2050 (Van Wagner 2018). Estimated natural gas production from the Coastal Plain ranges from 0 to 7 TCF of gas produced (Attanasi 2005). See **Appendix B** for more information on development potential, assumptions behind potential estimates, and estimates for the baseline future hypothetical development scenario for petroleum.

[1] German for "ice on top"; it is a sheet-like mass of layered ice that forms from successive flows of groundwater during freezing temperatures.

Table ES-2
Hypothetical Projected Facilities and Estimated Surface Disturbance by Action Alternative[1]

Facility Type	Alternative B		Alternative C		Alternatives D1 and D2	
	Number of Potential Facilities	Estimated Acres of Disturbance	Number of Potential Facilities	Estimated Acres of Disturbance	Number of Potential Facilities	Estimated Acres of Disturbance
CPF, airstrip, anchor well pad	4	200	3	150	2	100
Satellite pads	14	168	15	180	16	192
Roads	174 miles	1,305	180 miles	1,350	185 miles	1,388
Vertical support members (pipeline miles)	212 miles	8	214 miles	9	217 miles	9
Seawater treatment plant	1	15	1	15	1	15
Barge landing and storage	1	10	1	10	1	10
Gravel pits and stockpiles[2]	—	296	—	292	—	288
Total (approximate)	—	**2,000**	—	**2,000**	—	**2,000**

Sources: BLM 2004, 2012; US Army Corps of Engineers (USACE) 2017

[1]All potential facility numbers and surface disturbance acreages are general hypothetical estimates and are not based on specific project proposals. Acreages are approximate and are rounded to the nearest acre.

[2]The number of gravel pits is dependent on the locations of gravel resources in relation to project components and thus is unknown at this time.

— = not applicable

IMPACT ANALYSIS

Issuance of oil and gas leases under the directives of Section 20001(c)(1) of PL 115-97 would have no direct impacts on the environment because by itself a lease does not authorize any on-the-ground oil and gas activities; however, a lease does grant the lessee certain rights to drill for and extract oil and gas subject to further environmental review and reasonable regulation, including applicable laws, terms, conditions, and stipulations of the lease. The impacts of such future exploration and development activities that may occur because of the issuance of leases are considered potential indirect impacts of leasing. Such post-lease activities could include seismic and drilling exploration, development, and transportation of oil and gas in and from the Coastal Plain. Therefore, the analysis in **Chapter 3** is of potential direct, indirect, and cumulative impacts from on-the-ground post-lease activities, which can be considered potential indirect impacts of leasing.

The geographic scope of the analysis includes marine vessel traffic from the shore of the Arctic Refuge to Dutch Harbor, Alaska. Direct and indirect impacts cannot be analyzed on a site-specific basis within this EIS, but they are analyzed for the program area generally, based on the hypothetical development scenarios in **Appendix B**. Additional site-specific analyses would be conducted during the permit review process for subsequent exploration and development applications.

If leases were explored and developed, the following general impacts would be expected from future oil and gas exploration, development, and production activities under all action alternatives:

- Potential impacts on subsistence users, both from impacts on subsistence species and from direct disturbance of hunts, displacement of resources from traditional harvest areas, and hunter avoidance of industrialized areas

- Potential impacts on water quality caused by water extraction and construction of ice roads and pads, gravel mining, and wastewater discharges from a CPF
- Potential impacts from exploration, development, and production on air quality and air quality-related values due to air pollutant emissions
- Greenhouse gas (GHG) emissions from exploration, development, and production, produced oil and natural gas downstream combustion, and permafrost surface disturbance
- Potential impacts on topography, geology, soils, and permafrost from gravel mining and placing fill for infrastructure development
- Potential impacts on birds from predators and increased human presence
- Potential impacts on marine mammals, including human-polar bear interactions; vehicle, aircraft and boat traffic and noise disturbance; and accidental, unplanned take by vessel strikes or oil spills
- Potential impacts on terrestrial mammals, including disturbance from vehicle and aircraft noise, human presence, and habitat fragmentation and loss
- Disturbance and loss of permafrost, vegetation, and wetlands
- Potential impacts on state employment, labor income, and revenues
- Potential impacts on North Slope Borough (NSB) employment, income, and revenue
- Potential impacts on cultural resources by lease development
- Visual impacts from infrastructure and artificial light
- Loss or reduced quality of some access to recreation and use opportunities around areas leased for energy infrastructure

Residents of Kaktovik are the primary users of the program area and would therefore be most likely to experience potential impacts from future development. The community of Nuiqsut could experience impacts on caribou, waterfowl, and fish harvests from development. Residents of Arctic Village, Venetie, and other communities beyond the program area that rely on the PCH and Central Arctic Caribou Herd (CAH) could experience potential impacts from future development on caribou and, to a lesser extent, waterfowl. Incremental development of oil and gas-related infrastructure throughout the program area may erode cultural connections to, and subsistence uses of these lands for the Iñupiaq, Gwich'in, and Inuvialuit.

CONSULTATION AND COORDINATION

The BLM is the lead agency for this EIS. Cooperating agencies are the USFWS, EPA, State of Alaska, NSB, Native Village of Kaktovik, Native Village of Venetie Tribal Government, Venetie Village Council, and the Arctic Village Council.

The BLM, as the lead federal agency, consulted with federally recognized tribal governments during preparation of this EIS. The BLM has contacted the Arctic Village Council, Iñupiat Community of the Arctic Slope, Native Village of Kaktovik, Venetie Village Council, Native Village of Venetie Tribal Government, Beaver Village Council, Birch Creek Tribal Council, Chalkyitsik Village Council, Gwichyaa Zhee Gwich'in Tribal Government (Fort Yukon), Naqsragmiut Tribal Council (Anaktuvuk Pass), Native Village of Barrow Iñupiat Traditional Government, Native Village of Nuiqsut, and Native Village of Stevens. The BLM offered these entities the opportunity to participate in formal government-to-government consultation, to participate as cooperating agencies, or to simply receive information about the project. The dates and locations of government-to-government meetings that have taken place are provided in **Appendix C**.

The BLM also consulted with the Arctic Slope Regional Corporation (ASRC) and Kaktovik Iñupiat Corporation (KIC) under the DOI's Policy for Consultation with ANCSA corporations. The BLM also held consultations with Doyon, Limited, to discuss the EIS process (see **Appendix C**).

The BLM is consulting with the Alaska SHPO, in accordance with Section 106 of the NHPA, as the BLM has a responsibility to take into account the effects of the proposed leasing program on historic properties, which are properties listed in or eligible for listing in the National Register of Historic Places (NRHP). This is to determine how proposed activities could affect cultural resources listed on or eligible for inclusion on the NRHP. Formal consultations with the SHPO also may be required when individual projects are implemented. SHPO consultations for the leasing program are ongoing and will be completed by the time the ROD is signed.

To comply with Section 7(a)(2) of the Endangered Species Act of 1973 (ESA), the BLM began consulting with the USFWS and National Marine Fisheries Service (NMFS) early in the EIS process. Both provided input on issues, data collection and review, and alternatives development. The BLM is consulting with the USFWS and NMFS to identify ESA issues and support development of their Biological Opinions.

Section 810 of ANILCA focuses on issues related to the effects of proposed activities on subsistence use. An ANILCA Section 810 notice and public hearing process is required if a proposed action may significantly restrict subsistence uses and needs. A final evaluation and findings of effects on subsistence uses and needs from actions that could be undertaken under the four alternatives considered in this EIS is provided in **Appendix E**. The preliminary evaluation found that the cumulative case presented in the EIS met the "may significantly restrict" threshold for the community of Kaktovik; therefore, it made a positive finding pursuant to ANILCA Section 810. As a result, a public hearing was held in the potentially affected community of Kaktovik on February 5, 2019 in conjunction with the Draft EIS public meeting. The final evaluation also finds that the cumulative case may significantly restrict subsistence uses for Kaktovik.

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Chapter 1. Introduction

1.1 OVERVIEW

The BLM Alaska State Office is preparing this EIS in accordance with NEPA, as amended, to implement an oil and gas leasing program in the Arctic Refuge Coastal Plain. Congress identified the Coastal Plain in Section 1002 of ANILCA for its oil and natural gas potential. Congress passed new legislation in December 2017, PL 115-97, lifting a prohibition on oil and gas development imposed by Section 1003 of ANILCA and requiring the BLM to implement an oil and gas leasing program. The Coastal Plain program area is composed of approximately 1,563,500 acres in the approximately 19.3-million-acre Arctic Refuge (**Map 1-1**, Program Area, in **Appendix A**). The oil and gas leasing program must consider the Arctic Refuge purposes set out in Section 303(2)(B) of ANILCA, as amended by Section 20001 of PL 115-97.

The BLM is developing the EIS to implement Section 20001(c)(1) of PL 115-97, and, specifically, to analyze the environmental impacts of issuing oil and gas leases in accordance with that directive. Issuance of an oil and gas lease does not have any direct effects on the environment since it does not authorize drilling or any other ground disturbing activities; however, a lease does grant the lessee certain rights to drill for and extract oil and gas subject to reasonable regulation, including applicable laws, terms, conditions, and stipulations of the lease. Although the BLM cannot ascertain the precise extent of the effects of granting those rights until it receives and reviews potential future site-specific proposals for exploration and development, in order to meet the intent of NEPA, and as described in the CEQ *Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations*, the BLM has developed a hypothetical development scenario consistent with those leases, in a good faith effort to identify indirect effects that are not known at this time but nonetheless could be considered "reasonably foreseeable" (40 Code of Federal Regulations [CFR] Section 1508.8(b)) (see **Appendix B**).

The BLM developed the hypothetical development scenario in recognition of not only the rights granted by an oil and gas lease but also PL 115-97's direction to the Secretary to "manage the oil and gas program in the Coastal Plain in a manner similar to the administration of lease sales under the Naval Petroleum Reserves Production Act of 1976 (including regulations)." However, there is tremendous uncertainty regarding potential exploration and development on the Coastal Plain. Any development scenario at this point is highly speculative given that it is unknown whether or where leases will be issued, whether or where exploratory drilling may occur under such leases, and whether or where economically developable oil and gas discoveries may be made. This uncertainty is due in part to the remoteness and lack of previous exploration and development of the Coastal Plain as well as its harsh environment and challenging engineering considerations, along with the extended time it has taken to go from leasing to development in other regions of the North Slope of Alaska including in the National Petroleum Reserve-Alaska (NPR-A).

1.2 PURPOSE AND NEED

Section 20001 of PL 115-97 requires the Secretary of the Interior, acting through the BLM, to establish and administer a competitive oil and gas program for the leasing, development, production, and transportation of oil and gas in and from the Coastal Plain area within the Arctic Refuge. Further, Section 20001 of PL 115-97 requires that at least two lease sales be held by December 22, 2024, and that each sale offer for lease at least 400,000 acres of the highest HCP lands within the Coastal Plain, allowing for up to 2,000 surface acres of Federal land to be covered by production and support facilities.

The BLM is undertaking this Leasing EIS to implement the leasing program consistent with PL 115-97. The Leasing EIS will serve to inform the BLM's implementation of PL 115-97, Section 20001(c)(1), which is the requirement to hold multiple lease sales. It may also inform post-lease activities, including seismic and drilling exploration, development, and transportation of oil and gas in and from the Coastal Plain. Specifically, the Leasing EIS considers and analyzes the environmental impact of various leasing alternatives, including the areas to offer for sale, and the indirect impacts that could result, in consideration of the hypothetical development scenario. All action alternatives were designed to meet Section 20001 of PL 115-97 and to account for all purposes of the Arctic Refuge. The alternatives analyze various terms and conditions (i.e., lease stipulations and ROPs) to be applied to leases and associated oil and gas activities, to properly balance oil and gas development with protection of surface resources.

This Leasing EIS evaluates which lands to offer to lease and what terms and conditions to apply to those leases; it does not in itself authorize on-the ground exploration or development. Future on-the-ground actions requiring BLM approval, including potential exploration and development proposals, would require further NEPA analysis based on the site-specific proposal. For example, before drilling on any lease, an operator would be required to submit an application for permit to drill, which would require appropriate NEPA analysis (as well as compliance with other applicable laws) before any drilling could be authorized. Potential applicants would be subject to the terms of the lease; however, the BLM Authorized Officer may require additional site-specific terms and conditions before authorizing any oil and gas activity based on the project level NEPA analysis.

1.3 DECISIONS TO BE MADE

The BLM's decisions will include which tracts of land will be offered for lease and the terms and conditions to be applied to such leases and subsequent authorizations for oil and gas activities. The decisions evaluated in this Leasing EIS and its ROD would not authorize any on-the-ground activity associated with the exploration or development of oil and gas resources in the Coastal Plain.

The USFWS continues to manage all federal lands in the Arctic Refuge Coastal Plain, including both potential leased and unleased areas; however, the BLM manages all aspects of the oil and gas program, including the issuance and administration of oil and gas leases, and permitting of all oil and gas activities. Although the BLM intends to consult with the USFWS, as noted in **Table 2-3** (footnote 1) when making oil and gas program decisions, Section 20001(a)(2) and (b)(2)(A) of PL 115-97 assigns the BLM the sole responsibility for making such decisions.

1.4 PROGRAM AREA

The USFWS is the predominant land manager in the program area. Other lands in the Coastal Plain include Alaska Native lands conveyed pursuant to ANCSA and Native allotments (see **Table 1-1**).

Table 1-1
Land Administration Included in PL 115-97 Coastal Plain

Subject to the BLM's Oil and Gas Leasing Authority	Acres	Outside the BLM's Oil and Gas Leasing Authority	Acres
USFWS-managed lands, including submerged lands	1,562,600	Native-conveyed	24,400
Native allotment	900	Native-selected	4,400
Total	**1,563,500**	**Total**	**28,800**

Source: BLM GIS 2018
Note: Acreages are rounded to nearest 100.

The Coastal Plain program area was previously referred to as the 1002 Area. The program area includes all Federal lands and waters comprising the approximately 1,563,500 acres of the Coastal Plain within the 19.3 million-acre Arctic Refuge (**Map 1-1** in **Appendix A**). The program area excludes a northern coastal portion of Air Force-administered lands near Kaktovik. As subsurface mineral interest owner, the BLM may lease subsurface of allotment; however, allotment holders retain ownership of the surface. Lands outside the BLM's oil and gas leasing authority are those lands excluded from the definition of the Coastal Plain in PL 115-97, Native conveyed lands, and Native selected lands.

As acknowledged by PL 115-97, in Map Plates 1 and 2, State selection rights to approximately 20,000 acres in the northwest portion of the Coastal Plain are the subject of administrative appeals brought by the State of Alaska, pending before the Interior Board of Land Appeals (IBLA 2016-109 and IBLA 2017-55). The US currently owns this land and must manage it under PL 115-97.

The USFWS would continue management of Arctic Refuge lands under the guidance of its current CCP (USFWS 2015a) and any amendments thereto. The BLM does not have authority to enter into cooperative agreements for co-management of surface resources in the Arctic Refuge, because they are not BLM public lands under FLPMA Section 307(b).

1.5 Scoping and Issues

The BLM conducted formal scoping for the Leasing EIS following publication of a Notice of Intent in the *Federal Register* on April 20, 2018. In May and June 2018, the BLM held scoping meetings in Alaska, in Anchorage, Arctic Village, Fairbanks, Kaktovik, Utqiaġvik, and Venetie, and also in Washington, DC. Oral comments were captured by a court reporter at all meetings. The BLM formally accepted scoping comments through June 15, 2018. For more information on the scoping process, see the final scoping report on the BLM's project website: https://goo.gl/HVo5Mj.

The following summaries highlight a few of the issues identified during scoping and addressed in this Leasing EIS. The full list of summaries is available in the final scoping report.

- **Fish and wildlife—**Commenters stated concerns about impacts on fish and wildlife, including caribou and other large terrestrial mammals, marine mammals, migratory birds, and fish and other aquatic species. Potential impacts on the PCH were of particular concern. Commenters requested that the EIS evaluate the use and importance of the program area to herd movement during different life stages and seasons and how the proposed program might affect calving grounds, insect relief areas, and migration routes.
- **Special status species—**Commenters noted that the proposed program could reduce and fragment available terrestrial denning habitat for the Southern Beaufort Sea (SBS) subpopulation of polar bear, which is listed as threatened under the ESA. Commenters requested that the BLM analyze impacts on all special status species, including marine mammals, such as ringed seals, bearded seals, and bowhead whales.
- **Oil and gas—**Commenters requested that the EIS analysis consider direct, indirect, and cumulative impacts of all aspects of oil and gas exploration and development; examples given were access routes, support facilities, and other infrastructure needed for exploration and development and their potential future impacts.
- **2,000-acres of surface development—**Commenters requested further definition of the 2,000-acres of surface development limit, as described in Section 20001(c)(3) of PL 115-97, and asked for

clarification on what types of surface disturbance would be included and how the 2,000-acre footprint would be measured.

- **Subsistence and sociocultural systems—**Commenters noted that local tribes are culturally tied to the Coastal Plain and the PCH and requested that the BLM analyze impacts on their traditional way of life. They asked that the BLM consider the positive and negative economic changes to communities, impacts on traditional subsistence-based economy, food scarcity, changes to access to traditional subsistence use areas, and subsistence food resources.

Issues outside of the scope of the EIS were also identified during scoping, as follows:

- Comments advocating keeping the Coastal Plain closed to oil and gas leasing
- Comments about land management actions outside of the BLM's jurisdiction
- Comments on issues that do not meet the stated purpose and need of the EIS, such as investing in renewable energy alternatives instead of an oil and gas leasing program

1.6 EIS Process

The Leasing EIS process began with the notice of intent to prepare the EIS, followed by the formal scoping period (see **Section 1.5**, Scoping and Issues). After the scoping period and after receiving additional input from the public, the BLM consulted with the cooperating agencies, tribes, and ANCSA corporations, researched information on the resources and uses of the area, developed a range of reasonable management alternatives, and analyzed the impacts of those alternatives. These analyses underwent review within the BLM and among the cooperating agencies, resulting in the Draft EIS.

The EPA published the Notice of Availability of the Draft EIS in the *Federal Register* on December 28, 2018, initiating a 45-day public comment period. The Draft EIS comment period was extended 30 days to March 13, 2019, for a total of 75 days. In February 2019, the BLM held public meetings to receive comments on the Draft EIS in Anchorage, Arctic Village, Fairbanks, Fort Yukon, Kaktovik, Utqiagvik, Venetie, and Washington, DC. On February 5, 2019, in conjunction with the Draft EIS public meeting, the BLM held a subsistence hearing in the potentially affected community of Kaktovik, pursuant to Section 810(a) of ANILCA. The BLM received written comments by mail, fax, email, online comment form via ePlanning, and handwritten and verbal testimony at public meetings. Comments received covered a wide spectrum of thoughts, opinions, ideas, and concerns. A total of 1,066,803 comment letter submissions were received; 3,709 of these were considered unique submissions and 1,063,094 were part of form letter campaigns. Overall, more than 4,000 substantive scoping comments were identified (see **Appendix S**). The BLM will not issue its decision on the leasing program, called the ROD, until at least 30 days after the EPA publishes the Notice of Availability of this Final EIS in the *Federal Register*.

1.7 Collaboration and Coordination

1.7.1 Lead and Cooperating Agencies

The BLM is the lead agency for this EIS. Participating in the Leasing EIS as cooperating agencies are the USFWS, EPA, State of Alaska, NSB, Native Village of Kaktovik, Native Village of Venetie Tribal Government, Venetie Village Council, and Arctic Village Council. The BLM requested their participation because of their expertise. Their participation does not constitute their approval of the analysis, conclusions, or alternatives presented in this EIS; for these, the BLM is solely responsible. Cooperating agencies, including the USFWS, assisted the BLM in developing alternatives, providing data, and reviewing and providing input on the EIS. The list of preparers for the Leasing EIS is in **Appendix C**.

1.7.2 Consultation with Tribes and ANCSA Corporations

The BLM, as the lead federal agency, consulted with federally recognized tribal governments during preparation of this EIS and identified 16 tribes potentially affected by the leasing program. Consistent with DOI policy on government-to-government consultation with tribes, the BLM first sent a letter of notification and inquiry on March 2, 2018, to the Arctic Village Council, the Iñupiat Community of the Arctic Slope, the Native Village of Kaktovik, the Venetie Village Council, and the Native Village of Venetie Tribal Government. In its letter, the BLM offered these entities the opportunity to participate in formal government-to-government and National Historic Preservation Act Section 106 consultations, to participate as NEPA cooperating agencies, or to simply receive information about the project.

The BLM sent a second invitation letter on April 23, 2018, to the following tribal entities: Beaver Village Council, Birch Creek Tribal Council, Chalkyitsik Village Council, Gwitchyaa Zhee Gwich'in Tribal Government (Fort Yukon), Naqsragmiut Tribal Council (Anaktuvuk Pass), Native Village of Barrow Iñupiat Traditional Government, Native Village of Nuiqsut, and the Native Village of Stevens. The dates and locations of government-to-government meetings that have taken place are provided in **Appendix C**. Discussions with potentially affected tribal governments occurred throughout the EIS process.

The BLM also sent a letter of notification and inquiry on March 2, 2018, to ASRC and KIC, offering the opportunity to participate in formal ANCSA corporation consultation. The BLM held consultations with both ANCSA corporations, as well as Doyon, Limited, to discuss the EIS process (see **Appendix C**).

1.7.3 Coordination and Consultation with Local, State, and Federal Agencies

The BLM is consulting with the Alaska SHPO, in accordance with Section 106 of the NHPA, as the BLM has a responsibility to take into account the effects of the proposed leasing program on historic properties, which are properties listed in or eligible for listing in the NRHP. This is to determine how proposed activities could affect cultural resources listed on or eligible for listing on the NRHP. Formal consultations with the SHPO also may be required when individual projects are implemented. SHPO consultations for the leasing program are ongoing and will be completed by the time the ROD is signed.

To comply with Section 7(a)(2) of the ESA, the BLM began consulting with the USFWS and NMFS early in the EIS process. The USFWS and NMFS provided input on issues, data collection and review, and alternatives development. The BLM has consulted with the USFWS and NMFS to identify ESA issues and to develop the biological assessments.

1.8 Requirements for Further Analysis

The decision on oil and gas leasing based on the analysis in this EIS will authorize multiple lease sales. The first lease sale and subsequent sales might offer only a portion of the lands identified in the ROD as available, making possible a phased approach to leasing and development. However, for impact analysis, this EIS assumes that no fewer than 400,000 acres of land that BLM decides to make available for leasing would be offered in each of the first two lease sales.

The timing of subsequent lease sales and the lands offered therein would depend in part on the response to the first sale and the results of the exploration that follows. This EIS is intended to fulfill NEPA requirements for lease sales conducted at least through December 2027 and potentially thereafter. Before it conducts the second and each subsequent lease sale, the BLM will evaluate the adequacy of the EIS in light of new information and circumstances to determine whether additional analysis is needed in order to comply with NEPA.

Future on-the-ground actions requiring BLM approval, including potential exploration and development proposals, would require further NEPA analysis based on the site-specific proposal. Potential applicants would be subject to the terms of the lease; however, the BLM Authorized Officer may require additional site-specific terms and conditions before authorizing any oil and gas activity based on the project level NEPA analysis.

1.9 International Agreements, Laws, Regulations, and Permits

In implementing the Coastal Plain Oil and Gas Leasing Program, the BLM would comply with applicable international agreements, federal, state, and local laws, regulations, and executive orders (EOs). Secretarial Order (SO) 3349, American Energy Independence, issued on March 29, 2017, directed the DOI, under EO 13783, Promoting Energy Independence and Economic Growth (March 28, 2017), to "review all existing regulations, orders, guidance documents, policies, and any other similar actions that potentially burden the development or utilization of domestically produced energy resources." This SO can be viewed in its entirety at https://elips.doi.gov/elips/0/doc/4512/Page1.aspx. SO 3360, issued on December 22, 2017, rescinded orders and guidance that were found to be inconsistent with SO 3349. The SO can be viewed in its entirety at https://elips.doi.gov/elips/0/doc/4628/Page1.aspx.

In 1973, the US signed the Agreement on the Conservation of Polar Bears (Range States Agreement). This is an agreement between the governments of Canada, Denmark, Norway, the former Union of Soviet Socialist Republics, and the US, recognizing the responsibilities of circumpolar countries for coordinating actions to protect polar bears.

Additionally, signed in 1988 and reaffirmed in 2000 by the Inuvialuit Game Council and the NSB Fish and Game Management Committee, the Iñupiat-Inuvialuit Agreement on Polar Bear Management in the Southern Beaufort Sea, is a user-to-user agreement on the conservation of polar bears specific to the Southern Beaufort subpopulation.

In 1987, the US and Canadian governments signed the Agreement between the Government of the United States of America and the Government of Canada on the Conservation of the Porcupine Caribou Herd. The main objectives of the agreement are to conserve the herd and its habitat through international cooperation and coordination. The goal is to minimize the risk of irreversible damage or long-term adverse effects, including cumulative effects, as a result of use of caribou or their habitat. Further, it ensures opportunities for customary and traditional uses of the PCH. The agreement set up the International Porcupine Caribou Board, composed of delegated representatives from both countries, who give advice and recommendations to the countries on the conservation and management of the herd.

The US, Canada, Mexico, Russia, and Japan have also signed treaties protecting birds that have been added to the Migratory Bird Treaty Act. For a summary of applicable international agreements, federal, state, and local laws, regulations, permits, and EOs, refer to **Appendix D**. The BLM will continue to consult with regulatory agencies, as appropriate, during subsequent NEPA processes before oil and gas activities are authorized, to ensure that all requirements are met.

1.9.1 2,000-Acre Facility Limit in the Tax Cuts and Jobs Act of 2017 (Public Law 115-97)

This section contains the BLM's interpretation of Section 20001(c)(3) of PL 115-97, which states the following:

> SURFACE DEVELOPMENT—In administering this section, the Secretary shall authorize up to 2,000 surface acres of Federal land on the Coastal Plain to be covered by production and support

facilities (including airstrips and any area covered by gravel berms or piers for support of pipelines) during the term of the leases under the oil and gas program under this section.

The BLM interprets this provision as limiting to 2,000 the total number of surface acres of *all* federal land across the Coastal Plain, regardless of whether such land is leased, which may be covered by production and support facilities *at any given time*. Under this interpretation, production and support facilities not authorized by an oil and gas lease (e.g., off-lease pipelines or roads authorized by a right-of-way grant), would be counted toward the 2,000-acre limit as would on-lease production and support facilities, and reclaimed acreage of Federal land formerly containing production and support facilities would no longer count towards the 2,000-acre limit. The limit does not apply to production and support facilities located on non-federal lands, including Native allotments and land owned by ANCSA corporations.

The BLM interprets this limitation to generally refer to acres of land directly occupied by non-ephemeral facilities (i.e., those that occupy the land for more than one winter season) that are primarily used for the purpose of development, production, and transportation of oil and gas in and from the Coastal Plain. In applying that standard, 1) "facility" is given its ordinary dictionary definition, which is something that is built, installed, or established to serve a particular purpose; here, the development, production, and transportation of oil and gas in and from the Coastal Plain; 2) the limitation does not apply to surface disturbance indirectly related to or resulting from those facilities; and 3) the limitation applies only to those portions of oil and gas facilities that touch the land; thus, the BLM interprets the types of "production and support" facilities that will count toward the 2,000-acre limit as including any type of gravel or other fill constructed facility which touches the land, to include:

- Gravel pads used for production or processing facilities (including wells), pump or compressor stations, and lodging facilities for workers
- Gravel airstrips or roads
- Any other area covered by gravel berms or piers for support of pipelines

Examples of types of facilities that would not count toward the 2,000-acre limit include the portion of facilities that do not touch the land (e.g., elevated pipelines), and facilities constructed with snow or ice (e.g., snow trails and ice roads/pads). In addition, the BLM interprets "production and support facilities" to include gravel mines used to supply mineral materials for construction and maintenance of oil and gas facilities within the Coastal Plain; specifically, the unreclaimed portions of land that have undergone excavation of mineral materials or contain stockpiles of mined mineral materials. For purposes of impact analysis, the BLM employs this interpretation as an assumption in each of the action alternatives analyzed in the EIS.

See **Section S.1.2** of **Appendix S** for a detailed explanation of the basis for the foregoing interpretation. See also **Table S-1** of **Appendix S**, which includes the BLM's response to public comments received on the interpretation included in the Draft EIS.

1.10 ANILCA Section 810 Evaluation

Section 810 of ANILCA focuses on issues related to the effects of proposed activities on subsistence use. An ANILCA Section 810 notice and public hearing process is required if a proposed action may significantly restrict subsistence uses and needs. A final evaluation and finding of effects on subsistence uses and needs from actions that could be undertaken under the four alternatives considered in this EIS is provided in **Appendix E**. The preliminary evaluation, published with the Draft EIS, found that the cumulative case presented in the EIS met the "may significantly restrict" threshold for the community of Kaktovik; therefore, it made a positive finding pursuant to ANILCA Section 810. As a result, a public subsistence hearing was held in the potentially affected community of Kaktovik on February 5, 2019 in conjunction with the Draft EIS public meeting. The final evaluation made the same findings as the preliminary evaluation, concluding that the cumulative case presented in the EIS met the “may significantly restrict” threshold for the community of Kaktovik.

1.11 TRANSLATION

Using BLM funds provided through the Bureau of Indian Affairs, the Arctic Village Council translated and distributed key sections of the Draft EIS into the Gwich'in language. The key sections were the **Executive Summary**, **Chapter 2**: Alternatives, **Chapter 3**: Cultural Resources, Subsistence Uses and Resources, and **Appendix E**: ANILCA Section 810 Preliminary Evaluation. In addition, translators were available in Arctic Village, Venetie, Kaktovik, and Utqiagvik for public testimony during the scoping and Draft EIS public meetings.

This Final EIS may be translated into a language other than English to facilitate public participation in the decision process. The English-language version has been prepared by the BLM and is the official version of the document for all purposes. Any translated version of this document has been prepared for the convenience of non-English-speaking members of the public. In the event of any discrepancy, the English-language version controls.

Chapter 2. Alternatives

2.1 INTRODUCTION

The alternatives presented in this chapter address the public's concerns, including those comments expressed during the formal scoping period and Draft EIS comment period, as well as those raised through consultation with tribes, Native corporations, and cooperating agencies. The range of alternatives presented in this chapter was developed by the BLM's Alaska State Office, in coordination with the cooperating agencies. The alternatives respond to the purpose and need for action, including the legislative requirement to establish and administer a competitive oil and gas program in the Coastal Plain in the Arctic Refuge.

The alternatives have benefitted from the insights and expertise of the cooperating agencies, though those agencies are not responsible for the range of alternatives examined in this Leasing EIS (see **Section 1.7.1**, Lead and Cooperating Agencies, for a list of the cooperating agencies). The BLM as the lead agency is solely responsible for the alternatives in this Leasing EIS.

The action alternatives (Alternatives B, C, and D) described in **Section 2.2**, Description of the Alternatives, include a mix of lease stipulations and ROPs that contain measures to avoid or mitigate surface damage and minimize ecological disturbance throughout the program area. Alternative B is BLM's preferred alternative. However, in its ROD, BLM may select another alternative or make adjustments to aspects of Alternative B or another alternative that are within the spectrum of alternatives analyzed in this EIS.

The BLM is analyzing this range of alternatives to ensure that a wide range of management options are considered, consistent with applicable law and the purposes of the Arctic Refuge, and to address public suggestions and agency concerns to protect resources. Any decision that the BLM makes following the analysis in this Leasing EIS must be consistent with PL 115-97 and take into consideration the Refuge purposes set out in Section 303(2)(B) of ANILCA, as amended by Section 20001 of PL 115-97. Decisions must also conform to other applicable laws and regulations.

2.2 DESCRIPTION OF THE ALTERNATIVES

Table 2-1 highlights the key differences among alternatives relative to areas available for leasing and lease stipulations. **Table 2-2** provides the acreages attributed to each stipulation proposed in the alternatives. Alternative D contains two sub-alternatives, Alternatives D1 and D2, which use different approaches to mitigate impacts on resources through lease stipulations. Therefore, acreages associated with Alternatives D1 and D2 may be different even though the stipulation for a given resource is the same. **Table 2-3** is a complete description of all decisions proposed for each alternative.

Table 2-1
Quantitative Summary of Lease Stipulations by Alternative

Lease Availability/Stipulations (acres)	B	C	D1	D2
Not offered for lease sale	**0**	**0**	**526,300**	**763,500**
Available for lease sale, subject to NSO	359,400	932,500	708,600	505,800
Available for lease sale, subject to CSU	0	0	123,900	105,200
Available for lease sale, subject to TLs	585,400	317,100	0	189,000
Subject to only standard terms and conditions	618,700	313,900	204,700	0
Total available for lease sale	**1,563,500**	**1,563,500**	**1,037,200**	**800,000**

Source: BLM GIS 2018

Table 2-2
Quantitative Comparison of Individual Lease Stipulations by Alternative

Lease Availability/Stipulations (acres)	B	C	D1	D2
1—Rivers and Streams (NSO)	290,400	389,000	347,800	278,500
2—Canning River Delta and Lakes (NSO)	0	0	68,000	68,000
3—Springs/Aufeis (not offered for sale)	0	0	93,100	127,000
3—Springs/Aufeis (NSO)	0	0	63,500	63,500
4—Nearshore Marine, Lagoon, and Barrier Islands (NSO)	72,400	72,400	72,200	59,000
5—Coastal Polar Bear Denning River Habitat (NSO)	0	0	105,400	90,600
6—Caribou Summer Habitat (TL)	0	0	0	799,900
7—Porcupine Caribou Herd Calving Area (not offered for sale)	0	0	476,600	645,800
7—Porcupine Caribou Herd Calving Area (NSO)	0	606,200	196,700	82,800
7—Porcupine Caribou Herd Calving Area (TL)	721,200	115,000	0	0
8—Porcupine Caribou Herd Post-Calving Area (not offered for sale)	0	0	0	67,500
8—Porcupine Caribou Herd Post-Calving Area (controlled surface use)	0	0	264,300	196,800
8—Porcupine Caribou Herd Post-Calving Area (TL)	0	985,700	0	0
9—Coastal Area (NSO)	0	145,100	197,000	148,400
10—Wilderness Boundary (not offered for sale)	0	0	0	70,000
10—Wilderness Boundary (NSO)	0	0	96,600	49,100

Source: BLM GIS 2018

2.2.1 Alternative A—No Action Alternative

Under Alternative A, the No Action Alternative, no federal minerals in the Coastal Plain would be offered for future oil and gas lease sales after the ROD for this EIS has been signed. Alternative A would not comply with the directive under PL 115-97 to establish and administer a competitive oil and gas program for leasing, developing, producing, and transporting oil and gas in and from the Coastal Plain in the Arctic Refuge. It also would not meet the purpose of the Arctic Refuge to provide for an oil and gas program on the Coastal Plain, set out in Section 303(2)(B)(v) of ANILCA. Under this alternative, current management actions would be maintained, and resource trends are expected to continue, as described in the Arctic Refuge Revised CCP (USFWS 2015a).

Alternative A would not meet the purpose and need of the action, which is the BLM's implementation of PL 115-97, including the requirement to hold multiple lease sales and to permit associated post-lease oil and gas activities; however, Alternative A is being carried forward for analysis to provide a baseline for comparing impacts under the action alternatives, as required by the CEQ NEPA regulations.

2.2.2 Alternative B (Preferred Alternative)

Alternative B is the BLM's preferred alternative; the Draft EIS did not identify a preferred alternative. Although Alternative B offers the opportunity to lease the entire program area and there would be the fewest acres with NSO stipulations, it nevertheless provides substantial protections in the form of NSO and other lease stipulations as well as ROPs that would apply to post-lease oil and gas activities to reduce potential impacts. Areas of the Coastal Plain that are available for lease sale and applicable stipulations under Alternative B are shown in **Map 2-1**, Alternative B, and **Map 2-2**, Alternative B, Lease Stipulations.

2.2.3 Alternative C

The entire program area could also be offered for lease sale under Alternative C; however, a large portion of the program area would be subject to NSO. The BLM would rely on the same ROPs as under Alternative B to reduce potential impacts from post-lease oil and gas activities. Areas of the Coastal Plain that are available for lease sale and applicable stipulations under Alternative C are shown in **Map 2-3**, Alternative C, and **Map 2-4**, Alternative C, Lease Stipulations.

2.2.4 Alternative D

Under Alternative D, portions of the Coastal Plain would not be offered for lease sale. In addition, a large portion of the remaining area would be subject to NSO. In some instances, more prescriptive ROPs are analyzed under Alternative D than under Alternatives B and C.

Alternative D contains two sub-alternatives, Alternatives D1 and D2, which use different approaches to mitigate impacts on resources through lease stipulations. Areas of the Coastal Plain that are available for lease sale and applicable stipulations under Alternative D1 are shown in **Map 2-5**, Alternative D1, and **Map 2-6**, Alternative D1, Lease Stipulations. Alternative D2 lands available for lease sale and applicable stipulations are shown in **Map 2-7**, Alternative D2, and **Map 2-8**, Alternative D2, Lease Stipulations. Based on public comments received on the Draft EIS, the amount of land available for leasing under Alternative D2 has been reduced from 1,037,200 to 800,000 acres. The revision prioritizes high potential areas available for lease, while providing additional consideration for caribou calving and post-calving habitat (areas along the coast of Camden Bay and east of the mouth of the Niguanak River), expansion of existing buffers, and expansion of lands adjacent to springs and aufeis habitats. Alternative D2 reflects the total minimum acreage PL 115-97 requires to be offered in two mandated lease sales.

2.2.5 Lease Stipulations and Required Operating Procedures

Protective measures in Alternatives B, C, and D are of two types: lease stipulations and ROPs (see **Table 2-3**, below).

Lease Stipulations

Appropriate stipulations are attached to the lease when the BLM issues it. As part of a lease contract, stipulations are specific to the lease. All oil and gas activity permits issued to a lessee must comply with the lease stipulations appropriate to the activity under review, such as exploratory drilling or production pad construction.

A stipulation included in an oil and gas lease could be subject to a waiver, exception, or modification, as appropriate. The objective of a stipulation must be met before a waiver, exception, or modification would be granted. Waivers, exceptions, and modifications are:

- A waiver—A permanent exemption to a stipulation on a lease
- An exception—A one-time exemption to a lease stipulation, determined on a case-by-case basis
- A modification—A change attached to a lease stipulation, either temporarily or for the life of the lease

The BLM Authorized Officer may authorize a modification to a lease stipulation only if the officer determines that the factors leading to the stipulation have changed sufficiently to make the stipulation no longer justified; the proposed operation would still have to meet the objective stated for the stipulation.

While the BLM may grant a waiver, exception, or modification of a stipulation through the permitting process, it may also impose additional requirements through permitting terms and conditions to meet the objectives of any stipulation. This would be the case if the BLM Authorized Officer considers that such requirements are warranted to protect the land and resources, in accordance with the BLM's responsibility under relevant laws and regulations. Note that PL 115-97 requires that the BLM authorize rights-of-way (ROWs) for essential roads and pipeline crossings, and other necessary access, even in areas closed to leasing or with a NSO.

Required Operating Procedures

The ROPs under Alternatives B, C, and D describe the protective measures that the BLM would impose on applicants during the permitting process. Together with the lease stipulations, the ROPs also provide a basis for analyzing the potential impacts of the alternatives in this Leasing EIS. Similar to stipulations, the objective of a ROP must be met in order for exceptions, modifications, or waivers to be granted.

Any applicant requesting authorization for an activity from the BLM will have to address the applicable ROPs in one of the following ways:

- Before submitting the application (e.g., performing and documenting subsistence consultation or surveys)
- As part of the application proposal (e.g., including in the proposal statements that the applicant will meet the objective of the ROP and how the applicant intends to achieve that objective)
- As a term imposed by the BLM in a permit or right-of-way authorization

At the permitting stage, the BLM Authorized Officer would not include those ROPs that, because of their location or other inapplicability, are not relevant to a specific land use authorization application. Note also that at the permitting stage, the BLM Authorized Officer may establish additional requirements as warranted to protect the land, resources, and uses in accordance with the BLM's responsibilities under relevant laws and regulations.

Table 2-3
Lease Stipulations, Required Operating Procedures, and Lease Notices by Alternative[1]

Alternative B (Preferred Alternative)	Alternative C	Alternative D
LEASE STIPULATIONS		
PROTECTIONS THAT APPLY IN SELECT BIOLOGICALLY SENSITIVE AREAS		
Lease Stipulation 1—Rivers and Streams (Map 2-2) Objective: Minimize the disruption of natural flow patterns and changes to water quality; the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of floodplain and riparian areas, springs, and aufeis; the loss of spawning, rearing, or overwintering fish habitat; the loss of cultural and paleontological resources; the loss of raptor habitat; impacts on subsistence cabins and campsites; and the disruption of subsistence activities. Requirement/Standard: (NSO) Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are prohibited in the streambed and within the described setback distances outlined below, from the southern boundary of the Coastal Plain to the stream mouth. For streams that are entirely in the Coastal Plain, the setback extends to the head of the stream, as identified in the National Hydrography Dataset. Essential pipelines and road crossings would be permitted through setback areas in accordance with Section 20001(c)(2) of PL 115-97, which requires issuance of rights-of-way or easements across the Coastal Plain, including access to private land used in support of the federal oil and gas leasing program, for the exploration, development, production, or transportation	***Lease Stipulation 1—Rivers and Streams (Map 2-4)*** Objective: Same as Alternative B. Requirement/Standard: (NSO) Same NSO requirements and setback distances as described under Alternative B; the setback distances for the following rivers have changed under Alternative C: a. Canning River: from the western boundary of the Coastal Plain to 2 miles east of the eastern edge of the active floodplain b. Hulahula River: 2 miles in all directions from the active floodplain c. Okpilak River: 2 miles from the banks' ordinary high-water mark	***Lease Stipulation 1—Rivers and Streams (Map 2-6 and Map 2-8)*** Objective: Minimize the disruption of natural flow patterns and changes to water quality; the disruption of natural functions from the loss or change to vegetative and physical characteristics of floodplain and riparian areas, springs, and aufeis; the loss of spawning, rearing, or overwintering habitat for fish; the loss of cultural and paleontological resources; the loss of raptor habitat; impacts on subsistence cabins and campsites; the disruption of subsistence activities; impacts on hunting and recreation; and impacts on scenic and other resource values. Protect the water quality, quantity, and diversity of fish and wildlife habitats and populations associated with springs and aufeis across the Coastal Plain. Requirement/Standard: (NSO) Same NSO requirements as Alternative B. River setback distances under Alternative D are the following: a. Canning River: From the western boundary of the Coastal Plain to 3 miles east of the eastern edge of the active floodplain b. Hulahula River: 4 miles in all directions from the active floodplain c. Aichilik River: 3 miles from the eastern edge of the Coastal Plain boundary d. Okpilak River: 3 miles from the banks' ordinary high-water mark

[1]While the language in **Table 2-3** refers only to the BLM or its Authorized Officer, it is understood that all activities, including plan development, study development, and consideration of exceptions, modifications, or waivers would include appropriate coordination with the USFWS as the surface management agency, and, if necessary, consultation under the ESA. In addition, the BLM would coordinate with other appropriate federal, state, and NSB agencies, tribes, ANCSA corporations, and other Native organizations as appropriate.

Alternative B (Preferred Alternative)	Alternative C	Alternative D
necessary to carry out Section 20001. Gravel mines could be permitted in setback areas. Setbacks may not be practical in river deltas; in these situations, an exception may be granted by the Authorized Officer if the operator can demonstrate: (1) there are no practical alternatives to locating facilities in these areas; (2) the proposed actions would maintain or enhance resource functions; and (3) permanent facilities are designed to withstand a 100-year flood. a. Canning River: from the western boundary of the Coastal Plain to 1 mile east of the eastern edge of the active floodplain b. Hulahula River: 1 mile in all directions from the active floodplain c. Aichilik River: 1 mile from the eastern edge of the Coastal Plain boundary d. Okpilak River: 1 mile from the banks' ordinary high-water mark e. Jago River: 1 mile from the banks' ordinary high-water mark f. The following rivers and creeks will have a 0.5-mile setback from the banks' ordinary high-water mark: i. Sadlerochit River ii. Tamayariak River iii. Okerokovik River iv. Katakturuk River v. Marsh Creek	*(see above)*	e. The following rivers would have a 1-mile setback from the banks' ordinary high-water mark: i. Sadlerochit River ii. Jago River f. The following rivers and creeks would have a 0.5-mile setback from the banks' ordinary high-water mark: i. Tamayariak River ii. Katakturuk River iii. Nularvik River iv. Okerokovik River v. Niguanak River vi. Sikrelurak River vii. Angun River viii. Kogotpak River ix. Marsh Creek x. Carter Creek xi. Itkilyariak Creek
Lease Stipulation 2—Canning River Delta and Lakes Objective: Protect and minimize adverse effects on the water quality, quantity, and diversity of fish and wildlife habitats and populations, subsistence resources, and cultural resources; protect and minimize the disruption of natural flow patterns and changes to water quality, the disruption of natural functions resulting from the loss or change to vegetation and physical characteristics of floodplain and riparian areas; the loss of passage, spawning, rearing, or overwintering habitat for fish; the loss of cultural and paleontological resources; and adverse effects to migratory birds. Requirement/Standard: See **ROP 9** for additional requirements/standards		***Lease Stipulation 2—Canning River Delta and Lakes (Map 2-6*** *and* ***Map 2-8)*** Objective: Same as Alternatives B and C. Requirement/Standard: (NSO) Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are prohibited within 0.5 miles of the ordinary high-water mark of any waterbody[2] in Townships 8 and 9, north of the Canning and

[2]For the purposes of this document, waterbody is defined as any feature included in the National Hydrography Dataset. This is a feature-based database that interconnects and uniquely identifies the stream segments or reaches that make up the nation's surface water drainage system.

<table>
<tr><th>Alternative B (Preferred Alternative)</th><th>Alternative C</th><th colspan="2">Alternative D</th></tr>
<tr><td colspan="2">*(see above)*</td><td colspan="2">Tamyariak watersheds. Essential pipelines, road crossings, gravel mines, and other permanent facilities may be considered through the permitting process in these areas where the lessee/operator/contractor can demonstrate on a site-specific basis that impacts would be minimal.</td></tr>
<tr><td colspan="2">***Lease Stipulation 3—Springs/Aufeis***

Objective: Protect the water quality, quantity, and diversity of fish and wildlife habitats and populations associated with springs and aufeis across the Coastal Plain. River systems with springs provide year-round habitat and host the most diverse and largest populations of fish, aquatic invertebrates, and wildlife; they are associated with major subsistence activity and cultural resources. An aufeis is a unique feature associated with perennial springs. It helps sustain river flow during summer and provides insect relief for caribou. Because the subsurface flow paths to perennial springs are unknown and could be disturbed by drilling, use buffer areas around the major perennial springs that support fish populations in which no leasing is permitted.

Requirement/Standard:
a. Before drilling, the lessee/operator/permittee would conduct studies to ensure drilling would not disrupt flow to or from the perennial springs and waste injection wells will not contaminate any perennial springs. Study plans would be developed in consultation with the BLM, USFWS, and other agencies, as appropriate.

See **Lease Stipulation 1** for additional requirements/standards.</td><td>***ALTERNATIVE D1***

Lease Stipulation 3—Springs/Aufeis (Map 2-6)

Objective: Same as Alternatives B and C. This spring supports an isolated, dwarf population of Dolly Varden, unique plant and invertebrate communities, and an extensive aufeis field that persists through much of the summer, providing insect relief habitat for caribou. The Fish Hole 1 spring provides overwintering habitat for arctic grayling and a large population of anadromous Dolly Varden. Residents of Kaktovik routinely harvest Dolly Varden in Fish Hole 1 during winter. The spring produces an extensive aufeis field that persists through much of the summer. The Canning River is the largest river crossing the Coastal</td><td>***ALTERNATIVE D2***

Lease Stipulation 3—Springs/Aufeis (Map 2-8)

Objective: Same as Alternative D1

Requirement/Standard: Same as Alternatives B and C. Aufeis areas listed in Alternative D1, but over a larger area, would not be offered for lease sale.</td></tr>
</table>

Alternative B (Preferred Alternative)	Alternative C	Alternative D	
(see above)		Plain. It has several perennial springs originating upstream of the Coastal Plain that provide steady flow under ice across the Coastal Plain. The river supports several fish species, including arctic grayling and a large population of anadromous Dolly Varden. Aufeis fills the river corridor across the Coastal Plain and extends well into the delta, providing insect relief to caribou during the early summer. <u>Requirement/Standard:</u> Same as Alternatives B and C, with the addition of the following areas identified that would not be offered for lease sale or identified as NSO: a. <u>No leasing</u> and no new non-subsistence infrastructure would be permitted within 3 miles adjacent to or above Sadlerochit Spring (04N031E) nor within a 1-mile buffer below the spring to where it enters the Sadlerochit River and along the aufeis formation (04N031E and 05N031E).	*(see above)*

Alternative B (Preferred Alternative)	Alternative C	Alternative D	
(see above)		<u>No leasing</u> would be permitted within 3 miles adjacent to or above the perennial spring at Fish Hole 1 on the Hulahula River (05N032E). Further, no new non-subsistence infrastructure would be permitted within 4 miles of the perennial spring at Fish Hole 1 on the Hulahula River (05N032E), per **Lease Stipulation 1**, nor within 1 mile of the aufeis field (05N032E and 06N032E). b. <u>No leasing</u> would be permitted within 3 miles adjacent to or above the perennial Tamayariak Spring, and no new non-subsistence infrastructure would be permitted within 1 mile of the associated aufeis field (07N026E). c. <u>No leasing</u> would be permitted within 3 miles adjacent to or above the perennial Okerokavik Spring (04N036E), and no new non-subsistence infrastructure would	*(see above)*

<table>
<tr><th>Alternative B (Preferred Alternative)</th><th>Alternative C</th><th colspan="2">Alternative D</th></tr>
<tr><td colspan="2">(see above)</td><td>be permitted within 1 mile of the associated aufeis field in the Jago River drainage (05N035E and 05N036E).
d. NSO from the western boundary of the Coastal Plain to 3 miles east of the eastern edge of the active floodplain.</td><td>(see above)</td></tr>
<tr><td colspan="2">Lease Stipulation 4—Nearshore marine, lagoon, and barrier island habitats of the Southern Beaufort Sea within the boundary of the Arctic Refuge (Map 2-2 and Map 2-4)

Objective: Protect fish and wildlife habitat, including that for waterfowl and shorebirds, caribou insect relief, marine mammals, and polar bear summer and winter coastal habitat; preserve air and water quality; and minimize impacts on subsistence activities, recreation, historic travel routes, and cultural resources in the nearshore marine area.

Requirement/Standard: (NSO) Exploratory well drill pads, production well drill pads, or a CPF for oil or gas would not be permitted in nearshore marine waters, lagoons, or barrier islands within the boundaries of the Coastal Plain.
a. The BLM Authorized Officer may approve infrastructure for oil and gas activities necessary to be located in these critical and sensitive habitats, such as barge landing, docks, spill response staging and storage areas, and pipelines.
b. Before conducting open water activities, the lessee/operator/contractor would consult with the Alaska Eskimo Whaling Commission, the NSB, and local whaling captains' associations to minimize impacts on subsistence whaling and other subsistence activities of the communities of the North Slope. In a case in which the BLM authorizes permanent oil and gas infrastructure in the nearshore marine area, the lessee/operator/contractor would develop and implement an impact and conflict avoidance and monitoring plan. This would be used to assess, minimize, and mitigate the effects of the infrastructure and its use on these nearshore marine area habitats and their use by wildlife and people, including the following:
i. Design and construct facilities to minimize impacts on subsistence uses, travel corridors, and seasonally concentrated fish and wildlife resources.
ii. Daily operations, including use of support vehicles, watercraft, and aircraft, alone or in combination with other past, present, and reasonably foreseeable activities, would be conducted to minimize impacts on subsistence and other public uses, travel corridors, and seasonally concentrated fish and wildlife resources.
iii. The location of oil and gas facilities, including artificial islands, platforms, associated pipelines, ice or other roads, and bridges or causeways, would be sited and constructed to not pose a</td><td colspan="2">Lease Stipulation 4—Nearshore marine, lagoon, and barrier island habitats of the Southern Beaufort Sea within the boundary of the Arctic Refuge (Map 2-6 and Map 2-8)

Objective: Same as Alternatives B and C.

Requirement/Standard: (NSO) Same as Alternatives B and C, with the following additional requirements:
a. The BLM Authorized Officer may approve infrastructure necessary for oil and gas activities in these critical and sensitive habitats, such as barge landing, docks, spill response staging and storage areas, and pipelines. Approval would be on a case-by-case basis, in consultation with the USFWS or NMFS or both, as appropriate.
b. All lessees/operators/contractors involved in authorized activities in nearshore marine waters must coordinate construction and use infrastructure with all other prospective Arctic Refuge users or user groups, which may be accomplished through public notice and coordination with users in affected communities. Before conducting open water activities, the lessee/operator/contractor would consult with the Alaska Eskimo Whaling Commission, the NSB, and local whaling captains' associations to minimize impacts on subsistence whaling and other subsistence activities of the communities of the North Slope.</td></tr>
</table>

Alternative B (Preferred Alternative)	Alternative C	Alternative D
hazard to public navigation, using traditional high-use subsistence-related travel routes into and through the major coastal lagoons and bays, as identified by the community of Kaktovik and the NSB. iv. Operators would be responsible for developing comprehensive prevention and response plans, including Oil Discharge Prevention and Contingency Plans and Spill Prevention, Control, and Countermeasure plans and maintain adequate oil spill response capability to effectively respond during periods of ice, broken ice, or open water, based on the statutes, regulations, and guidelines of the USFWS, EPA, Alaska Department of Environmental Conservation (ADEC), and the Bureau of Safety and Environmental Enforcement (BSEE), as well as ROPs, stipulations, and policy guidelines of the BLM.		(TL) Oil and gas exploration operations, such as drilling, seismic exploration, and testing, are not allowed on the major nearshore marine waters, lagoons, barrier islands, and coastal islands between May 15 and November 1 or when sea ice edge (as defined by Fetterer et al. 2017) is 10 miles distant or greater from the coast each season, whichever is later. Requests for approval of any activities must be submitted in advance and must be accompanied by evidence and documentation that demonstrates to the satisfaction of the BLM Authorized Officer that the actions or activities meet all the following criteria: a. Exploration would not unreasonably conflict with subsistence uses or significantly affect seasonally concentrated fish and wildlife resources. The location of exploration and related activities would be sited to not pose a hazard to navigation by the public using high-use, subsistence-related travel routes into and through the nearshore marine waters, as identified by the NSB and the Native Village of Kaktovik, recognizing that marine and nearshore travel routes change over time and are subject to shifting environmental conditions.
Lease Stipulation 5—Coastal Polar Bear Denning River Habitat Objective: Minimize disturbance to denning polar bears, and disturbance or alteration of key river and creek maternal denning habitat areas. Requirement/Standard: Comply with ESA and Marine Mammal Protection Act (MMPA) requirements.		***Lease Stipulation 5—Coastal Polar Bear Denning River Habitat (Map 2-6** and **Map 2-8)*** Objective: Same as Alternatives B and C. Requirement/Standard: The following requirements/standards apply from the coastline to 5 miles inland within the program area boundary. a. (NSO) From the coastline to 5 miles inland, no permanent oil and gas infrastructure would be within 1 mile of potential polar bear denning habitat on the Niguanak River, Katakturuk River, Marsh Creek, Carter Creek, and Sadlerochit River, and all associated tributaries as defined by Durner et al. (2006), unless the BLM Authorized Officer approves alternative protective measures.

<table>
<tr><th>Alternative B (Preferred Alternative)</th><th>Alternative C</th><th colspan="2">Alternative D</th></tr>
<tr><td colspan="2">(see above)</td><td colspan="2">b. (TL) From the coastline to 5 miles inland, between October 30 and April 15 of any year, the lessee/operator/contractor would not conduct oil and gas activities within 1 mile of potential polar bear denning habitat on the Niguanak River, Katakturuk River, Marsh Creek, Carter Creek, and Sadlerochit River, and all associated tributaries as defined by Durner et al. (2006), unless the BLM Authorized Officer approves alternative protective measures.</td></tr>
<tr><td colspan="2" rowspan="2">Lease Stipulation 6—Caribou Summer Habitat

Note: All lands in the Arctic Refuge Coastal Plain are recognized as habitat of the PCH and CAH and would be managed to allow for unhindered movement of caribou through the area.

<u>Objective:</u> Minimize disturbance and hindrance of caribou or alteration of caribou movements.

<u>Requirement/Standard:</u> See ROP 23.</td><td colspan="2">Lease Stipulation 6—Caribou Summer Habitat (Map 2-8)

Note: Same as Alternatives B and C.

<u>Objective:</u> Same as Alternatives B and C.</td></tr>
<tr><td>ALTERNATIVE D1

<u>Requirement/Standard:</u> Same as Alternatives B and C.</td><td>ALTERNATIVE D2

<u>Requirement/Standard:</u> Same as Alternatives B and C, with the following additional requirement:

(TL) Construction activities using heavy equipment, excluding drilling from existing production pads, would be suspended from no later than May 20 through no earlier than July 20, unless approved by the BLM Authorized Officer, in consultation with the appropriate federal, state, and NSB regulatory and resource agencies. The intent of this requirement and</td></tr>
</table>

Alternative B (Preferred Alternative)	Alternative C	Alternative D	
(see above)		*(see above)*	allowance for deviation is to restrict activities that would disturb caribou during calving and insect-relief periods but allow for activity if caribou are unlikely to be disturbed in significant numbers. If caribou arrive on the Coastal Plain before May 20, or if they remain in the area past July 20 in significant numbers (greater than approximately 10 percent of the estimated calving cow population or 1,000 during insect-relief periods), construction activities using heavy equipment would be suspended. The lessee would submit with the development proposal a stop work plan that considers this, and any other mitigation related to caribou early arrival or late departure. Major equipment, materials, and supplies to be used at oil and gas work sites would be stockpiled before or after the period of May 20 through July 20 to minimize road traffic.

Alternative B (Preferred Alternative)	Alternative C	Alternative D	
Lease Stipulation 7—Porcupine Caribou Primary Calving Habitat Area (Map 2-2) *<u>Note:</u> PCH primary calving habitat area was defined as the area used for calving (based on annual 95 percent contours calculated using kernel density estimation of parturient female caribou locations May 26-June 10) during more than 40 percent of the years surveyed.* <u>Objective:</u> Minimize disturbance and hindrance of caribou or alteration of their movements in the south-southeast portion of the Coastal Plain, which has been identified as important caribou habitat during calving. <u>Requirement/Standard:</u> (TL) Construction activities using heavy equipment, excluding drilling from existing production pads, would be suspended in the PCH primary calving habitat area from May 20 through June 20. These areas encompass approximately **721,200** acres. If caribou arrive on the Coastal Plain before May 20, construction activities using heavy equipment would be suspended. The lessee shall submit with the development proposal a stop work plan that considers this, and any other mitigation related to caribou early arrival. The intent of this latter requirement is to provide flexibility to adapt to changing climate conditions that may occur during the life of fields in the region. The Authorized Officer may waive this stipulation if the operator, through coordination with appropriate federal, state, and local regulatory agencies can demonstrate calving is not occurring in the lease area; or may grant an exception if the operator can demonstrate their action would not hinder caribou or alter their movements.	***Lease Stipulation 7—Porcupine Caribou Primary Calving Habitat Area (Map 2-4)*** *<u>Note:</u> Same as Alternative B.* <u>Objective:</u> Same as Alternative B. <u>Requirement/Standard:</u> a. (NSO) Approximately **606,200** acres of the PCH primary calving habitat area may be offered for lease but subject to NSO. b. (TL) Approximately **115,000** acres may be offered for lease but subject to the same TLs under Alternative B.	***ALTERNATIVE D1*** ***Lease Stipulation 7—Porcupine Caribou Primary Calving Habitat Area (Map 2-6)*** *<u>Note:</u> Same as Alternative B.* <u>Objective:</u> Same as Alternative B. <u>Requirement/Standard:</u> a. (No leasing) Approximately **476,600** acres of the PCH primary calving habitat area would not be offered for lease and would not be available for surface occupancy. b. (NSO) Approximately **196,700** acres may be offered for lease but subject to NSO.	***ALTERNATIVE D2*** ***Lease Stipulation 7—Porcupine Caribou Primary Calving Habitat Area (Map 2-8)*** *<u>Note:</u> Same as Alternative B.* <u>Objective:</u> Same as Alternative B. <u>Requirement/Standard:</u> a. (No leasing) Approximately **645,800** acres of the PCH primary calving habitat area would not be offered for lease and would not be available for surface occupancy. b. (NSO) Approximately **82,800** acres may be offered for lease but subject to NSO.

Alternative B (Preferred Alternative)	Alternative C	Alternative D	
a. The following ground and air traffic restrictions would apply to permanent oil and gas-related roads in the areas and time periods indicated: i. Within the calving habitat area, from May 20 through June 20, traffic speed shall not exceed 15 miles per hour when caribou are within 0.5 mile of the road. Additional strategies may include limiting trips and using convoys and different vehicle types, to the extent practicable. The lessee shall submit with the development proposal a vehicle use plan that considers these and any other mitigation. The plan shall include a vehicle-use monitoring plan. The BLM Authorized Officer would require adjustments if resulting disturbance is determined to be unacceptable. a. Major equipment, materials, and supplies to be used at oil and gas work sites in the calving habitat area should be stockpiled prior to the period of May 20 through June 20 to minimize road traffic during that period. ii. Operators of aircraft used for permitted activities would maintain an altitude of at least 1,500 feet above ground level (except for takeoffs and landings) over caribou calving range, unless doing so would endanger human life or violate safe flying practices. See Required Operating Procedure 34 for additional conditions.	*(see above)*	*(see above)*	*(see above)*
Lease Stipulation 8—Porcupine Caribou Post-Calving Habitat Area <u>Note:</u> *The PCH post-calving area was defined as the area used by female caribou (based on annual 95 percent contours calculated using kernel density estimation of female caribou locations June 11-30) during more than 40 percent of the years surveyed.*	***Lease Stipulation 8—Porcupine Caribou Post-Calving Habitat Area (Map 2-4)*** <u>Note:</u> *Same as Alternative B.* <u>Objective:</u> Same as Alternative B. <u>Requirement/Standard:</u> (TL) The permittee or a contractor shall observe caribou movement from May 20 through August 20, or earlier if caribou are present prior to May 20. Based on these	***Lease Stipulation 8—Porcupine Caribou Post-Calving Habitat Area (Map 2-6 and Map 2-8)*** <u>Note:</u> *Same as Alternative B.* <u>Objective:</u> Same as Alternative B. <u>Requirement/Standard:</u> (CSU) No CPFs would be allowed in the PCH post-calving habitat area. Well pads, roads, airstrips, and pipelines would be permitted, in accordance with **ROP 23**.	

Alternative B (Preferred Alternative)	Alternative C	Alternative D
Objective: To protect key surface resources and subsistence resources/activities from permanent oil and gas development and associated activities in areas used by caribou during post-calving and insect-relief periods. Requirement/Standard: See **ROP 23**.	observations, traffic would be stopped temporarily to allow crossing by 10 or more caribou. Sections of road would be evacuated whenever an attempted crossing by a large number of caribou (approximately 100 or more) appears to be imminent (June 15–July 20). The permittee shall submit with the development proposal a vehicle use plan that considers these and any other mitigation to minimize or prevent caribou/vehicle interactions during the post-calving period.	Infrastructure would be limited across the area to 100 acres per township, not to exceed 510 acres total in this area. (TL) The permittee or a contractor shall observe caribou movement from May 20 through August 20, or earlier if caribou are present prior to May 20. Based on these observations, traffic would be stopped temporarily to allow crossing by 10 or more caribou. Sections of road would be evacuated whenever an attempted crossing by a large number of caribou (approximately 100 or more) appears to be imminent (June 15–July 20). The permittee shall submit with the development proposal a vehicle use plan that considers these and any other mitigation to minimize or prevent caribou/vehicle interactions during the post-calving period.
Lease Stipulation 9—Coastal Area Objective: Protect nearshore marine waters, lagoons, barrier islands, coastlines, and their value as fish and wildlife habitat, including for waterfowl, shorebirds, and marine mammals; minimize the hindrance or alteration of caribou movement in caribou coastal insect-relief areas; minimize hindrance or alteration of polar bear use and movement in coastal habitats; protect and minimize disturbance from oil and gas activities to nearshore marine habitats for polar bears and seals; prevent loss and alteration of important coastal bird habitat; and prevent impacts on nearshore marine subsistence resources and activities. Requirement/Standard: Before beginning exploration or development within 2 miles inland of the coastline, the lessee/operator/contractor would develop and implement an impact and conflict avoidance and monitoring plan to assess, minimize, and mitigate the effects of the infrastructure and its use on these coastal habitats and their use by wildlife and people. Operators would be responsible for developing	***Lease Stipulation 9—Coastal Area (Map 2-4)*** Objective: Same as Alternative B. Requirement/Standard: Same as Alternative B, plus: (NSO) Exploratory well drill pads, production well drill pads, or CPFs for oil and gas would not be permitted within 1 mile inland of the coastline. The BLM Authorized Officer may approve infrastructure necessary for oil and gas activities in these critical and sensitive coastal habitats, such as barge landing, docks, spill response staging and storage areas, or pipelines. Approval would be on a case-by-case basis, in consultation with the USFWS, or the NMFS, or both, as appropriate. All lessees/operators/contractors involved in authorized activities in the coastal area must coordinate construction and use infrastructure with all other prospective Arctic Refuge users or user groups. Before conducting open water activities, the lessee/operator/contractor would consult with the Alaska Eskimo Whaling Commission, the NSB, and local whaling captains' associations to minimize impacts on subsistence whaling and other subsistence activities of the communities of the	***Lease Stipulation 9—Coastal Area (Map 2-6** and **Map 2-8)*** Objective: Same as Alternative B. Requirement/Standard: Same as Alternative C, plus: (NSO) Exploratory well drill pads, production well drill pads, or CPFs for oil or gas would not be permitted within 2 miles inland of the coastline. In a case in which the BLM authorizes permanent oil and gas infrastructure in the nearshore marine area, the lessee/operator/contractor would develop and implement an impact and conflict avoidance and monitoring plan. This would be used to assess, minimize, and mitigate the effects of the infrastructure and its use on these coastal area habitats and their use by wildlife and people, including the following: i. Design and construct facilities to minimize impacts on subsistence uses, travel corridors, and seasonally concentrated fish and wildlife resources. ii. Daily operations, including use of support vehicles, watercraft, and aircraft, alone or in combination with other past, present, and

Alternative B (Preferred Alternative)	Alternative C	Alternative D
comprehensive prevention and response plans, including Oil Discharge Prevention and Contingency Plans and spill prevention, control, and countermeasure plans and maintain adequate oil spill response capability to effectively respond during periods of broken ice or open water, based on the statutes, regulations, and guidelines of the EPA, ADEC, and the BSEE, as well as ROPs, stipulations, and policy guidelines of the BLM.	North Slope. Operators would be responsible for developing comprehensive prevention and response plans, including Oil Discharge Prevention and Contingency Plans and spill prevention, control, and countermeasure plans and maintain adequate oil spill response capability to effectively respond during periods of broken ice or open water, based on the statutes, regulations, and guidelines of the EPA, ADEC, and the BSEE, as well as ROPs, stipulations, and policy guidelines of the BLM.	reasonably foreseeable activities, would be conducted to minimize impacts on subsistence and other public uses, travel corridors, and seasonally concentrated fish and wildlife resources. iii. The location of oil and gas facilities, including artificial islands, platforms, associated pipelines, ice or other roads, bridges or causeways, would be sited and constructed to not pose a hazard to public navigation, using traditional high-use subsistence-related travel routes into and through the major coastal lagoons and bays, as identified by the community of Kaktovik and the NSB. iv. Operators would be responsible for developing comprehensive prevention and response plans, including Oil Discharge Prevention and Contingency Plans and spill prevention, control, and countermeasure plans and maintain adequate oil spill response capability to effectively respond during periods of broken ice or open water, based on the statutes, regulations, and guidelines of the EPA, Alaska Department of Environmental Conservation (ADEC), and the BSEE, as well as ROPs, stipulations, and policy guidelines of the BLM.

<table>
<tr><th>Alternative B (Preferred Alternative)</th><th>Alternative C</th><th colspan="2">Alternative D</th></tr>
<tr><td colspan="2">Lease Stipulation 10—Wilderness Boundary

No similar objective or requirement/standard.</td><td>ALTERNATIVE D1

Lease Stipulation 10—Wilderness Boundary (Map 2-6)

<u>Objective:</u> Protect wilderness values in the Mollie Beattie Wilderness Area.

<u>Requirement/Standard:</u> (NSO) Surface occupancy, including exploratory and production well drill pads, structures and facilities, and gravel and ice roads, would not be allowed within 3 miles of the southern and eastern boundaries of the Coastal Plain where they are near designated wilderness.

To the extent practicable, aircraft operations would be planned to minimize flights below 2,000 feet when flying within 3 miles of the Mollie Beattie Wilderness Area boundary.</td><td>ALTERNATIVE D2

Lease Stipulation 10—Wilderness Boundary (Map 2-8)

<u>Objective:</u> Same as Alternative D1.

<u>Requirement/Standard:</u>
● (No leasing) Areas north of the Mollie Beattie Wilderness Area would not be offered for lease and would not be available for surface occupancy.
● (NSO) Same as Alternative D1 where not otherwise closed to leasing.

To the extent practicable, aircraft operations would be planned to minimize flights below 2,000 feet when flying within 3 miles of the Mollie Beattie Wilderness Area boundary.</td></tr>
<tr><td colspan="4">Lease Stipulation 11

<u>Objective:</u> Ensure Native allotment owners maintain control over use of their land.

<u>Requirement/Standard:</u> Use of the surface of Native allotments for the construction and maintenance of improvements is prohibited unless written consent is obtained from the allotment owner.</td></tr>
</table>

Alternative B (Preferred Alternative)	Alternative C	Alternative D
REQUIRED OPERATING PROCEDURES		
WASTE PREVENTION, HANDLING, DISPOSAL, SPILLS, AND PUBLIC SAFETY		
Required Operating Procedure 1 Objective: Protect public health, safety, and the environment by disposing of solid and waste and garbage, in accordance with applicable federal, State, and local laws and regulations. Requirement/Standard: Areas of operation would be left clean of all debris.		
Required Operating Procedure 2 Objective: Minimize impacts on the environment from nonhazardous and hazardous waste generation. Encourage continuous environmental improvement. Protect the health and safety of oil and gas field workers, local communities, Coastal Plain subsistence users, Coastal Plain recreationists, and the general public. Avoid human-caused changes in predator populations. Minimize attracting predators, particularly bears, to human use areas. Requirement/Standard: The lessee/operator/contractor would prepare and implement a comprehensive waste management plan for all phases of exploration, development, and production, including seismic activities. The plan would include methods and procedures to use bear resistant containers for all waste materials and classes. The plan would be submitted to the BLM Authorized Officer for approval, in consultation with federal, State, and NSB regulatory and resource agencies, as appropriate (based on agency legal authority and jurisdictional responsibility), as part of a plan of operations or other similar permit application. Management decisions affecting waste generation would be addressed in the following order of priority: (1) prevention and reduction, (2) recycling, (3) treatment, and (4) disposal. The plan would consider and take into account the following requirements: a. Methods to avoid attracting wildlife to food and garbage: The plan would identify precautions that are to be taken to avoid attracting wildlife to food and garbage. The use of bear-resistant containers for all waste would be required. b. Disposal of rotting waste: Requirements prohibit burying garbage. Lessees/operators/contractors would have a written procedure to ensure that rotting waste would be handled and disposed of in a manner that prevents the attraction of wildlife. All rotting waste would be incinerated, backhauled, or composted in a manner approved by the BLM Authorized Officer. All solid waste, including incinerator ash, would be disposed of in an approved waste-disposal facility, in accordance with EPA and ADEC regulations and procedures. Burying human waste is prohibited, except as authorized by the BLM Authorized Officer. The use of bear-resistant containers for all waste would be required. c. Disposal of pumpable waste products: Except as specifically provided, the BLM requires that all pumpable solid, liquid, and sludge waste be disposed of by injection, in accordance with the applicable regulations and procedures. On-pad temporary muds and cuttings storage, as approved by the ADEC, would be allowed as necessary to facilitate annular injection and backhaul operations. d. Disposal of wastewater and domestic wastewater: The BLM prohibits wastewater discharges or disposal of domestic wastewater into bodies of fresh, estuarine, and marine water, including wetlands, unless authorized by an Alaska Pollutant Discharge Elimination System (APDES) or State permit. e. Prevention of the release of poly- and perfluoroalkyl substances: At facilities where fire-fighting foam is required, use fluorine-free foam unless other state or federal regulations require aqueous film-forming foam (AFFF) use. If AFFF use is required, contain, collect, treat, and properly dispose of all runoff, wastewater from training events, and, to the greatest extent possible, from any emergency response events. All discharges must be reported to the ADEC Spill Response Division, Contaminated Sites Program. Measures should also be taken to fully inform workers/trainees of the potential health risks of fluorinated foams and to specify appropriate personal protective equipment to limit exposure during training and use. Training events shall be conducted in lined areas or basins to prevent the release of poly- and perfluoroalkyl substances associated with AFFF.		

<table>
<tr><th>Alternative B (Preferred Alternative)</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td colspan="2">Required Operating Procedure 3

Objective: Minimize the impact of contaminants from refueling operations on fish, wildlife, and the environment.

Requirement/Standard: Refueling equipment within 100 feet of the active floodplain of any waterbody is prohibited. Fuel storage stations would be located at least 100 feet from any waterbody, except for small caches (up to 210 gallons) for motor boats, float planes, and ski planes, and for small equipment, such as portable generators and water pumps. The BLM Authorized Officer may allow storage and operations at areas closer than the stated distances if properly designed and maintained to account for local hydrologic conditions.</td><td>Required Operating Procedure 3

Objective: Same as Alternatives B and C.

Requirement/Standard: Refueling equipment within 500 feet of the active floodplain of any waterbody is prohibited. Fuel storage stations would be at least 500 feet from any waterbody, except for small caches (up to 210 gallons) for motor boats, float planes, ski planes, and small equipment, such as portable generators and water pumps. The BLM Authorized Officer may allow storage and operations at areas closer than the stated distances if properly designed and maintained to account for local hydrologic conditions.</td></tr>
<tr><td colspan="3">Required Operating Procedure 4

Objective: Minimize conflicts from the interaction between humans and bears during oil and gas activities.

Requirement/Standard:
● Implement policies and procedures to conduct activities in a manner that minimizes adverse impacts on polar bears, their habitat, and their availability for subsistence uses.
● Implement adaptive management practices, such as temporal or spatial activity restrictions, in response to the presence of polar bears or polar bears engaged in a biologically significant activity, must be used to avoid interactions with and minimize impacts to them and their availability for subsistence uses.
● Cooperate with the USFWS and other designated federal, state, and local agencies to monitor and mitigate the impacts of Industry activities on polar bears.
● Designate trained and qualified personnel to monitor for the presence of polar bears, initiate mitigation measures, and monitor, record, and report the effects of Industry activities on polar bears.
● Provide polar bear awareness training to personnel.
● Contact affected subsistence communities and hunter organizations to discuss potential conflicts.
● Polar bears: The lessee/operator/contractor, as a part of lease operation planning, would prepare and implement polar bear-interaction plans to minimize conflicts between polar bears and humans. These polar bear interaction plans would be developed in consultation with and approved by the USFWS and the ADFG. The plans would include specific measures identified by the USFWS for petroleum activities on the Coastal Plain, which may include updated measures and/or may include similar measures identified in the current USFWS Incidental Take Regulations (81 CFR 52318; § 18.128) that have been promulgated and applied to petroleum activities to the west of the Coastal Plain. If the USFWS issues Incidental Take Regulations for petroleum activities in the Coastal Plain, those would be followed instead. These plans must include:
○ The type of activity and where and when the activity will occur (i.e., a plan of operation);
○ A food, waste, and other ‘‘bear attractants’’ management plan;
○ Personnel training policies, procedures, and materials;
○ Site-specific polar bear interaction risk evaluation and mitigation measures;
○ Polar bear avoidance and encounter procedures; and
○ Polar bear observation and reporting procedures.
● Grizzly bears: The lessee/operator/contractor would prepare and implement a grizzly bear interaction plan as necessary, in consultation with and approved by the ADFG.</td></tr>
</table>

<table>
<tr><th>Alternative B (Preferred Alternative)</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td colspan="3">Required Operating Procedure 5

<u>Objective</u>: Reduce air quality impacts.

<u>Requirement/Standard</u>: All oil and gas operations (vehicles and equipment) that burn diesel fuels must use ultra-low sulfur diesel, as defined by the EPA.</td></tr>
<tr><td colspan="3">Required Operating Procedure 6

<u>Objective:</u> Prevent unnecessary or undue degradation of the air and lands and protect health.

<u>Requirement/Standard:</u>
a. All projects and permitted uses will comply with all applicable National and State Ambient Air Quality Standards (NAAQS/AAAQS) and ensure Air Quality Related Values (AQRVs) are protected under the Clean Air Act, or other applicable statutes.
b. Prior to initiation of a NEPA analysis for an application to develop a CPF, production pad/well, airstrip, road, gas compressor station, or other potential air pollutant emission source (hereafter called project), the BLM Authorized Officer may require the project proponent to provide a minimum of 1 year of baseline ambient air monitoring data for pollutants of concern, as determined by the BLM. This would apply if no representative air monitoring data are available for the project area or if existing representative ambient air monitoring data are insufficient, incomplete, or do not meet minimum air monitoring standards set by the ADEC or the EPA. If the BLM determines that baseline monitoring is required, this pre-analysis data must meet ADEC and EPA air monitoring standards and cover the year before the submittal. Pre-project monitoring may not be appropriate where the life of the project is less than 1 year.
c. For an application to develop a CPF, production pad/well, airstrip, road, gas compressor station, or other potential substantial air pollutant emission source:
i. The project proponent shall prepare and submit for BLM approval an emissions inventory that includes quantified emissions of regulated air pollutants from all direct and indirect sources related to the proposed project, including reasonably foreseeable air pollutant emissions of criteria air pollutants, volatile organic compounds (VOCs), hazardous air pollutants, and GHGs estimated for each year for the life of the project. The BLM uses this estimated emissions inventory to identify pollutants of concern and to determine the appropriate form of air analysis to be conducted for the proposed project.
ii. The BLM may require air quality modeling for purposes of analyzing project direct, indirect, or cumulative impacts on air quality. The BLM may require air quality modeling depending on:
1) the magnitude of potential air emissions from the project;
2) proximity to a federally mandated Class I area;
3) proximity to a population center;
4) location within or proximity to a nonattainment or maintenance area;
5) meteorological or geographic conditions;
6) existing air quality conditions;
7) magnitude of existing development in the area; or
8) issues identified during the NEPA process.
The BLM will determine the information required for a project-specific modeling analysis through the development of a modeling protocol for each analysis. The BLM will consult with appropriate federal (including federal land managers), State, and/or local agencies regarding modeling to inform its modeling decision and avoid duplication of effort. The modeling shall compare predicted impacts to all applicable local, State, and federal air quality standards and increments, as well as other scientifically defensible significance thresholds (such as impacts on air quality related values, incremental cancer risks, etc.).
iii. The BLM may require the proponent to provide an emissions reduction plan that includes a detailed description of operator-committed measures to reduce project-related air pollutant emissions, including, but not limited to, criteria pollutants, GHGs, heavy metals, mercury, and fugitive dust.
d. Air monitoring or air modeling reports will be provided to the BLM; federal land managers; federal, state, local community, or Tribal governments; and other interested parties, as appropriate.
e. The BLM may require monitoring for the life of the project depending on:
1) the magnitude of potential air emissions from the project;</td></tr>
</table>

Alternative B (Preferred Alternative)	Alternative C	Alternative D
2) proximity to a federally mandated Class I area; 3) proximity to a population center; 4) location within or proximity to a nonattainment or maintenance area; 5) meteorological or geographic conditions; 6) existing air quality conditions; 7) magnitude of existing development in the area; or 8) issues identified during the NEPA process. f. If ambient air monitoring or air quality modeling indicates that project-related emissions cause or contribute to impacts, unnecessary or undue degradation of the lands, exceedances of the NAAQS/AAAQS, or fails to protect health (either directly or through use of subsistence resources), then the BLM may require changes or additional emission control strategies. To reduce or minimize emissions from proposed activities, in order to comply with the NAAQS/AAAQS and/or minimize impacts to AQRVs, the BLM shall consider air quality mitigation measure(s) within its authority in addition to regulatory requirements and proponent-committed emission reduction measures, and also for emission sources not otherwise regulated by ADEC or EPA. Mitigation measures will be analyzed through the appropriate formof NEPA analysis to determine effectiveness. The BLM will consult with the federal land managers and other appropriate federal, state, and/or local agencies to determine potential mitigation options for any predicted significant impacts from the proposed project development. g. Publicly available reports on air quality baseline monitoring, emissions inventory, and modeling results developed in conformance with this ROP shall be provided by the project proponent to the NSB and to local communities and tribes in a timely manner.		
Required Operating Procedure 7 No similar objective or requirement/standard.		***Required Operating Procedure 7*** <u>Objective</u>: Ensure that permitted activities do not create human health risks by contaminating subsistence foods. <u>Requirement/Standard</u>: A lessee/operator/contractor proposing a permanent oil and gas development would design and implement a monitoring study of contaminants in locally used subsistence foods. The monitoring study preparers would examine subsistence foods for all contaminants that could be associated with the proposed development. The study would identify the level of contaminants in subsistence foods before the proposed permanent oil and gas development and would monitor the level of these contaminants throughout the operation and abandonment phases. If ongoing monitoring detects a measurable and persistent increase in a contaminant in subsistence foods, the operator would design and implement a study to determine how much, if any, of the increase originates from the operator's activities. If the study preparers determine that a portion of the increase in contamination is caused by the operator's activities, the BLM Authorized Officer may require changes in

Alternative B (Preferred Alternative)	Alternative C	Alternative D
(see above)		the operator's processes to reduce or eliminate emissions of the contaminant. The design of the study must meet the approval of the BLM Authorized Officer, who may coordinate with appropriate entities before approving the study design. The BLM Authorized Officer may require or authorize changes in the design of the studies throughout the operations and abandonment period or terminate or suspend studies if results warrant.
WATER USE FOR PERMITTED ACTIVITIES		
Required Operating Procedure 8 Objective: In flowing waters (rivers, springs, and streams), ensure water of sufficient quality and quantity to conserve fish, waterbirds, and wildlife populations and habitats in their natural diversity. Requirement/Standard: Withdrawal of unfrozen water from springs, rivers and streams during winter (onset of freeze-up to break-up) is prohibited. The removal of ice aggregate from grounded areas 4 feet deep or less may be authorized from rivers on a site-specific basis.		
Required Operating Procedure 9 Objective: Maintain natural hydrologic regimes in soils surrounding lakes and ponds, and maintain populations of, and adequate habitat for, fish, birds, and aquatic invertebrates. Requirement/Standard: Withdrawal of unfrozen water from lakes and the removal of ice aggregate from grounded areas 4 feet deep or less during winter (onset of freeze-up to break-up) and withdrawal of water from lakes during the summer may be authorized on a site-specific basis, depending on water volume and depth, the fish community, and connectivity to other lakes or streams and adjacent bird nesting sites. Current water use guidelines are as follows: Winter Water Use a. Lakes with fish except ninespine stickleback or Alaska blackfish: unfrozen water available for withdrawal is limited to 15 percent of calculated volume deeper than 7 feet; only ice aggregate may be removed from lakes that are 7 feet deep or less. b. Lakes with only ninespine stickleback or Alaska blackfish: unfrozen water available for withdrawal is limited to 30 percent of calculated volume deeper than 5 feet; only ice aggregate may be removed from lakes that are 5 feet deep or less. c. Lakes with no fish, regardless of depth: water available for use is limited to 20 percent of total lake volume. d. In lakes where unfrozen water and ice aggregate are both removed, the total use would not exceed the respective 15 percent, 20 percent, or 30 percent volume calculations above, unless recharge calculations, river overbank flooding, or a connection to a stream or river indicate recharge will replenish full water withdrawal plus additional ice aggregate withdrawal amounts above these limits. e. Compacting snow cover or removing snow from fish-bearing water bodies would be prohibited, except at approved ice road crossings, water pumping stations on lakes, or areas of grounded ice.		***Required Operating Procedure 9*** Objective: Same as Alternatives B and C. Requirement/Standard: Same as Alternatives B and C, with the following additional requirement: a. Additional modeling and monitoring of lake recharge may be required to ensure natural hydrologic regime, water quality, and aquatic habitat for birds.

<table>
<tr><th>Alternative B (Preferred Alternative)</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td colspan="2">Summer Water Use
f. Requests for summer water use must be made separately, and the volume allowance would be evaluated on a case-by-case basis. Approval from the BLM Authorized Officer is required.

All Water Use
g. Any water intake structures in fish-bearing or non-fish-bearing waters would be designed, operated, and maintained to prevent fish entrapment, entrainment, or injury. Note: All water withdrawal equipment must be equipped with and use fish screening devices approved by the ADFG, Division of Habitat.
h. Additional modeling or monitoring may be required to assess water level and water quality conditions before, during, and after water use from any fish-bearing lake or lake of special concern.</td><td>(see above)</td></tr>
<tr><td colspan="3">WINTER OVERLAND MOVES AND SEISMIC WORK
The following ROPs apply to overland and over-ice moves, seismic work, and any similar cross-country vehicle use and heavy equipment on surfaces without roads during winter. These restrictions do not apply to the use of such equipment on ice roads after they are constructed.</td></tr>
<tr><td colspan="2">Required Operating Procedure 10

Objective: Protect grizzly bear, polar bear, and seal denning and birthing locations.

Requirement/Standard:
a. Grizzly bear dens: Cross-country use of all vehicles, equipment, and oil and gas activity is prohibited within 0.5 mile of occupied grizzly bear dens identified by the ADF&G or the USFWS, unless alternative protective measures are approved by the BLM Authorized Officer, in consultation with the ADF&G.
b. Polar bear dens: Cross-country use of vehicles, equipment, oil and gas activity, and seismic survey activity is prohibited within 1 mile of known or observed polar bear dens, unless alternative protective measures are approved by the BLM Authorized Officer and are consistent with the MMPA and the ESA.
Polar bear and seal mitigation measures for onshore activities.
c. In order to limit disturbance around known polar bear dens:
○ Attempt to locate polar bear dens. Operators seeking to carry out onshore activities in known or suspected polar bear denning habitat during the denning season (approximately November–April) must make efforts to locate occupied polar bear dens within and near areas of operation, utilizing appropriate tools, such as infrared imagery and/or polar bear scent-trained dogs. All observed or suspected polar bear dens must be reported to the USFWS prior to the initiation of activities.
○ Observe the exclusion zone around known polar bear dens. Operators must observe a 1.6-km (1-mi) operational exclusion zone around all known polar bear dens during the denning season (approximately November–April, or until the female and cubs leave the areas). Should previously unknown occupied dens be discovered within 1 mi of activities, work must cease and the USFWS contacted for guidance. The USFWS would evaluate these instances on a case-by-case basis to recommend the appropriate action. Potential actions may range from cessation or modification of work to conducting additional monitoring, and the holder of the authorization must comply with any additional measures specified.</td><td>Required Operating Procedure 10

Objective: Same as Alternatives B and C.

Requirement/Standard: Same as Alternatives B and C, with the following additional requirements:
a. In addition to NMFS MMPA requirements: Prior to operating in the nearshore areas (≤ 3 m water depth) during the ice-covered season (between approximately November-June of any year), a lessee/operator/contractor working in seal lair habitat would conduct a survey to detect seal lairs, in consultation with the NMFS, throughout the planned area of activities.</td></tr>
</table>

Alternative B (Preferred Alternative)	Alternative C	Alternative D
○ *Use the den habitat map developed by the US Geological Survey (USGS).* This measure ensures that the location of potential polar bear dens is considered when conducting activities in the coastal areas of the Beaufort Sea. ○ *Polar bear den restrictions.* Restrict the timing of the activity to limit disturbance around dens. d. In order to limit disturbance of activities to seal lairs in the nearshore area (≤3 m water depth): Specific to seismic operations: i. Before the seismic survey begins, the operator would conduct a sound source verification test to measure the distance of vibroseis[3] sound levels through grounded ice to the 120 decibels (dB) re 1 µPa threshold in open water and water within ungrounded ice . Once that distance is determined, it would be shared with the BLM and NMFS. The distance would be used to buffer all on-ice seismic survey activity operations from any open water or ungrounded ice throughout the project area. The operator would draft a formal study proposal that would be submitted to the BLM and NMFS for review and approval before the activity begins. For all activities: ii. Maintain airborne sound levels of equipment below 100 dB re 20 µPa at 66 feet. If different equipment would be used than was originally proposed, the applicant must inform the BLM Authorized Officer and share sound levels and air and water attenuation information for the new equipment. iii. On-ice operations after May 1 would employ a full-time trained protected species observer (PSO) on vehicles to ensure all basking seals are avoided by vehicles by at least 500 feet and would ensure that all equipment with airborne noise levels above 100 dB re 20 µPa were operating at distances from observed seals that allowed for the attenuation of noise to levels below 100 dB. All sightings of seals would be reported to the BLM using a NMFS-approved observation form. iv. Ice paths must not be greater than 12 feet wide. No driving beyond the shoulder of the ice path or off planned routes unless necessary to avoid ungrounded ice or for other human or marine mammal safety reasons. On-ice driving routes should minimize travel over snow/ice/topographical features that lead to birthing lair development. *v.* No unnecessary equipment or operations (e.g., camps) would be placed or used on sea ice.		*(see above)*
Required Operating Procedure 11 <u>Objective</u>: Protect stream banks and freshwater sources, minimize soils compaction and the breakage, abrasion, compaction, or displacement of vegetation. <u>Requirement/Standard</u>: a. Ground operation would be allowed when soil temperatures at 12 inches below the tundra surface (defined as the top of the organic layer) reaches 23 degrees Fahrenheit (°F) and snow depths are an average of 9 inches, or 3 inches over the highest tussocks. Ground operations would cease when the spring snowmelt begins. The dates would be determined by the BLM Authorized Officer.		***Required Operating Procedure 11*** <u>Objective</u>: Same as Alternatives B and C. <u>Requirement/Standard</u>: a. Ground operation would be allowed when soil temperature at 12 inches below the tundra surface (defined as the top of the organic layer) reaches 23 °F and snow depth and density amounts to no less than a snow water equivalent of 3 inches over the highest tussocks.

[3]Vibroseis is a truck-mounted system that uses a large oscillating mass to put a range of frequencies into the earth.

<table>
<tr><th>Alternative B (Preferred Alternative)</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td colspan="2">b. Low ground pressure vehicles used for off-road travel would be defined by the BLM Authorized Officer. These vehicles would be selected and operated in a manner that eliminates direct impacts on the tundra caused by shearing, scraping, or excessively compacting the tundra. Note: This provision does not include the use of heavy equipment required during ice road construction; however, heavy equipment would not be allowed on the tundra until conditions in “a,” above, are met.
c. Bulldozing tundra mat and vegetation, trails, or seismic lines is prohibited. Clearing or smoothing drifted snow is allowed to the extent that the tundra mat is not disturbed. Only smooth pipe snow drags would be allowed for smoothing drifted snow.
d. To reduce the possibility of excessive compaction, vehicle operators would avoid using the same routes for multiple trips, unless necessitated by serious safety or environmental concerns and approved by the BLM Authorized Officer. This provision does not apply to hardened snow trails or ice roads.
e. Ice roads would be designed and located to avoid the most sensitive and easily damaged tundra types as much as practicable. Ice roads may not use the same route each year; offsets may be required to avoid using the same route or track in subsequent years.
f. Conventional ice road construction may not begin until off-road travel conditions are met (as described in “a,” above) within the ice road route and approval to begin construction is given by the BLM Authorized Officer.
g. Snow fences may be used in areas of low snow to increase snow depths within an ice road or snow trail route. Excess snow accumulated by snow fences must be excavated or pushed to decrease snow depths to that found in surrounding tundra at the end of road use.
h. Seismic operations and winter overland travel may be monitored by agency representatives, and the operator may be required to accommodate the representative during operations.
i. Incidents of damage to the tundra would be reported to the BLM Authorized Officer within 72 hours of occurrence. Follow-up corrective actions would be determined in consultation with and approved by the BLM Authorized Officer.</td><td>Ground operations would cease when the spring snowmelt begins (approximately May 5 in the foothills, where elevations reach or exceed 500 feet, and approximately May 15 in the northern coastal areas). The exact dates would be determined by the BLM Authorized Officer.
b. Low ground pressure vehicles used for off-road travel would be defined by the BLM Authorized Officer. These vehicles would be selected and operated in a manner that eliminates direct impacts on the tundra caused by shearing, scraping, or excessively compacting it. Note: This provision does not include the use of heavy equipment required during ice road construction; however, heavy equipment would not be allowed on the tundra until conditions in “a,” above, are met.
c. Bulldozing tundra mat and vegetation, trails, or seismic lines is prohibited. Clearing or smoothing drifted snow is allowed, to the extent that the tundra mat is not disturbed. Only smooth pipe snow drags would be allowed for smoothing drifted snow.
d. To reduce the possibility of excessive compaction, vehicle operators would avoid using the same routes for multiple trips unless necessitated by serious safety or environmental concerns and approved by the BLM Authorized Officer. This provision does not apply to hardened snow trails or ice roads.
e. Ice roads would be designed and located to avoid the most sensitive and easily damaged tundra types as much as practicable. Ice roads may not use the same route each year; they would be offset to avoid portions of an ice road route from the previous 2 years.
f. Conventional ice road construction may not begin until off-road travel conditions are met (as described in “a,” above) within the ice road route and approval to begin construction is given by the BLM Authorized Officer.</td></tr>
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Alternative B (Preferred Alternative)	Alternative C	Alternative D
(see above)		g. To minimize changes in snow distribution resulting from oil and gas activities that could affect bear denning habitat and water quality and quantity, snow fences may be used in areas of low snow to increase snow depths within an ice road or snow trail route, with the approval of the BLM Authorized Officer. h. Seismic operations and winter overland travel may be monitored by agency representatives, and the operator may be required to accommodate the representative during operations. i. Incidents of damage to the tundra would be reported to the BLM Authorized Officer within 72 hours of occurrence. Follow-up corrective actions would be determined in consultation with and approved by the BLM Authorized Officer and the USFWS. j. Provide the BLM with an as-build of all ice roads, snow trails, and ice pads after the infrastructure is completed. Data must be in the form of Environmental Systems Research Institute shapefiles referencing the North American Datum of 1983
Required Operating Procedure 12 Objective: Maintain natural spring (breakup) runoff patterns and fish passage, minimize flooding from human-made obstructions, prevent streambed sedimentation and scour, and protect water quality and stream banks. Requirement/Standard: No similar requirements		***Required Operating Procedure 12*** Objective: Same as Alternatives B and C. Requirement/Standard: a. The permittee shall provide the BLM any ice thickness and water depth data collected at ice road or snow trail stream crossings during the pioneering stage of road/trail construction. b. At the end of operations in spring, the permittee must provide the BLM with photographs of all stream crossings that have been removed, breached, or slotted.

<table>
<tr><th>Alternative B (Preferred Alternative)</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td colspan="3">Required Operating Procedure 13

<u>Objective</u>: Avoid additional freeze-down of aquatic habitat harboring overwintering fish and aquatic invertebrates that fish prey on.

<u>Requirement/Standard</u>: Travel up and down streambeds is prohibited unless it can be demonstrated that there would be no additional impacts from such travel on overwintering fish, the aquatic invertebrates they prey on, and water quality. Rivers, streams, and lakes would be crossed at areas of grounded ice or with the approval of the BLM Authorized Officer and when it has been demonstrated that no additional impacts would occur on fish or aquatic invertebrates.</td></tr>
<tr><td colspan="2">Required Operating Procedure 14

<u>Objective</u>: Minimize the effects of high-intensity acoustic energy from seismic surveys on fish.

<u>Requirement/Standard</u>:
When conducting vibroseis-based surveys above potential fish overwintering areas (water 6 feet deep or greater, ice plus liquid depth), lessees/operators/contractors would follow recommendations by Morris and Winters (2005): only a single set of vibroseis shots would be conducted if possible; if multiple shot locations are required, these would be conducted with minimal delay; multiple days of vibroseis activity above the same overwintering area would be avoided, if possible.</td><td>Required Operating Procedure 14

<u>Objective</u>: Same as Alternatives B and C.

<u>Requirement/Standard</u>:
Seismic surveys would not be conducted over unfrozen water with fish overwintering potential.</td></tr>
<tr><td colspan="3">Required Operating Procedure 15

<u>Objective</u>: Reduce changes in snow distribution associated with the use of snow fences to protect water quantity and wildlife habitat, including snow drifts used by denning polar bears.

<u>Requirement/Standard</u>: The use of snow fences to reduce or increase snow depth requires permitting by the BLM Authorized Officer.</td></tr>
<tr><td colspan="3">OIL AND GAS EXPLORATORY DRILLING</td></tr>
<tr><td colspan="3">Required Operating Procedure 16

<u>Objective</u>: Protect water quality in fish-bearing water bodies and minimize alteration of riparian habitat.

<u>Requirement/Standard</u>: Exploratory drilling is prohibited in fish-bearing rivers and streams and other fish-bearing water bodies. On a case-by-case basis, the BLM Authorized Officer may consider exploratory drilling in floodplains of fish-bearing rivers and streams.</td></tr>
<tr><td colspan="3">Required Operating Procedure 17

<u>Objective</u>: Minimize surface impacts from exploratory drilling.

<u>Requirement/Standard</u>: Construction of gravel roads would be prohibited for exploratory drilling. Use of a previously constructed road or pad may be permitted if it is environmentally preferred.</td></tr>
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<table>
<tr><th>Alternative B (Preferred Alternative)</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td colspan="3">FACILITY DESIGN AND CONSTRUCTION</td></tr>
<tr><td colspan="3">Required Operating Procedure 18

Objective: Protect subsistence use and access to subsistence hunting and fishing areas..

Requirement/Standard: All roads must be designed, constructed, maintained, and operated to create minimal environmental impacts and to avoid or minimize impacts on subsistence use and access to subsistence hunting and fishing areas. The BLM Authorized Officer would consult with appropriate entities before approving construction of roads. Subject to approval by the BLM Authorized Officer, the construction, operation, and maintenance of oil and gas field roads is the responsibility of the lessee/operator/contractor, unless the construction, operation, and maintenance of roads are assumed by the appropriate governing entity.</td></tr>
<tr><td colspan="3">Required Operating Procedure 19

Objective: Protect water quality and the diversity of fish, aquatic invertebrates, and wildlife populations and habitats.

Requirement/Standard:
a. Permanent oil and gas facilities, including roads, airstrips, and pipelines, are prohibited within 500 feet, as measured from the ordinary high-water mark, of fish-bearing water bodies, unless further setbacks are stipulated under Lease Stipulations 1, 2, or 3. Pipeline and road crossings would be permitted by the BLM Authorized Officer in accordance with PL 115-97, following coordination with the appropriate entities.
b. Temporary winter exploration and construction camps are prohibited on frozen lakes and river ice.
c. Siting temporary winter exploration and construction camps on river sand and gravel bars is allowed and encouraged. Where trailers or modules must be leveled and the surface is vegetation, they would be leveled using blocking in a way that preserves the vegetation.</td></tr>
<tr><td colspan="3">Required Operating Procedure 20

Objective: Maintain free passage of marine and anadromous fish, protect subsistence use and access to subsistence hunting and fishing and anadromous fish, and protect subsistence use and access to subsistence and non-subsistence hunting and fishing.

Requirement/Standard:
a. Causeways and docks are prohibited in river mouths and deltas. Artificial gravel islands and permanent bottom-founded structures are prohibited in river mouths and active stream channels on river deltas.
b. Causeways, docks, artificial islands, and bottom-founded drilling structures would be designed to ensure free passage of marine and anadromous fish and to prevent significant changes to nearshore oceanographic circulation patterns and water quality characteristics. A monitoring program, developed in coordination with appropriate entities (e.g., USFWS, NMFS, State of Alaska, or NSB), would be required to address the objectives of water quality and free passage of fish.</td></tr>
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<table>
<tr><th>Alternative B (Preferred Alternative)</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td colspan="3">Required Operating Procedure 21

<u>Objective</u>: Minimize impacts of the development footprint.

<u>Requirement/Standard</u>: Facilities would be designed and located to minimize the development footprint and impacts on other purposes of the Arctic Refuge. Issues and methods that are to be considered, as appropriate, are as follows:
a. Using extended-reach drilling for production drilling to minimize the number of pads and the network of roads between pads
b. Sharing facilities with existing development
c. Collocating all oil and gas facilities with drill pads, except airstrips, docks, base camps, and seawater treatment plants (STPs)
d. Using gravel-reduction technologies, e.g., insulated or pile-supported pads
e. Using approved impermeable liners under gravel infrastructure to minimize the potential for hydrocarbon and other hazardous materials spills to migrate to underlying ground.
f. Harvesting the tundra organic layer within gravel pad footprints for use in rehabilitation
g. Coordinating facilities with infrastructure in support of adjacent development
h. Locating facilities and other infrastructure outside areas identified as important for wildlife habitat, subsistence uses, and recreation
i. Where aircraft traffic is a concern, balancing gravel pad size and available supply storage capacity with potential reductions in the use of aircraft to support oil and gas operations
j. Facilities and infrastructure will be designed to minimize alteration of sheetflow/overland flow
k. Where gravel is brought in from outside of the Coastal Plain, require the use of Certified Weed-Free Gravel</td></tr>
<tr><td colspan="3">Required Operating Procedure 22

<u>Objective</u>: Reduce the potential for ice-jam flooding, damage from aufeis, impacts on wetlands and floodplains, erosion, alteration of natural drainage patterns, and restriction of fish passage.

<u>Requirement/Standard</u>:
a. To allow for sheet flow and floodplain dynamics and to ensure passage of fish and other organisms, single-span bridges are preferred over culverts, if technically feasible. When necessary, culverts could be constructed on smaller streams, if they are large enough to avoid restricting fish passage or adversely affecting natural stream flow.
b. To ensure that crossings provide for fish passage, all proposed crossing designs would adhere to the Best Management Practices (BMPs) outlined in Fish Passage Design Guidelines, developed by the USFWS Alaska Fish Passage Program, McDonald & Associates (1994), Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings (USFS 2008), and other generally accepted best management procedures prescribed by the BLM Authorized Officer, in consultation with the USFWS.
c. In addition to the BMPs outlined in the aforementioned documents for stream simulation design, the design engineer would ensure that crossing structures are designed for aufeis, permafrost, sheet flow, additional freeboard during breakup, and other unique conditions of the arctic environment.</td></tr>
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<tr><th>Alternative B (Preferred Alternative)</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td colspan="3">Required Operating Procedure 23

Objective: Minimize disruption of caribou movement and subsistence use.

Requirement/Standard: Pipelines and roads would be designed to allow the free movement of caribou and the safe, unimpeded passage of those participating in subsistence activities. Listed below are the accepted design practices.
a. Aboveground pipelines would be elevated a minimum of 7 feet, as measured from the ground to the bottom of the pipeline at vertical support members (VSMs).
b. In areas where facilities or terrain would funnel caribou movement or impede subsistence or public access, ramps of appropriate angle and design over pipelines, buried pipelines, or pipelines buried under roads may be required by the BLM Authorized Officer, in coordination with the appropriate entity.
c. A minimum distance of 500 feet between pipelines and roads would be maintained. Where it is not feasible, alternative pipeline routes, designs, and possible burial under the road for pipeline road crossings would be considered by the BLM Authorized Officer.
d. Aboveground pipelines would have a nonreflective finish.
e. When laying out oil and gas field developments, lessees would orient infrastructure to avoid impeding caribou migration and to avoid corralling effects.
f. Before the construction of permanent facilities is authorized, the lessee would design and implement and report a study of caribou movement, unless an acceptable study specific to the PCH and CAH has been completed within the last 10 years and approved by the BLM Authorized Officer.
g. A vehicle use management plan would be developed by the lessee/operator/contractor and approved by the BLM Authorized Officer, in consultation with the appropriate federal, State, and NSB regulatory and resource agencies. The management plan would minimize or mitigate displacement during calving and would avoid, to the extent feasible, delays to caribou movements and vehicle collisions during the midsummer insect season, with traffic management following industry practices. By direction of the BLM Authorized Officer, traffic may be stopped throughout a defined area for up to 4 weeks, to prevent displacement of calving caribou. If required, a monitoring plan could include collection of data on vehicle counts and caribou interaction.</td></tr>
<tr><td colspan="2">Required Operating Procedure 24

Objective: Minimize the impact of mineral materials mining on air, land, water, fish, and wildlife resources.

Requirement/Standard: Gravel mine site design, construction, and reclamation would be done in accordance with a plan approved by the BLM Authorized Officer. The plan would take into consideration the following:
a. Locations inside or outside the active floodplain, depending on potential site-specific impacts
b. Design and construction of gravel mine sites in active floodplains to serve as water reservoirs for future use
c. Potential use of the site for enhancing fish and wildlife habitat
d. Potential storage and reuse of sod/overburden for the mine site or at other disturbed sites on the North Slope</td><td>Required Operating Procedure 24

Objective: Same as Alternatives B and C.

Requirement/Standard: Gravel mine site design, construction, and reclamation would be done in accordance with a plan approved by the BLM Authorized Officer. The plan would take into consideration the following:
a. Construction of gravel mine sites or water reservoirs may not be considered within the active floodplains of the four rivers that support populations of freshwater, anadromous, or endemic fish (Canning, Sadlerochit, Hulahula, and Aichilik Rivers)
b. Design and construction of gravel mine sites may be considered at locations inside or outside of the active floodplain
c. Design and construction of gravel mine sites that may also serve as water reservoirs may be considered in active floodplains, except for waters identified in “a,” above</td></tr>
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<table>
<tr><th>Alternative B (Preferred Alternative)</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td colspan="2">(see above)</td><td>d. Potential storage and reuse of sod/overburden for the mine site or at other disturbed sites on the North Slope
e. All constructed water storage reservoirs should be a sufficient distance from drill sites, fueling stations, or other temporary or permanent site that generates or maintains more than 220 gallons of fuel, drilling fluids, or other hazardous materials to avoid contamination via surface or groundwater of the storage reservoir; the lessee should implement a water quality and contaminants monitoring program for any constructed water storage facility</td></tr>
<tr><td colspan="3">Required Operating Procedure 25

<u>Objective</u>: Avoid human-caused changes in predator populations on ground-nesting birds.

<u>Requirement/Standard</u>:
a. Lessee/operator/contractor would use best available technology to prevent facilities from providing nesting, denning, or shelter sites for ravens, raptors, and foxes. The lessee/operator/contractor would provide the BLM Authorized Officer with an annual report on the use of oil and gas facilities by ravens, raptors, and foxes as nesting, denning, and shelter sites.
b. Feeding of wildlife and allowing wildlife to access human food or odor-emitting waste is prohibited.</td></tr>
<tr><td colspan="3">Required Operating Procedure 26

<u>Objective</u>: Reduction of risk of attraction and collisions between migrating birds and oil and gas and related facilities during low light conditions.

<u>Requirement/Standard</u>: All structures would be designed to direct artificial exterior lighting, from August 1 to October 31, inward and downward, rather than upward and outward, unless otherwise required by the Federal Aviation Administration (FAA).</td></tr>
<tr><td colspan="3">Required Operating Procedure 27

<u>Objective</u>: Minimize the impacts to bird species from direct interaction with oil and gas facilities.

<u>Requirement/Standard</u>:
a. To reduce the possibility of birds colliding with aboveground utility lines (power and communication), such lines would either be buried in access roads or would be suspended on VSMs, except in rare cases, limited in extent. Exceptions are limited to the following situations:
i. Overhead power or communication lines may be allowed when located entirely within the boundaries of a facility pad;
ii. Overhead power or communication lines may be allowed when engineering constraints at the specific and limited location make it infeasible to bury or connect the lines to a VSM; or
iii. Overhead power or communication lines may be allowed in situations when human safety would be compromised by other methods.
If exceptions are granted allowing overhead wires, overhead wires would be clearly marked along their entire length to improve visibility to low-flying birds. Such markings would be developed through consultation with the USFWS.
b. To reduce the likelihood of birds colliding with them, communication towers would be located, to the extent practicable, on existing pads and as close as possible to buildings or other structures and on the east or west side of buildings or other structures. Towers would be designed to reduce bird strikes and</td></tr>
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<tr><th>Alternative B (Preferred Alternative)</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td colspan="3">raptor nesting. Support wires associated with communication towers, radio antennas, and other similar facilities, would be avoided to the extent practicable. If support wires are necessary, they would be clearly marked along their entire length to improve visibility to low-flying birds. Such markings would be developed through consultation with the USFWS.</td></tr>
<tr><td colspan="3">Required Operating Procedure 28

<u>Objective</u>: Use ecological mapping as a tool to assess wildlife habitat before developing permanent facilities to conserve important habitat types.

<u>Requirement/Standard</u>: An ecological land classification map of the area would be developed before approval of facility construction. The map would integrate geomorphology, surface form, and vegetation at a scale and level of resolution and position accuracy adequate for detailed analysis of development alternatives. The map would be prepared in time to plan an adequate number of seasons of ground-based wildlife surveys needed, if deemed necessary by the BLM Authorized Officer, before the exact facility location and facility construction is approved.</td></tr>
<tr><td colspan="3">Required Operating Procedure 29

<u>Objective</u>: Protect cultural and paleontological resources.

<u>Requirement/Standard</u>: The lessee/operator/contractor would conduct a cultural and paleontological resources survey before any ground-disturbing activity, based on a study designed by the lessee/operator/contractor and approved by the BLM Authorized Officer. If any potential cultural or paleontological resource is found, the lessee/operator/contractor would notify the BLM Authorized Officer and would suspend all operations in the immediate area until she or he issues a written authorization to proceed.</td></tr>
<tr><td colspan="3">Required Operating Procedure 30

<u>Objective</u>: Prevent or minimize the loss of nesting habitat for cliff-nesting raptors.

<u>Requirement/Standard</u>:
a. Removing greater than 100 cubic yards of bedrock outcrops, sand, or gravel from cliffs shall be prohibited.
b. Any extraction of sand or gravel from an active river or stream channel would be prohibited, unless preceded by a hydrological study that indicates no potential impact on the integrity of the river bluffs.</td></tr>
<tr><td colspan="3">Required Operating Procedure 31

<u>Objective</u>: Prevent or minimize the loss of raptors due to electrocution by power lines.

<u>Requirement/Standard</u>: Comply with the most up-to-date, industry-accepted, suggested practices for raptor protection on power lines. Current accepted standards were published in Reducing Avian Collisions with Power Lines: The State of the Art in 2012, by the Avian Power Line Interaction Committee (APLIC 2012) and are updated as needed.</td></tr>
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Alternative B (Preferred Alternative)	Alternative C	Alternative D
Required Operating Procedure 32 Objective: Avoid and reduce temporary impacts on productivity from disturbance near Steller's or spectacled eider nests. Requirement/Standard: Ground-level vehicle or foot traffic within 200 meters (656 feet) of occupied Steller's or spectacled eider nests, from June 1 through July 31, would be restricted to existing thoroughfares, such as pads and roads. Construction of permanent facilities, placement of fill, alteration of habitat, and introduction of high noise levels within 200 meters (656 feet) of occupied Steller's or spectacled eider nests would be prohibited. Between June 1 and August 15, support/construction activity must occur off existing thoroughfares, and USFWS-approved nest surveys must be conducted during mid-June before the activity is approved. Collected data would be used to evaluate whether the action could occur based on a 200-meter (656-foot) buffer around nests or if the activity would be delayed until after mid-August once ducklings are mobile and have left the nest site. The BLM would also work with the USFWS to conduct nest surveys or oil spill response training in riverine, marine, and intertidal areas that is within 200 meters (656 feet) of shore outside sensitive nesting/brood-rearing periods. The protocol and timing of nest surveys for Steller's or spectacled eiders would be determined in cooperation with and must be approved by the USFWS. Surveys would be supervised by biologists who have previous experience with Steller's or spectacled eider nest surveys.		
Required Operating Procedure 33 Objective: Provide information to be used in monitoring and assessing wildlife movements during and after construction. Requirement/Standard: A representation, in the form of ArcGIS-compatible shapefiles, of the footprint of all new infrastructure construction would be provided to the BLM Authorized Officer, the USFWS Arctic Refuge Manager, State of Alaska, and NSB by the operator. During the planning and permitting phase, GIS shape files representing proposed footprint locations would be provided. Within 6 months of construction completion, shapefiles of all new infrastructure footprints would be provided. Infrastructure includes all gravel roads and pads, facilities built on pads, pipelines, and independently constructed power lines (as opposed to those incorporated in pipeline design). Gravel pads would be included as polygon features. Roads, pipelines, and power lines may be represented as line features but must include ancillary data to denote such data as width and number of pipes. Poles for power lines may be represented as point features. Ancillary data would include construction beginning and ending dates.		
USE OF AIRCRAFT FOR PERMITTED ACTIVITIES		
Required Operating Procedure 34 Objective: Minimize the effects of low-flying aircraft on wildlife, subsistence activities, local communities, and recreationists of the area, including hunters and anglers. Requirement/Standard: The operator would ensure that operators of aircraft used for permitted oil and gas activities and associated studies maintain altitudes according to the following guidelines (**Note:** This ROP is not intended to restrict flights necessary to survey wildlife to gain information necessary to meet the stated objectives of the lease stipulations and ROPs; however, such flights would be restricted to the minimum necessary to collect such data and should consider other technologies, such as remote sensing and drones, in order to minimize impacts from aircraft): a. Land users would submit an aircraft use plan as part of an oil and gas exploration or development proposal, which includes a plan to monitor flights and includes a reporting system for subsistence hunters to easily report flights that disturb subsistence harvest. The plan would address strategies to minimize impacts on subsistence hunting and associated activities, including the number of flights, type of aircraft, and flight altitudes and routes, and would also include a plan to monitor flights. Proposed aircraft use plans would be reviewed by the appropriate Alaska Native or subsistence		***Required Operating Procedure 34*** Objective: Same as Alternatives B and C. Requirement/Standard: Same as Alternatives B and C, except: • Requirement "c" adjusts the altitude to 2,000 feet above ground level; • Requirements "c" and "d" include the caribou post-calving and calving range; and • Requirement "d" minimizes the number of helicopter landings in caribou calving ranges from May 20 through July 20.

<table>
<tr><th>Alternative B (Preferred Alternative)</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td colspan="2">organization. Consultations with these same agencies would be required if unacceptable disturbance is identified by subsistence users. Adjustments, including possible suspension of all flights, may be required by the BLM Authorized Officer, if resulting disturbance is determined to be unacceptable. The number of takeoffs and landings to support oil and gas operations with necessary materials and supplies would be limited to the maximum extent practical.
b. Use of aircraft, especially rotary wing aircraft, would be kept to a minimum near known subsistence camps and cabins or during sensitive subsistence hunting periods (e.g., spring goose hunting, summer caribou) and when recreationists are present.
c. Operators of aircraft used for permitted activities would maintain an altitude of at least 1,500 feet above ground level (except for takeoffs and landings) within 0.5 miles of cliffs identified as raptor nesting sites, and over caribou calving range, unless doing so would endanger human life or violate safe flying practices. An exception to flight altitudes may be approved by the Authorized Officer after coordination and review of the aircraft use plan to accommodate requirements to fly lower for some required activities (e.g., archaeological clearance).
d. Minimize the number of helicopter landings in caribou calving ranges from May 20 through June 20.
e. Pursuing running wildlife is hazing. Hazing wildlife by aircraft pilots is prohibited, unless otherwise authorized. If wildlife begins to run as an aircraft approaches, the aircraft is too close, and the operator must break away.
f. Avoid operation of aircraft over snow goose staging areas between August 15 and September 30. Necessary overflights during this timeframe should avoid areas of heavy snow goose concentrations.
g. When polar bears are present:
● Operators of support aircraft should conduct their activities at the maximum distance possible from concentrations of polar bears.
● Aircraft will not operate at an altitude lower than 457 m (1,500 ft) within 805 m (0.5 mi) of polar bears observed on ice or land. Helicopters may not hover or circle above such areas or within 805 m (0.5 mile) of such areas. When weather conditions do not allow a 457-m (1,500-ft) flying altitude, operators will take precautions to avoid flying directly over or within 805 m (0.5 mile) of these areas.
● Plan all aircraft routes to minimize any potential conflict with known subsistence polar bear hunting activity.</td><td>(see above)</td></tr>
<tr><td colspan="3">OIL AND GAS FIELD ABANDONMENT</td></tr>
<tr><td colspan="2">Required Operating Procedure 35

<u>Objective</u>: Ensure ongoing and long-term reclamation of land to its previous condition and use.

<u>Requirement/Standard</u>: Before final abandonment, land used for oil and gas infrastructure—including well pads, production facilities, access roads, and airstrips—would be reclaimed. The leaseholder would develop and implement a BLM-approved abandonment and reclamation plan. The plan would describe short-term stability, visual, hydrological, and productivity objectives and steps to be taken to ensure eventual rehabilitation to the land’s previous hydrological, vegetation, and habitat functions. The BLM Authorized Officer may grant exceptions to satisfy stated environmental or public purposes.</td><td>Required Operating Procedure 35

<u>Objective</u>: Same as Alternatives B and C.

<u>Requirement/Standard</u>:
a. Oil and gas infrastructure, including gravel pads, roads, airstrips, wells and production facilities, would be removed and the land restored on an ongoing basis, as extraction is complete.
b. Before final abandonment, land used for oil and gas infrastructure—including well pads, production facilities, access roads, and</td></tr>
</table>

Alternative B (Preferred Alternative)	Alternative C	Alternative D
(see above)		airstrips—would be restored to ensure eventual restoration of ecosystem function and to restore general wilderness characteristics. The leaseholder would develop and implement a BLM-approved abandonment and reclamation plan. The plan would describe short-term stability, visual, hydrological, and productivity objectives and steps to be taken to ensure eventual ecosystem restoration to the land's previous hydrological, vegetation, and habitat condition, wild and scenic river (WSR) eligibility/suitability, and intent to restore general wilderness characteristics of the area. The BLM Authorized Officer may grant exceptions to satisfy stated environmental or public purposes. c. Reclamation shall include but not be limited to: • Saving of topsoil for final application after reshaping of disturbed areas have been completed; • Measures to control erosion, landslides, and water runoff; • Measures to isolate, remove, or control toxic materials; • Reshaping the area disturbed, application of the topsoil, and revegetation of disturbed areas, where reasonably practicable; and • Rehabilitation of fisheries and wildlife habitat. When reclamation of the disturbed area has been completed, the Authorized Officer shall be notified so that an inspection of the area can be made.
SUBSISTENCE CONSULTATION FOR PERMITTED ACTIVITIES		
Required Operating Procedure 36 <u>Objective</u>: Provide opportunities for subsistence users to participate in planning and decision-making to prevent unreasonable conflicts between subsistence uses and other activities. <u>Requirement/Standard</u>: The lessee/operator/contractor would coordinate directly with affected communities, using the following guidelines: a. Before submitting an application to the BLM, the applicant would work with directly affected subsistence communities, the Native Village of Kaktovik, NSB, and the North Slope and Eastern Interior Alaska Subsistence Regional Advisory Councils. They would discuss the siting, timing, and methods of their proposed operations to help discover local traditional and scientific knowledge. This is to minimize impacts on subsistence uses. Through this coordination, the applicant would make every reasonable effort, including such mechanisms as conflict avoidance agreements (CAAs) and mitigating measures, to ensure		

Alternative B (Preferred Alternative)	Alternative C	Alternative D

that proposed activities would not result in unreasonable interference with subsistence activities. In the event that no agreement is reached between the parties, the BLM Authorized Officer would work with the involved parties and determine which activities would occur, including the time frames.

b. Applicants would submit documentation of coordination as part of operation plans to the North Slope and Eastern Interior Alaska Subsistence Regional Advisory Councils for review and comment. Applicants must allow time for the BLM to conduct formal government-to-government consultation with Native Tribal governments if the proposed action requires it.

c. A plan would be developed that shows how the activity, in combination with other activities in the area, would be scheduled and located to prevent unreasonable conflicts with subsistence activities. The plan would also describe the methods used to monitor the effects of the activity on subsistence use. The plan would be submitted to the BLM Authorized Officer as part of the plan of operations. The plan would address the following items:
   i. A detailed description of the activities to take place (including the use of aircraft).
   ii. A description of how the applicant would minimize or address any potential impacts identified by the BLM Authorized Officer during the coordination process.
   iii. A detailed description of the monitoring to take place, including process, procedures, personnel involved, and points of contact both at the work site and in the local community.
   iv. Communication elements to provide information on how the applicant would keep potentially affected individuals and communities up-to-date on the progress of the activities and locations of possible, short-term conflicts (if any) with subsistence activities. Communication methods could include holding community open house meetings, workshops, newsletters, and radio and television announcements.
   v. Procedures necessary to facilitate access by subsistence users to conduct their activities.
   vi. Barge operators requiring a BLM permit are required to demonstrate that barging activities will not have unmitigable adverse impacts, as determined by NMFS, on the availability of marine mammals to subsistence hunters.
   vii. All operators of vessels over 50 feet in length engaged in operations requiring a BLM permit must have an automatic identification system transponder system on the vessel.

d. Permittees who propose transporting facilities, equipment, supplies, or other materials by barge to the Coastal Plain in support of oil and gas activities in the Arctic Refuge would notify and coordinate with the Alaska Eskimo Whaling Commission, the appropriate local community whaling captains' associations, and the NSB to minimize impacts from the proposed barging on subsistence whaling.

e. For polar bears:
Operators must minimize adverse impacts on the availability of polar bears for subsistence uses.
- *Community consultation.* Applicants must consult with potentially affected communities and appropriate subsistence user organizations to discuss potential conflicts with subsistence polar bear hunting caused by the location, timing, and methods of operations and support activities.
- *Plan of Cooperation (POC).* If conflicts arise, the applicant must address conflict avoidance issues through a POC, where an operator will be required to develop and implement a USFWS-approved POC.

Required Operating Procedure 37

Objective: Avoid conflicts between subsistence activities and seismic exploration.

Requirement/Standard: In addition to the coordination process described in **ROP 36** for permitted activities, before seismic exploration begins, applicants would notify the local search and rescue organizations in proposed seismic survey locations for that operational season. For the purpose of this standard, a potentially affected cabin or campsite is defined as one used for subsistence purposes and located within the boundary of the area subject to proposed geophysical exploration or within 1 mile of actual or planned travel routes used to supply the seismic operations.

a. Because of the large land area covered by typical geophysical operations and the potential to affect a large number of subsistence users during the exploration season, the permittee/operator would notify all potentially affected subsistence use cabin and campsite users.

b. The official recognized list of subsistence users of cabins and campsites is the NSB's most current inventory of cabins and campsites, which have been identified by the subsistence users' names.

<table>
<tr><th>Alternative B (Preferred Alternative)</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td colspan="3">c. A copy of the notification letter, a map of the proposed exploration area, and the list of potentially affected users would also be provided to the office of the appropriate Native Tribal government.
d. The BLM Authorized Officer would prohibit seismic work within 1 mile of any known subsistence use cabin or campsite, unless an alternate agreement between the owner or user is reached through the consultation process and presented to the BLM Authorized Officer.
e. Each week, the permittee would notify the appropriate local search and rescue of the operational location in the Coastal Plain. This notification would include a map indicating the extent of surface use and occupation, as well as areas previously used or occupied during the operation. The purpose of this notification is to give hunters up-to-date information regarding where seismic exploration is occurring and has occurred, so that they can plan their hunting trips and access routes accordingly. A list of the appropriate search and rescue offices to be contacted can be obtained from the coordinator of the North Slope and Eastern Interior Alaska Subsistence Regional Advisory Councils in the BLM’s Arctic District Office.</td></tr>
<tr><td colspan="3">Required Operating Procedure 38

<u>Objective</u>: Minimize impacts from non-local hunting, trapping, and fishing activities on subsistence resources.

<u>Requirement/Standard</u>: Hunting, trapping, and fishing by lessees/operators/contractors are prohibited when persons are on work status. This is defined as the period during which an individual is under the control and supervision of an employer. Work status is terminated when workers’ shifts ends, and they return to a public airport or community (e.g., Kaktovik, Utqiaġvik, or Deadhorse). Use of operator/permittee facilities, equipment, or transport for personnel access or aid in hunting, trapping, and fishing is prohibited.</td></tr>
<tr><td colspan="3">Required Operating Procedure 39

<u>Objective:</u> Prevent disruption of subsistence use and access.

<u>Requirement/Standard:</u> Before starting exploration or development, lessees/operators/contractors are required to develop a subsistence access plan, in coordination with the Native Village of Kaktovik and the City of Kaktovik, to be approved by the BLM Authorized Officer.</td></tr>
<tr><td colspan="3">ORIENTATION PROGRAMS ASSOCIATED WITH PERMITTED ACTIVITIES</td></tr>
<tr><td colspan="3">Required Operating Procedure 40

<u>Objective</u>: Minimize cultural and resource conflicts.

<u>Requirement/Standard</u>: All personnel involved in oil and gas and related activities would be provided with information concerning applicable lease stipulations, ROPs, standards, and specific types of environmental, social, traditional, and cultural concerns that relate to the region. The operator would ensure that all personnel involved in permitted activities would attend an orientation program at least once a year. The proposed orientation program would be submitted to the BLM Authorized Officer for review and approval and would accomplish the following:
a. Provide sufficient detail to notify personnel of applicable lease stipulations and ROPs and to inform individuals working on the project of specific types of environmental, social, traditional, and cultural concerns that relate to the region.
b. Address the importance of not disturbing archaeological and biological resources and habitats, including endangered species, fisheries, bird colonies, and marine mammals, and provide guidance on how to avoid disturbance, including on the preparation, production, and distribution of information cards on endangered or threatened species.
c. Be designed to increase sensitivity and understanding of personnel to community values, customs, and lifestyles in areas in which personnel would be operating.
d. Include information concerning avoidance of conflicts with subsistence and pertinent mitigation.
e. Include information for aircraft personnel concerning subsistence activities and areas and seasons that are particularly sensitive to disturbance by low-flying aircraft; of special concern is aircraft use near traditional subsistence cabins and campsites, flights during spring goose hunting and fall caribou and moose hunting seasons, and flights near potentially affected communities.</td></tr>
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<tr><th>Alternative B (Preferred Alternative)</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td colspan="3">f. Provide that individual training is transferable from one facility to another, except for elements of the training specific to a site.
g. Include on-site records of all personnel who attend the program for so long as the site is active, though not to exceed the 5 most recent years of operations; this record would include the name and dates of attendance of each attendee.
h. Include a module discussing bear interaction plans to minimize conflicts between bears and humans.
i. Provide a copy of 43 CFR 3163 regarding noncompliance assessment and penalties to on-site personnel.
j. Include training designed to ensure strict compliance with local and corporate drug and alcohol policies; this training would be offered to the NSB Health Department for review and comment.
k. Include employee training on how to prevent transmission of communicable diseases, including sexually transmitted diseases, to the local communities; this training would be offered to the NSB Health Department for review and comment.

In order to limit disturbance around known polar bear dens:
Monitoring requirements.
● Develop and implement a site-specific, USFWS-approved marine mammal monitoring and mitigation plan to monitor and evaluate the effectiveness of mitigation measures and the effects of activities on polar bears, and the subsistence use of this species.
● Provide trained, qualified, and USFWS-approved onsite observers to carry out monitoring and mitigation activities identified in the marine mammal monitoring and mitigation plan.
● For offshore activities, provide trained, qualified, and USFWS-approved observers on board all operational and support vessels to carry out monitoring and mitigation activities identified in the marine mammal monitoring and mitigation plan.
● Cooperate with the USFWS and other designated Federal, State, and local agencies to monitor the impacts of Industry activities on polar bears. Where information is insufficient to evaluate the potential effects of activities on polar bears, and the subsistence use of this species, operators may be required to participate in joint monitoring and/or research efforts to address these information needs and ensure the least practicable impact to these resources.</td></tr>
<tr><td colspan="3">Reporting requirements. Operators must report the results of monitoring and mitigation activities to the USFWS.
● In-season monitoring reports
○ Activity progress reports. Notify the USFWS at least 48 hours prior to the onset of activities; provide the USFWS weekly progress reports of any significant changes in activities and/or locations; and notify the USFWS within 48 hours after ending of activities.
○ Polar bear observation reports. Report all observations of polar bears and potential polar bear dens, during any Industry activity. Information in the observation report must include, but is not limited to: (1) Date, time, and location of observation; (2) Number of bears; (3) Sex and age; (4) Observer name and contact information; (5) Weather, visibility, sea state, and sea-ice conditions at the time of observation; (6) Estimated closest distance of bears from personnel and facilities; (7) Industry activity at time of sighting; (8) Possible attractants present; (9) Bear behavior; (10) Description of the encounter; (11) Duration of the encounter; and (12) Mitigation actions taken.
● Notification of LOA incident report. Report all bear incidents during any Industry activity. Reports must include: (1) All information specified for an observation report; (2) A complete detailed description of the incident; and (3) Any other actions taken.
● Final report. The results of monitoring and mitigation efforts identified in the marine mammal monitoring and mitigation plan must be submitted to the USFWS for review within 90 days of the expiration of an authorization. Information in the final report must include: (1) Copies of all observation reports submitted under an authorization; (2) A summary of the observation reports; (3) A summary of monitoring and mitigation efforts, including areas, total hours, total distances, and distribution; (4) Analysis of factors affecting the visibility and detectability of polar bears during monitoring; (5) Analysis of the effectiveness of mitigation measures; (6) Analysis of the distribution, abundance, and behavior of polar bears observed; and (7) Estimates of take in relation to the specified activities.</td></tr>
</table>

Alternative B (Preferred Alternative)	Alternative C	Alternative D
SUMMER VEHICLE TUNDRA ACCESS		
Required Operating Procedure 41 Objective: Protect stream banks and water quality; minimize compaction and displacement of soils; minimize the breakage, abrasion, compaction, or displacement of vegetation; protect cultural and paleontological resources; maintain populations of and adequate habitat for birds, fish, and caribou and other terrestrial mammals; and minimize impacts on subsistence activities. Requirement/Standard: On a case-by-case basis, the BLM Authorized Officer, in consultation with the USFWS, may permit low-ground-pressure vehicles to travel off gravel pads and roads during times other than those identified in **ROP 11**. Permission for such use would be granted only after an applicant has completed the following: a. Submitted studies satisfactory to the BLM Authorized Officer of the impacts on soils and vegetation of the specific low-ground-pressure vehicles to be used; these studies would reflect use of such vehicles under conditions like those of the route proposed and would demonstrate that the proposed use would have no more than minimal impacts on soils and vegetation. Alternatively, the most current list of summer off-road vehicles approved by the State may be used to fulfill this requirement. b. Submitted surveys satisfactory to the BLM Authorized Officer of subsistence uses of the area as well as of the soils, vegetation, hydrology, wildlife, and fish (and their habitats), paleontological and archaeological resources, and other resources, as required by the BLM Authorized Officer. c. Designed or modified the use proposal to minimize impacts to the BLM Authorized Officer's satisfaction; design steps to achieve the objectives and based on the studies and surveys may include timing restrictions (generally it is considered inadvisable to conduct tundra travel before August 1 to protect ground-nesting birds), shifting work to winter, rerouting, and not proceeding when certain wildlife are present or subsistence activities are occurring.		
GENERAL WILDLIFE AND HABITAT PROTECTION		
Required Operating Procedure 42 Objective: Minimize disturbance of wildlife or alteration and hinderance of wildlife movements through the Coastal Plain. Requirement/Standard: a. Following wildlife with ground vehicles or aircraft is prohibited. Particular attention would be given to avoid disturbing caribou. b. Avoid and minimize the disturbance to loafing and nesting birds to the extent practicable.		
Required Operating Procedure 43 Objective: Prevent the introduction or spread of nonnative, invasive species in the Coastal Plain. Requirement/Standard: a) Certify that all equipment, supplies (including gravel, lumber, erosion control material), and vehicles (including helicopters, planes, boats, off-road vehicles, trucks, tracked vehicles, and barges) intended for use either off or on roads are free of invasive species before transiting into the Coastal Plain.. b) Survey annually along roads, drilling platforms, and barge access points for invasive species and begin effective eradication measures on evidence of their introduction. c) Before beginning operations into the Coastal Plain, submit a plan, for BLM approval, detailing the methods for: 1) cleaning equipment, supplies, and vehicles, including off-site disposal of cleaning fluids or materials and detected organisms, and 2) early detection surveys, and eradication response measures (including post treatment monitoring) for all invasive species, noxious plants and animals, and weeds.		

<table>
<tr><th>Alternative B (Preferred Alternative)</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td colspan="3">Required Operating Procedure 44

<u>Objective</u>: Minimize loss of populations and habitat for plant species designated as sensitive by the BLM in Alaska.

<u>Requirement/Standard</u>: If a development is proposed in an area that provides potential habitat for a BLM sensitive plant species, the development proponent would conduct surveys at appropriate times of the summer season and in appropriate habitats for the sensitive plant species. The results of these surveys and plans to minimize impacts would be submitted to the BLM with the application for development.</td></tr>
<tr><td colspan="3">Required Operating Procedure 45

<u>Objective</u>: Minimize loss of individuals and habitat for mammalian, avian, fish, and invertebrate species designated as sensitive by the BLM in Alaska.

<u>Requirement/Standard</u>: If a development is proposed in an area that provides potential habitat for BLM sensitive species, the development proponent would conduct surveys at appropriate times of the year and in appropriate habitats to detect the presence of BLM sensitive species. The results of these surveys and plans to minimize impacts would be submitted to the BLM with the application for development.</td></tr>
<tr><td colspan="3">MARINE VESSEL TRAFFIC-ASSOCIATED ACTIVITIES</td></tr>
<tr><td colspan="3">Required Operating Procedure 46

<u>Objective:</u> Minimize impacts on marine mammals from vessel traffic.

<u>Requirement/Standard</u>:

General Vessel Traffic
a. Operational and support vessels would be staffed with dedicated PSOs to alert crew of the presence of marine mammals and to initiate adaptive mitigation responses.
b. When weather conditions require, such as when visibility drops, support vessel operators must reduce speed and change direction, as necessary (and as operationally practicable), to avoid the likelihood of injuring marine mammals.
c. The transit of operational and support vessels is not authorized before July 1. This operating condition is intended to allow marine mammals the opportunity to disperse from the confines of the spring lead system and minimize interactions with subsistence hunters. Exemption waivers to this operating condition may be issued by the NMFS and USFWS on a case-by-case basis, based on a review of seasonal ice conditions and available information on marine mammal distributions in the area of interest.
d. Vessels may not be operated in such a way as to separate members of a group of marine mammals from other members of the group.
e. Operators should take reasonable steps to alert other vessel operators in the vicinity of marine mammals.
f. Operators should report any dead or injured listed marine mammals to NMFS and the USFWS.
g. Vessels will not allow tow lines to remain in the water when not towing, all closed lops will be cut, and all trash will be retained on board for disposal in secure landfills, thereby reducing the potential for marine mammal entanglement.
h. The lessees will implement measures to minimize risk of spilling hazardous substances. These measures will include: avoiding operation of watercraft in the presence of sea ice to the extent practicable and using fully operational vessel navigation systems composed of radar, chartplotter, sonar, marine communication systems, and satellite navigation receivers, as well as Automatic Identification System for vessel tracking.

Vessels in Vicinity of Whales
a. Vessel operators would avoid groups of three or more whales by staying at least 1 mile away. A group is defined as being three or more whales observed within a 1,641-foot (500 meter) area and displaying behaviors of directed or coordinated activity (e.g., group feeding).
b. All boat and barge traffic will be scheduled to avoid periods when bowhead whales are migrating through the area. Boat, hovercraft, barge, and aircraft will remain at least 12 miles from Cross Island during the bowhead whale subsistence hunting consistent with the CAA.</td></tr>
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<tr><th>Alternative B (Preferred Alternative)</th><th>Alternative C</th><th>Alternative D</th></tr>
<tr><td colspan="3">c. The transit of operational and support vessels through the north Slope region is not authorized prior to July 1. This operating condition is intended to allow marine mammals the opportunity to disperse from the confines of the spring lead system and minimize interactions with subsistence hunters. Exemption waivers to this operating condition may be issued by NMFS and USFWS on a case-by-case basis, based upon a review of seasonal ice conditions and available information on marine mammal distributions in the area of interest.
d. If the vessel approaches within 1 mile of observed whales, except when providing emergency assistance to whalers or in other emergency situations, the operator would take reasonable precautions to avoid potential interaction with the whales by taking one or more of the following actions, as appropriate:
i. Reducing vessel speed to less than 5 knots within 900 feet of the whale
ii. Steering around the whale if possible
iii. Operating the vessel to avoid causing a whale to make multiple changes in direction, avoiding sudden or multiple course changes
iv. Checking the waters around the vessel to ensure that no whales are within 164 feet of the vessel prior to engaging the propellers
v. Reducing vessel speed to 9 knots or less when weather conditions reduce visibility to avoid the likelihood of injury to whales
vi. Vessels shall not exceed speeds of 10 knots in order to reduce potential whale strikes
vii. If a whale approaches the vessel and if maritime conditions safely allow, the engine will be put in neutral and the whale will be allowed to pass beyond the vessel. If the vessel is taken out of gear, vessel crew will ensure that no whales are within 50 m of the vessel when propellers are re-engaged, thus minimizing risk of marine mammal injury.
e. Vessels will stay at least 984 feet away from cow-calf pairs, feeding aggregations, or whales that are engaged in breeding behavior. If the vessel is approached by cow-calf pairs, it will remain out of gear a long as whales are within 984 feet of the vessel (consistent with safe operations)
f. Consistent with NMFS marine mammal viewing guidelines (https://alaskafisheries.noaa.gov/pr/mm-viewing-guide), operators of vessels will, at all times, avoid approaching marine mammals within 300 feet. Operators will observe direction of travel and attempt to maintain a distance of 300 feet or greater between the animal and the vessel by working to alter course or slowing the vessel.
g. Special consideration of North Pacific right whale and their critical habitat:
i. Vessel operators will avoid transit through North Pacific right whale critical habitat. If such transit cannot be avoided, operators must post a dedicated PSO on the bridge and reduce speed to 10 knots while in the North Pacific right whale critical habitat. Alternately, vessels may transit at no more than 5 knots without the need for a dedicated PSO.
ii. Vessel operators will remain at least 800 m from all North Pacific right whales and avoid approaching whales head-on, consistent with vessel safety.
iii. Operators will maintain a ship log indicating the time and geographic coordinates at which vessels enter and exit North Pacific right whale critical habitat.

Vessels in Vicinity of Pacific Walruses and Polar Bears
a. Operators should take all reasonable precautions, such as reduce speed or change course heading, to maintain a minimum operational exclusion zone of 0.5 mile around groups of feeding walruses.
b. Except in an emergency, vessel operators would not approach within 0.5 mile of observed polar bears, within 0.5 mile of walrus observed on ice, or within 1 mile of walrus observed on land.
c. For Polar Bears:
● Operational and support vessels must be staffed with dedicated marine mammal observers to alert crew of the presence of polar bears and initiate mitigation responses.
● Vessels must maintain the maximum distance possible from concentrations of polar bears. No vessel should approach within an 805-m (0.5-mi) radius of polar bears observed on land or ice.
● Vessels must avoid areas of active or anticipated polar bear subsistence hunting activity as determined through community consultations.
● The USFWS may require trained marine mammal monitors on the site of the activity or on board any vessel or vehicles to monitor the impacts of Industry’s activity on polar bear.</td></tr>
</table>

Alternative B (Preferred Alternative)	Alternative C	Alternative D
Vessels in Vicinity of Seals a. Vessels used as part of a BLM-authorized activity would be operated in a manner that minimizes disturbance to wildlife in the coastal area. Vessel operators would maintain a 1-mile buffer from the shore when transiting past an aggregation of seals (primarily spotted seals) when they have hauled out on land, unless doing so would endanger human life or violate safe boating practices. **Vessel Transit through Steller Sea Lion Critical Habitat/Near Major Rookeries and Haulouts** Vessels will remain 3 nautical miles (nm) (5.5 km) from all Steller sea lion rookery sites listed in paragraph 50 CFR 224.103 (d)(1)(iii). The vessel operator will not purposely approach within 3 nm of any major Steller sea lion rookery or haulout unless doing so is necessary to maintain safe conditions.		
ENDANGERED SPECIES ACT SECTION 7 CONSULTATION AND MARINE MAMMAL PROTECTION ACT ACTION CONSULTATION		
Lease Notice 1. The lease areas may now or hereafter contain plants, animals, or their habitats determined to be threatened or endangered. The BLM may require modifications to exploration and development proposals to further its conservation and management objective to avoid BLM-approved activities that would contribute to the need to list such a species or designate critical habitat for listed species. The BLM would not approve any activity that may affect any such species or critical habitat until it completes its obligations under applicable requirements of the ESA, as amended (16 United States Code [USC] 1531 et seq.), including completion of any required procedure for conference or consultation.		
Lease Notice 2. The lease area and/or potential project areas may now or hereafter contain marine mammals. The BLM may require modifications to exploration and development proposals to ensure compliance with Federal laws, including the MMPA. The BLM would not approve any exploration or development activity with the potential to "take" (e.g., kill, injure, or disrupt the behavioral patterns of) marine mammals unless the applicant/operator applies for relevant take authorization(s) under the MMPA. The BLM would require documentation of compliance with the MMPA by the USFWS and NMFS prior to commencement of such activities.		

2.3 Alternatives Considered But Eliminated From Detailed Analysis

2.3.1 Renewable Energy Alternative

An alternative that considers development of alternative or renewable energy was considered but eliminated from detailed analysis. Such an alternative does not meet the purpose and need for an oil and gas program on the Coastal Plain and is not consistent with PL 115-97.

2.3.2 Deferred Leasing

An alternative that considers deferring leasing was considered but eliminated from detailed analysis because PL 115-97 requires the BLM to hold a minimum of two lease sales, that offer not fewer than 400,000 acres each by 2024, the first of which must be held by December 2021. Further, such an alternative would have essentially the same impacts as the action alternatives already analyzed.

2.3.3 No Waivers, Modifications, and Exceptions

An alternative that would disallow waivers, modifications, or exceptions to any lease stipulation or required operating procedure was considered but eliminated from detailed analysis because it was not reasonable or practicable. There are several lease stipulations and required operating procedures that do not allow waivers, modifications, or exceptions; however, it is not reasonable to eliminate the potential for such flexibility for all lease stipulations and required operating procedures, particularly if in accordance with 43 CFR 3101.1-4 the factors leading to the adoption of the lease stipulation or required operating procedure have changed sufficiently to make the protection it provides no longer justified or if the proposed operation would not cause unacceptable impacts. Also, in some cases it is not practicable to comply with all lease stipulations and required operating procedures. For example, in specific areas it may be impossible to avoid certain setbacks in the construction of linear features such as pipelines.

2.3.4 Less Than 2,000 Acres of Surface Facilities

An alternative that allowed less than 2,000 acres of surface facilities would be inconsistent with PL 115-97 as Congress explicitly established the protective facility acreage limit. Section 20001(c)(3) of PL 115-97 states "the Secretary shall authorize up to 2,000 surface acres … to be covered by production and support facilities." BLM cannot administratively modify this explicit statutory limitation.

2.3.5 Preclude Future Development or Only Allow Contiguous Development

An alternative that precludes development is not consistent with PL 115-97, which requires the BLM to establish and administer a competitive oil and gas program for the leasing, development, production, and transportation of oil and gas in and from the Coastal Plain and to hold at least two lease sales of not fewer than 400,000 acres each. Oil and gas leases gives lessees the right to develop the oil and gas underlying the leases. Precluding development would not allow reasonable access to any leases purchased. Similarly, allowing only contiguous development may also preclude reasonable access to leases purchased if they are not next to each other.

Chapter 3. Affected Environment and Environmental Consequences

3.1 Introduction

This chapter combines the description of baseline environmental conditions and the analysis of environmental impacts for each resource. Though these two aspects are often in separate chapters in an EIS, they are combined here to facilitate continuity for the reader from baseline conditions to potential impacts on each resource. Following the description of baseline conditions, the discussion of potential direct, indirect, and cumulative impacts from future oil and gas development under each resource provides the scientific and analytic basis for evaluating the potential impacts of each of the alternatives described in **Chapter 2**. The approach to impact analysis is discussed further in **Appendix F**.

Issuance of oil and gas leases under the directives of Section 20001(c)(1) of PL 115-97 would have no direct impacts on the environment because by itself a lease does not authorize any on the ground oil and gas activities; however, a lease does grant the lessee certain rights to drill for and extract oil and gas subject to further environmental review and reasonable regulation, including applicable laws, terms, conditions, and stipulations of the lease. The impacts of such future exploration and development activities that may occur because of the issuance of leases are considered potential indirect impacts of leasing. Such post-lease activities could include seismic and drilling exploration, development, and transportation of oil and gas in and from the Coastal Plain; therefore, the analysis in **Chapter 3** considers potential direct, indirect, and cumulative impacts from on-the-ground post-lease activities.

The proposed leasing alternatives are a result of surface resource and management considerations and describe areas to offer for lease and the terms and conditions that would apply to post-lease exploration and development activities; they do not specifically propose development of oil and gas resources. For this reason, the analysis relies on a hypothetical development scenario consistent with those alternatives and PL 115-97 in a good faith effort to identify indirect effects of leasing that are not known at this time but nonetheless could be considered "reasonably foreseeable" (40 CFR Section 1508.8(b)) (see **Appendix B**).

The regulations governing leasing and development provide for multiple decision stages prior to any ground-disturbing activities being authorized and require further compliance with applicable laws, including NEPA, during post-leasing decision stages. Until the BLM receives and evaluates an application for an exploration permit, permit to drill, or other authorization that includes site-specific information about a particular project, impacts of actual exploration and development that might follow lease issuance are speculative, as so much is unknown as to location, scope, scale, and timing of that exploration and development. At each decision stage, the BLM retains the authority to approve, deny, or reasonably condition any proposed ground-disturbing activity based on compliance with the terms and conditions of the lease and applicable laws and policies; therefore, the analysis of effects of exploration and development in this Leasing EIS necessarily reflects a more general, programmatic approach than could occur at the post-lease project-specific stage.

There are many uncertainties associated with projecting future petroleum exploration and development. These uncertainties include the amount and location of technically and economically recoverable oil; the timing of oil field discoveries and associated development; the future prices of oil and gas, and, more to the point, the many exploration companies' individual assessment of future prices and other competitive calculations that play into corporate investment decisions; and the ability of industry to find petroleum and to mobilize the requisite technology to exploit it.

To address these uncertainties, the BLM has made reasonable assumptions based on the previous two-dimensional seismic exploration of the Coastal Plain, the history of development in the NPR-A and other North Slope developments, its own knowledge of the almost entirely unexplored petroleum endowment of the Coastal Plain and current industry practice, and professional judgment. In making these assumptions, the BLM has striven to minimize the chance that the resultant impact analysis would understate potential impacts; therefore, the hypothetical development scenarios (**Appendix B**) are intended to represent optimistic high-production, successful discovery, in a situation of favorable market prices.

The BLM has relied on the best available science to inform its consideration of the environmental impacts surrounding an oil and gas leasing program in the Coastal Plain; however, the nature, abundance, and quality of the data often vary, depending on the action, the geographic region in which it occurs, and the environmental resources that may be affected. All these variables influence the understanding of how certain oil and gas exploration and development activities may affect environmental features. Where information is missing, this EIS complies with 40 CFR 1502.22 (see **Appendix Q**).

3.2 PHYSICAL ENVIRONMENT

3.2.1 Climate and Meteorology

Affected Environment

Climate is described by the National Weather Service (NWS) as the most recent 30-year averages of meteorological parameters, such as temperature, precipitation, humidity, and winds; thus, climate change is treated here as the longer-term change in such variables. Climate change can be driven by natural forces, such as volcanic activity, solar output variability, and the earth's orbital variations, or by human activity, such as land use changes or GHG emissions. Much attention in recent decades has focused on the potential climate change effects of GHGs, especially carbon dioxide (CO_2), which has been increasing in concentration in the global atmosphere since the end of the last ice age.

For a description of climate trends in the Arctic and on the North Slope, the reader is referred to Section 3.2.3.1 of the Greater Mooses Tooth 2 (GMT2) Development Project Final Supplemental Environmental Impact Statement (GMT2 Final SEIS), issued in August 2018 (BLM 2018a). These trends have been confirmed in the Fourth National Climate Assessment's Alaska Chapter (Markon et al. 2018), including that Alaska has been warming twice as fast as the global average since the middle of the twentieth century. Because climate is defined as weather conditions over the most recent three decades, the information contained in the GMT2 Final SEIS is applicable to the program and thus is incorporated here by reference.

The program area is in the Arctic Refuge in northeast Alaska, along the Beaufort Sea, which is part of the Arctic Ocean. The area is considered an arctic climate zone, with cold winters spanning approximately 8 months of the year (October through May) and cool summers, spanning approximately 4 months of the year (June through September).

Weather data measured at the Kaktovik Airport on Barter Island from late 1947 through mid-2016 are available on the Western Regional Climate Center website under the historical climate data pages. The period of record climatological data summary for this location is shown in **Table 3-1**.

Table 3-1
Kaktovik Airport Period of Record Monthly Climate Summary

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average max. temperature (F)	-7.7	-13.9	-8.8	6.7	26.3	38.4	45.4	43.8	35.4	20.3	5.1	-5.8	15.4
Average min. temperature (F)	-20.3	-26.3	-22.5	-9.3	15.7	30.4	34.8	34.4	27.9	10.1	-6.7	-18.3	4.1
Average total precipitation (in.)	0.48	0.23	0.21	0.19	0.31	0.53	1.03	1.1	0.68	0.77	0.41	0.26	6.19
Average total snowfall (in.)	5	2.7	2.6	2.4	3	1.6	0.5	1.5	4.9	9.2	5	3.4	41.8
Average snow depth (in.)	12	14	15	15	10	2	0	0	1	5	8	10	8

Source: WRCC 2018a. Historical Climate Summaries. https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?ak0558.
Percent of possible observations from September 23, 1947, to June 7, 2016: maximum temperature: 98.6 percent; minimum temperature: 99.7 percent; precipitation: 99.7 percent snowfall: 95.7 percent snow depth: 98.5 percent

Based on the Kaktovik climate data, average monthly precipitation in the area is heaviest in July and August, with slightly more than an inch in each of these months. Annual total precipitation averages a little greater than 6 inches of liquid equivalent. Monthly snowfall is highest in October, with slightly more than 9 inches, on average. Snow is typically on the ground for approximately 10 months of the year, with only July and August usually having little or no snow depth. July is the warmest month, with an average maximum temperature around 45°F and an average minimum temperature around 35°F. February is the coldest month, with an average maximum temperature of around -14°F and an average minimum temperature of around -26°F.

Wind speed and direction is measured on Barter Island, at the Kaktovik Airport, as part of the automated weather observing system (AWOS) network, operated and controlled by the FAA. The Kaktovik AWOS station is near the coast, next to the Coastal Plain area. Using the Iowa State University, Iowa Environmental Mesonet website, the Barter Island wind data for the most recent 10 full years, 2008–2017, were plotted to produce the wind rose in **Figure 3-1**, Wind Rose Plot for Barter Island, Kaktovik, Alaska, in **Appendix A** (ISU 2018). The wind rose shows a very strong predominance of winds from the east and the west, with east winds being the most common. Winds from northerly and southerly directions are very infrequent in this area. Average wind speed is also relatively high at 13.8 miles per hour. Calm winds are recorded less than 5 percent of the time.

Farther inland, near the Brooks Range, monthly mean wind speeds are slightly lower (9.4 miles per hour; Olsson et al. 2002), but strong winds from the south, readily exceeding exceed 45 miles per hour, can originate as katabatic[1] flows down the many north-oriented valleys of the Brooks Range (Sturm and Stuefer 2013). In general, snow depth and snow water equivalent decrease from inland to the coast (snow water equivalent values of 6 to 8 inches near the foothills to 2 to 5 inches near the coast; Liston and Sturm 1998), while bulk snow density and the prevalence of wind slabs increase (Sturm and Liston 2003).

Wind speed and direction are important to the dilution and transport of air pollutants; wind direction determines where the air pollutants emitted in the area are transported. Based on the Kaktovik wind rose, air pollutants are most often transported in a westerly direction, and secondarily, in an easterly direction. Wind speed affects the concentration of air pollutants. This is because dispersion and turbulence increase with

[1]Caused by local downward motion of cool air

increasing wind speeds, thereby decreasing air pollutant concentrations resulting from an emitted plume of pollutants.

The degree of stability in the atmosphere is also a key factor in the dispersion of emitted pollutants. During stable conditions, vertical movement in the atmosphere is limited, and the dispersion of pollutants is inhibited. Conversely, during unstable conditions, upward and downward movement in the atmosphere is enhanced, and dispersion of pollutants in the atmosphere increases. Conditions where temperatures increase with height, known as temperature inversions, can result in very stable conditions, with virtually no vertical air motion. The program area typically experiences more large-scale temperature inversions in the winter than in the summer due to colder stable air masses settling closer to the ground during winter. Summer periods in the program area typically have greater instability, due to warming and solar-induced vertical (convective) air currents.

Recorded climate trends in Alaska, including the North Slope, show a significant increase in temperatures, mostly occurring as a step change in 1977, when the Pacific decadal oscillation (PDO) changed from a negative phase to a positive phase. The positive phase of the PDO correlates with more southerly winds over Alaska in the winter, leading to positive temperature anomalies (ACRC 2019).

The only North Slope weather station summarized for temperature trends by the Alaska Climate Research Center (ACRC) is in Utqiaġvik. Temperature records there show an increase in annual average temperature of 6.3°F from 1949 to 2016; a 5.9°F increase has occurred since the PDO shift in 1977. Conversely, the 18 other primary reporting stations distributed throughout Alaska show an average of 2.0°F warming since 1977 (ACRC 2019); thus, it is likely that a reduction in ice cover along the north coast of Alaska has had a disproportionate effect on temperature trends since 1977 along the northern coast, compared with the rest of Alaska. This is apparent by looking at changes in monthly ice concentration on the north Alaska coast and its correlation with changes in temperature (Wendler et al. 2014).

In contrast to temperature, annual average total precipitation shows no discernable trend from 1925 through 2016 in the North Slope climate division of Alaska (WRCC 2018b).

In addition to weather data provided by the FAA and NWS stations in northern Alaska, such as at Kaktovik and Utqiaġvik, the US Geological Survey (USGS) operates a 16-station, permafrost monitoring network in the NPR-A (12 stations) and the Arctic Refuge (4 stations) to help detect changes in meteorological conditions and soil temperatures. This network, known as the DOI/Global Terrestrial Network for Permafrost Observing System, began operations at some sites as early as 1998, and now has over 10 years of data from each site. The four Arctic Refuge stations include three in the program area: Marsh Creek, Camden Bay, and Niguanak. The data collected can be found in the 2016 annual report for this monitoring network (Urban and Clow 2018) at the following website: https://pubs.usgs.gov/ds/1092/ds1092.pdf.

Baseline Greenhouse Gas Emissions

Greenhouse gas (GHG) emissions are typically expressed as carbon dioxide (CO_2) equivalents (CO_2e). Each GHG (other than water vapor) caused by humans has an estimated global warming potential (GWP) based on its modeled effects on the atmosphere's energy balance compared to CO_2. The GWP of CO_2 is equal to 1.0.

The next most important gases are methane (CH_4) and nitrous oxide (N_2O), whose GWPs are estimated at a 100-year time horizon of 25 and 298, respectively, according to EPA rules for GHG reporting at 40 CFR 98, Subpart A. For methane, for example, this means that a metric ton of methane has approximately 25 times the GWP of a metric ton of CO_2 at 100 years after emission. Over a shorter period, such as 20 years, methane's

GWP has been estimated to be in the range of 84 to 86, given that it has a relatively short half-life of approximately 12 years in the atmosphere. The higher GWP may imply greater climate impacts at time scales of decades; nevertheless, the ocean-atmosphere-cryosphere[2] responds relatively slowly to GHG effects, mainly due to the very large thermal inertia of the oceans; therefore, the analysis here presents CO_2e estimates for 100-year time horizons.

An inventory of recent GHG emissions, expressed as CO_2e, at various geographic scales is provided in **Table 3-2**, in units of million metric tons (MMT) per year. Development-related emissions can be compared against these values to provide an estimate of the relative contribution of such emissions at various geographic scales. Note that the emissions in the table do not include sinks that tend to remove some of the emissions from the atmosphere. Approximately 55 percent of the carbon emitted by humans each year is taken up by the biosphere[3] (USCCSP 2019).

Table 3-2
GHG Emissions at Various Geographic Scales in 2015

Geographic Area	Data Source	Annual Emissions (MMT/year)	Percent of Global Emissions
Alaska	ADEC 2018a	41.3	0.084
US	EPA 2018a	6,638	13.5
Global	Olivier et al. 2017	49,100	100

Source: Olivier et al. 2017; ADEC 2018a; EPA 2018a

Local and Global Direct and Indirect Impacts

Issuance of oil and gas leases under the directives of Section 20001(c)(1) of PL 115-97 would have no direct impacts on the environment because by itself a lease does not authorize any on the ground oil and gas activities; however, a lease does grant the lessee certain rights to drill for and extract oil and gas subject to further environmental review and reasonable regulation, including applicable laws, terms, conditions, and stipulations of the lease. The impacts of such future exploration and development activities that may occur because of the issuance of leases are considered potential indirect impacts of leasing. Such post-lease activities could include seismic and drilling exploration, development, activities (e.g., well construction, well completion, and oil and gas production) and transportation of oil and gas in and from the Coastal Plain; therefore, the analysis considers potential impacts on the climate (via GHG emissions) from on-the-ground post-lease activities.

This assessment deals primarily with climate, defined as longer-term (30 years or more) variations in meteorological conditions. Any potential effects of post-lease oil and gas activities on meteorological conditions would be on a very small scale (microscale) and would cover very small portions of the program area, for example, such as a decrease in localized wind speeds and the creation of snowdrifts immediately downwind of structures; therefore, impacts on meteorological conditions are not addressed further in this section. The climate and meteorology impacts of the Coastal Plain oil and gas leasing program are generally similar among the action alternatives being considered.

[2]Those portions of the earth's surface where water is in solid form, such as sea ice, lake ice, river ice, snow cover, glaciers, ice caps, ice sheets, and frozen ground.
[3]The surface, atmosphere, and water bodies of the earth where there are living organisms.

Regarding the potential effects of climate change on the region in general, the reader is referred to Section 3.2.4 of the GMT2 Final SEIS for a detailed discussion (BLM 2018a). With respect to climate change effects of post-lease oil and gas activities, there are two aspects of potential climate impacts that are addressed below:

1. Climate change impacts associated with potential development (due to emissions of GHGs)
2. Climate change impacts on potential development

Climate Change Impacts Associated with Potential Development

The potential impacts of post-lease oil and gas activities on the climate could occur at the microscale, due to building structures and installing combustion sources that can heat localized areas near development. These effects would be very small and of little effect in the vast majority of the program area.

The macroscale effects on climate change would be through GHG emissions that can contribute to a change in the composition of the global atmosphere, thereby increasing the greenhouse effect on the planet's heat retention. The GHG emissions that could result from post-lease oil and gas activities would result from combustion of fossil fuels (mainly natural gas, diesel fuel and gasoline) for construction, drilling, production, processing, and transport of the petroleum products. Smaller amounts of emissions would occur through permafrost degradation from surface-disturbing activities. Additional GHG emissions would result from combustion of the products themselves in the global marketplace.

Estimates of potential GHG emission changes resulting from future development following the leasing decision can be described as either direct emissions or indirect emissions. The direct emissions are those resulting from construction, drilling, production, processing, and transportation. The indirect emissions are those resulting from the combustion of the petroleum products, due to a relatively small increase in US demand for liquid petroleum products, which could result from increased US supply due to potential development. The natural gas produced as a result of future oil and gas development may initially be re-injected to conserve the natural gas and maintain reservoir pressure for oil recovery, as is currently done with excess gas that is not used as fuel on the North Slope, or periodically flared for safety. Some amount of natural gas would be produced as a byproduct of oil production in some formations. Use of this natural gas on the global markets is anticipated at some point in the future; the State of Alaska is pursuing a plan to build a natural gas transport pipeline from the North Slope to access markets in Asia. Gas transported through the pipeline is expected to come from established fields with proven reserves initially but could eventually include natural gas from the Coastal Plain. The analysis presented below includes potential production and use of natural gas from the Coastal Plain.

Direct GHG Emissions from Future Development

To provide an approximation of total potential GHG emissions from post-lease oil and gas activities including construction, drilling, production, processing, and transportation of oil and gas (not accounting for the fact that such emissions are likely not entirely additive in a global context), the GMT2 Final SEIS (BLM 2018a) projections for direct GHG emissions were scaled according to the respective total amounts of estimated oil production from GMT2, versus the ranges projected for the Coastal Plain leasing program. For the GMT2 development, total recoverable oil is estimated at approximately 170 million barrels (BLM 2018a). For the Coastal Plain development, total production potential is estimated to range from 1.5 to 10 billion barrels of oil (BBO), or anywhere from 9 to 59 times as much as for GMT2.

Assuming that the potential direct GHG emissions are directly proportional to oil production, and using the GMT2 emissions estimates (BLM 2018a, Table 79) as a basis for scaling the Coastal Plain development emissions, a comparison of estimated oil production and related maximum annual GHG emissions for the

Coastal Plain development is provided in **Table 3-3**. The GHG emissions in **Table 3-3** are estimated as carbon dioxide equivalents (CO_2e). Note that based on the GMT2 Final SEIS, the estimated GHG emissions vary substantially by year of the development; thus, the GMT2 Final SEIS annual average over an assumed 37-year construction, drilling, and production period is used for this analysis. The Coastal Plain production could extend much longer than 37 years, perhaps from 50 to 100 years; 70 years is assumed for purposes of making annual GHG projections for this Leasing EIS. While a 100-year production duration would substantially decrease annual average emissions from the Coastal Plain, the effect on total development GHG emissions would not change. This is because the Coastal Plain development would still represent approximately 9 to 59 times the estimated oil production and therefore 9 to 59 times the direct GHG emissions of the GMT2 development.

Table 3-3
Projected Oil Production and Direct GHG Emissions Estimates

Development	Total Oil Produced (Million Barrels)	Average Annual Oil Produced (Million Barrels)	Average Annual GHG Emissions (Metric Tons of CO_2e)
GMT2	170.1	4.6	12,180
Coastal Plain	1,500 to 10,000	21 to 143	56,739 to 378,261

Source: BLM 2018a

Indirect GHG Emissions from Future Development

While petroleum is obviously a global commodity, the analysis here is based on changes in US demand, projected from estimates made with a market demand model called MarketSim, developed by the Bureau of Ocean Energy Management (BOEM). The MarketSim model considers only the US supply and demand for petroleum and other US energy use; thus, the accuracy of the change (increase) in petroleum demand estimated from MarketSim projections is limited, given its scope is just the US market; however, any type of supply and demand projections must be considered quite uncertain, given the inherent difficulties in economic projections.

According to the US Department of Energy, Energy Information Administration (EIA 2018), global petroleum liquids production and consumption in 2018 is projected to average approximately 100 million barrels of oil (equivalents) per day. The proposed Coastal Plain oil and gas leasing program is expected to result in potential production totaling in the range of 1.5 to 10 BBO. Assuming a 70-year period for this production, the average for this development over its operating life would therefore range from 0.06 to 0.39 million barrels per day; thus, post-lease oil and gas activities could supply in the range of 0.1 to 0.5 percent of global oil production, once the field has reached peak production. Given that global oil production continues to increase, the development that could occur with the Coastal Plain oil and gas leasing program would represent a smaller fraction of global production as the years pass. The potential natural gas production estimate for the Coastal Plain ranges from 0 to 7 trillion cubic feet (TCF) of gas produced (Attanasi 2005). For comparison purposes, combustion of the projected upper-end of total natural gas production (7 TCF) would generate approximately 8.4 percent of the GHGs (as CO_2e) from combustion of the projected upper-end of total oil production (10 BBO).

BOEM applied its MarketSim model for the Coastal Plain development on the North Slope, for both the low- and high-end production cases (BOEM 2018a). The BOEM projections show that, without the Coastal Plain production, US energy demand would be lower. The lower amount would be equal to 3.4 percent of the energy represented by the Coastal Plain petroleum production under low end production and 3.9 percent of the energy under the high end production .

Looking at it another way, post-lease oil and gas activities are projected to increase US energy demand by 3.4 percent (low-end case) to 3.9 percent (high-end case) of the projected Coastal Plain leasing production of energy. Conversely, over 96 percent of the Coastal Plain energy production is projected to replace other US (and likely global) energy production that would not happen if Coastal Plain development goes forward. The BOEM projections include production of both oil and natural gas from the Coastal Plain, expressed as barrels of oil equivalent. For natural gas, the analysis assumes the production eventually makes its way to the US or global market, regardless of whether some of the natural gas production is initially reinjected.

Using the MarketSim projections for the incremental (Action minus No Action) production in barrels of oil equivalent, BOEM applied its Greenhouse Gas Lifecycle model (GHG Model) to estimate total GHG emissions with and without Coastal Plain development. Based on this analysis, and assuming a 70-year production and consumption period for the Coastal Plain, the incremental (Action minus No Action) average (over 70 years) annual indirect GHG emissions estimates are shown in **Table 3-4**. BOEM's GHG life cycle paper and the MarketSim documentation are available at https://www.boem.gov/ESPIS/5/5612.pdf and at https://www.boem.gov/OCS-Report-BOEM-2016-065/, respectively.

Table 3-4
Projected Oil Production and Indirect GHG Emissions Estimates for the Coastal Plain

Case	Total Oil Produced (Million Barrels)	MarketSim Demand Increase Fraction of Coastal Plain Production (%)	Annual GHG Emissions Increase (Million Metric Tons of CO_2e)
Low-end Case	1,500	3.4	0.7
High-end Case	10,000	3.9	5.0

Source: BOEM 2018a

See **Appendix R** of this EIS for BOEM's estimates of gross GHG emissions from the proposed action and from the substitute energy assumed to be supplied under Alternative A (the No Action Alternative). Note that BOEM did not model alternative future carbon policies and foreign energy consumption, as explained in **Appendix R**.

The estimated Coastal Plain oil and gas development potential direct and indirect emissions portion of estimated 2015 global emissions are shown in **Table 3-5**, along with the percentage of development-related GHG emissions at the state and national scales. The projected annual average Coastal Plain drilling and operational direct emissions would equate to up to 0.0008 percent of 2015 global emissions. The estimated indirect emissions resulting from development due to post-lease oil and gas activities would equate to up to approximately 0.01 percent of global GHG emissions, as shown in **Table 3-5**. As discussed above, the direct emissions are those from production, processing and transport activities, while the indirect emissions are those from combustion of the net fuel production exported to markets.

While most of the Coastal Plain emissions estimates summarized in **Table 3-5** are combustion-related, some of the reservoir hydrocarbons, most importantly methane, escape to the atmosphere without being combusted. These methane emissions are due to leaks during the drilling, production, processing and transport of natural gas. It is difficult to obtain accurate estimates of the amount of GHG emissions (as CO_2e) from such leaks as compared to the GHG emissions from combustion processes. The 2016 emission inventory from the EPA estimates that 81 percent of US GHG emissions (as CO_2e) are CO_2, 10 percent are methane, and the remainder are other GHGs (EPA 2018b). EPA estimates that 31 percent of the 2016 methane contribution is from oil and gas production activities, which would mean that 3.1 percent of US total GHG emissions are from

Table 3-5
Estimated Future Development Annual GHG Emissions versus 2015 Emissions at Various Geographic Scales

Geographic Area	Inventory Year	Data Source	Annual CO_2e Emissions (Million Metric Tons of CO_2e)	Portion of US Emissions (%)	Portion of Global Emissions (%)
Coastal Plain Direct Emissions	NA	Projected	0.06 to 0.38	0.0009 to 0.006	0.0001 to 0.0008
Coastal Plain Minimum Indirect Emissions	NA	Projected	0.7	0.01	0.0014
Coastal Plain Maximum Indirect Emissions	NA	Projected	5.0	0.08	0.012
Alaska	2015	ADEC 2018a	41.3	0.62	0.084
US	2015	EPA 2018a	6,638	100	13.5
Global	2015	Olivier et al. 2017	49,100	740	100

Source: Olivier et al. 2017; ADEC 2018a; EPA 2018a
MMT = million metric tons of GHG measured as CO_2e.

methane associated with oil and gas production. Nationally, the EPA estimate of methane's GHG contribution from petroleum production processes equates to approximately 5 percent of the CO_2e contribution from the nationwide petroleum and natural gas combustion; thus, this would represent a marginal portion of the direct plus indirect GHG emissions, equal to roughly 5 percent of the estimated direct plus indirect emissions from the Coastal Plain development shown in **Table 3-5**.

An approximate estimate of the global CO_2 parts per million (ppm) increase due to the projected GHG emissions from oil and gas development in the Coastal Plain can be made based on total direct and indirect CO_2e emissions of the Coastal Plain versus global CO_2e emissions in **Table 3-5**. The fraction of the global CO_2e emissions represented by the Coastal Plain's maximum estimated production is approximately 0.012 percent.

The rate of CO_2 concentration increase measured at Mauna Loa, in Hawaii in recent years is approximately 2.5 ppm per year. Assuming the CO_2/CO_2e ratios are similar for the Coastal Plain and global emissions, the annual CO_2 increase in ppm can be multiplied by the fraction of global CO_2e emissions represented by the Coastal Plain. This would represent an estimated annual Coastal Plain contribution of less than 0.0003 ppm to the global CO_2 concentration increase. If the production life of the development area is 70 years, this would yield a cumulative total of less than 0.02 ppm of CO_2 increase globally for the Coastal Plain, compared to a current global CO_2 level of around 410 ppm.

Social Costs of GHG Emissions

Section F2.1 in **Appendix F** provides detail on the reasons why the use of what is known as the social cost of carbon protocol was not included in this EIS.

Impacts of Climate Change on Potential Development

The impacts of climate change on potential development could include a shorter winter construction season. This is defined as the time when the ground and lakes are adequately frozen to support heavy equipment movement. Permafrost is not likely to disappear in the program area during the life of any oil and gas development in the program area; however, if temperatures continue to warm in the area, the warm season active zone (thawed soil zone) would go deeper, making equipment movement more difficult in warm months, possibly increasing road maintenance frequency and costs. If summer active soil depth increases substantially, allowances would need to be made for more substantial structural supports that rely on permafrost, perhaps requiring deeper anchoring of such supports.

Long-term trends show that the annual mean Arctic sea ice extent is decreasing (IPCC 2014). However, summer sea ice extent in the Arctic has risen slightly from the lows of the past decade, with July 2018 monthly average sea ice extent the highest it has been of any July since 2005, at 3.66 million square miles. This is approximately 20 percent lower than the maximum measured July average Arctic sea ice extent of 4.56 million square miles in 1983, and about 12 percent higher than the lowest July extent of 3.27 million square miles measured in 2012 (DMI 2018). The period of record for these satellite measurements goes back only to 1979, which is likely near a modern peak in Arctic ice, given the shift in the PDO that occurred in 1977. After 1977 there was a dramatic shift upward in annual mean temperatures in Alaska, along with a multi-decade decrease in Arctic ice extent. Continued recovery or further declines in Arctic sea ice can have their most significant impacts on temperatures in North Slope coastal areas, such as the program area. Inland areas are buffered from the moderating effects of open water, so the program area would be more sensitive to changes in sea ice, compared to developments farther inland.

In coastal areas near the Coastal Plain, the average age of ice is less than a year. This is because there typically has been open water along the coast and well offshore during the late summer and early fall, for at least the past couple of decades. This is not because there is no older (multi-year) or thicker ice left in the Arctic, but because prevailing ocean currents and winds have been keeping the thicker and older ice farther east. Here, for most of the past couple of decades, it has been pushed up against northeastern Canada and northern Greenland during the summer. This can be seen by viewing the animation of monthly sea ice thickness calculations provided by the Danish Meteorological Institute at http://polarportal.dk/en/sea-ice-and-icebergs/sea-ice-thickness-and-volume/ (DMI 2019). It shows data from January 2004 through the present time.

At current rates of sea level rise, from around 7 inches per century (tide gauge record) to 12 inches per century (satellite measurements), sea waters are not expected to encroach on any potential development within an approximate 70-year life of production facilities or access roads for the program area.

Transboundary Impacts

GHG emissions disperse relatively quickly and evenly over the time scales of concern for climate change (decades or longer) throughout the global atmosphere; therefore, impacts from the proposed Coastal Plain leasing program would not be concentrated close to such emissions, such as in the Arctic Refuge or in adjacent areas of Canada. Consequently, the proximity of the proposed development to Canada would have no greater climate change-related impacts there than if the related GHG emissions occurred, for example, in Antarctica.

Cumulative Impacts

As described above, GHG emissions disperse through the global atmosphere relatively quickly relative to the time scales of concern for climate, which are decades to centuries. GHG emissions from oil and gas development projects on the North Slope and elsewhere around the globe are implicitly included in the supply/demand analysis of GHG emissions described under *Indirect GHG Emissions from Future Development*, above. The indirect emissions projections in **Table 3-5** compare the effects of post-lease oil and gas activities in the context of statewide, US, and global GHG emissions, which continue to increase. The potential cumulative climate impacts of global development and associated GHG emissions have been discussed extensively in the published literature, including several reports by the Intergovernmental Panel on

Climate Change and numerous scientific journals, and therefore, are not repeated here (BLM 2018a; IPCC 2014; Melillo et al. 2014; ACIA 2005).

3.2.2 Air Quality

Affected Environment

Air quality is measured by the concentration of air pollutants in a geographic area. Wind, temperature, humidity, and geographic features, in addition to natural and anthropogenic emissions sources, are factors that have the potential to affect the resource. Indicators of impacts on air quality are the inability to meet NAAQS/AAAQS and a degradation of air quality related values (AQRVs), such as visibility and deposition.

Air Quality

The federal Clean Air Act provides the framework for protecting air quality at the national, state, and local level. The act designates the EPA as the chief governing body of air resources in the US; however, it provides states with the management authority to implement their own air quality legislation, monitoring, and control measures. With EPA approval, state and local air districts can implement their own permitting and emissions control regulations to implement federal requirements, and the state and local requirements cannot be less stringent than the federal requirements. The ADEC is the regulating authority to enforce the Alaska Air Quality Control Regulations under 18 Alaska Administrative Code (AAC) 50.

Under the authority of the Clean Air Act, the EPA has set time-averaged NAAQS for six criteria air pollutants considered to be key indicators of air quality: carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), sulfur dioxide (SO_2), lead (Pb), and two categories of particulate matter (less than 10 microns in diameter [PM_{10}] and less than 2.5 microns in diameter [$PM_{2.5}$]) (EPA 2018c). These standards may be updated periodically based on peer-reviewed scientific data. States may set their own ambient air quality standards for criteria pollutants and other pollutants, but their criteria pollutant standards must be at least as stringent as the federal standards. The AAAQS are the same as the NAAQS, except for the addition of a standard for ammonia. The program area is in attainment or unclassifiable (treated as attainment for regulatory purposes) for each of the NAAQS (EPA 2018d). The nearest nonattainment area is in Fairbanks, approximately 350 miles southwest of the Coastal Plain; Fairbanks is in a nonattainment status for the 24-hour averaged $PM_{2.5}$ NAAQS (EPA 2018d).

The Clean Air Act requires each state to identify areas that have ambient air quality in violation of federal standards using monitoring data collected through state and federal monitoring networks. There are no state or federal air quality monitoring stations in or near the program area. Industry monitoring that conforms to EPA guidance is the only available quantitative indicator of air quality on the North Slope. There are two monitoring stations that report complete, multiyear data near the program area: BPXA's A-Pad Meteorological and Ambient Air Monitoring Station, approximately 60 miles west of the Coastal Plain boundary, and ConocoPhillips Alaska, Inc.'s Nuiqsut Ambient Air Quality and Meteorological Monitoring Station, approximately 110 miles west of the Coastal Plain boundary. **Table 3-6** shows the measured pollutant concentrations at each of these stations for the most recent 3 years of verified data.

In addition, ADEC shares monitoring values for short-term, project-specific air quality monitors used in the air permitting process. There are nine monitors on the North Slope, including the two described in **Table 3-6**, from which data have been collected and verified since 2009, usually for 1 year. None of the data from any of these monitors have shown exceedances of the NAAQS/AAAQS (ADEC 2018b). Based on the limited oil and gas development and the small size of the locally-produced emissions near the Coastal Plain, it is likely

Table 3-6
Air Pollutant Monitoring Values, Nuiqsut and A-Pad Monitors

Nuiqsuit								
Pollutant (units)	**Avg Period**	**Rank**	**2015**	**2016**	**2017**	**Avg.**	**NAAQS / AAAQS**	**Below NAAQS/ AAAQS?**
CO (ppm)	1 hr	2nd highest daily max	1	1	1	1	9	Yes
	8 hr	2nd highest daily max	1	1	1	1	35	Yes
NO_2 (ppb)	1 hr	98th percentile of daily max	23.6	18.0	27.4	23	100	Yes
	Annual	Annual average	2	1	2	2	53	Yes
SO_2 (ppb)	1 hr	99th percentile of daily max	1.2	3.2	3.5	2.6	75	Yes
	3 hr	2nd highest daily max	1.2	3.4	3.5	2.7	500	Yes
	24 hr	2nd highest	1.1	3.1	3.4	2.5	140	Yes
	Annual	Average	0.1	0.8	0.9	0.6	30	Yes
PM_{10} (µg/m^3)	24 hr	2nd highest	98.5	128.8	48.8	92.1	150	Yes
$PM_{2.5}$ (µg/m^3)	24 hr	98th percentile	10.0	5.5	6.9	7.5	35	Yes
	Annual	Average	2.8	1.3	1.6	1.9	12	Yes
O_3 (ppb)	8 hr	4th highest daily max	46	43	45	44	70	Yes

A-Pad								
Pollutant (units)	**Avg Period**	**Rank**	**2014**	**2015**	**2016**	**Avg.**	**NAAQS / AAAQS**	**Below NAAQS/ AAAQS?**
NO_2 (ppb)	1 hr	98th percentile of daily max	33.3	36.4	24.8	31.5	100	Yes
	Annual	Annual average	3	3	2	2.7	53	Yes
SO_2 (ppb)	1 hr	99th percentile of daily max	4.3	4.3	3.3	4.0	75	Yes
	3 hr	2nd highest daily max	5	4	0	3.0	500	Yes
	24 hr	2nd highest	1.7	2.1	0	1.3	140	Yes
	Annual	Average	5	1	0	2.0	30	Yes
O_3 (ppb)	8 hr	4th highest daily max	51	44	43	46	70	Yes

Sources: ADEC 2018b
NAAQS/AAAQS for O_3 were converted from parts per million (ppm) to parts per billion (ppb), and the 24-hour and annual SO_2 AAAQS were converted from µg/m^3 to parts per billion

that the baseline air quality pollutant concentrations in the program area are lower than those reported by A-Pad, Nuiqsut, and other monitoring stations on the North Slope.

In addition to criteria pollutants, the Clean Air Act regulates toxic air pollutants, or hazardous air pollutants, that are known or suspected to cause cancer or other serious health effects or adverse environmental impacts. The hazardous air pollutant regulatory process identifies specific chemical substances that are potentially hazardous to human health. It sets emission standards to regulate the amount of those substances that can be released by individual facilities or by specific types of equipment. Controls can be required at the source, either through manufacturer requirements or via add-on control devices, to limit the release of these air toxics into the atmosphere. The hazardous air pollutants most relevant to oil and gas operations are formaldehyde, n-hexane, benzene, toluene, ethylbenzene, xylenes, acetaldehyde, ethylene glycol, and methanol; other compounds may be identified as potentially hazardous air pollutants and evaluated during project-specific analysis. There are limited sources for these pollutants in the Coastal Plain.

Air Quality Related Values

AQRVs are resources that may be affected by a change in air quality. The Clean Air Act gives federal land managers the responsibility for protecting these values in Class I areas from the adverse impacts of air pollution (40 CFR 51.166). The Class I area nearest to the program area is Denali National Park, which lies about 425 miles southwest. In a NEPA context, analysis is sometimes done to assess potential impacts in Class II areas considered sensitive in the context of preserving the visitor experience, such as federally managed national parks, monuments, wilderness areas, and wildlife refuges that were not designated as Class I areas. The nearest such areas are the Arctic Refuge, in which the Coastal Plain is located, and Gates of the Arctic National Park, approximately 125 miles southwest of the Coastal Plain.

Visibility

Haze is a form of air pollution that occurs from refraction of sunlight on particles in the atmosphere. The result of haze is impaired visibility. In 1999, the EPA published the Regional Haze Rule, implementing a visibility protection program for Class I areas.

Visibility in some of these areas is monitored through the Interagency Monitoring for the Protection of Visual Environments (IMPROVE). Visibility is described by two units of measure: haze index in deciviews (dv) and standard visual range. Visibility at Bettles Field Station (near Gates of the Arctic National Park, the closest monitored location to the program area, is shown in **Figure 3-2**, Visibility Data for Gates of the Arctic National Park, in **Appendix A** (IMPROVE 2018a). Visibility at Denali National Park and Preserve, the closest monitored Class I location to the program area, is also shown in **Figure 3-2**. Data collected at the Bettles monitor showed an improvement in conditions on the haziest days and essentially constant visibility conditions for the clearest days from 2010 to 2014. The 4 dv measure on the clearest days corresponds to a visual range of about 160 miles; the approximately 13 to 9 dv on the haziest days corresponds to a visual range of 65 to 100 miles (IMPROVE 2018b). At Denali National Park and Preserve, the haze index on the haziest days generally shows a downward trend from 1990 to 2017, with the maximum value of approximately 15 dv (visual range of about 54 miles) occurring in 2009 and 2010. On the clearest days, the haze index in Denali National Park and Preserve has consistently been slightly higher than natural conditions since 2000, ranging from approximately 2 to 3 dv (visible range of 180 to 200 miles) (IMPROVE 2018b). Visibility data have been collected since 2018 at the Toolik Field Station, approximately 110 miles southwest of the Coastal Plain, though no validated data are yet available.

Deposition

In atmospheric deposition, air pollutants are removed from the atmosphere and subsequently deposited in aquatic and land-based ecosystems. This can occur through precipitation or through the dry gravitational settling of particles onto soil, water, and vegetation. A primary issue of atmospheric deposition is the potential formation of acids, particularly nitrogen and sulfur species. In areas of heavy emissions, this can lead to acid rain and snow and the subsequent deterioration of lakes, streams, soils, nutrient cycling, and biological diversity. Additional compounds that can accumulate from atmospheric deposition are air toxins, heavy metals, such as mercury, and nutrients, such as nitrates and ammonium.

Bettles Field Station (near Gates of the Arctic National Park) is the nearest area where nitrogen critical loads have been analyzed and recorded. The critical load ranged between 1 and 3 kilograms per hectare per year (kg/ha-yr), based on 2010 and 2011 estimates, while the maximum nitrogen deposition was 0.94 kg/ha-yr, based on recorded values from 2008 through 2015 (BLM 2018a, Table 27). At Denali National Park and Preserve, the critical load ranged between 1 and 3 kg/ha-yr, based on 2010 and 2011 estimates, while the maximum nitrogen deposition was 0.64 kg/ha-yr, based on recorded values from 1980 through 2016 (BLM 2018a, Table 27).

The National Atmospheric Deposition Program/National Trends Network measures concentrations and deposition rates of constituents removed from the atmosphere by precipitation (wet deposition). It focuses on those that affect rainfall acidity and those that may cause adverse ecological effects. Trends for ammonium, nitrate, and sulfate ions show that for Bettles Field Station, near Gates of the Arctic National Park, recorded deposition is decreasing, while for Denali National Park and Preserve, deposition is increasing (BLM 2018a, Figures 4 to 6).

The Clean Air Status and Trends Network (CASTNET) measures air quality and deposition trends in rural areas. In conjunction with other national monitoring networks, CASTNET data are used to assess relationships between regional pollution and total deposition patterns and to evaluate the effectiveness of national and regional emission control programs. For dry deposition, CASTNET records flux data from monitoring stations across the country; flux is the rate at which dry particles reach the ground. The nearest monitor with recent data is in Denali National Park and Preserve. From 1998 through 2016, sulfate ion dry deposition reached its maximum at 2.5 kg/ha/yr in 2006. Nitrate ion dry deposition reached its maximum just below 2.0 kg/ha/yr in 2004, and ammonium ion dry deposition reached its maximum of 1.4 kg/ha/yr in 2004. The annual average trend for all three ion fluxes has been consistent over the period of record for this monitoring station (BLM 2018a, Figure 7).

Toolik Field Station began collecting data on acid deposition in 2017 and mercury deposition in 2018, but no validated data are yet available.

Air Pollutant Sources

There are few sources of air pollutants in the Coastal Plain. The primary pollutant sources are residential and commercial heating sources and mobile sources, such as snowmachines, vehicles, and aircraft. Additional emission sources on the wider region of the North Slope are oil and gas facilities, with lesser contributions by electricity generation and waste treatment. The nearest oil and gas facilities occur in the Point Thompson, Badami, Liberty, and Duck Island oil and gas units, west of the Coastal Plain (Alaska Division of Oil and Gas 2017). As of 2003, there were more than 4,800 exploratory and production wells on Alaska’s North Slope (NRC 2003); as of 2018, there were approximately 2.7 million acres of active leases there (Alaska Division of Oil and Gas 2018). There are no active leases or active wells in the Coastal Plain.

Alaska is affected by international long-range transport of pollutants that affect visibility conditions. International transport of pollutants into Alaska has been documented through a variety of research studies. Storm activity in arid desert regions of Asia affects Alaska from March to May. Arctic haze is attributed to anthropogenic aerosols from Northern Europe and Russia that reach Alaska from November to May. Human caused and natural fires from Siberia, Asia, Europe and North America affect Alaska from April to August (Huff 2017).

Direct and Indirect Impacts

Issuance of oil and gas leases under the directives of Section 20001(c)(1) of PL 115-97 would have no direct impacts on the environment because by itself a lease does not authorize any on-the-ground oil and gas activities; however, a lease does grant the lessee certain rights to drill for and extract oil and gas subject to further environmental review and reasonable regulation, including applicable laws, terms, conditions, and stipulations of the lease. The impacts of such future exploration and development activities that may occur because of the issuance of leases are considered potential indirect impacts of leasing. Such post-lease activities could include seismic and drilling exploration, development, and transportation of oil and gas in and from the Coastal Plain; therefore, the analysis considers potential impacts on air quality from on-the-ground post-lease activities.

This section describes the potential impacts of future Coastal Plain oil and gas development on air resources. Oil and gas leasing would have no direct impacts on air quality or AQRVs, as it would not authorize any on-the-ground actions. A decision to authorize leasing may lead to indirect impacts because the issuance of leases could result in on-the-ground oil and gas activities being permitted. These post-lease activities would emit air pollutants from a variety of sources during exploration, development, production, and abandonment and reclamation. These pollutants could affect air quality and AQRVs in the Coastal Plain and in nearby areas. A quantitative analysis may be required once a project has been proposed.

Alternative A

Under Alternative A, no federal minerals in the program area would be offered for future oil and gas lease sales. No potential impacts on air quality or AQRVs from oil and gas development in the Coastal Plain would occur. Local and regional air emission sources, described above under *Affected Environment*, would continue to contribute air pollutants to the North Slope. The increase in emissions from oil and gas-generating sources in the Coastal Plain would be limited in the absence of oil and gas development; however, emissions-generating sources outside the Coastal Plain would continue to increase, particularly those related to onshore and offshore oil and gas development.

Impacts Common to All Action Alternatives

The types of air emission sources typically associated with oil and gas development on the North Slope of Alaska are described in detail in a number of studies and EISs, including the Alpine Satellite Development Plan (BLM 2004), the GMT1 Final SEIS (BLM 2014), the GMT2 Final SEIS (BLM 2018a), and the Nanushuk Project EIS (USACE 2018). These studies detail the oil and gas development phases and the associated emission sources required during each phase to bring oil and gas resources on the North Slope to production. The types of emissions sources analyzed in those studies would be similar to those required to recover oil and gas resources in the Coastal Plain.

As described by these reports, emissions and emission sources would vary based on the phase of development, as summarized below:

- During exploration, seismic surveying emissions would be produced by vibreosis rubber tracked vehicles, helicopters, and bulldozers or larger tracked vehicles used to pull the camp trains. Pollutant emissions would consist primarily of nitrogen oxides and CO, with lower levels of other criteria pollutants.
- During exploratory drilling and pad construction, emissions would be produced mainly by drilling equipment required for exploratory and delineation wells. Additional sources of emissions would be equipment required to build ice roads, support equipment and vehicles to bring personnel, materials,

and supplies to the well pad locations, and intermittent activities such as mud degassing and well testing. Pollutant emissions would be dominated by nitrogen oxides, with more moderate levels of VOCs (volatile organic compounds) and CO (carbon monoxide), and lower levels of other criteria and hazardous pollutants. Exploration of the first lease area is anticipated to occur within 2 to 4 years of the first lease sale. Emissions from exploration activities would be short term and temporary.

- During the development phase, emissions would be produced by heavy construction equipment used to construct the CPFs, satellite well pads, ice roads, airstrips, and pipelines; well drilling and completion drilling engines/turbines; diesel trucks used to bring in equipment and gravel; blasting at gravel sources and gravel road construction; and support vehicles and aircraft. Emissions also would be produced by construction equipment used to construct the seawater treatment plant and barge landing area. The primary emissions during development would be particulates from ground disturbance and exhaust-related emissions from equipment, including nitrogen oxides and CO, with lesser amounts of VOCs, particulate matter, and SO_2. The first lease area is anticipated to be developed within 5 to 7 years of the first lease sale. Emissions associated with construction would be short term and temporary.
- During the production phase, the primary source of emissions would be power generation for heating, oil pumping, and water injection. The emissions would consist primarily of CO and nitrogen oxides, with smaller amounts of particulate matter. There would also be evaporative losses of VOCs from oil/water separators, pump and compressor seals, valves, and storage tanks. Venting and flaring could be an intermittent source of methane, nitrogen oxides, VOCs, and possibly SO_2. Production of the first lease area is anticipated to begin within 8 years of the first lease sale and to continue for 40 years after. Emissions during production would be long term and would include not only production-related stationary emission sources but also intermittent and recurring emissions, such as annual construction of ice roads, and mobile sources, such as aircraft. Emissions also would occur at off-lease locations from operating the seawater treatment plant, the barge landing area, and the marine transport route, and from increased flight traffic at the Kaktovik airport.
- During abandonment and reclamation, the primary source of emissions would be heavy equipment used to move the gravel from roads, pads, and support facilities and diesel trucks used to haul the gravel to the reuse site or gravel mine. This would occur at the end of production for a given lease area.

The emission sources described above would be in multiple locations in the Coastal Plain during overlapping time frames as additional fields are explored, developed, put into production, and subsequently abandoned and reclaimed. The RFD (**Appendix B**) projects that oil and gas activities would continue for 85 years or more. The total number of wells and the production levels of oil and gas are projected to be the same across all action alternatives.

Emissions from exploration and abandonment/reclamation are expected to be lower than emissions from development and production. The emissions inventory developed for the BOEM Arctic Air Modeling Study estimated that for all phases of onshore oil and gas development (seismic surveys, exploratory drilling, and development/production), seismic survey operations accounted for less than 1 percent of each type of criteria or hazardous air pollutant emitted, and exploratory drilling accounted for less than 20 percent of VOCs and less than 10 percent of each other type of pollutant emitted (BOEM 2014, Table VI-4). The seismic survey activities evaluated in the BOEM emissions inventory report (BOEM 2014, page III-1) would be similar in scale to seismic survey activities in the Coastal Plain (Brumbaugh pers comm 2018)[4]; thus, potential emissions in the short term would be less than emissions in the long term, assuming that exploration ultimately led to the buildout of oil and gas facilities described by the hypothetical development scenario (**Appendix B**).

Since the program area is undeveloped, oil and gas resource development would require the construction of a system of gravel and ice roads, bridges of varying sizes, and airstrips to access the CPFs and satellite well pads, as well as construction of the CPFs and satellite pads themselves. This construction would require the development of gravel pits. Infrastructure and gravel pit development would be sources of localized fugitive particulate matter emissions, both during construction of these features and during use of the roads and operation of the gravel pits (e.g., blasting, loading, and hauling).

Because the location, timing, and level of future oil and gas development in the Coastal Plain is unknown at this time, a qualitative analysis was performed. At this initial leasing stage, there is a lack of location- and timing-specific information regarding any potential on-the-ground oil and gas activities that may result from leasing. Future on-the-ground actions requiring BLM approval, including seismic surveys, exploratory drilling, and specific development proposals, would each require further NEPA analysis based on specific and detailed information about where and what kind of activity is being proposed.

Based on the air analyses performed for the Alpine Satellite Development Plan, NPR-A, GMT1, GMT2, and Nanushuk Project EISs, and the BOEM Air Modeling Study (BLM 2004, 2012, 2014, 2018a; USACE 2018; BOEM 2014, 2016, 2017), the low levels of criteria air pollutants in the ambient air (**Table 3-6**), and the meteorological conditions of the Coastal Plain described in **Section 3.2.1**, Climate and Meteorology, it is not anticipated that a future project-specific proposal in the Coastal Plain would exceed a project-level Prevention of Significant Deterioration increment or cause ambient conditions to exceed an NAAQS/AAAQS, or an air quality related value threshold, as determined through project-specific air modeling. However, because near-field modeling performed in support of NEPA analyses for some of the projects described above have shown levels of pollutant concentrations approaching the NAAQS/AAAQS (or exceeding the NAAQS/AAAQS in the case of GMT1); because air quality conditions at the time of future project proposals would be different than air quality conditions today; and because oil and gas development on the North Slope overall would continue to increase and contribute to air quality impacts over time, each project-specific proposal would require a NEPA analysis to determine the potential direct, indirect, and cumulative impacts on air quality and AQRVs.

No significant impacts on air quality or AQRVs at Class I areas are expected, given that the distance to the nearest Class I area from the program area, Denali National Park and Preserve, is 425 miles to the southwest.

Separate from the NEPA analyses required for site-specific development proposals, ADEC would require air emission permits and dispersion modeling to assess potential impacts of specific facilities in accordance with EPA and Alaska rules and guidance. Air pollutant emissions from a proposed future project would be subject to federal and state air quality regulations under the Clean Air Act. Air pollution impacts are limited by air quality regulations and standards, and state implementation plans, established under the federal Clean Air Act and the Clean Air Act amendments of 1990. In Alaska, air pollution impacts are managed by ADEC under the Alaska Air Quality Control Regulations (18 AAC 50) and the EPA-approved state implementation plan.

[4]Brumbaugh, Robert. Personal communication. Email from Robert Brumbaugh, BLM to Amy Cordle, EMPSi on September 4, 2018 regarding seismic survey activity levels.

In Alaska, portable oil and gas operations must be authorized under an ADEC minor air quality permit. Future projects would be required to obtain all applicable state air quality permits.

Project-specific terms and conditions required prior to authorizing any future oil and gas activity would be determined as part of site-specific NEPA analyses and would include one or more of the following as outlined in ROP 6 (**Chapter 2**):

- Requiring the project proponent to provide a minimum of 1 year of baseline ambient air monitoring data for any pollutant(s) of concern, as determined by the BLM if no representative air monitoring data are available for the program area, or existing representative ambient air monitoring data are insufficient, incomplete, or do not meet minimum air monitoring standards set by the EPA or the ADEC.
- Preparing an emissions inventory of regulated air pollutants from all direct and indirect sources related to the proposed project, including emissions of criteria air pollutants, VOCs, hazardous air pollutants, and GHGs estimated for each year for the life of the project; the BLM would use this emissions inventory to determine pollutants of concern and the appropriate level of analysis.
- Conducting air modeling to analyze direct, indirect, and cumulative impacts, if necessary to support ’s analysis of the proposal, based on the magnitude of the project, its proximity to Class I areas or population centers, meteorological and geographic conditions, existing air quality conditions, magnitude of existing development in the area, and issues identified during scoping.
- Providing an emissions reduction plan that includes a detailed description of operator-committed measures, if required by the BLM, to reduce project-related air emissions of criteria pollutants, GHGs, heavy metals, mercury, and fugitive dust.
- Conducting monitoring for the life of the project depending on the magnitude of potential air emissions from the project, proximity to population centers, or other factors.
- Implementing project changes or additional emission control strategies, as required by the BLM, in consultation with federal land managers and other appropriate federal, state, and/or local agencies, if ambient air monitoring or air quality modeling indicates that project-related emissions cause or contribute to impacts, unnecessary or undue degradation of the lands, exceedances of the NAAQS/AAAQS, or fail to protect health (either directly or through use of subsistence resources).
- Providing air quality baseline monitoring, emissions inventory, and modeling results to the state, local communities, tribes, and other entities in a timely manner

In addition to ROP 6, under ROP 5, all oil and gas operations (vehicles and equipment) that burn diesel fuels would be required to use “ultra-low sulfur” diesel as defined by the EPA, which would minimize emissions from these sources. ROP 5 and ROP 6 would be applied under all of the action alternatives. As noted above, the RFD (**Appendix B**) assumes the total number of wells and the overall production of oil and gas would be the same across all action alternatives.

Alternative B (Preferred Alternative)

Air pollutants emitted in the development phase under Alternative B would be as described under *Impacts Common to All Action Alternatives*. Under Alternative B, 4 CPF development clusters, with 14 total satellite pads, would be constructed. Two CPF development clusters would be in the high potential area (the western portion of the program area), one would be in the medium potential area (south of Kaktovik), and one would be in the low potential area (the southern portion of the program area). One or more of the CPF development clusters would be roadless. This would require an expanded airstrip at the CPF, with the capacity to handle the larger cargo planes, which would increase air traffic. In addition, one seawater treatment plant and at least one barge landing and storage pad would be constructed on the coast.

Emissions would likely be highest under Alternative B because of the greater number of CPFs considered. Aircraft-related emissions also would be the highest, due to the potential for roadless developments, which would increase air traffic in the program area and at the Kaktovik Airport, with the potential for associated impacts in that area on air quality and public health. Likewise, the CPF development cluster south of Kaktovik would have the potential for increasing air pollutant levels near Kaktovik; however, site-specific NEPA analyses and ADEC permitting requirements would determine the potential for impacts and the mitigation and operator-committed measures required to reduce impacts to appropriate levels.

Alternative C

Air pollutant emissions sources by development phase under Alternative C would be as described under *Impacts Common to All Action Alternatives*. Under Alternative C, 3 CPF development clusters with 15 total satellite pads would be constructed. Two CPF development clusters would be in the high potential area (the western portion of the program area) and one would be in the medium potential area (south of Kaktovik). No CPFs would be roadless. In addition, one seawater treatment plant and one barge landing and storage pad would be constructed.

Emissions under Alternative C would likely be less than those described for Alternative B because one less CPF would be developed. Impacts associated with the CPF development cluster south of Kaktovik would be as described for Alternative B; however, there would likely be fewer flights in and out of the Kaktovik, with reduced air quality and public health impacts in that area, compared with Alternative B.

Alternative D

Air pollutant emission sources by development phase under Alternatives D1 and D2 would be as described under *Impacts Common to All Action Alternatives*. Under Alternatives D1 and D2, 2 CPF development clusters and 16 total satellite pads would be constructed. One CPF would be in the high potential area (the western portion of the program area) and one would be in the medium potential area (south of Kaktovik). No CPFs would be roadless. Under both alternatives, one seawater treatment plant and one barge landing and storage pad would be constructed. Because a timing limitation stipulation would be applied to the entire Coastal Plain under Alternative D2, the time frames for reaching peak production could be extended, compared with the other action alternatives.

Emissions under Alternatives D1 and D2 would likely be less than those described for Alternative B because two fewer CPFs would be developed; however, impacts associated with the CPF development cluster south of Kaktovik may be greater than those described for Alternative B, if more satellite pads closer to Kaktovik were associated with this CPF. Fewer flights in and out of Kaktovik would likely occur than under Alternative B, with reduced impacts on air quality and public health, compared with Alternative B.

Transboundary Impacts

Future oil and gas development in the Coastal Plain was evaluated to determine the potential for transboundary air quality impacts within Canada. The Coastal Plain program area is approximately 30 miles from Canada at its nearest point and slightly under 125 miles at its most distant point. The wind rose in **Figure 3-1** in **Appendix A** shows that wind direction recorded at the Barter Island station is bimodal, occurring from both the east and the west, with annual average wind direction more from the east. Monthly wind rose data show that westerly winds are more predominant from November through March, while easterly winds are more predominant from April through October and especially from May through July (IEM 2019). Emissions from oil and gas development in the Coastal Plain have the potential to transport air pollutants into Canada and have transboundary effects, particularly in those months with more westerly winds.

Cumulative Impacts

Potential cumulative effects on air quality and AQRVs over the life of this EIS would result from existing sources of air pollutants in combination with the reasonably foreseeable future actions described in **Appendix F**. The cumulative effects analysis area for air quality includes the North Slope and the areas described under *Affected Environment* as sensitive in the context of preserving visitor experience, including the Arctic Refuge and Gates of the Arctic National Park. The nearest federal Class I area, Denali National Park and Preserve, is over 425 miles south of the Coastal Plain and is therefore not included in the cumulative effects analysis area.

No quantitative cumulative analysis has been prepared specifically for this EIS. Air analyses prepared for the GMT2 Final SEIS (BLM 2018a) and the BOEM Arctic Air Quality Modeling Study's Photochemical Modeling Report (BOEM 2016) are used to inform the cumulative effects analysis for this EIS, recognizing that these efforts did not include oil and gas development on the Coastal Plain in the modeling of potential cumulative effects on air quality and AQRVs because no such development had been proposed at the time of those analyses. In addition, the GMT2 direct emissions did not include the full suite of emission sources described in the RFD for the Coastal Plain (**Appendix B**); for instance, GMT2 modeling did not include a CPF and additional satellite pads. For these reasons, these cumulative air impact analyses are being used to inform the discussion but do not infer the impacts expected from projects on the Coastal Plain; rather, a cumulative air assessment specific to proposed development on the Coastal Plain would be necessary to properly assess these impacts.

The methodology for analyzing cumulative effects on air quality in the GMT2 Final SEIS was described in Section 4.6.5 of that document (BLM 2018a). This included evaluating the effects of 14 onshore and offshore oil and gas development sources and the Deadhorse Power Plant. The results were included in Tables 143 through 146 in BLM 2018a. Cumulative criteria air pollutant concentrations in the Arctic Refuge (BLM 2018a, Table 143) and Gates of the Arctic National Park (BLM 2018a, Table 144) were modeled to be well under the NAAQS/AAAQS. Cumulative visibility impacts were estimated at a change of less than 5 dv at the Arctic Refuge and approximately 1 dv at Gates of the Arctic National Park (BLM 2018a, Table 145).

Cumulative deposition impacts were estimated at 0.025 kg/ha-yr for nitrogen and 0.006 kg/ha-yr for sulfur at the Arctic Refuge and 0.004 kg/ha-yr for nitrogen and 0.001 kg/ha-yr for sulfur at Gates of the Arctic National Park (Table 4.6-8, BLM 2018a). As described above under *Affected Environment*, measured maximum nitrogen deposition was 0.94 kg/ha-yr at Gates of the Arctic National Park; adding the cumulative nitrogen deposition level of 0.004 kg/ha-yr would yield a value of 0.944 kg/ha-yr, which is below the critical load range of 1 to 3 kg/ha-yr. Nitrogen deposition and critical load information for the Arctic Refuge was not available to make a similar calculation. Future individual development proposals in the Coastal Plain are anticipated to be similar in scope to the GMT2 project, though cumulative impacts would depend on the location and extent of other air emissions sources at the time of project proposal.

The BOEM Photochemical Modeling Report (BOEM 2016) evaluated the potential for cumulative effects on air quality and AQRVs from BOEM-authorized offshore oil and gas development along the North Slope in combination with other offshore vessel traffic, onshore oil and gas fields, airports, the Trans-Alaska Pipeline System (TAPS), and onshore non-oil and gas activities such as power plants, stationary fuel combustion sources, on- and off-road mobile sources, waste burning, wastewater treatment, fuel dispensing operations, and road dust (BOEM 2014, Table I-1).

Modeled visibility impacts from new oil and gas sources showed a change in visibility of 1 dv or greater on 160 days of the year at the Arctic Refuge's Coastal Plain and on 24 days of the year at Gates of the Arctic National Park (BOEM 2016, Section 7.3, Table 7-4). Deposition levels were modeled above 0.01 kg/ha-yr for nitrogen and sulfur in the Arctic Refuge and above 0.01 kg/ha-yr for nitrogen in the Gates of the Arctic National Park (BOEM 2016, Section 7.3.2, Tables 7-6 to 7-8). Cumulative visibility impacts and deposition levels for all sources included in the BOEM analysis were above thresholds and warrant additional quantitative (project and cumulative level) analysis.

As described above, the cumulative analyses for the GMT2 Final SEIS and the BOEM Arctic Air Quality Modeling Study did not account for proposed oil and gas development in the Coastal Plain, and therefore the potential cumulative effects of future oil and gas activities are not fully known at this time. As described by ROP 6, the direct, indirect, and cumulative effects of individual oil and gas development projects would be analyzed at the time of a specific project proposal to fully assess the effect of Coastal Plain development on air resources.

In addition, the BLM is undertaking its own study, the Cumulative Alaska North Slope Air Quality Regional Model, to assess the cumulative effects of oil and gas development on the North Slope, including in the Coastal Plain. This study will build on the BOEM study to provide an up-to-date assessment of the potential cumulative effects of North Slope onshore and offshore oil and gas development on air quality and AQRVs in the region.

The BLM anticipates that this model will provide the foundation for future updated NEPA analyses. Because it is expected that the growth of oil and gas activities on the North Slope will continue for many years, the model will be updated periodically, pending funding availability, to reflect actual development rates and locations, allowing the BLM, other federal land managers, and the state to monitor the effects oil and gas development is having on air quality and AQRVs so that appropriate measures can be put in place to minimize the impact on these resources as needed. The modeling study would not be tied to a specific decision or NEPA effort; rather, it would be used to inform future oil and gas-related NEPA analyses on the North Slope., especially those pertaining to specific development proposals The first modeling study is expected to be completed in 2020.

3.2.3 Acoustic Environment

The acoustic environment, or soundscape, is the combination of all sounds in a given area. These include natural sounds, such as from wind and water and those sounds caused by insects, birds, other wildlife, and humans. Human-caused sounds are considered noise because they have the potential to affect the natural acoustical environment and the noise-sensitive resources in that environment. Noise-sensitive resources include human receptors that may be affected by oil and gas-related activities in the Coastal Plain. Also included are terrestrial wildlife, marine mammals, fish and aquatic species, and numerous bird species. Some of these species are important subsistence resources for rural residents, for residents of Kaktovik, including those engaged in subsistence activities in the Coastal Plain beyond the village itself. Such resources are also important for visitors to the Coastal Plain, such as wilderness values in congressionally designated Wilderness that borders the Coastal Plain to the south and east. An example is the opportunity to experience solitude, with the absence of human-caused noise.

Affected Environment

This section incorporates by reference the overview of acoustical principles in the acoustical environment section from the GMT2 Final SEIS (BLM 2018a, Section 3.2.3.6). Because the greater Nuiqsut area, the focus of the GMT2 Final SEIS, has a different acoustical setting than the Coastal Plain, the 2010 background acoustic monitoring done by the US Army Corps of Engineers (USACE) at Point Thomson, next to the western Coastal Plain boundary, is used as a comparable description of existing acoustic environment in the program area (USACE 2012, Appendix O).

Terrestrial Acoustic Environment

The terrestrial acoustic environment includes sounds caused by wildlife and natural features of the landscape, as well as unwanted human-caused sounds. As previously stated, such sounds are considered noise because they have the potential to affect the natural acoustical environment and noise-sensitive resources and values. In the context of a leasing program, noise-sensitive resources, along with wildlife, are people engaged in subsistence pursuits, recreation, and other activities.

The degree to which noise may disturb wildlife and human receptors depends on many factors, such as the following (Francis and Barber 2013):

- Wildlife responses to noise are known to vary by species
- Acoustical factors, such as the frequency, intensity (loudness), and duration of noise
- Non-acoustical factors, such as life-history stage, environmental or behavioral context, and degree of past exposure

Noise that is abrupt and unpredictable may be perceived as a threat, potentially triggering a startle response or antipredator behavior (Frid and Dill 2002; Francis and Barber 2013). Chronic noise may affect sensory capabilities via masking of biologically important natural sounds, such as those used for communication or detection of predators or prey (Francis and Barber 2013). Similarly, human responses to noise also are contingent both on acoustical and non-acoustical factors. Examples of the latter are social context and perceived ability to exert control over the noise source (Kroesen et al. 2008; Stallen 1999).

Existing noise sources in the Coastal Plain area are the following:

- On-road and off-road vehicles and snowmobiles and community noise, such as generators and other small equipment motors, in the village of Kaktovik
- Aircraft and boats for village access, tourism, recreation access to remote sites, and scientific research

Disturbance of subsistence resources (particularly caribou) and subsistence activities by low-flying aircraft, including helicopters, associated with oil and gas development has long been an issue of concern to North Slope residents. The level of concern has increased over time as use of aircraft to support research and monitoring, recreation, oil and gas development, and other activities on the North Slope has increased during the past few decades (USFWS and BLM 2018).

As reported in Stinchcomb (2017), sound levels perceived as unwanted or annoying by humans correspond with the range of sound levels emitted by low-flying aircraft. Aircraft sound is concentrated at low frequencies, which lose little energy over long distances and produce vibrations that elicit feelings of discomfort and annoyance.

Sound Propagation Through Air

The propagation of sound in outdoor settings is affected by many variables: distance from the source; meteorological conditions, such as temperature, wind, and humidity; and landscape features and surface characteristics that may interfere with sound through absorption, reflection, or diffraction (Attenborough 2014).

Among these, distance is the most significant factor. For a point source producing a constant sound, sound levels are expressed as dB and generally decrease by approximately 6 dB for each doubling of distance from the source. The same 6 dB reduction with doubling distance holds for the maximum sound level produced by a single moving source, such as an aircraft in flight, when the source is at its closest point of approach to the receptor (Attenborough 2014). For a line of moving sources, such as vehicle traffic on a road, sound levels decrease by approximately 3 dB with doubling distance.

When wind is present, sound diminishes with distance is less than expected in the downwind direction—downwind propagation is enhanced—and greater than expected in the upwind direction. Temperature inversions reduce decreases and enhance propagation. In general, meteorological conditions tend to enhance sound levels to a lesser degree, such as 1 to 5 dB, than decrease sound levels, such as 5 to 20 dB (Attenborough 2014).

Terrestrial Acoustic Monitoring

No long-term acoustic monitoring has been established in the program area for detecting future changes in acoustic conditions and attributing such changes to particular activities, including those associated with oil and gas exploration and development (USFWS and BLM 2018); however, in 2010, the USACE conducted short-term baseline acoustical monitoring in the extreme northwest corner of the program area for the Point Thomson EIS. In this area, approximately 9 miles inland from the coast and 3 miles west of the Canning River, noise from human activities was generally absent (USACE 2012). Those conducting the baseline monitoring recorded hourly median sound levels of 23 to 28 A-weighted decibels (dBA) during winter conditions (April 27–June 8) and 24 to 26 dBA during summer conditions (July 12–August 12). This baseline dBA reflects a “natural quiet” condition and represents the benchmark target condition for attempts to maintain natural quiet in the program area.

The program area is expected to have an acoustic environment similar to that described by the USACE (2012). In that study, the USACE noted that the low levels of sound recorded across all hours of the day, and across different seasons of the year, show loud events are rare. Natural sources, such as wildlife and wind, were the dominant sound of the sampling areas in the soundscape in both winter and summer. The USACE observed that human-caused noise, dominated by aircraft, ranged from zero to one event per hour (see also **Section 3.4.9**, Transportation).

Marine Acoustic Environment

The underwater and terrestrial acoustic environment is particularly important to marine mammals since they use noise to navigate, find prey, communicate, and detect disturbances or threats. While cetaceans typically rely on underwater acoustics, pinnipeds[5] and polar bears perceive noises in and out of the water, such as when individuals are hauled out, spy-hopping, or traveling across the sea ice as is the case with polar bears (BOEM 2018b).

In the Beaufort Sea, natural sources of marine sound include wind stirring the surface of the ocean, storms, ice movements, and animal vocalizations and noises (including whale calls and echolocation clicks). The frequency and magnitude of noise from each of these producers can differ dramatically, as a result of variation in the seasonal presence of the sound sources. Existing human sources of sound in the Beaufort Sea include

[5]Seals, walruses, and sea lions

vessels (such as motorboats used for subsistence and local transportation, commercial shipping, and research vessels); navigation and scientific research equipment (such as benthic trawls); airplanes and helicopters; human settlements; military activities; and offshore industrial activities.

Sound Propagation Through Water and Ice

The propagation of sound and sound pressure levels through water and ice is an important consideration. This is because such activities as seismic surveys, pile driving, and vessel traffic have the potential to affect fish and other aquatic species, birds, and marine mammals that use aquatic environments.

Propagation of sound produced underwater depends highly on environmental characteristics, such as bathymetry, bottom type, water depth, temperature, and salinity. The sound received at a particular location would be different from that near the source due to the interaction of many factors, such as propagation loss, how the sound is reflected, refracted, or scattered, the potential for reverberation, and interference due to multi-path propagation. In addition, absorption greatly affects the distance over which higher frequency sounds propagate (US Navy 2019).

Sound propagation in the Arctic differs from nonpolar regions. High-frequency sound waves that hit the underside of sea ice tend to attenuate by scattering caused by repeated reflection. Sound waves travelling near the surface of the water column in ice-covered water would therefore not propagate as far as sound waves travelling deeper in the water column or as far as sound waves travelling near the surface in ice-free water. Arctic waters also exhibit a very different sound speed profile than in nonpolar regions, which is caused by a layer of freshwater near the surface or by layers with different temperatures. As a result, sound waves tend to get trapped within a certain layer of the water column (100 to 300 meters) and to propagate farther than if they were not trapped in this channel (Au and Hastings 2008, cited in PAME 2019).

No long-term underwater acoustic monitoring has been undertaken in the program area.

Direct and Indirect Impacts

Issuance of oil and gas leases under the directives of Section 20001(c)(1) of PL 115-97 would have no direct impacts on the environment because by itself a lease does not authorize any on-the-ground oil and gas activities; however, a lease does grant the lessee certain rights to drill for and extract oil and gas subject to further environmental review and reasonable regulation, including applicable laws, terms, conditions, and stipulations of the lease. The impacts of such future exploration and development activities that may occur because of the issuance of leases are considered potential indirect impacts of leasing. Such post-lease activities could include seismic surveys and drilling exploration, development, and transportation of oil and gas in and from the Coastal Plain; therefore, the analysis considers potential impacts on the acoustic environment from on-the-ground post-lease activities.

Impacts from noise are characterized by their effects on wildlife and the human environment. Impacts are most concentrated in places that are highly populated, highly sensitive to sound, or of disproportionate importance to people or wildlife. The village of Kaktovik is the only permanent settlement within to the program area, though the broader Coastal Plain is used for a variety of subsistence activities, most notably hunting. The program area provides habitat for a number of species that are particularly susceptible to noise disturbance, as follows: bowhead whales, especially during fall migration; polar bears, especially during denning; caribou, especially during calving and post-calving; and migratory birds, especially during breeding and brood-rearing activities. Migrating bowhead whales avoid areas where the noise from exploratory drilling and marine seismic exploration exceeds 117 to 135 dB (NAS 2003). Noise impacts specific to wildlife and subsistence users, and the differences of impacts among alternatives, are analyzed more fully in those resource sections.

Methods of estimating noise impacts described in the GMT2 Final SEIS analysis (BLM 2018a, Section 4.2.3.3) are applicable to this EIS. In evaluating potential impacts of future project-related noise, it is necessary to consider noise levels in relation to existing ambient sound levels at the location of the receptor:

- Noise that is 10 or more dBA below the existing ambient sound level likely would be inaudible to the human ear.
- Noise that is approximately equal to existing ambient sound level would only be marginally or slightly audible, depending on the hearing capabilities of the individual receptor.
- Noise that is 10 dBA or greater above existing ambient sound level would become the dominant element of the acoustical environment.
- Noise levels of 40 dBA would be readily audible in a setting with an existing ambient sound level of 35 dBA or less, but likely would be inaudible in a setting where the existing ambient sound level is 50 dBA or more.

Noise levels generally associated with vehicles and equipment that would be used during exploration, development, production, and abandonment and reclamation are provided in **Table 3-7**, below. Sound levels referenced in the alternatives analysis all refer to this table and are all 1,000 feet from the noise source. Note that actual attenuation distances would depend on the variables described under *Sound Propagation Through Air*, above.

Table 3-7
Summary of Noise Levels for Project Equipment

Noise Source	Phase	Estimated Sound 1,000 Feet from the Source (dBA) [a]	Distance to 35 dBA (mi)	Distance to 23 dBA[b] (mi)	Source[c]
Construction equipment (5 pieces of equipment)	E, D, AR	62	4.2	16.8	BLM 2018a
Construction equipment (heavy, single equipment)	All	48–75	1.3–3.8	5.3–15	FHWA 2006
Impact pile driving (Lmax)	D	84	53	212	USACE 2018
Drill rig (Lmax)	E, D	84.4	56	222	BLM 2018a
Drill rig (median)	E, D	52.4	1.4	5.5	BLM 2018a
Gravel mining	D	62	4.2	16.8	BLM 2018a
Gravel blasting (Lmax)	D	90	102	424	USACE 2018
Helicopters	D, P	70–80	10.6–33.6	42–134	USACE 2018
Fixed-wing aircraft (twin engine)	D, P	69–81	9.5–37.8	38–150	USACE 2018
Tugboats, marine vessels, barges	D, P	40	0.3	1.3	BLM 2018a
Central processing facility	P	36–64	0–5.3	0.8–21	USACE 2018
Flaring at CPF	P	71	12	47.6	USACE 2018

Source: BLM 2018a
Note: dBA (decibels); mi (miles); Lmax (short-term, maximum sound level); E (exploration); D (development); P (production); AR (abandonment/reclamation)
[a] Unmitigated sound level
[b] 23 dBA is the minimum ambient sound level in the analysis area, based on USACE 2012.
[c] Sound levels in original sources are converted to sound levels at 1,000 feet.

Alternative A

Under Alternative A, no federal minerals in the Coastal Plain would be offered for future oil and gas lease sales, and no changes would occur to the ambient noise environment as a result of future oil and gas development in the Coastal Plain. Alternative A would not have direct or indirect impacts on the acoustic environment related to aircraft, and would retain background noise levels, which include the effect of noise generated by approximately nine flights per day to and from the Kaktovik Airport.

Impacts Common to All Action Alternatives

The nature and type of impacts would be similar across action alternatives. The primary noise sources associated with future oil and gas development are ground-based equipment, vessel and barge traffic, and aircraft. Impacts common to all action alternatives from these primary noise sources are described below; potential impacts by development phase under each alternative are discussed in the following section.

Ground-Based Equipment and Activities

Sources of noise associated with fluid mineral development are from construction, operation, and support activities for oil and gas wells. Construction activities contribute shorter term, temporary noises associated with the initial exploration and development of oil and gas infrastructure. This includes the construction of new roads, the use of vehicles and equipment to construct wells, and the drilling of wells. Blasting at gravel pits and pile installation provide the greatest source of sound and vibration impacts but are intermittent noise sources. Production activities provide a long-term source of noise at generally lower levels than construction. Plugging and capping wells and removing oil and gas infrastructure during the abandonment and reclamation phase of fluid mineral development also would result in short-term construction-related noise. Off-site ancillary infrastructure along the coast, including a seawater treatment plant and barge landing and offloading, would be sources of noise along the coast at these locations.

Vessel Traffic. Vessel traffic would be a lesser source of noise but would extend noise impacts into the marine environment along the entire 1,600-nautical-mile marine barge route; there would be underwater-radiated noise effects from commercial ships. These impacts would be short term and infrequent, with only two trips anticipated per year.

Aircraft Traffic. Kaktovik Airport is approximately 1 mile from the village of Kaktovik and is the nearest and most central airport to the program area. The amount of air traffic through Kaktovik and routing aircraft through the region could be strongly influenced by the future construction of additional airstrips in the program area. It is difficult to estimate the magnitude of aircraft use that would result from enabling fluid mineral activity in the Coastal Plain; the rate of development and potential use of ships or vehicles on new roads are two key uncertainties that would affect air traffic.

A highly conservative estimate of the level of air traffic related to oil and gas activities in the region is represented by Deadhorse Airport, which serves as the primary hub for oil and gas activities on the North Slope of Alaska. Airport master records for this airport, which provides key air connections to Fairbanks and Anchorage, report a 12-month average of 91 flights per day, relative to Kaktovik Airport's average of 9 flights per day (AMR 2018a, 2018b). A 2010 USACE noise analysis that reported aircraft noise levels on the order of one event per hour is consistent with these numbers; however, the 2010 analysis could have captured elevated levels of air traffic on the western portions of the program area from air traffic at other airports (USACE 2012, Section 5.20.8).

In addition to the air traffic into Kaktovik, support activities using helicopters are likely to be enabled by leasing. Currently, the BLM and USFWS permit a very small number of helicopter landings in the Arctic Refuge, mostly related to scientific research and photography.

The noise reduction estimates tabulated as part of the GMT2 Final SEIS analysis (BLM 2018a, Table 110) suggest that air traffic could be discernable 5 to 10 miles from the source of the loudest aircraft routinely operating in the region (based on a background noise level of 35 dB). At a higher background noise level (50 dB), more typical of the environment and villages west of the Arctic Refuge, this distance can be reduced to 1 to 2.5 miles. The extent to which flights are routed from Fairbanks, or routed farther north between Deadhorse and Kaktovik, could significantly alter the location, number, and intensity of affected acres.

Because of the proximity of Kaktovik Airport to the community of Kaktovik, there is a potential for high, localized impacts on the acoustic environment of the community from future oil and gas exploration, development, and production; impacts would be commensurate with use of the airport. Takeoffs and landings at the airport are audible and dominant sounds in Kaktovik. The different action alternatives do not present a clear basis for differences in use of the airport, so use levels are estimated to be the same among them. These use levels could be up to ten times the current use levels if air traffic levels at the Deadhorse Airport are indicative of future air traffic levels at Kaktovik Airport. Although measures to manage aircraft type could influence the noise levels experienced by the community, even quieter aircraft dominate the soundscape at 1 mile under 35 dB background noise conditions.

Alternative B (Preferred Alternative)

There would be no direct noise impacts from leasing under Alternative B.

Under Alternative B, the entire program area could be offered for lease sale, and there would be the fewest acres with restrictions on activities. **Table 2-1** in **Chapter 2** identifies acres available for lease sale subject to NSO, TL, or only to standard terms and conditions. Three-D seismic surveys not associated with leases could result in short-term noise impacts throughout the entire federal Coastal Plain. For smaller, operator-associated 3D surveys following the first lease sale, there would be no sources of sound from ground-based equipment in NSO areas (359,400 acres); however, there would be existing noise impacts in NSO areas resulting from noise sources located outside the NSO areas. Areas available for lease sale subject to TL or only standard terms and conditions would involve ground-based equipment that could increase ambient sound levels.

The BLM estimates that the entire federal Coastal Plain could be subject to 3D seismic surveys unrelated to leases (see **Appendix B**). After the first sale, operators would likely conduct smaller scale 3D surveys on their own lease blocks, assuming that seismic information would not already be available. Multiple vehicles could be used simultaneously and miles apart to conduct vibroseis exploration, or convoys of trucks could travel in a line, which is less common. Noise levels would likely be in the range of 48 to 53 dBA for individual trucks or 59.8 dBA for multiple trucks.

Seismic operations would include ski-mounted camp buildings towed by bulldozers or other tracked vehicles; the buildings would be moved weekly. Noise levels from these activities would likely be in the range of 52 to 61 dBA for individual bulldozers or tracked vehicles or 62 dBA for multiple pieces of equipment. These activities would occur only during the winter and would be short term, intermittent, and only in the areas around this equipment.

Exploratory activities would include constructing ice roads and ice pads and performing exploratory drilling. Noise levels from construction would be in the range of 62 dBA. Ice road construction would proceed linearly, with noise impacts being temporary in the area being constructed. Traffic noise on ice roads would be as described above for seismic operations, while equipment, materials, and drill cuttings are being transported to or from the ice pads.

Median noise levels of drill rigs at 1,000 feet are estimated to be 52 dBA, and maximum noise levels are estimated to be 84.4 dBA. In a 35 dBA ambient sound level, representative of the program area, both would be high impact, dominant sounds. At a 50 dBA ambient sound level, representative of developed coastal areas, the median noise levels would be marginally audible, but maximum sound levels would still be dominant. Noise from drilling would occur over the weeks to months that it would take to drill each well and would cease once the well is either completed or abandoned. As with seismic operations, exploratory activities would occur only in the winter.

Development would start following the discovery of an anchor field. Potential development would likely begin with the construction of a gravel pad for wells, CPF, airstrip, storage tanks, communications center, waste treatment unit, and a camp for workers. Noise sources during the development phase would include large-capacity dump trucks, bulldozers, and other heavy construction equipment. Average noise levels 1,000 feet from construction equipment for multiple pieces of construction equipment would be 62 dBA. Noise effects would be short term.

Development would include ice roads and vehicle travel along those roads for transporting materials, equipment, supplies, personnel, waste, and fuel. Gravel haul trucks would produce the greatest level of traffic noise, up to 110 dBA 50 feet from the noise source (USACE 2018); however, because gravel would most likely be sourced from areas surrounding the anchor and satellite pad sites (**Appendix B**), gravel hauling would be minimized. Other types of truck traffic would produce lesser noise levels, up to 81 dBA 50 feet from the noise source, or 55 dBA 1,000 feet from the noise source.

Gravel mining would result in noise levels of 62 dBA 1,000 feet from the source. Because this would be a similar noise level as other construction equipment, it would not be a dominant noise source in the development area. The exception to this is blasting, which can produce sound levels of 90 dBA at 1,000 feet from the source. Blasting would produce the highest discrete noise level during development but would occur only occasionally in the program area.

Impact equipment would be required for installing pipeline supports (VSMs). This equipment produces pulsed sound that can have a higher sound level and pressure than continuous sound. Sound levels generated by impact or impulse noise significantly exceed the background sound pressure level for a very short period. In-air noise levels at 50 feet from impact equipment can be 79 to 110 dBA (USACE 2018). Sound levels associated with pile driving and blasting are higher than other noise-producing activities; because of this, they could reach a larger area and be more disturbing than steady equipment noise and would be the dominant noise when they occur. Pile driving would occur for short durations.

As described for exploration, median noise levels of drill rigs at 1,000 feet are estimated to be 52 dBA, and maximum noise levels are estimated to be 84.4 dBA. In a 35 dBA ambient sound level, representative of the program area, both would be high impact, dominant sounds. At a 50 dBA ambient sound level, representative of developed coastal areas, the median noise levels would be marginally audible, but maximum sound levels would still be dominant. Assuming a diminishing rate of 6 dB per doubling of distance, sounds from onshore drilling 6 miles away would be below 24 dB at their median level. This median noise level would be inaudible in a 35 dB ambient sound level, but maximum noise levels would be audible and dominant from 6 miles away at that same ambient noise level. These impacts would be short term for each well drilled but would occur over a broad area.

The development of a seawater treatment plant and barge landing and storage pad would contribute to long-term, localized noise impacts in the marine environment. Noise would occur near barge loading and offloading operations. Similarly, underwater-radiated noise effects from commercial ships would occur at the anticipated frequency of two vessels per year on average for shipping modules for constructing the estimated four CPFs (see **Appendix B**). This would result in short-term noise impacts in the marine environment along the entire 1,600-nautical-mile marine barge route.

One or more of the CPF development clusters would likely be roadless, which would entail an expanded airstrip with the capacity to handle the larger cargo planes and increased air traffic. Noise resulting from fixed-wing aircraft is estimated to be 69 to 81 dB at a distance of 1,000 feet from the expanded airstrip. It would be audible 38 to 150 miles before noise levels diminish to the minimum ambient sound level in the analysis area, or the "natural quiet" condition; however, Alternative B would minimize the potential effects of low-flying aircraft on wildlife, subsistence activities, local communities, and recreationists in the area, including hunters and anglers, through ROP 34.

Operations would begin when a development is brought online. The predominant noise source would be from the CPFs. These facilities produce noise levels of 36 to 64 dBA at a distance of 1,000 feet. Noise would be audible up to 0.8 to 21 miles before levels diminish to the minimum ambient sound level in the analysis area, or the natural quiet condition. Flaring, if it is used, would produce a sound level of 71 dBA at a distance of 1,000 feet. Noise impacts from ground, barge, and aircraft traffic would be similar to those described under development.

Noise from abandonment and reclamation would be at levels comparable to general construction. This phase would involve plugging wells with cement, subsequently cutting and burying the well casing, removing gravel from pads and roads, and removing on-site equipment, facilities, and solid wastes. There would be short-term, temporary noises associated with this phase of fluid mineral development.

Alternative C

There would be no direct noise impacts from leasing under Alternative C.

The potential impacts from future oil and gas exploration would be similar to Alternative B. Non-lease-associated 3D seismic surveys could result in short-term noise impacts throughout the entire federal Coastal Plain. For smaller, operator-associated 3D surveys following the first lease sale, there would be no sources of sound from ground-based equipment in NSO areas (932,500 acres); however, there would be existing noise impacts in NSO areas resulting from seismic survey noise sources located outside the NSO areas.

Under Alternative C, the potential impacts from development would be similar to Alternative B; however, they would occur in fewer areas. The BLM would rely on the same ROPs as under Alternative B but would apply more restrictive lease stipulations. **Table 2-1** in **Chapter 2** identifies acres available for lease sale subject to NSO, TL, or standard terms and conditions. There would be no sources of sound from ground-based equipment in areas with NSO (932,500 acres), although existing noise impacts would continue in NSO areas from outside noise sources.

The remaining acres available for lease sale subject to TL (317,100 acres) or standard terms and conditions only (313,900 acres) would experience sound from ground-based equipment; however, this would not occur during certain times for acres available for lease sale subject to TL. Acres available for lease sale subject to

TL or standard terms and conditions would involve ground-based equipment that can increase ambient sound level, as described under Alternative B.

Noise impacts in the marine environment along the entire 1,600-nautical-mile marine barge route would be slightly less, compared with Alternative B. This is because, under that alternative, only three CPFs (two in the high potential area and one in the medium potential area south of Kaktovik) would need to be constructed (see **Appendix B**).

Production-related noise would be similar to Alternative B but would occur in fewer areas, because only three CPFs would be developed instead of four.

Similar to Alternative B, noise from abandonment and reclamation would be at levels comparable to general construction.

Alternative D

There would be no direct noise impacts from leasing under Alternatives D1 or D2.

The potential impacts from future oil and gas exploration would be similar to Alternative B. Three-D seismic surveys not associated with any lease could result in short-term noise impacts throughout the entire federal Coastal Plain. For smaller, operator-associated 3D surveys following the first lease sale, there would be no sources of sound from ground-based equipment in areas not offered for lease sale (526,300 acres and 763,500 acres for Alternatives D1 and D2, respectively) or NSO areas (708,600 acres and 505,800 acres for Alternatives D1 and D2, respectively); however, there would be existing noise impacts in NSO areas or areas not offered for lease sale resulting from noise sources located outside these areas.

Lease Stipulation 10 would protect wilderness values (including impacts from noise) in the Mollie Beattie Wilderness Area. Alternative D would also incorporate additional requirements under ROP 10, which would require operators to conduct a sound source verification test before beginning seismic surveys. These surveys would be implemented to measure the distance of vibroseis sound levels through grounded ice to the NMFS-approved threshold of disturbance in open water and to maintain airborne sound levels of seismic equipment below 120 decibels.

Alternative D1 would also minimize the potential effects of low-flying aircraft on wildlife, subsistence activities, local communities, and recreationists in the area, including hunters and anglers, through ROP 34.

The potential impacts from future oil and gas development and production would be similar to Alternative B; however, they would occur in a smaller area within the Coastal Plain. **Table 2-1** in **Chapter 2** identifies acres not offered for lease sale (Alternatives D1 and D2) and acres available for lease sale subject to NSO (Alternatives D1 and D2), CSU (Alternatives D1 and D2), TL (Alternative D2), or standard terms and conditions (Alternative D1). Alternative D2 would offer only 800,000 acres of land for lease (the minimum requirement of the Tax Act). There would be no sources of sound from ground-based equipment in areas not offered for lease sale (526,300 acres under Alternative D1 or 763,500 acres under Alternative D2) or areas with NSO stipulations (708,600 acres under Alternative D1 or 505,800 acres under Alternative D2); however, existing noise impacts would continue in NSO areas from outside noise sources. The remaining acres available for lease sale subject to CSU (123,900 acres under Alternative D1 or 105,200 acres under Alternative D2), TL in Alternative D2 (189,000 acres), or only standard terms and conditions in Alternative D1 (204,700 acres) would experience sound from ground-based equipment; however, this would not occur during certain times of the year for acres available for lease sale subject to TL. Acres available for lease sale subject to CSU, TL, or only standard terms and conditions would involve ground-based equipment that can increase ambient sound level, as described under Alternative B.

Under Alternative D, Lease Stipulation 9 would prohibit exploratory well drill pads, production well drill pads, or CPFs for oil or gas within 2 miles inland of the coast. This would serve to reduce noise impacts in this area; however, existing noise impacts would continue in this facility-free area from noise sources outside the 2-mile zone. Facilities along the coast, as well as offshore industry and sea vessels, would continue to produce noise that would be audible within this 2-mile facility-free area.

Short-term noise impacts in the marine environment along the entire 1,600-nautical-mile marine barge route would be reduced, compared with Alternative B. This is because shipments would be required for the construction of only two CPFs, one in the high potential area and one in the medium potential area south of Kaktovik (see **Appendix B**).

Noise from fixed-wing aircraft would be as described under Alternative B. To the extent practicable, aircraft operations would be planned to minimize flights below 2,000 feet when flying within 3 miles of the Mollie Beattie Wilderness Area boundary. As a result, fewer impacts from aircraft noise, as described under Alternative B, would be expected in that area. Alternative D would also minimize the potential effects of low-flying aircraft on wildlife, subsistence activities, local communities, and recreationists of the area, including hunters and anglers, through ROP 34.

Production-related noise would be similar to that under Alternative B but would occur in fewer areas, as only two CPFs would be developed instead of four.

Similar to Alternative B, noise from abandonment and reclamation would be at levels comparable to general construction.

Transboundary Impacts

Transboundary impacts related to noise levels with anticipated direct and indirect effects on resources are discussed in the respective resource sections. Noise levels associated with each phase of oil and gas development, discussed above for each alternative, may have the potential for transboundary effects on particular resources. Given that at its closest point Canada is approximately 30 miles from the Coastal Plain, and that transportation routes are anticipated to approach Coastal Plain operations from the west and south, noise generated from oil and gas operations in the Coastal Plain generally would not be capable of being heard in Canada.

Cumulative Impacts

Past activities have increased ambient sound levels on the North Slope, including those resulting from development in the NPR-A, development on state lands on the Prudhoe Bay Oil Field, offshore drilling activities, and surface, air, and marine transportation. Present and future oil and gas development on the North Slope could result in localized but cumulative impacts on the acoustic environment from exploration and operations and related air traffic levels in the region, whose reach extends at least 50 miles from any standard connection route. In particular, the proposed 3D seismic exploration to be conducted in the Coastal Plain of the Arctic Refuge by SAExploration could begin in winter 2019/2020 and would involve the use of 12 to15 rubber-tracked vibrators with 4 linear miles of receivers and 8 linear miles of source per typical square mile (BLM 2018j).

The action alternatives would contribute a similar potential for noise from oil and gas exploration and from development and transportation. Oil and gas exploration, development, and production in the western

Canadian Arctic also contribute to cumulative noise impacts. These planned activities include the development of a gas treatment plant at Prudhoe Bay (see **Appendix F**). As areas in and around Prudhoe Bay continue to be developed, projected levels of air traffic have the greatest potential for contributing to cumulative impacts by increasing the number of flights over an area per day. The potential cumulative impacts on the acoustic environment would affect the community of Kaktovik and individuals throughout the program area, as well as noise-sensitive resources along aircraft flight paths outside of the program area.

The direct and indirect impacts under all action alternatives would add to these cumulative impacts on noise in the program area from increased air traffic, seismic activities, and the expansion of ground-based equipment.

3.2.4 Physiography

Affected Environment

Physiography describes the physical features of an area, including landforms and topography. The Coastal Plain[6] of the Arctic Refuge occupies about 1,563,500 acres in the northeast corner of Alaska. It stretches about 100 miles from the Staines River, the westernmost distributary of the Canning River, on the west to the Aichilik River on the east. From the coast of the Beaufort Sea, the Coastal Plain extends south about 40 miles at its widest point. Elevations range from sea level along the coast to about 2,000 feet at the southern boundary. The Coastal Plain is drained by braided channel rivers, which have their headwaters in highlands to the south. These sediment-laden rivers form deltas where they flow into the sea. **Map 3-1** in **Appendix A** depicts the topography of the Coastal Plain.

Table 3-8 describes the primary types of terrain found in the Coastal Plain, based on the mapping of Walker et al. (1982).

Physiographic Provinces

A physiographic province is a region of similar topography and climate that has had a unified geomorphic history. The Coastal Plain encompasses parts of three physiographic provinces, as defined by Wahrhaftig (1965). These provinces, shown on **Map 3-2** in **Appendix A**, consist of the Arctic Coastal Plain, the Arctic Foothills, and the Arctic Mountains.

Ecoregions have also been defined for the State of Alaska, including the Coastal Plain (Nowacki et al. 2001). Besides climate and topography, ecoregions are based on additional characteristics such as soils and vegetation data. Ecoregions are described in **Section 3.3.1**, Vegetation and Wetlands.

Ninety percent of the Coastal Plain is in the Arctic Coastal Plain physiographic province. The Arctic Coastal Plain physiographic province is divided into the Teshekpuk and White Hills sections. The Teshekpuk section makes up roughly the western two-thirds of the Arctic Coastal Plain province, including the areas that have been previously developed for oil and gas resources, such as Prudhoe Bay and the NPR-A. The Teshekpuk section is generally characterized as a smooth plain rising gradually from the Beaufort Sea to a maximum elevation of 600 feet above sea level (asl). It is covered with elongated thaw lakes having a similar orientation. The coastline has low relief and the shore is typically only 1 to 10 feet asl. The White Hills section is characterized by scattered groups of low hills rising above the plain.

[6] In this EIS, "Coastal Plain" describes the program area and is consistent with the language in Public Law 115-97, Section 20001. It should not be confused with the Arctic Coastal Plain physiographic province, which extends across all of northern Alaska and into Canada, or the general physiographic term "coastal plain," which refers to a flat, low-lying area next to an ocean.

Table 3-8
Terrain Types in the Coastal Plain

Terrain Type	Percent of Study Area[1]	Description
Foothills	44.7	The hills typically have rounded, north-trending interfluves between the major drainages. Elevations of the hilltops range from about 300 feet at the coastward boundary to over 1,200 feet at the southern limits of the study area.
River floodplains and deltas	24.6	Includes present channels, braided drainages, and adjacent abandoned channels and deltas. Also includes active and relict steep river bluffs that are subject to mudflows and solifluction.[2]
Hilly coastal plains	22.4	Complex region of gently undulating tundra, with small thaw lakes and pond complexes stretching inland between the Hulahula and Jago Rivers. Drainages are better defined than on flat coastal plains, and large expanses of well-drained terrain border many of the streams.
Flat thaw-lake plains	3.1	The proximity of the Brooks Range to the coast results in a much narrower coastal plain than areas to the west. Typical coastal plain topography, with large thaw lakes, drained lake basins, and low-centered, ice-wedge polygons, is found only in a few small areas, including the Canning River delta, the adjacent coastal area 40 to 50 miles eastward, and a small area southwest of Barter Island.
Mountainous terrain	<0.1	Mountainous terrain underlain by quartzite occurs in the area of Sadlerochit Spring. Elevations are mostly over 1,900 feet.

Source: Walker et al. 1982
[1]The study area for Walker et al. (1982) was defined as the 1.4-million-acre area that was being considered for seismic oil exploration at the time. "Ocean" comprises an additional 5.2 percent of the study area.
[2] See *Geologic Hazards* in **Section 3.2.5**, Geology and Minerals.

The topography in the White Hills section is much more varied than the Teshekpuk section. The northwest corner of the Coastal Plain is part of the Teshekpuk section and the remainder of the Arctic Coastal Plain physiographic province in the Coastal Plain belongs to the White Hills section (Wahrhaftig 1965). The White Hills section is more hilly in the western half than the eastern half.

The Arctic Coastal Plain features a series of large alluvial fans (USFWS 2015a, p. 4-17); these are deposits occurring where the carrying capacity of the stream lessens, resulting in deposition. This often occurs where stream gradient decreases, and the deposits spread out downslope. The alluvial fans create upland terrain with moderate slopes that can extend to the coast, especially south of Camden Bay (Jorgenson et al. 2015).

Most of the southern edge of the Coastal Plain is in the Arctic Foothills physiographic province, as shown on **Map 3-2** in **Appendix A**. This province consists of rolling plateaus and low, east-west trending linear mountains.

About 28,000 acres, or less than 2 percent, of the Coastal Plain along the southern border is in the Central and Eastern Brooks Range section of the Arctic Mountains physiographic province (Wahrhaftig 1965) (see **Map 3-2** in **Appendix A**). The Central and Eastern Brooks Range consists of rugged east-west trending ridges, reaching elevations of 7,000 to 8,000 feet asl in areas outside the Coastal Plain.

Beaufort Sea Coast

The Coastal Plain extends outward from the coastline to the Arctic Refuge boundary, which includes tidally influenced areas of the Beaufort Sea. The Beaufort Sea coastline is irregular, with narrow beaches and small tides. It is characterized by numerous deltas, peninsulas, offshore shoals, mudflats, spits, bars, low-lying barrier islands, and shallow lagoons. The most pronounced deltas are associated with the Canning, Hulahula-

Okpilak, Jago, and Aichilik Rivers (Clough et al. 1987). Rivers of the Coastal Plain are discussed in **Section 3.2.10**, Water Resources.

Coastal bluffs are typically 4 to 5 feet high but, as noted above, can be as high as 25 feet. The highest elevation along the coast is at 3-mile-wide Barter Island, which is more than 50 feet. Lagoons and bays are generally only 3 to 12 feet deep, except for Camden Bay where depths are greater than 15 feet (Clough et al. 1987, p. 9). Camden Bay extends across more than half of the Coastal Plain coastline and is the largest single feature. The Beaufort Sea coastline is gradually receding. Coastal erosion, one factor that can contribute to a receding coastline, is discussed under geologic hazards in **Section 3.2.5**, Geology and Minerals.

Permafrost Features

The Coastal Plain is underlain by permafrost that extends to depths of over 2,000 feet (Collett et al. 1989). Although permafrost generally occurs in materials where the temperature is below 32°F, in areas of elevated salinity or liquid hydrocarbons, materials may not be frozen because the freezing point is lower.

Permafrost is covered by a surface “active layer,” which freezes and thaws annually. The active layer in the Coastal Plain is generally 1 to 4 feet thick (USFWS 2015a). A year-round thawed layer, termed a thaw bulb, may be beneath lakes, 7 feet deep or greater, and beneath some parts of deeper rivers, such as the Canning. Based on studies of seawater and borehole temperatures, the permafrost layer in the nearshore area of the Beaufort Sea probably extends out to water depths of 500 feet (Brewer 1987).

A number of topographic features are associated with permafrost, the most prominent of which are ice-wedge polygons. These are vertical wedge-shaped veins of ice that develop in thermal-contraction cracks. These cracks form in a pattern of interconnected polygons that can vary in size. Most range from 30 to 200 feet in diameter and are visible at the surface, although some in the southern part of the Coastal Plain are masked by tussock-type tundra (Brewer 1987).

Other features associated with permafrost that can be found in the Coastal Plain are as follows (USFWS 2015a):

- Beaded streams—series of small ponds connected by small streams
- Frost boils—upwellings of mud that result in barren and partially vegetated areas
- Pingos—low, ice-cored mounds formed as soil-covered water freezes and expands upward
- Gelifluction lobes—tongue-shaped deposits formed from slow flows of the active layer on slopes of 5 to 20 degrees
- Stone stripes—lines of stones that form through frost heaves

Permafrost is described in greater detail in **Section 3.2.8**, Soil Resources.

Climate Change

Changes to the coast and overall topography in the Coastal Plain could occur as a result of climate warming. The general warming of the Arctic appears to have lengthened the open-water period in the Beaufort Sea (USACE 2012, Chapter 5). A longer open-water period allows for longer exposure of beaches to coastal processes and increases the fetch[7] for generating larger sea waves. These factors combine to produce more rapid coastal erosion and shoreline retreat, especially at locations not protected by barrier islands.

[7]The area of water over which the wind blows in an essentially constant direction, thus generating waves.

Direct and Indirect Impacts

Issuance of oil and gas leases under the directives of Section 20001(c)(1) of PL 115-97 would have no direct impacts on the environment because by itself a lease does not authorize any on the ground oil and gas activities; however, a lease does grant the lessee certain rights to drill for and extract oil and gas subject to further environmental review and reasonable regulation, including applicable laws, terms, conditions, and stipulations of the lease. The impacts of such future exploration and development activities that may occur because of the issuance of leases are considered potential indirect impacts of leasing. Such post-lease activities could include seismic and drilling exploration, development, and transportation of oil and gas in and from the Coastal Plain; therefore, the analysis considers potential impacts on physiography from on-the-ground post-lease activities.

The effects of climate change described under *Affected Environment* above, could influence the rate or degree of the potential direct and indirect impacts.

Alternative A

Under Alternative A, current management actions would be maintained as described in the Arctic Refuge Revised CCP (USFWS 2015a). No potential impacts on physiographic features from future oil and gas exploration, development, and production would occur.

Impacts Common to All Action Alternatives

Future construction of infrastructure would affect topography in the program area and could reshape geomorphological features, such as water bodies and permafrost features.

All the action alternatives would require placement of gravel fill, which would have the potential direct impact of altering the topography within the site-specific development footprint. Gravel infrastructure would include pads, roads, and airstrips, as described in **Appendix B**. This potential long-term impact would begin during the construction phase and would last throughout the development phase until the gravel is removed and the site has been restored to pre-program conditions. ROP 35 would require an abandonment and reclamation plan that describes measures to ensure eventual ecosystem restoration to the land’s previous hydrological, vegetation, and habitat condition; however, exceptions may be granted. Impacts would last longer if not all gravel infrastructure, such as access roads, is removed. Furthermore, if the site cannot be restored to pre-program conditions, for example, if a depression remains, then impacts from gravel fill placement could be permanent.

In addition to the potential direct effects on topography that would result from placement of gravel fill, the presence of gravel infrastructure would alter existing geomorphic features. For example, the sea barge landing and staging structures would affect the pattern of sediment erosion and deposition, which could result in local, long-term changes to the coastline configuration. Likewise, if the gravel pad for the STP is placed in water rather than on land, similar effects on physiography would occur. This impact would last throughout the development phase and for some period after the structure is removed during reclamation. Other gravel infrastructure could affect permafrost features or result in changes to stream or lake morphology. Potential direct and indirect impacts on permafrost features are further described in **Section 3.2.8**. Potential direct and indirect impacts on surface water features are further described in **Section 3.2.10**.

All action alternatives assume a surface development area of approximately 2,000 acres from future oil and gas development and production. Under all action alternatives most, but not all, of the surface development is associated with gravel extraction and placement of gravel fill. The size of the STP would be an estimated 15 acres under all action alternatives. For the sea barge landing, each action alternative assumes a 10-acre gravel area, including a pad for staging modular units. The footprint of other gravel infrastructure would vary, depending on the alternative (see discussion of each alternative below).

All the action alternatives would include potential future development of a gravel mine or mines, which would also result in potential direct long-term impacts on topography. The surface area of the gravel mines would total approximately 280 to 300 acres for each action alternative. The acreage required for gravel mining could increase or decrease, depending on local conditions. Impacts of gravel mining on physiography would last beyond the development phase because the pits remaining from gravel extraction would typically not be completely backfilled, and any remaining depression could fill with water and become a permanent lake. ROP 30 would reduce potential impacts of mining on river bluffs and cliffs by limiting the volume that could be removed from cliffs and prohibiting extraction that could affect the integrity of river bluffs. Gravel mines are described further in **Section 3.2.9**, Sand and Gravel Resources.

Future ice infrastructure (e.g., pads and roads), used primarily during the exploration and development phases, would have negligible impacts on topography but could affect permafrost and surface water geomorphic features, as discussed further in **Section 3.2.8** and **Section 3.2.10**. Additionally, vehicle tracks from 3D-seismic surveys during the exploration phase can directly affect microtopography and lead to permafrost thaw and settlement (Walker et al. 2019). Such impacts could be long term or permanent. These impacts and ROPs 23 and 24 that address protection of permafrost are described in **Section 3.2.8**.

Potential changes to physiography associated with geologic hazards (e.g., subsidence or slope failure) are addressed in **Section 3.2.5**.

Alternative B (Preferred Alternative)

Approximate acreages associated with future gravel infrastructure specific to Alternative B are as follows:

- 168 acres for 14 satellite drill pads
- 200 acres for four CPFs
- 1,305 acres for 174 miles of gravel roads

Alternative C

Approximate acreages associated with future gravel infrastructure specific to Alternative C are as follows:

- 180 acres for 15 satellite drill pads
- 150 acres for three CPFs
- 1,350 acres for 180 miles of gravel roads

Alternative D

Approximate acreages associated with future gravel infrastructure are the same for both Alternative D1 and Alternative D2 and would include:

- 192 acres for 16 satellite drill pads
- 100 acres for two CPFs
- 1,388 acres for 185 miles of gravel roads

Under Alternative D, ROP 35 contains a provision requiring that reclamation include "reshaping the area disturbed…where reasonably practicable." This ROP would help to minimize permanent impacts on topography.

Transboundary Impacts

Transboundary impacts associated with physiography have not been identified for any of the alternatives.

Cumulative Impacts

Potential impacts on topography and geomorphic features resulting from future gravel infrastructure are generally localized to the footprint or adjacent area; therefore, the geographic area relevant for assessing cumulative impacts on physiography is the program area. Other past, present, and reasonably foreseeable future actions on the North Slope (**Appendix F**) have had or would have impacts on physiography; however, with the exception of the SAExploration 3D seismic proposal and Arctic Strategic Transportation and Resources (ASTAR) program, none of these actions have been or are proposed to be in the program area and so would not contribute to cumulative impacts on physiographic features in the Coastal Plain. At locations where seismic surveys overlap the footprint of future oil and gas development, cumulative effects on permafrost features could result. These impacts are described more fully in **Section 3.2.8**. Gravel roads could be constructed in the Coastal Plain as part of the ASTAR program. Impacts on topography from these roads would be cumulative and would be similar to the impacts described above for the proposed project. The effects of climate change described under Affected Environment above, could influence the rate or degree of the potential cumulative impacts. Alternative A would not contribute to cumulative impacts on physiography as there are no direct or indirect impacts under that alternative.

3.2.5 Geology and Minerals

Affected Environment

Geology

The Coastal Plain is in the eastern part of the North Slope geologic province and has greater geologic complexity than that found elsewhere in northern Alaska. The North Slope geologic province is part of a tectonic feature referred to as the Arctic Alaska microplate. The geologic history for this continental microplate includes three primary tectonic settings: a south-facing passive continental margin during the Devonian to Triassic, a northern rifted margin in the Jurassic to Early Cretaceous, and a southern orogenic[8] margin, with a related foreland basin and fold-and-thrust belt from the Jurassic to recent time (Bird 1999).

A thin layer of surficial deposits covers the bedrock geology in most of the Coastal Plain; therefore, information and understanding of the bedrock geology has been obtained primarily from geophysical remote sensing, observations in the mountains south of the area, and wells drilled west and north of the area (Bird 1999).

Four tectono-stratigraphic sequences characterize the Northern Alaska geologic province (see **Figure 3-3**, Stratigraphy of the Coastal Plain, in **Appendix A**) (USGS 1998a). The oldest sequence is the Franklinian, which consists of a thick succession of metamorphosed sedimentary, volcanic, and igneous rocks of Proterozoic to Early Devonian age. The overlying Ellesmerian sequence of Middle Devonian to Triassic age rocks represents the south-facing passive margin referred to above. The Beaufortian sequence records the Jurassic and Cretaceous rifting, which severed the continental connection of northern Alaska and opened the Canada basin. The Brookian sequence, Cretaceous to recent age, consists of sediments originating from the ancestral and modern Brooks Range and deposited in foreland basin and passive margin settings (Bird 1999). Information regarding the oil and gas potential for these sequences is provided in **Section 3.2.6**, Petroleum Resources.

[8]Mountain building

Geologic structures in the Coastal Plain consist of closely spaced folds and faults in rocks that were deposited in the foreland basin setting and broad, domed faulted structures in the pre-foreland basin and basement rocks. These structures formed in one or more episodes of Brooks Range-related deformation during Cenozoic time. Devonian and possibly older structures are also present in the Coastal Plain, and these structures have controlled the orientation of some younger Cenozoic structures (Bird 1999).

A major structural feature of the Coastal Plain is the east-northeast trending Marsh Creek anticline, which formed during the Oligocene (Bird 1999). Rather than being a simple anticline, the Marsh Creek anticline is interpreted to be either a triangle zone or an anticlinorium[9] (Bird and Magoon 1987). The Marsh Creek anticline divides the Coastal Plain into two areas having different structural characteristics. Rocks northwest of the Marsh Creek anticline are in the "undeformed area" and have remained nearly undeformed since their deposition. Rocks to the southeast of the Marsh Creek anticline, the "deformed area," have been thrust faulted, folded, and uplifted (Magoon et al. 1987). The deformed area is about twice the size of the undeformed area.

Figure 3-4 in **Appendix A** is a surficial geologic map of the Coastal Plain. The Coastal Plain is largely covered by a thin mantle of Quaternary unconsolidated sediments that range in thickness from a few feet to about 100 feet (Clough et al. 1987). These include river deposits (alluvium), beach deposits, colluvium, alluvial fans, terrace deposits, marine terrace deposits, glacial deposits, glaciofluvial deposits, and landslides (Marshall et al. 1998). **Map 3-3** in **Appendix A** includes further details of the surficial geology, particularly related to depositional environment. For a more detailed map of surficial geology, refer to Carter et al. 1986.

During the Pleistocene, portions of the Coastal Plain near the Sadlerochit Mountains were glaciated. Tills believed to be from either or both the Anaktuvuk River and Sagavanirktok River glaciations are present along the Canning, Tamayariak, Sadlerochit, Hulahula, and Jago River drainages (Rawlinson 1993, Figure 32). The glacial tills occur as isolated outcrops and well-defined moraines. Glaciofluvial deposits and eolian[10] materials are widespread, even in unglaciated areas (Clough et al. 1987).

As shown in **Figure 3-4** in Appendix A, two general types of surficial deposits predominate in the Coastal Plain: gravel and sand and silt and very fine sand over gravel. Gravel and sand include deposits associated with river floodplains and terraces and upland terraces that lack a silt cover. Silt and very fine sand over gravel comprise a fine-grained cover, generally more than 6.6 to 10 feet thick and ice rich, and commonly containing fine-grained organic debris. These deposits include ice-rich, Pleistocene eolian silts (**Map 3-11**). Morainal deposits composed of compact, silty, bouldery till are present in the previously glaciated areas along the southern border of the Coastal Plain, described above. Near the coast, surficial unconsolidated deposits typically consist of alluvial sediments (silt, sand, and gravel) overlying finer-grained marine sediments. Surficial sediments and soils are described further in **Section 3.2.8**, Soils.

The cover of unconsolidated sediments is broken up by outcrops of Tertiary-Cretaceous sedimentary rocks. The largest of these outcrop areas occurs along the Marsh Creek anticline and upper Jago River. Outcrops in the Marsh Creek anticline area include the Sagavanirktok and Canning Formations (Marshall et al. 1998). The Sagavanirktok Formation, which overlies the Canning Formation, consists of poorly consolidated gray siltstone, mudstone, sandstone, and lesser amounts of conglomerate that were deposited in non-marine and shallow marine environments. This rock unit is as much as 4,900 feet thick on the north flank of the Marsh Creek anticline and 7,500 feet thick in wells near the mouth of Canning River. The Canning Formation consists of gray shale and siltstone containing interbeds of mostly thin-bedded, very fine to fine-grained lithic

[9]An intensely deformed series of anticlines and synclines that together form a general arch
[10]Windblown

sandstone; they represent turbidites deposited in a deep-water marine environment by a sediment gravity flow. The Canning Formation was measured at 4,900 to 5,000 feet thick in wells west of Canning River (Molenaar et al. 1987).

The Jago River Formation crops out in the upper Jago River area (Marshall et al. 1998). This formation consists of well hardened, thick-bedded, fine- to coarse-grained, lithic sandstone and conglomerate. There are also minor amounts of coal and carbonaceous shale deposited in a primarily nonmarine environment with minor shallow marine influence. The Jago River Formation is 9,800 feet thick in its type section along Igilatvik (Sabbath) Creek (Buckingham 1987).

Smaller bedrock outcrops occur around the Sadlerochit Mountains and in the east-central part of the Coastal Plain. In addition to the Canning Formation, these outcrops expose the Cretaceous Hue Shale, Pebble Shale unit, and Kemik Sandstone; Cretaceous-Jurassic Kingak Shale; Triassic Karen Creek Sandstone; Permian and Triassic Sadlerochit Group; and Pennsylvanian-Mississippian Lisburne Group (Marshall et al. 1998).

For more detailed information regarding the rock units and geologic structure of the Coastal Plain, refer to Bird and Magoon (1987) and Bird (1999).

Geologic Hazards

Geologic hazards are natural physical conditions that could damage land or structures and injure humans. Potential geologic hazards in the Coastal Plain are earthquakes, surface faults, landslides, land subsidence, flooding, sea ice ride-up and override, coastal erosion, and storm surge.

Earthquakes and Surface Faults

The USGS has prepared seismic hazard maps for Alaska that portray the probability of ground motion (peak ground acceleration) due to an earthquake (Wesson et al. 2007). For the Coastal Plain, the USGS estimates that peak ground accelerations of up to 0.2 g (where g equals the acceleration due to gravity); there is a 5 percent probability that this acceleration would be exceeded in 50 years; thus, the Coastal Plain is in an area of relatively low seismic risk. This risk may be revised in the future, based on August 2018 seismic activity, described below.

Historically the level of earthquake activity in the Coastal Plain has been low. Earthquakes of magnitude (M) 6 and larger on the Richter scale of intensity are potentially destructive; earthquakes of M 5 could cause local damage (Clough et al. 1987). Prior to August 2018, epicenters of five earthquakes with M 4.5 to M 5.0 had been recorded in or within 15 miles of the Coastal Plain (USGS 2018a). Of these, three were centered in the Coastal Plain: A M 4.7 earthquake in February 2006 and M 4.5 and M 4.9 earthquakes in April 2007. Three earthquakes above M 5.0 had been recorded in the northeast corner of Alaska, the closest of which was an M 5.2 earthquake centered about 30 miles southwest of the Coastal Plain in August 1995. The largest of the three was an M 5.5 earthquake in August 2003 about 80 miles from the southwest corner of the Coastal Plain (USGS 2018a).

On August 12, 2018, an M 6.4 earthquake occurred 52 miles southwest of Kaktovik (and less than 10 miles south of the Coastal Plain) in the Sadlerochit Mountains. It was felt widely across the eastern NSB, and was, by a wide margin, the largest earthquake ever recorded north of the Brooks Range in Alaska (Alaska Earthquake Center 2018). This earthquake was followed by a number of aftershocks on the same day, including an M 6.0 earthquake about 20 miles east of the M 6.4 event. From August 13 to September 2, 2018, 13 earthquakes between M 4.0 and M 4.8 were recorded in the same area. The Alaska Earthquake Center indicated that this seismic activity is consistent with natural earthquake activity. Aftershocks are expected to slowly decline but remain active for many weeks or months. According to the University of Alaska Fairbanks Earthquake Center, as of March 31, 2019, numerous earthquakes less than M 4.0 and several between M 4.0 and 5.0 have continued to occur in the seismically active area about 50 miles south-southwest of Kaktovik (Alaska Earthquake Center 2019).

The USGS's Quaternary fault and fold database (USGS and ADNR 2006) contains information on faults and associated folds in the US that are believed to be sources of earthquakes greater than M 6 during the Quaternary (i.e., the past 1.6 million years). This database indicates the presence of one Quaternary surface feature in the Coastal Plain, which is the Marsh Creek anticline (described above and depicted on **Map B-1** in **Appendix B**). A group of several faults, known as the Camden faults or Camden fault zone, is offshore. The closest of these faults is about 10 miles from the coast. The most recent deformation on the Camden faults is less than 15,000 years old.

Slope Failure

Slope failure in the Coastal Plain can occur in the form of solifluction[11] and creep or slump along coastal bluffs, terrace escarpments, lake margins, and ridge slopes. Locally along a stretch of the Katakturuk River and near Marsh and Carter Creeks, landslides have occurred in weathered and soft Tertiary shale, siltstone, and sandstone. In all areas having any appreciable slope and exposed mineral soil, the soil migrates gradually downslope because of seasonal frost heaving of individual soil grains (Clough et al. 1987).

Retrogressive thaw slumps are slope failures resulting from thawing, ice-rich permafrost. They develop along streams or coastlines and expand inland to form landslide-like U-shaped scars (Lantuit et al. 2013).

Subsidence

The volume of ice in permafrost soils, particularly in the first few tens of feet below the ground surface, can be several times the volume of the mineral components (Brewer 1987). In one study of 65 field sites along the Beaufort Sea coast (Kanevskiy et al. 2013), t. Natural and human-induced thawing of this near-surface ice generally results in uneven lowering of the ground surface, which may lead to water ponding or preferential erosion or both (Rawlinson 1993). Because of the presence of ice-rich permafrost, about one-third of the Coastal Plain has the potential for thaw settlement of 16 to 98 feet (Jorgenson et al. 2015).

Flooding and River Ice Jams

Most streams in the Coastal Plain have swift, braided courses across broad gravel flats that typically freeze to the bottom in the winter. In addition, groundwater from seeps and springs that flow throughout the winter freezes and forms thick, layered sheets of ice, called aufeis.[12] During spring when meltwater begins to flow, the presence of ice in the stream channels causes the streams to flood. As meltwater runs over the top of river ice, the ice breaks into pieces. As the ice flows downstream, it may lodge in constricted parts of the channel, creating jams and forcing more water out of the stream channel (USACE 2012, p. 3-61). Streams draining the Brooks Range also have the potential to produce significant summer precipitation-driven flood discharges (USACE 2012, p. 3-47). Flooding is discussed further in **Section 3.2.10**.

Sea Ice Ride-up and Override

On shorelines exposed to the open ocean, onshore winds can push sea ice 100 feet or more onshore and 10 to 20 feet high, in a process called sea ice ride-up and override (USACE 2012, p. 3-42). Any natural or human-

[11]Very slow deformation of the seasonally thawed surface, forming elongated shallow lobes
[12]A mass of layered ice that forms from successive flows of groundwater during freezing temperatures

made features exposed to this sea ice push are susceptible to damage, including shoreline and seabed scouring. Lagoon areas are not generally subject to this phenomenon.

Coastal Erosion and Storm Surge

Beach erosion varies greatly from place to place and year to year along the entire Beaufort coast, depending on storm intensities and the nearness of pack ice. Erosion and deposition of eroded sands and gravel also produce barrier island or spit migration, especially where established vegetation is absent (Brewer 1987). Gibbs and Richmond (2017) have calculated average and maximum shoreline change rates for two regions of the Coastal Plain. Region 1 is the shoreline from the US-Canada border to the Hulahula River, and Region 2 is the shoreline from the Hulahula River to the Staines River. For both Regions 1 and 2, the average rate of shoreline change is -3.0 feet per year over the short term and long term. The negative value indicates that, overall, erosion is greater than accretion. The maximum long-term and short-term rates of erosion observed in Region 1 are -48.6 and -64.3 feet per year; the maximum long-term and short-term rates of erosion in Region 2 are both -22.3 feet per year. In this study, erosion indicates landward movement or retreat of the shoreline and does not distinguish between physical erosion and flooding of the coast, due to land subsidence or sea level rise.

Erosion along the coast can also be caused by wind. Wind erosion is generally confined to exposed spits and barrier islands and the Canning, Hulahula, Okpilak, and Jago River deltas, where active dunes are found along their western banks (Clough et al. 1987).

Although outside the program area, studies of coastal erosion at Kaktovik and the US Air Force's Defense Early Warning (DEW) Line site on Barter Island provide insight into the potential for impacts on coastal structures in the program area. Along the coastal permafrost bluffs that front the village and DEW Line site, an average erosion rate of 4.3 feet per year was measured during 2014 and 2015 by Gibbs et al. (2019). Higher erosion rates have been observed along the Barter Island coast during some years, including 65 feet of retreat in a single year (Gibbs et al. 2019).

According to USACE (2009), a timber crib wall was installed in the 1990s to protect the lagoon area of Kaktovik. The runway at the Kaktovik Airport has been stabilized with erosion protection measures; however, flooding due to storm surges is an ongoing problem during the open-water season. A gravel bag revetment was installed to provide erosion protection at the DEW Line site in 1999 (USACE 2009).

Abnormally high rises in sea level, referred to as storm surges, are caused by strong westerly winds and can be 4 to 6 feet above the elevation of sea level, or even greater with winds at 50 to 60 knots (USACE 2012, p. 3-31). Storm surges can cause coastal flooding, particularly along low-profile beaches common in the Coastal Plain.

Additional details regarding shoreline erosion and storm surge along the Beaufort Sea coast can be found in Barnes et al. (1992), Jones et al. (2009), USACE (2012, Chapter 3), and Gibbs and Richmond (2017).

Minerals

In the 1970s, before ANILCA, the USGS and former US Bureau of Mines conducted limited reconnaissance geological and mineral investigations in northeast Alaska. Limited mineral industry work was also conducted in the 1970s (USFWS 2015a, p. 4-37). Under ANILCA, the Arctic Refuge was closed to all forms of appropriation under the public land laws, including the mineral leasing and mining laws (USFWS 2015a, p. 4-1).

The BLM classifies mineral resources it manages as salable, leasable, or locatable. Salable minerals are subject to the Materials Act of 1947, as amended, and include common construction materials, such as sand, gravel, decorative rock, and building stone. Salable minerals relevant to the Coastal Plain (sand and gravel) are addressed in **Section 3.2.9**.

Leasable minerals generally include energy minerals, such as petroleum, geothermal, and coal resources, as well as potash, sodium, and phosphate; petroleum resources are addressed in **Section 3.2.6**. Geothermal resources in Alaska are associated with the Aleutian volcanic arc or thermal springs in the interior or southeastern Alaska and have not been identified around the Coastal Plain (Miller 1994).

Coal occurs in isolated areas throughout Alaska, referred to as provinces. The North Slope coal province has the largest coal deposits in Alaska, and the eastern edge of the province extends into the Coastal Plain (Flores et al. 2004; Stricker et al. 2011). The most important Cretaceous coal-bearing rocks in the province are in the Colville and Nanushuk groups west of Prudhoe Bay (Flores et al. 2004). Coal deposits in the eastern North Slope coal province primarily occur in the Tertiary Sagavanirktok Formation in two separate zones and are characterized as sub-bituminous (Stricker et al. 2011).

Locatable minerals are subject to the General Mining Law of 1872 and include metallic minerals, such as gold, silver, copper, lead, zinc, and uranium; nonmetallic minerals, such as alunite, asbestos, barite, gypsum, and mica; and certain varieties of stone. These are also referred to as hardrock minerals. The following discussion addresses locatable minerals and phosphate (a leasable mineral).

The USGS maintains a database with descriptions of mines, prospects, and mineral occurrences in Alaska. The records in the database are generally for metallic mineral commodities only but also may include certain high value industrial minerals, such as barite and rare earth elements. No mineral occurrences are documented in the Coastal Plain; however, seven mineral occurrences are documented within 15 miles (see **Table 3-9**; **Map 3-4** in **Appendix A**). These minerals are copper, rare earth elements, phosphorus, uranium, and phosphates.

Hartman (1973) assessed mineral potential in the Arctic Refuge and identified granitic intrusions with metallic mineral deposits in the Romanof Mountains and along the southern edge of the Brooks Range. Closer to the Coastal Plain, Hartman identified abundant low-grade phosphate deposits in the Shublik Formation that crops out along the northern edge of the Brooks Range.

A 1978 report of the mineral resource potential for the Brooks Range included all but the northwest corner of the Coastal Plain (Grybeck and DeYoung 1978). This assessment indicates that most of the Coastal Plain has uranium potential. Just to the south are areas with copper and phosphate potential. The phosphate areas are described as deposits of marine phosphate beds with minor uranium, vanadium, and fluorite content. No information is provided regarding the areas of copper potential.

The Geochemical Atlas of Alaska (Lee et al. 2016) provides maps of the distribution of 68 elements for the state, including the Coastal Plain. The maps are based on compilation and modeling of sediment and soil samples. These maps indicate, in part, that portions of the Coastal Plain have relatively higher concentrations of gold, uranium, phosphorus, and copper. The maps can be viewed online at https://pubs.er.usgs.gov/publication/ds908.

Table 3-9
Documented Mineral Occurrences within 15 Miles of the Coastal Plain

Site	Latitude	Longitude	Location Description	Commodities	Ore Minerals	Geologic Description
Unnamed	69.47	-142.82	Accurate to within 5,000 feet	Copper	Chalcopyrite	Mafic volcanic rocks
Aichilik River	69.53	-143.15	Deposit along the Aichilik River; accurate to within 5,000 feet	Rare earth elements	Ytterbium, yttrium	Efflorescent salts coat outcrops of Kingak shale and accumulate along the margins of ephemeral pools at the foot of cut banks.
Itkilyariak Creek	69.63	-144.75	Accurate to within 4,000 feet	Copper	Native copper	Greenstone, probably Proterozoic
Katakturuk River	69.59	-145.6	1,890-foot hill at the confluence of two forks of the Katakturuk River, in the headwaters of the Katakturuk River, near the south flank of the Sadlerochit Mountains; accurate to within 1,500 feet	Phosphorus, uranium	Phosphate, uranium	Shublik Formation
Fire Creek	69.53	-145.2	Within 1 mile	Phosphate	—	Shublik Formation
Hulahula River	69.48	-144.38	Not provided	Phosphate	—	Shublik Formation
Unnamed	69.63	-144.42	Accurate to within 1 mile	Phosphate	—	Shublik Formation

Source: USGS 2018b
Note:
— = not applicable

Climate Change

Climate change produces changes in several geologic hazards, including subsidence, flooding, and coastal erosion. An increase in the active layer expected from a warming climate could result in greater areas of land subsidence. Climate change is also expected to affect the frequency and severity of extreme storms and floods. Storms with surges would be stronger and more frequent, which, combined with rising sea levels, could lead to greater coastal erosion (BLM 2012). The Arctic Refuge Revised CCP (USFWS 2015a, Section 1.10.1) predicts that climate change would result in earlier breakup and delayed freeze-up. These changes could affect flooding conditions in the program area.

Direct and Indirect Impacts

Issuance of oil and gas leases under the directives of Section 20001(c)(1) of PL 115-97 would have no direct impacts on the environment because by itself a lease does not authorize any on the ground oil and gas activities; however, a lease does grant the lessee certain rights to drill for and extract oil and gas subject to further environmental review and reasonable regulation, including applicable laws, terms, conditions, and stipulations of the lease. The impacts of such future exploration and development activities that may occur because of the issuance of leases are considered potential indirect impacts of leasing. Such post-lease activities could include seismic and drilling exploration, development, and transportation of oil and gas in and from the Coastal Plain; therefore, the analysis considers potential impacts on geology and minerals from on-the-ground post-lease activities.

The effects of climate change described under *Affected Environment* above, could influence the rate or degree of the potential direct and indirect impacts.

Alternative A

Under Alternative A, current management actions would be maintained as described in the Arctic Refuge CCP (USFWS 2015a). Consistent with ANILCA, the Coastal Plain would remain closed to all forms of appropriation under the public land laws, including the mineral leasing and mining laws. No potential impacts on geology or mineral resources from future oil and gas exploration, development, and production would occur.

Impacts Common to All Action Alternatives

None of the action alternatives would affect mineral resources in the program area, with the exception of petroleum and aggregate resources, which are addressed in **Sections 3.2.6** and **3.2.9**, respectively.

Potential impacts on geologic resources would be site specific. As described above, bedrock is minimally exposed across much of the Coastal Plain; therefore, existing bedrock outcrops are highly valuable in developing the best possible surface and subsurface geologic understanding of the area. There are a number of relatively small, low-relief, but critically important bedrock outcrops exposed along the Niguanak and Jago Rivers and their tributaries in the northeastern part of the program area (specifically in the area ranging from Townships 6-8 North and Ranges 35-37 East). These exposures are reported to include strata of the Kingak shale, pebble shale unit, Hue shale, and Canning Formation (Marshall et al. 1998). The structural, stratigraphic, and source rock implications of these strata remain enigmatic and warrant further geologic study.

Important bedrock exposures also occur along the Marsh Creek anticline in the western part of the program area. If outcrops are covered by gravel or modified by blasting for gravel extraction, the localized bedrock would no longer be available for analysis. Potential impacts would be long term and would last until the gravel is removed, up to 85 years.

Land within 1 mile of the Jago River and 0.5 mile of the Tamayariak River, Katakturuk River, and Marsh Creek would be subject to the NSO limitations (i.e., only essential pipeline and road crossings permitted) under all action alternatives. This would provide some protection for the outcrops in these areas. Seismic surveys would not affect bedrock outcrops. No other potential direct or indirect impacts on geology have been identified. Abandonment and reclamation (described in **Appendix B**) would not affect geologic resources.

Oil and gas exploration, development, and production could also affect the risk of several geologic hazards identified in the *Affected Environment* section, including seismicity, slope failure, subsidence, flooding, and river ice jams.

Future development of petroleum resources would include injection of seawater or gas into the production field to maintain reservoir pressure. Also, wastewater, produced water, spent fluids, and chemicals would be disposed of in injection wells. Injection of large volumes of fluids into low permeability and brittle rocks has potential to trigger low level seismicity (earthquakes). This phenomenon is generally associated with the high volumes of waste injection associated with the high density of wells needed to fully develop tight unconventional resource plays, such as shale source rocks, rather than conventional hydrocarbon production. The potential for induced seismicity associated with the action alternatives would be low.

Slope failure could be triggered or worsened by placement of gravel fill in the future; however, horizontal and extended-reach drilling technology allows flexibility in placing drill sites, so they can be sited in locations that are not prone to slope failure. Roads and pipelines would be designed and constructed using methods that would avoid or minimize potential slope failure along stream banks and other areas of steep slopes. Geotechnical evaluations would typically be conducted for oil and gas development projects on a project-specific basis, as needed, to mitigate the risk of slope failure. ROP 30 lists the following measures that would help to mitigate impacts at cliff and bluff locations:

- Removing greater than 100 cubic yards of bedrock outcrops, sand, or gravel from cliffs would be prohibited.
- Any extraction of sand or gravel from an active river or stream channel would be prohibited, unless it is preceded by a hydrological study that indicates no potential impact on the integrity of the river bluffs.

Therefore, the potential for leasing and development to influence slope failure risk would be low. Likewise, slope failure is unlikely to affect infrastructure associated with oil and gas exploration, development, and production.

Subsidence associated with thawing permafrost could adversely affect oil and gas infrastructure. To minimize the potential for subsidence associated with thawing of near surface ice, gravel pads and roads would be constructed with a thickness sufficient to maintain a stable thermal regime (see **Chapter 2**). Future pipelines would be constructed primarily aboveground and would not contribute to permafrost thaw. All future buildings would be supported aboveground on pilings to accommodate ground settling or frost heaving.

Warm production and injection wells can cause thawed areas around the well. In 2017, an oil production well within the original Prudhoe Bay field on the North Slope suffered a cracked casing due to subsidence from thawing, which resulted in an oil spill. The well's construction geometry contributed to the failure (AOGCC 2017). This type of failure is minimized by modern well construction methods, including installing thermosyphons around wells to remove heat transfer from wellbore fluids.

Under all action alternatives, the risk of flooding and river ice jams would be mitigated by ROP 22, which states, "the design engineer would ensure that crossing structures are designed for aufeis, permafrost, sheet flow, additional freeboard during breakup, and other unique conditions of the arctic environment."

Disturbance caused by removing gravel fill during abandonment and reclamation could increase the potential for slope failure in areas of steep slopes. Measures to restore vegetation and hydrologic conditions, described in ROP 35, also would serve to stabilize slopes under all action alternatives.

Alternative B (Preferred Alternative)

Potential impacts on geology and minerals from future oil and gas exploration, development, and production under Alternative B would be the same as identified above for all action alternatives.

Alternative C

Potential impacts on geology and minerals from future oil and gas exploration, development, and production under Alternative C would be the same as identified above for all action alternatives.

Alternative D

Potential impacts on geology and minerals from future oil and gas exploration, development, and production under Alternative D would be the same as identified above for all action alternatives, except for an additional NSO limitation that would provide some protection for critically important outcrops. Land within 0.5 miles of the Niguanak River would be subject to the NSO limitation. While this restriction could help mitigate the potential for outcrops in these areas to be covered by gravel fill, some of the key outcrops (those in the northern part of Township 6 North, Range 36 East) are along intermittent tributaries up to 5 miles west of the Niguanak River.

As indicated above, for all action alternatives ROP 35 stipulates developing and implementing an abandonment and reclamation plan to restore previous conditions. Under Alternative D, ROP 35 includes the following additional reclamation plan requirements that would minimize the risk of slope failure:

- Implementing measures to control erosion, landslides, and water runoff
- Reshaping the area disturbed, applying the topsoil, and revegetating disturbed areas, where reasonably practicable

Transboundary Impacts

Impacts on the geologic and mineral resources described in this section are site specific and, as such, no transboundary impacts would occur under any of the alternatives.

Cumulative Impacts

The geographic area relevant for assessing cumulative impacts for geology and minerals is the program area. No other past, present, and reasonably foreseeable future actions that could affect geology or mineral resources have occurred or are expected to occur in the program area. The effects of climate change described under *Affected Environment* above, could influence the rate or degree of potential geologic hazards. Alternative A would have no contribution to cumulative impacts on geology and minerals.

3.2.6 Petroleum Resources

Affected Environment

Regulatory Information

Section 20001 of PL 115-97 directs the BLM to undertake an oil and gas leasing program in the Coastal Plain (also known as the 1002 Area) of the Arctic Refuge. Under the ANILCA, the Coastal Plain was not designated wilderness, and Congress reserved the area for potential future oil and gas development. The USFWS Revised CCP (2015a) recommended the area for wilderness designation and the area has been managed for wilderness characteristics. PL 115-97 opened all federal lands in the Coastal Plain to leasing, however, Alaska Native selected lands within the program area boundary remain segregated from mineral leasing due to their selected status. PL 115-97limited surface development from oil and gas production and support facilities to a maximum of 2,000 acres.

Oil and Gas Resources

The Coastal Plain encompasses approximately 1,563,500 acres. Currently no acreage is open to petroleum leasing. It is estimated that approximately 427,900 acres of the program area are projected to have high potential for petroleum resources, 658,400 acres are projected to have moderate potential, and 477,200 acres are projected to have low potential. Estimates are based on best available information, but due to the limited amount of exploration that has occurred in the area, petroleum development potential and acreages should be considered rough estimates. The one exploration well drilled in the Coastal Plain is held as confidential information, so exact formation compositions and oil and gas percentages are not well established across the entire region. Existing oil and gas wells are shown in **Map 3-5** in **Appendix A**. See the hypothetical development scenario (**Appendix B**) for more information on development potential, assumptions behind potential estimates, and estimates for the baseline future development scenario for petroleum.

Approximately 80 percent of petroleum resources are estimated to be in the undeformed western portion of the program area (USGS 1998b). As shown in **Table 3-10**, the identified potential plays in the undeformed area are the Topset play, Thompson play, Turbidite play, Wedge, Kemik, and Undeformed Franklinian. Potential plays in the deformed area are the Thin-Skinned Thrust Belt, Ellesmerian Thrust Belt, Deformed Franklinian, and Niguanak/Aurora (Attanasi 2005).

All oil and gas volumes represent the mean estimated technically recoverable volumes unless otherwise noted. The Topset is expected to be the primary play in the Coastal Plain, with an estimated technically recoverable 4.325 BBO and 1.193 TCF of gas. The Turbidite play is the second most productive, with an estimated technically recoverable 1.279 BBO and 1.120 TCF of gas. In the deformed area, the Thin-Skinned Thrust Belt is the primary play, with an estimated technically recoverable 1.038 BBO and 1.608 TCF of gas (Attanasi 2005). In total, the undeformed area is estimated to contain a technically recoverable total of 6.420 BBO and 3.424 TCF of gas, and the deformed area is estimated to contain a technically recoverable total of 1.267 BBO and 3.617 TCF of gas. Natural gas liquids would also be produced as part of the oil and gas production process. Additional exploration would take place to refine knowledge of the geology and petroleum resources of the area should one of the action alternatives be implemented.

Table 3-10
Estimated Mean Undiscovered Petroleum Resources in the Coastal Plain

Area	Play Name	Oil (BBO)	Gas (TCF)	Natural Gas Liquids (Billion Barrels of Liquid)
Undeformed	Topset	4.325	1.193	0.010
	Turbidite	1.279	1.120	0.065
	Wedge	0.438	0.226	0.005
	Thompson	0.246	0.470	0.039
	Kemik	0.047	0.116	0.010
	Undeformed Franklinian	0.085	0.30	0.029
	Undeformed subtotal	*6.420*	*3.424*	*0.159*
Deformed	Thin-Skinned Thrust Belt	1.038	1.608	0.017
	Ellesmerian Thrust Belt	0.000	0.876	0.018
	Deformed Franklinian	0.046	0.86	0.046
	Niguanak/Aurora	0.183	0.273	0.016
	Deformed subtotal	*1.267*	*3.617*	*0.096*
Total	**-**	**7.687**	**7.041**	**0.225**

Source: Attanasi 2005
Note: Totals are technically recoverable amounts; oil associated gas and natural gas liquid estimates were combined with non-oil associated gas and natural gas liquid estimates.

Trends

Due to the prior prohibition on leasing, there has been no development of oil and gas resources in the Coastal Plain to date. Section 1002 of ANILCA identified the Coastal Plain for studying the potential oil and gas leasing and development, and there has been interest from some ANCSA corporations in developing the Coastal Plain ever since 1980, when the 1002 Area was identified (Doyon Limited 2018; Rexford 2017). The area has had limited exploration; as further exploration occurs, a greater understanding of the size and characteristics of petroleum resources would be gained.

Ninety percent of technically recoverable resources were estimated to be economically recoverable at $55/barrel (2005 dollars, approximately $70/barrel in 2018 dollars; Attanasi 2005). The threshold price to initiate exploration was estimated to be from $20 to $21/barrel (2005 dollars). (The economics may have changed significantly since that study was published.) As of August 2018, the price of West Coast crude was approximately $75/barrel and the price of West Texas Intermediate crude was approximately $65/barrel. The

US Energy Information Agency forecasts the price of crude oil to steadily rise to over $85/barrel over the next 10 years (EIA 2018).

Direct and Indirect Impacts

Issuance of oil and gas leases under the directives of Section 20001(c)(1) of PL 115-97 would have no direct impacts on the environment because by itself a lease does not authorize any on the ground oil and gas activities; however, a lease does grant the lessee certain rights to drill for and extract oil and gas subject to further environmental review and reasonable regulation, including applicable laws, terms, conditions, and stipulations of the lease. The impacts of such future exploration and development activities that may occur because of the issuance of leases are considered potential indirect impacts of leasing. Such post-lease activities could include seismic and drilling exploration, development, and transportation of oil and gas in and from the Coastal Plain; therefore, the analysis considers potential impacts on petroleum resources from on-the-ground post-lease activities.

Alternative A

Under Alternative A (No Action Alternative), no federal minerals in the Coastal Plain would be offered for future oil and gas lease sales. Alternative A would not establish and administer a competitive oil and gas program for the leasing, development, production, and transportation of oil and gas in and from the Coastal Plain in the Arctic Refuge. Current management actions would be maintained, and resource trends would continue, as described in the Arctic Refuge CCP (USFWS 2015a). No future extraction or use of petroleum resources would occur and as a result no potential direct or indirect impacts on petroleum resources from future oil and gas exploration, development, and production would occur.

Impacts Common to All Action Alternatives

Potential future impacts on petroleum resources under all action alternatives can reasonably be expected to result in the irreversible commitment of petroleum hydrocarbon resources of the PL 115-97 through future oil and gas exploration, development, and production; however, the stated purpose of this EIS is to facilitate petroleum leasing, development, and production.

Potential impacts on petroleum resources would vary based on the amount of acreage available for leasing and restrictions on future access to available acreage. Under all action alternatives, surface development is expected to reach the 2,000-acre maximum. The approach for allocating the 2,000 acres of allowable production and support facilities would be generally described in the detailed statement of sale accompanying the notice of sale for the first lease sale. Mean estimates for the program area suggest it contains approximately 7.687 billion barrels of technically recoverable oil and 7.04 TCF of technically recoverable natural gas (Attanasi 2005). Due to high costs associated with operating in the Arctic it is extremely unlikely that all technically recoverable resources would be produced. The US Energy Information Administration estimated that a total of approximately 3.4 BBO would be produced in the Arctic Refuge by 2050 (Van Wagner 2018). Oil would be transported to market by a connection to the TAPS.

Given the uncertainty involved in defining undiscovered resources in the program area, attempting to define variances in production by alternative is too speculative to provide value in the analysis. NSO restrictions could require that well pads be located outside optimal locations for the most efficient oil recovery under some alternatives; however, horizontal drilling technology would allow operators to recover oil and gas from NSO areas. Under some alternatives, additional pads could be required to access all areas, potentially decreasing the overall volume of oil and gas that would be economically recoverable.

A natural gas transport pipeline from the North Slope to southcentral Alaska is currently planned, where the gas would be transformed into liquefied natural gas. Gas transported through the pipeline is expected to come from established fields with proven reserves initially. If proven gas resources are discovered in the Coastal Plain they could be connected to the pipeline to maintain pipeline capacity as the primary fields are depleted. Estimated natural gas production from the Coastal Plain ranges from 0 to 7 TCF of gas produced (Attanasi 2005). Any co-occurring gas produced with oil would be reinjected to maintain reservoir pressure or would be used to manufacture natural gas liquids to blend and transport with the oil (**Appendix B**). Gas flaring would be limited to the minimum necessary to safely operate processing facilities. Production wells would be fractured to stimulate production, but no hydraulic fracturing to produce unconventional resources is anticipated (**Appendix B**). There is no unconventional oil and gas production on Alaska's North Slope (BLM 2012) due to high development and production costs in the Arctic. The viability of hydraulic fracturing of unconventional petroleum resources has not been proven in the Arctic from a technology or commercial viability standpoint.

Under all action alternatives potential future spills and leakage of petroleum resources are expected to result in a loss of productive use of those resources. In the NPR-A the average crude oil spill rate from 1985 to 2010, for large (500 barrels or greater) spills is 0.65 spills per 1 BBO produced, with an average spill size of 1,229 barrels. During that time the North Slope produced a total of 12.40 BBO. The historic small (less than 500 barrels) crude oil spill rate from 1989 to 2009 for the Alaska North Slope is 187 spills per billion barrels produced, with an average spill size of 2.8 barrels (117.6 gallons). During this time 9.4 BBO were produced (BLM 2012).

An estimated 1.5 BBO to 10 BBO is anticipated to be produced from the Coastal Plain. Assuming the spill rates would be the same as those in the NPR-A, it is reasonable to anticipate a theoretical program area total of between 786 and 5,236 barrels of oil spilled in approximately 281 to 1,870 small spills; there would be between 1,229 and 8,603 barrels spilled in one to seven large spills. In addition to damaging the environment, spills represent a loss of petroleum resources from productive use. Using a high case scenario and a USGS estimate that 9.3 BBO would be economically recoverable (Attanasi and Freeman 2009), it could be expected that there would be approximately 1,739 small spills with a total of approximately 4,869 barrels spilled, and approximately 6 large spills with a total spill size of 7,374 barrels, if the spill rate stays consistent over time. The rate of spills may decrease over time as industry practices improve.

Operators would be required to prepare and implement spill prevention and control plans in compliance with applicable federal and state regulations.

Alternative B (Preferred Alternative)

Table 3-11 shows acreages that would be subject to NSO restrictions, TLs or would be open to leasing under standard terms and conditions only. This alternative opens the entire Coastal Plain to leasing, allowing the greatest acreage for potential petroleum extraction (see **Map 3-6**, Hydrocarbon Potential, Alternative B, in **Appendix A** for more detail). Fewer restrictions on the locations of future CPFs and drill pads exist under this alternative.

Table 3-11
Lease Stipulation Acreages for Alternative B

Lease Stipulations	Low Oil Potential (acres)	Medium Oil Potential (acres)	High Oil Potential (acres)	Total (acres)
NSO	96,300	120,900	142,200	359,400
Standard Terms and Conditions Only	45,600	287,300	285,700	618,700
TL	335,300	250,100	0	585,400
Total	**477,200**	**658,300**	**427,900**	**1,563,500**

Source: BLM GIS 2018

Alternative C

Table 3-12 shows acreages that would be subject to NSO or TL restrictions, that would not be offered for leasing, or that would be open to leasing under standard terms and conditions only.

This alternative also opens the entire program area to leasing (see **Map 3-7**, Hydrocarbon Potential, Alternative C, in **Appendix A** for more detail). Under this alternative, 20 percent of the area would have standard terms and conditions only, including only 28 percent of the medium and high potential areas. The acreage subject to NSO would still allow for CPF and drill pad siting to maximize recovery from each pad.

Table 3-12
Lease Stipulation Acreages for Alternative C

Lease Stipulations	Low Oil Potential (acres)	Medium Oil Potential (acres)	High Oil Potential (acres)	Total (acres)
NSO	410,200	328,200	194,000	932,400
Standard Terms and Conditions Only	100	129,400	184,500	314,000
TL	66,900	200,800	49,400	317,100
Total	**477,200**	**658,400**	**427,900**	**1,563,500**

Source: BLM GIS 2018

Alternative D

Alternative D1. **Table 3-13** shows acreages that would be subject to NSO, CSU, or TL restrictions, that would not be offered for leasing, or that would be open to leasing under standard terms and conditions only. A total of 1,037,200 acres would be available for leasing.

The 526,300 acres that are not offered for leasing represent approximately 34 percent of the program area. The area closed to leasing is in low and moderate petroleum potential sections of the program area projected to have small accumulations of petroleum; thus, the percentage of petroleum resources closed to leasing would be less than 34 percent of the economically recoverable petroleum resources. See **Map 3-8**, Hydrocarbon Potential, Alternative D1, in **Appendix A**.

Under this alternative, only 19 percent of the medium and high potential areas would be available for leasing with standard terms and conditions. Approximately 45 percent of the program area is subject to NSO stipulations, which would limit the location of future CPFs and drill pads, potentially resulting in changes to pad configurations and reduced oil production. NSO restrictions are in portions of the high, medium and low areas.

Table 3-13
Lease Stipulation Acreages for Alternative D1

Lease Stipulations	Low Oil Potential (acres)	Medium Oil Potential (acres)	High Oil Potential (acres)	Total (acres)
CSU	11,000	80,500	32,400	123,900
Not offered for lease	398,300	120,700	7,300	526,300
NSO	67,900	384,600	256,200	708,600
Standard Terms and Conditions Only	0	72,800	131,900	204,700
Total	**477,200**	**658,400**	**427,900**	**1,563,500**

Source: BLM GIS 2018

Alternative D2. **Table 3-14** shows acreages that would be subject to NSO, CSU, or TL restrictions or that would not be offered for leasing. No acres would be open to leasing under standard terms and conditions only; a total of 800,000 acres would be available for leasing.

The 763,500 acres that are not offered for leasing represent approximately 49 percent of the program area. The area closed to leasing is in low and moderate petroleum potential sections of the program area projected to have small accumulations of petroleum; thus, the percentage of petroleum resources closed to leasing would be less than 49 percent of the economically recoverable petroleum resources. See **Map 3-9**, Hydrocarbon Potential, Alternative D2, in **Appendix A**.

Table 3-14
Lease Stipulation Acreages for Alternative D2

Lease Stipulations	Low Oil Potential (acres)	Medium Oil Potential (acres)	High Oil Potential (acres)	Total (acres)
CSU	0	72,700	32,400	105,200
Not offered for lease	477,100	279,100	7,300	763,500
NSO	0	249,500	256,300	505,800
TL	0	57,000	131,900	189,000
Total	**477,200**	**658,400**	**427,900**	**1,563,500**

Source: BLM GIS 2018

Under this alternative, there are no medium and high potential areas available for leasing subject only to standard terms and conditions. Approximately 63 percent of the leasable area is subject to NSO restrictions, which would limit the location of future CPFs and drill pads, potentially resulting in changes to pad configurations and reduced oil production.

Transboundary Impacts

No transboundary impacts on petroleum resources are anticipated due to the implementation of the proposed leasing program. Development of oil and gas pools that extend beyond the Coastal Plain boundary could affect petroleum resources outside the boundary. In this case, unitization agreements would be developed between the mineral owners and lessees of the pool.

Cumulative Impacts

Oil and gas exploration, development, and production around the North Slope have resulted in and would continue to result in irreversible commitment of oil resources. The Alaska Liquid Natural Gas Project and the Alaska Stand Alone Gas Pipeline, if completed, could result in the irreversible commitment of gas resources. Scientific information gained by the exploration program could result in a better understanding of the type and size of petroleum resources in the program area. Spills of produced petroleum products associated with oil and gas exploration and development would result in an irreversible loss of those resources. Under Alternative A no leasing would occur; this would preclude the possibility of developing petroleum resources in the Coastal Plain and would not contribute to cumulative impacts on petroleum resources. The production and subsequent consumption of petroleum resources would contribute to climate change, which are discussed in **Section 3.2.1**.

3.2.7 Paleontological Resources

Affected Environment

Paleontological resources include any physical evidence of past life, including fossilized flora and fauna, imprints, and traces of plants and animals. The program area, and all the North Slope, are widely regarded as fossiliferous.[13] It has borne evidence of past habitation that has expanded the scientific community's understanding of the geologic and paleontological record worldwide (BLM 2012).

As discussed in **Section 3.2.5**, various geologic units have been identified in the program area. This includes ten bedrock geologic units, with unconsolidated surficial deposits, covering more than 80 percent of the surface area. Eight of these ten units have potential or documented fossils, though the presence of paleontological features has not been specifically noted in outcrops in the program area. Program area bedrock geologic units and their approximate acreage in the program area are shown on **Map 3-10**, Paleontological Resources, in **Appendix A**, and are noted below.

The Potential Fossil Yield Classification (PFYC) system is a tool used to assess potential occurrences of paleontological resources in mapped geologic units. It provides classifications that may be used to assist in determining the need for further assessment or actions. The PFYC system is created from available geologic maps and assigns a class value to each geological unit, representing the potential abundance and significance of paleontological resources that occur in that geological unit. PFYC values range from Class 1, Very Low, to Class 5, Very High, which indicate both the probability for the mapped unit to contain significant paleontological resources and the degree of management concern for the resource. Geologic units without enough information associated with them to assign a PFYC value may be assigned Class U, Unknown Potential. Characteristics of PFYC values are included in **Appendix G**.

The PFYC model for Alaska is in development. Preliminary PFYC values have been assigned to the mapped geologic units in the program area and are included in **Table 3-15**. Excerpts from the in-progress PFYC model regarding preliminary rankings and unit descriptions are included in **Appendix G**. These PFYC assignments are maintained and updated by the BLM as additional data is available. The PFYC model in development relies on the geologic mapping presented in Wilson et al. 2015; some of the mapped units are characterized differently than those presented in **Section 3.2.5**.

Pleistocene, or ice age, fossils from between 2.59 million and 11,700 years ago have been identified across the North Slope in surficial quaternary deposits. These are the same deposits that cover approximately 1.4 million acres of the program area. Most of the recorded fossils exposed in North Slope surficial deposits are a result of stream bank erosion. These fossils include remains of animals that existed at the same time as human habitation of the area: horses, mammoths, antelope, bison, bears, lions, muskoxen, caribou, and moose (BLM 2018a).

[13]Rich in fossils or fossil potential

Table 3-15
PFYC Values of Program Area Geologic Bedrock Units

Geologic Unit	Acres in Program Area (Approximate)	Age (Millions of Years Ago [mya])	PFYC Value	Noted Fossil Presence in Unit
Sagavanirktok Formation	16,900	Tertiary (65–2.8)	3-4	Floral, microfauna, and mollusk fossils
Seabee Formation and Hue Shale	1,200	Cretaceous (145–66)	3-4	Ammonites, pelecypods, fish remains, bird trace fossil (footprint)
Jago River Formation	25,300	Upper Cretaceous, (100.5–66)	3	Palynomorphs, plant fossils
Sadlerochit Formation	2,800	Lower Triassic to Permian (289.9–247.2)	3	Ammonites, pelecypods, and brachiopods
Lisburne Group, undivided	500	Carboniferous (358.9–298.9)	3	Group noted as generally fossiliferous; contains corals, brachiopods, ammonites, nautiloids, and plants
Kingak Shale	200	Jurassic (201.3–145)	3	Marine mollusks and crinoids; pelecypods and ammonites
Surficial Quaternary Deposits	1,421,700	Quaternary, Pleistocene, and upper Tertiary (2.59–present)	2-3	Flora, fauna
Kemik Sandstone	200	Lower Cretaceous (146–100)	2-3	Trace fossils (footprints)
Kongakut Formation	200	Lower Cretaceous (146–100)	2-3	Pelecypods and abundant worm borings
Canning Formation	8,500	Cretaceous to Tertiary (145–2.8)	2-3	Palynomorphs

Sources: BLM GIS 2018; Breithaupt, B. BLM Regional Paleontologist, e-mail to Anna Kohl, HDR environmental scientist, on July 30, 2018, regarding preliminary PFYC rankings and unit descriptions for the program area.

Most paleontological resources identified on the North Slope have been identified in areas west of the program area. A description of the history of fossil discovery on the North Slope and conclusions regarding the fossil record is in BLM 2012, Section 3.2.7, and BLM 2018a, Section 3.2.1.6.

Climate Change

Changing climate conditions would not directly affect paleontological resources but could impact several geologic hazards, including thawing permafrost and coastal erosion. An increase in the active layer expected from a warming climate could result in greater areas of land subsidence, which may expose geologic units with paleontological resources to weathering action. Similarly, organic paleontological remains that have been preserved for millennia in permafrost would rapidly decompose once incorporated into the active layer. Coastal erosion could also expose previously protected units to weathering, which may expose and damage resources. Given the surficial context of these actions, the geologic unit with the greatest risk is the unconsolidated and poorly consolidated surficial Quaternary deposits, which may contain Pleistocene fossils.

Direct and Indirect Impacts

Issuance of oil and gas leases under the directives of Section 20001(c)(1) of PL 115-97 would have no direct impacts on the environment because by itself a lease does not authorize any on the ground oil and gas activities; however, a lease does grant the lessee certain rights to drill for and extract oil and gas subject to further environmental review and reasonable regulation, including applicable laws, terms, conditions, and stipulations of the lease. The impacts of such future exploration and development activities that may occur because of the issuance of leases are considered potential indirect impacts of leasing. Such post-lease activities could include seismic and drilling exploration, development, and transportation of oil and gas in and from the Coastal Plain; therefore, the analysis considers potential impacts on paleontological resources from on-the-ground post-lease activities.

The effects of climate change described under *Affected Environment* above, could influence the rate or degree of the potential direct and indirect impacts.

Alternative A

Under Alternative A, current management actions would continue as described in the Arctic Refuge CCP (USFWS 2015a). Changes to paleontological resources, such as increased exposure due to changes in permafrost, riverbank erosion, coastal erosion, and weathering, would continue to occur along current trends. There would be no potential direct or indirect impacts on paleontological resources from future oil and gas exploration, development, and production under Alternative A.

Impacts Common to All Action Alternatives

The limited bedrock outcrops and distribution of surficial quaternary deposits are the only sources for understanding the distribution and type of paleontological resources in the program area. As described in **Section 3.2.5**, if future program-related infrastructure includes gravel fill, the ability to evaluate and observe paleontological resources would be restricted; however, placement of gravel fill would also provide erosion protection, which may support preservation of the resource. Potential impacts would be long term and would last until the gravel is removed. Potential direct impacts on paleontological resources would be limited to future ground-disturbing activities, including drilling and gravel mining.

NSO restrictions associated with setbacks or exclusion from biological and ecological areas, as described in **Table 2-3** in **Chapter 2** would reduce the acreage of geologic units affected and therefore the potential for affecting paleontological resources. NSO restrictions associated with setbacks from March Creek and from the Canning, Hulahula, Aichilik, Okpilak, Jago, Sadlerochit, Tamayariak, Okerokovik, and Katakturuk Rivers would be common among all action alternatives. They would reduce ground-disturbing activities in the surficial quaternary deposits next to these water bodies. Since streambank erosion is a common mechanism to exposure Pleistocene fossils, these setbacks would prevent additional exposure of paleontological resources in surficial deposits. Marsh Creek and the Katakturuk, Jago, and Okerokovik Rivers pass within 1 mile of several bedrock outcrops that may bear paleontological resources (Sagavanirktok, Canning, and Jago River formations); NSO setbacks from these rivers would reduce potential future impacts on paleontological resources in these outcrops simply because of the exclusion of ground-disturbing activities.

Potential future indirect impacts on paleontological resources are due to increased exposure, either to humans or the elements. Since the resources in the program area have not been extensively studied, increased exposure from infrastructure construction and operation near bedrock outcrops may support additional scientific research and identification of paleontological resources. Similarly, improving access to areas with paleontological resources may increase unauthorized fossil removal, looting, and damage. Removal of ground cover that would expose fossil-bearing units would expose the unit to weathering influences, which may disturb the resource and its context.

The Paleontological Resources Protection Act (PRPA) of 2009 (16 USC 470aaa et seq.) directs the BLM to implement comprehensive paleontological resource management programs on managed lands. While the existing understanding of paleontological resources in the program area is limited, preliminary assumptions regarding the potential for paleontological resources may be made by associating mapped geologic units in the program area and the PFYC values assigned to the same units outside of the program area.

Ground-disturbing work in the program area would be subject to field survey requirements implemented by the BLM through the PRPA. It stipulates that field surveys must be conducted by individuals with the experience and qualifications in paleontology appropriate to the activity, as described in the BLM's Paleontological Resource Use Permit Application. This preliminary assumption regarding correlation of units in and outside the program area would require field verification. It would be conducted before ground-disturbing activities begin, as a component of individual permit applications to the BLM. Associated evaluation of potential impacts on paleontological resources would therefore be made on the basis of further field investigations conducted as part of individual exploration or development plans.

Alternative B (Preferred Alternative)

Potential future impacts on paleontological resources from oil and gas exploration, development, and production under Alternative B would be the same as identified above for all action alternatives.

Alternative C

Alternative C includes a greater acreage of NSO restrictions, as well as additional setbacks from water bodies than Alternative B. Because the land made available for ground-disturbing activities under Alternative C is less than that under Alternative B, fewer acres of surficial quaternary deposits and bedrock outcrops that may contain paleontological resources would be exposed and potentially affected by future oil and gas exploration, development, and production.

Alternative D

Alternative D includes a greater acreage of NSO restrictions, as well as additional setbacks from water bodies than Alternatives B and C. Because the amount of land made available for ground-disturbing activities under Alternative D is less than that under Alternatives B and C, fewer acres of surficial quaternary deposits and bedrock outcrops that may contain paleontological resources would be exposed and potentially affected by future oil and gas exploration, development, and production.

Transboundary Impacts

Transboundary impacts to paleontological resources were not identified for any alternatives. on

Cumulative Impacts

BLM (2018a) notes that activities with the potential to adversely affect paleontological resources are required to have professional inventories filed with BLM before specific development projects begin. These include requirements to minimize or eliminate adverse impacts on paleontological resources. No past or present actions that could affect paleontological resources have occurred in the program area. Reasonably foreseeable future actions (**Appendix F**) that could affect paleontological resources have occurred or would occur in the program area; therefore, no cumulative impacts on paleontological resources would occur. The effects of climate change described under *Affected Environment* above, could influence the rate or degree of the potential cumulative impacts. Alternative A would have no potential cumulative impacts on paleontological resources from future oil and gas exploration, development, and production.

3.2.8 Soil Resources

Affected Environment

The Coastal Plain is in the Coastal Plain physiographic sub-province and portions of the Arctic Foothills physiographic sub-province (see **Section 3.2.5**). The soils in the Coastal Plain sub-province are composed of poorly drained, unconsolidated sediments transected by fluvial deposits of rivers and stream flowing northward from the rolling foothills to the south (Wahrhaftig 1965). Most uplands in the program area are in the western half and extend from the foothills of the Sadlerochit Mountains southern boundary to near the coastline. Upland soils consist of loess (eolian silt), colluvium, and morainal deposits. Lowland Coastal Plain deposits east of the Hulahula River are interbedded marine and alluvial deposits associated with past marine transgressions. These soils generally include fluvial sands and gravels, silty sand, and organic silt over marine silts and clays. The eolian silts and marine silts and clay soils are generally ice rich and contain ice wedges (**Map 3-11**, Soils, and **Map 3-12**, Permafrost Soils, in **Appendix A**; Jorgenson et al. 2015).

Eolian silt deposits (yedoma) comprise nearly 40 percent of the surficial soil deposits in the program area and can range from 3 to 100 feet thick (Jorgenson et al. 2015; Rawlinson 1993). Yedoma deposits typically occur in flat lowland areas are normally frozen, with a high ice content; hillslopes generally have a thin eolian silt deposit cover, less than 15 inches thick. Alluvial and fluvial deposits, including active braided channels, terraces, and deltaic deposits, consist of sands and gravels in steeper gradients near the foothills. They transition to finer grained soils in floodplains and inactive channels (Jorgenson et al. 2015).

The ice-rich yedoma is more susceptible to thermokarst than more thaw-stable eolian sands and alluvial/fluvial deposits. Thaw strain measurements of coastal plain eolian silts indicate that settlement due to thawing frozen silts can be as much as 33 to 98 feet and is generally greater than thaw settlement of frozen eolian sand deposits (Pullman et al. 2007). The yedoma is generally present \in the western portion of the program area.

The Sadlerochit Mountains bordering the southwestern edge of the program area are composed of Tertiary sandstone and conglomerate noncarbonate sedimentary rocks. Colluvium deposits drape the northern slopes of the Sadlerochit Mountains and are composed of loose, silty to rubbly, unsorted deposits derived directly from weathering bedrock deposits upslope. Colluvium deposits are usually vegetated (Jorgenson et al. 2015). At the southern border of the program area, the Canning River and Hulahula River drainages are capped by glacial moraine deposits, consisting of silty sands and gravels, with some cobbles and boulders (Rawlinson 1993).

The entire program area is underlain by permafrost with isolated areas of thaw near deep lakes, springs, and rivers (Bird and Magoon 1987). Depending on their depth and size, lakes and rivers influence the presence of permafrost; deeper lakes and rivers, such as the Canning River, often form a thaw bulb below the water body (Rawlinson 1993). Permafrost and ground ice characteristics are variable, due to differences in climate, topography, soil properties, cryogenic processes, and environmental history (Jorgenson et al. 2015). Massive ice occurs in the form of ice wedges, buried glacial ice in glacial deposits, and intrusive ice (Jorgenson 2008). Permafrost in the Coastal Plain is generally between 650 and 1,300 feet thick (USFWS 2015a). Polygonal patterned ground is created when ice wedges form in the upper few feet of the ground surface and is indicative of ice-rich soils. Polygonal ground is a common surface feature in the program area, especially in lowland areas; polygons may be less apparent in drained upland areas, where vegetation can mask these surface features (Rawlinson 1993).

The top layer of the soil surface that typically thaws and refreezes annually is known as the active layer. In the Coastal Plain, the active layer is generally between 1 and 4 feet thick (USFWS 2015a). Active layer thickness can vary from year to year and depends on such factors as ambient air temperature, aspect, gradient, vegetation, drainage, snow cover, water content, and soil type. Long-term permafrost temperature monitoring shows a warming trend over the past 25 years, with the greatest warming near the coast. Soil temperatures increased 3 to 5°F between 1985 and 2004 (USFWS 2015a). At the approximately 4-foot depth at three USGS monitoring stations in the program area, average subsurface temperatures showed warming trends between 2000 and 2014 of 32.9 to almost 35.6°F (Urban and Clow 2017).

Degradation of permafrost can be affected by ice type and content, soil or vegetation removal, and ground disturbances, with ice-rich and thaw-unstable soils and hillsides being the most sensitive to thawing (ADNR 2018a). Thawing, ice-rich, permafrost soils, such as yedoma create thermokarst features that transform the landscape by subsidence, erosion, and changes in drainages, including channelization and ponding (Section 4.2.5 USFWS 2015a).

Alternatively, eolian sand lacks sufficient ice for thermokarst lake formation; however, thawing wedge ice can lead to thermokarst pits and troughs (Jorgenson et al. 2015). Changes in the landforms due to erosion and thermokarst, such as slumping and channelization, affects the vegetation and water characteristics of the area (USFWS 2015a). Additionally, carbon, mercury, metals, and other naturally occurring contaminants may be released as permafrost thaws and be introduced into plant and animal habitats (**Section 3.3.1**).

The vulnerability of permafrost to degradation depends on a complex interaction of surface changes and soil and permafrost characteristics (Jorgenson et al. 2015). Changes to soils and permafrost on the North Slope resulting from a changing climate are more fully described in BLM (2018a). They include an increase in the active layer thickness and the potential for increased settlement due to thermokarst and ice wedge degradation as warming temperatures increase.

Direct and Indirect Impacts

Issuance of oil and gas leases under the directives of Section 20001(c)(1) of PL 115-97 would have no direct impacts on the environment because by itself a lease does not authorize any on the ground oil and gas activities; however, a lease does grant the lessee certain rights to drill for and extract oil and gas subject to further environmental review and reasonable regulation, including applicable laws, terms, conditions, and stipulations of the lease. The impacts of such future exploration and development activities that may occur because of the issuance of leases are considered potential indirect impacts of leasing. Such post-lease activities could include seismic and drilling exploration, development, transportation of oil and gas in and from the Coastal Plain, and abandonment. **Appendix B** identifies oil and gas actions that would likely occur; therefore, the analysis considers potential impacts on soil resources from on-the-ground post-lease activities.

Potential impacts from the development and operation of facilities identified in the hypothetical development scenario (**Appendix B**) are as follows:

- The placement of gravel fills for pads, roads, and airstrips
- Construction of VSMs for pipelines and building foundations
- Construction of ice roads and pads
- Removal of sand and gravel resources for embankment fills
- Impacts from exploratory seismic activities
- Abandonment and reclamation of sand and gravel pads, roads, and airstrips

These future pre- and post-leasing actions during exploration, development, production, and reclamation, including vehicular travel on snow and ice-covered tundra, change and disturb the insulating surface vegetation layer. They also increase the active layer thickness, thawing the permafrost, and developing thermokarst structures. Thermokarst changes the surface topography, increasing water accumulation, changing surface water drainage patterns, and increasing the potential for soil erosion and sedimentation (BLM 2018a; Jorgenson et al. 2010).

As gravel pads, roads, and airstrips are abandoned and reclaimed, the material would be removed and either reused and placed elsewhere or placed back in sand and gravel pits (**Appendix B**, **Section B.7.5**). This would allow development to remain within the 2,000-acre limit of development outlined by the directives of Section 20001(c)(1) of PL 115-97 (**Appendix B**, **Section B.6.1**); however, it could also result in direct and indirect impacts on soil and permafrost resources beyond 2,000 acres as development expands after abandonment and reclamation. The impacts from this rolling acreage limit are outlined below in *Impacts Common to All Action Alternatives*.

The effects of climate change described under *Affected Environment* above, could influence the rate or degree of the potential direct and indirect impacts.

Alternative A

Under Alternative A, current management actions would be maintained as described in the Arctic Refuge CCP (USFWS 2015a). The Coastal Plain would remain undeveloped. No direct or indirect impacts on soils or permafrost would occur from post-leasing oil and gas activities.

Impacts Common to All Action Alternatives

Under all action alternatives, approximately 2,000 acres of direct disturbance due to placement of gravel fills and VSMs for future construction of roads, pads, airstrips, and structures would occur and would result in potential direct impacts on soil quality and permafrost in and next to the gravel fill footprint. Changes to surface drainage due to the placement of fills causes permafrost thawing and subsidence and water accumulation, which would not occur under Alternative A. Placement of fills would cover soils and kill existing vegetation, altering the thermal active layer (USACE 2018). Installation of VSMs for pipelines would displace and disturb soils around the VSM (BLM 2018a).

Ice road and pad construction and seismic survey impacts on soil and permafrost resources vary, depending on the type of vegetation, disturbance type, and depth of the active layer; however, the depth of thaw increases each year following ice road construction (Yokel and Ver Hoef 2014). Seismic surveys and ice road and pad construction supporting exploration for resources would be performed during the winter to reduce impacts; however, impacts on vegetation and disturbance of the active layer would result in direct impacts on the soil quality and permafrost where seismic survey activities occur (USFWS 2014; Jorgenson et al. 2010). ROP 11 outlines the protection and mitigation measures to be used to minimize impacts on soils and permafrost from off-road tundra travel, to include seismic exploration and placement of gravel fills. These measures include seasonal off-road travel, vehicle specifications, protection and mitigation for multi-season routes, and ice road and pad construction.

By changing drainage patterns of surface water, ponds and channels form and concentrate water that accelerates permafrost thaw. Where drainage patterns are altered, blockages can lead to ponding and sediment deposition. Where drainage patterns redirect surface flow or increase velocities, such as at embankments, erosion of sediments occurs (BLM 2018a).

Potential indirect impacts on soil and permafrost in and next to the gravel fill footprints would be due to dust deposition and snow accumulation. Fugitive dust would be suspended in the air by vehicle and equipment use and would settle onto surrounding vegetation and snow, which would decrease surface albedo.[14] A decrease in surface albedo due to the presence of gravel pads and roads can increase absorption of solar radiation, accelerate the rate of snowmelt, and lead to permafrost thaw (USACE 2018). Dust accumulation can also affect the pH and increase heavy metal and mineral concentrations (Herngren et al. 2006) of the surrounding soils, which may lead to changes in the health and growth of vegetation that hold soil in place.

Blowing snow conditions due to changes in topography from the construction of pads and roads and VSMs/infrastructure foundations changes the thermal regime of the soils and permafrost next to the pad and road or VSMs. Snow accumulation insulates the underlying soil during the winter, increasing the overall soil temperatures and leading to permafrost thaw at those locations, specifically the edge of toe on road and pad embankments. Snow accumulation would occur more frequently on the leeward side of embankments (USACE 2018).

Future sand and gravel material extraction and transport would be required to provide materials for embankment construction and would have impacts on the permafrost and soils in the mine site footprint, around its perimeter, and along transportation routes. **Section 3.2.9** discusses the impacts of material extraction in further detail.

Future reclamation of roads and pads would be subject to the permitting process. Removal of gravel would affect the underlying soil and permafrost resources by exposing the underlying soils to increased radiation and leading to continued permafrost degradation (USACE 2018). Where gravel bases are removed, thermokarst greatly affects the rehabilitation of the soils and vegetation; where ice-rich soils have thawed and formed deep lakes and troughs, intermingled with well-drained and high centered polygons, ice-poor and well-drained soils may result in shallow thaw lakes or ponds (Pullman et al. 2007).

Alternative B (Preferred Alternative)

Potential impacts on soils and permafrost under Alternative B would be the same as identified above for all action alternatives. Under Alternative B, where lease stipulations would allow development of gravel pads, roads, or ice roads and pads, approximately 389,000 acres of yedoma is present. Approximately 174 miles of gravel roads would be needed to connect facilities and would traverse multiple soil and permafrost types. The impacts of ice roads and pads described in the impact analysis would vary, based on project-specific exploration and development plans; however, they are anticipated to be in addition to the acreage estimated above. Approximately 12,509,000 cubic yards of material is required for constructing the embankment infrastructure, estimated to be 174 miles of gravel roads and up to 310 acres of disturbance to the ground surface and soils at material extraction sites.

Alternative C

Potential impacts on soils and permafrost under Alternative C would be the same as identified above for all action alternatives; however, lease stipulations would limit surface occupancy to the western half of the program area, which consists of greater areal deposits of alluvial sands and gravels, as well as marine deposits along the northern boundary. Under Alternative C, where lease stipulations would allow development of either gravel pads or roads, there are approximately 245,470 acres of yedoma. Approximately 180 miles of gravel roads would be needed to connect facilities and would traverse across multiple soil and permafrost types. The area impacts of ice roads and pads, as described in the impacts analysis, would vary, based on project-specific exploration and development plans; however, they are anticipated to be in addition to the acreage estimated above. Approximately 12,722,000 cubic yards of material is required for constructing the embankment

[14]The light that is reflected from the surface

infrastructure, estimated to be 180 miles of gravels and up to 315 acres of disturbance to the ground surface and soils at material extraction sites.

Alternative D

Alternative D1. Potential impacts on soils and permafrost under Alternative D1 would be the same as identified above for all action alternatives; however, lease stipulations would limit surface occupancy to the western third of the program area, which is primarily composed of fine sand and silt deposits with restricted use of areas next to alluvial plains, which are composed of sands and gravels.

Under Alternative D1, where lease stipulations would allow development of either gravel pads or roads, there are approximately 181,780 acres of yedoma. Approximately 185 miles of gravel roads would be needed to connect facilities and would traverse multiple soil and permafrost types. The areal impacts of ice roads and pads described in the impact analysis would vary, based on project-specific exploration and development plans; however, they are anticipated to be in addition to the acreage estimated above. Approximately 12,420,000 cubic yards of material is required for constructing the embankment infrastructure, estimated to be up to 308 acres of disturbance to the ground surface and soils at material extraction sites.

Alternative D2. Potential impacts on soils and permafrost under Alternative D2 would be the same as those identified above for all action alternatives; however, lease stipulations would limit surface occupancy to in the western quarter of the program area. This is primarily composed of fine sand and silt deposits, with restricted use of areas next to alluvial plains, which are composed of sands and gravels.

Under Alternative D2, where lease stipulations would allow development of either gravel pads or roads, there are approximately 171,060 acres of yedoma. The impacts of ice roads and pads described in the impact analysis would vary, based on project-specific exploration and development plans; however, they are anticipated to be in addition to the acreage estimated above. Approximately 12,420,000 cubic yards of material is required for constructing the embankment infrastructure, estimated to be up to 308 acres of disturbance to the ground surface and soils at material extraction sites.

Transboundary Impacts

Transboundary impacts onto soil and permafrost are not anticipated. This is because under any alternatives the limits of development and anticipated impacts next to development are restricted to the program area.

Cumulative Impacts

The geographic area relevant for assessing cumulative impacts for soils and permafrost is in the program area. Previous seismic survey explorations and an exploratory test well in the program area have typically resulted in minor disturbances to vegetation and to affected permafrost and changes to vegetation growth. Research has shown that the impact from seismic lines has recovered as much as 97 percent and camp trails and as much as 90 percent after 8 years of recovery (Emers et al. 1995); however, in some instances disturbance is still visible after 25 years of recovery (USFWS 2014; Jorgenson et al. 2010). Newer seismic technologies appear to cause less long-term damage (NRC 2003); with mitigation and awareness, future seismic surveys should result in reduced levels of impacts on the ground surface than previous efforts.

Each of the hypothetical development scenarios could affect over 2,000 acres of soils and permafrost, as acreage would be regained against the 2,000-acre surface development limit during reclamation (**Appendix B**), however the leased area of Alternative D2 is limited to 800,000 acres, less than under the other alternatives. The potential impacts are related to future changes to topography and landforms resulting in changes to soil chemical composition, drainage patterns, and erosion of soils. Disturbance to surface vegetation directly leads to changes in the thermal regime of soils due to placement of gravel fills for pads and roads and would last beyond the anticipated 85-year time frame. The effects of climate change described under *Affected Environment* above, could influence the rate (temporal) or degree and areal extents of the potential cumulative impacts.

Alternative A would not contribute to cumulative impacts on soils and permafrost from future post-lease oil and gas activities. This is because there would be no direct or indirect effects on soils under this alternative.

3.2.9 Sand and Gravel Resources

Affected Environment

Sand and gravel are most commonly present in the Coastal Plain in the valleys of larger rivers and streams (Bird and Magoon 1987); the valleys of larger streams are underlain by coarse sand and gravel. These include the Canning, Sadlerochit, Hulahula, and Aichilik Rivers, which are heavily braided and have extensive gravel bars generally free of vegetation. Sediments in the Coastal Plain in the western half of the program area are dominated by outwash sediments covered by younger fluvial sands and gravels within approximately 10 miles of the coastline; the outwash sediments are either directly below the fluvium or have been eroded and replaced by the fluvium (Rawlinson 1993). The eastern half of the program area is also composed of fluvial sediments overlying outwash sediments; however, the fluvial and outwash sediments extend farther inland into the Sadlerochit Mountains than the western side of the program area, about 24 miles.

The Canning River valley on the western border of the program area was formed by a large valley glacier. It formed a piedmont lobe along the Canning and Tamayariak Rivers, depositing glaciofluvial soils (Bird and Magoon 1987). These soils are composed of outwash sediments deposited in multiple terraces, formed by glacial outwash washed downstream and are capped by younger alluvial deposits. The outwash deposits near the northern boundaries of the program area are covered by eolian sand and overlain by lacustrine silt and peat, exposed at stream cuts, and bank exposures (Rawlinson 1993).

Sediments in the program area are dominated by outwash sediments covered by younger fluvial sands and gravels. The outwash sediments are either directly below the fluvium or have been eroded and replaced by it (Rawlinson 1993). Sands and gravels are often found in elevated terrain between river valleys and alluvial fans originating from the foothills to the south (Rawlinson 1993). Soils downstream and closer to the coastline become progressively fine grained, transitioning to deltaic and marine deposits (Bird and Magoon 1987).

Existing material sources in the Coastal Plain and west and outside of the program area are in similar geological environments and next to streams. These sites are reportedly excavated to depths of approximately 45 feet below the surface and are in similar glaciofluvial and fluvial deposits. These deposits have been observed to contain ice wedges and thin discontinuous beds of fine-grained material with abundant detrital wood debris (Rawlinson 1993).

Climate Change

Changes in climate may affect access to those sand and gravel resources. Developers of sand and gravel resources in the program area would use ice roads for access to the material sites. Depending on the excavation methods to mine sand and gravel resources, climate change could make the excavation easier, due to thawing permafrost, or more difficult, due to increased water or swampy conditions (BLM 2018a).

Direct and Indirect Impacts

Issuance of oil and gas leases under the directives of Section 20001(c)(1) of PL 115-97 would have no direct impacts on the environment because by itself a lease does not authorize any on the ground oil and gas activities; however, a lease does grant the lessee certain rights to drill for and extract oil and gas subject to further environmental review and reasonable regulation, including applicable laws, terms, conditions, and stipulations of the lease. The impacts of such future exploration and development activities that may occur because of the issuance of leases are considered potential indirect impacts of leasing. Such post-lease activities could include seismic and drilling exploration, development, material excavation, and transportation of oil and gas in and from the Coastal Plain (**Section 1.9.1**); therefore, the analysis considers potential impacts on sand and gravel resources from on-the-ground post-lease activities.

Potential impacts from the future development and operation of facilities identified in the hypothetical development scenarios (**Appendix B**) include the removal of sand and gravel resources for embankment fills. These actions change and disturb the surface vegetation layer and excavate landforms, resulting in changes to surface drainage, erosion of soils, and thawing of permafrost.

The effects of climate change described under *Affected Environment* above, could influence the rate or degree of the potential direct and indirect impacts.

Alternative A

Under Alternative A, current management actions would be maintained as described in the Arctic Refuge CCP (Chapter 2, USFWS 2015a). The Coastal Plain would remain undeveloped. No direct or indirect impacts on sand and gravel resources would occur from future post-lease oil and gas activities.

Impacts Common to All Action Alternatives

Sand and gravel resources would be required for future development projects under each of the action alternatives. Sand and gravel resources would need to be extracted for the construction of roads and pads. Investigations specific to material source development would be completed as part of the exploration and development phases of alternatives development. Sand and gravel would likely be obtained from more than one newly permitted mine site near the proposed development and would be accessed during winter via ice roads.

The BLM estimates that gravel pits and associated storage pads needed to supply oil exploration, development, and production in the Coastal Plain would encompass approximately 280 to 300 acres under all alternatives. The acreage required for gravel mining could increase or decrease, depending on local conditions. Gravel supply plans would be detailed in site-specific NEPA documentation for any future developments (**Appendix B.9.4**). Reclamation of development post-production would include removing gravel roads and pads, which would be reused in future production infrastructure development or replacement in the gravel mines (**Appendix B.7.5**). Where gravel bases are removed, thermokarst greatly affects the rehabilitation of the soils and vegetation. This is based on the soil and vegetation type and methods of reclamation (Pullman et al. 2007). Replacement of material in the mine sites would affect the thermal regime established by removing material and any ponding that may have occurred.

Sand and gravel mining would alter the geomorphic landforms and remove vegetation, leading to permafrost thaw. At mine site closure and, depending on site characteristics and reclamation requirements, the mine sites could be inundated with surface water, forming a pond. By changing the drainage patterns of surface water, ponds and channels form and concentrate water that accelerates permafrost thaw. Where drainage patterns are altered, blockages can lead to ponding and sediment deposition. Where drainage patterns redirect surface flow or increase velocities, such as at embankments, sediments erode. Water impoundment in a flooded pit would likely remain unfrozen near the bottom, creating a thaw bulb around and beneath the pit, which may cause the excavation walls to slough and deposit material into the pit (BLM 2018a).

Removal of gravel in the future from areas near or in streams could change stream configurations, hydraulics, flow patterns, erosion, sedimentation, and ice damming (USACE 2018). These actions would not occur under Alternative A. Gravel mine sites would be remediated in accordance with ROP 24 (**Table 2-3**).

Alternative B (Preferred Alternative)

Approximately 12,509,000 cubic yards of material would need to be mined for future gravel pads and roads. Multiple material source sites are expected to be used to meet the material demands and reduce haul distances. Based on areas of high potential mineral leasing under this alternative (**Map 3-6** in **Appendix A**), material sources are anticipated to be primarily in the outwash sediments from the Sadlerochit Mountains in the southwestern portion of the program area and in alluvial deposits of larger rivers.

Alternative C

Approximately 12,722,000 cubic yards of material would need to be mined for future gravel pads and roads. Multiple material source sites are expected to be used to meet the material demands and reduce haul distances. Based on areas of high potential mineral leasing under this alternative, material sources are anticipated to be primarily in the outwash sediments from the Sadlerochit Mountains in the southwestern portion of the program area and in alluvial deposits of larger rivers.

Alternative D

Alternative D1. Approximately 12,420,000 cubic yards of material would need to be mined for future gravel pads and roads. Multiple material sources sites are expected to be used to meet material demands and limit haul distances. Based on areas of high potential mineral leasing under this alternative, material sources are anticipated to be primarily from fluvial deposits between the Canning and Tamayariak Rivers, and material resources may be limited to streams and topographic high points.

Alternative D2. Approximately 12,420,000 cubic yards of material would need to be mined for future gravel pads and roads; however, offered leased areas would be limited to 800,000 acres. Multiple material source sites are expected to be used to meet material demands and limit haul distances. Based on areas of high potential mineral leasing under this alternative, material sources would be primarily from fluvial deposits between the Canning and Tamayariak Rivers; material resources may be limited to streams and topographic high points.

Transboundary Impacts

Transboundary impacts to sand and gravel resources are not anticipated under any alternatives. This is because the limits of material sources are restricted to the program area.

Cumulative Impacts

The geographic area relevant for assessing potential cumulative impacts for sand and gravel resources is the program area. Potential direct impacts would include permanent changes to landforms and vegetation, due to material extraction, which would lead to changes in permafrost. Changes to permafrost would likely be due to thaw and would result in subsidence, formation of thaw bulbs, and changes to drainages in and around the perimeter of the material site. Alternative C would require more cubic yards of material, compared to the other action alternatives. Past and present actions affecting sand and gravel in the program area are expected to continue, including natural riverbank and slope erosion. The effects of climate change described under *Affected Environment* above, could influence the rate or degree of the potential cumulative impacts. Alternative A would have no cumulative impacts on sand and gravel resources from post-leasing oil and gas activities.

3.2.10 Water Resources

Affected Environment

The climate, topography, and permafrost of the Arctic Refuge Coastal Plain (ARCP)[15] are the controlling physical forces of the hydrologic cycle and are characterized by low precipitation and below-freezing average temperatures during 8 months of the year (Lyons and Trawicki 1994). A comparison of average monthly temperatures at Barter Island on the coast and farther south in the coastal plain and northern Brooks Range foothills (represented by Kuparuk and Toolik Lake, respectively) are provided in **Table H-1** in **Appendix H**.

Snowfall measurements date back to 1949 on Barter Island, but the monitoring site was taken out of service in 1989, resulting in a discontinuous record of snow climatology. In 2000, three meteorological stations were established (Urban and Clow 2017) as part of the DOI/Global Terrestrial Network for Permafrost Observing System in remote parts of the ARCP. Locations of the three climate monitoring gaging stations can be seen in **Map 3-13**, Agency Monitoring Stations, in **Appendix A**. The limited data available from these stations are the only modern continuous record of snow accumulation in this region of Alaska. The available average annual water equivalent of monthly precipitation and snowfall data is provided in **Tables H-2** and **H-3** in **Appendix H**, respectively.

Hydrology

Water resources on the North Slope consist mainly of rivers, shallow discontinuous streams, lakes, and ponds. Hydrology is influenced by climate, topography, and permafrost. Topography of the program area ranges from the steep Brooks Range foothills to relatively flat and poorly drained tundra underlain with continuous permafrost closer to the coast.

Streams on the North Slope typically begin to freeze up in September and complete the breakup process in June, although there are variations from year to year in timing due to meteorological conditions. Streams with active perennial springs may stay open longer in the fall or may develop significant aufeis accumulations, which persist later in the summer, providing additional runoff. Due to the climate, the annual hydrologic cycle is dominated by an approximate 3-week period of spring breakup associated with snowmelt and overbank and overland flooding. The open water season is generally limited to June through September. While notable fall events have been recorded, annual peak stage (i.e., water level) and discharge in streams is associated with the spring break up in late May or early June. Runoff from summer rainfall are generally contained in the river channels.

Streams on the North Slope are generally divided into three types, based on the physiographic province of their origin: those that originate in (1) the coastal plain of the North Slope (a broader area than the program area), (2) the Arctic foothills, or (3) the Brooks Range (Gallant et al. 1995). Streams and rivers in the program area share flow characteristics that are typical of the region (Brabets 1996). In the winter, stream flow is generally nonexistent or so low as to not be measurable. During freeze-up, ice becomes anchored to the streambed, and in shallow locations the entire water column freezes. River flow begins during spring break up in late May or early June, and flooding may occur from rapid snowmelt, combined with ice- and snow-filled channels.

Spring breakup can inundate extremely large areas in a matter of days. More than half of the annual discharge for a stream can occur over several days to a few weeks (Sloan 1987). Most streams continue to flow throughout the summer but at substantially lower discharges. Rainstorms can increase stream flow, but they

[15]Lands in the Arctic Refuge, including the program area, that are part of the larger Arctic Coastal Plain that stretches east into Canada.

are seldom sufficient to cause flooding in the Arctic Coastal Plain. Stream flow rapidly declines in most streams shortly after the onset of freeze-up in September and ceases in most rivers by December.

The spring season brings about major shifts in hydrology that recharge aquatic habitats and support fish migration. Snowmelt starts earliest in the foothills and then proceeds to the coastal plain. During this time, sheets of snowmelt water flow over frozen ground. Extensive fields of aufeis that develop over the winter due to springs play an important role, both in directing river flow paths over land and into new channels and by augmenting summer discharge. Snowmelt and flood waters create ephemeral connections between aquatic habitats and recharge floodplain lakes and wet meadow zones. On the North Slope, up to 40 percent of snowmelt recharges the evaporation deficit from the previous summer; immediately following snowmelt, surface waters are at their maximum extent (Bowling et al. 2003). Within two weeks of snowmelt, overland flow ceases and many hydrologic systems become disconnected (Bowling et al. 2003).

Flooding of North Slope rivers is influenced by the type of physiographic region drained, the size of the drainage area, and the air temperatures during breakup. Snowmelt is the main cause of annual flooding in all North Slope rivers and it may be heavy during rapid temperature rises in late May or may occur to a lesser extent over a prolonged period of weeks. Snowmelt flooding nearly always produces the annual peak discharge on rivers in the study area. On some of the larger rivers, summer precipitation or late summer/fall snowmelt events have been observed to produce floods. **Table H-5** in **Appendix H** provides historic data of measured discharge for several rivers in the program area, and climate monitoring stream-gage locations are provided in **Map 3-13**, Agency Monitoring Stations, in **Appendix A**.

Watersheds, Rivers, and Streams

Ten major rivers and numerous smaller streams and rivers flow north from mountain/foothill and tundra watersheds that traverse the program area before flowing into the Arctic Ocean. During winter, some rivers may freeze to the bed while others have small pockets of unfrozen water beneath ice hummocks and along spring-fed reaches or exhibit flow sub-bed in unfrozen gravels. At locations where water is forced to the surface, extensive fields of aufeis may be generated and persist and melt during the summer, providing a continued source of flow. During late May to June, snowmelt begins in the foothills and proceeds to the coastal plain, providing as much as 50 percent of the annual flow to rivers (Clough et al. 1987; Sloan 1987). After spring breakup, the summer flows in the Jago Okpilak, Hulahula, and Sadlerochit Rivers are dominated by glacier meltwater (Nolan et al. 2011) **Table H-4** in **Appendix H** provides a list of the major drainage basins and water bodies in the program area, their drainage areas, other characteristics, and stream lengths.

Lakes and Wetlands

Most of the program area is considered wetland; however, lakes are very scarce (less than 2 percent of the land surface area), compared with the eastern NPR-A, where lakes cover approximately 20 percent of the land surface area, where using water from lakes for ice road building is common practice. Lakes are not evenly distributed across the program area but are concentrated 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). The low number of lakes is a function of a variety of factors, including precipitation, geology, soil type, permafrost, and topography. Lakes vary in surface area, from 1,500 acres to less than an acre and 90 percent are less than 12 acres. A study of 115 of the largest lakes indicated most are shallow and freeze to the bottom during winter (Trawicki et al. 1991). The estimated volume of liquid water in these lakes is 1.1 billion gallons by the end of the winter season. Eighty percent of this volume is concentrated in seven lakes in the Canning River Delta. One of these lakes is known to have salinity concentrations close to that of seawater.

The recharge capacity of many lakes is generally limited to snowmelt and direct precipitation near the lake. Deep lakes also have a larger thermal mass; thus, the deeper lakes may remain covered by ice into early July, much later than the shallow lakes (BLM 2014). Some lakes in the program area have been measured for lake volume (Trawicki et al. 1991), with some characteristics listed in **Table H-6** in **Appendix H**.

During winter, most water bodies on the ARCP freeze solid as they are typically not as deep as the depth of freeze, reported to be 6 to 7 feet (Trawicki et al. 1991; Lyons and Trawicki 1994). Small pockets of unfrozen water occur in lakes with depths that exceed ice growth. By the end of the winter season, the volume of liquid water in these lakes has been estimated to be reduced by 98 percent (Craig 1989). Up to 40 percent of snowmelt serves to recharge the evaporation deficit from the previous summer (Bowling et al. 2003).

Groundwater, Springs, and Aufeis

The perennial freshwater springs in the ARCP are unique, when compared with the lands to the west beyond the program area, which lack major spring-fed habitats. The source of groundwater feeding the perennial springs is thought to be limestone formations of the southern face of the Brooks Range (Kane et al. 2013). The springs are generally at an elevation of 656 to 2,953 feet asl. At elevations higher than 2,953 feet asl, groundwater lacks the piezometric head to express above the ground surface. At elevations below 656 feet asl, thick Quaternary sediments (permafrost) act as an impermeable layer to upwelling. There appears to be a correlation between the location of the springs and known mapped faults.

Spring-fed reaches maintain relatively stable flows and temperatures year-round, have relatively large productive stands of riparian vegetation, and produce extensive fields of aufeis. Aufeis formations near springs can be 20 feet high and more than 1 mile wide by the end of the winter. Aufeis persists throughout much of the summer season and represents at least a third of the cumulative annual base flow (Yoshikawa et al. 2007); some spring-fed reaches stay ice-free during the winter and provide critical overwintering habitat for high concentrations of macroinvertebrates and Dolly Varden (Craig 1989).

The most prolific springs in the program area are the Canning, Hulahula, Sadlerochit, Itkilyariak, and Katakturak, Tamayariak, and Okerokovik Springs. While locations of aufeis accumulations are fairly consistent and form each winter, their extent, thickness, and persistence varies with winter temperature and precipitation. Pavelsky and Zarnetske (2017) used satellite imagery to identify aufeis accumulations in Arctic Alaska and to determine how their extent and persistence has changed from 2000 to 2015 (Pavelsky and Zarnetske 2017). Shur et al. (2016) indicate that freeze back of streambeds can result in intra-gravel flows rising to the surface. This is due to severe winter temperatures, lack of snowfall, or other flow restrictions and results in aufeis accumulations. Other known flow restrictions are glacial moraine deposits and bedrock outcrops. Shur et al. (2016) indicate that seismic survey tracks across the Sagavanirktok delta area may have compressed snow and accelerated freeze back of the streambed, inducing aufeis growth.

Outside of the springs, usable groundwater is limited to distinct and unconnected shallow zones in the thaw bulbs of rivers and lakes, due to the presence of permafrost, which is continuous across the North Slope (Jorgenson et al. 2008). The frozen state of the soils, combined with their fine-grained characteristics and saturated conditions, form a confining layer that prevents percolation and recharge from surface water sources and prohibits the movement of groundwater. Because percolation and recharge are restricted, the formation of usable subsurface water resources is limited to unfrozen material on top of the permafrost or taliks (thawed zones) beneath relatively deep lakes, or zones in thawed sediments below major rivers and streams.

In general, while these shallow groundwater zones do exist, they are typically very small and are likely to have similar water quality as the rivers and lakes nearby (BLM 2004, Section 3.2.2.1). Shallow supra-permafrost water also occurs seasonally in the active zone above the impervious permafrost; the thickness of the active layer is typically 1.5 feet but can range from 1 to 4 feet (Gryc 1985). The USFWS (2015a) also reported that several of the streams leading from the springs can disappear into the bed and become intra-gravel flow during low discharge periods.

Nearshore Marine

There is a narrow continental shelf that extends offshore 31 to 62 miles into the Beaufort Sea. Surficial sediments of the shelf consist primarily of mud, with coarser material. The Beaufort shelf is most influenced by river input, but it is also affected by processes offshore in the deep basin, such as currents. During the open water season, surface currents are primarily wind driven close to shore. Ice covers the sea for up to 9 months, generally from September to July.

The nearshore environment is a mix of open coast and lagoons bounded by barrier islands. In summer, water along the coast becomes brackish and water temperatures can rise due to flow from the Mackenzie River and other rivers along the eastern Arctic coastline into the oftentimes still ice-covered nearshore environment. (Craig 1984; Hale 1990; Dunton et al. 2006). The lagoons are relatively shallow, the amplitude of the tides is very small (11.5 inches or less) and the currents are weak, allowing for wind to be a factor in mixing; waters can vary in temperatures (28°F to 57°F) and salinity (0 to >45%) throughout the year (Harris et al. 2017).

Water Quantity

Water quantity of lakes in the program area is limited and has been calculated and documented by the USFWS (Lyons and Trawicki 1994). There are 119 lakes with an annual ice-free volume of 55,382 acre-feet, as summarized in **Table H-6** in **Appendix H**. This volume is reduced to 3,366 acre-feet in April, when there is approximately 7 feet of ice. These values do not represent the total available quantity nor indicate suitable uses of the water, such as for ice road construction or potable uses.

Table H-5 in **Appendix H** provides the discharge statistics for many of the rivers and streams in the program area for June, July, and August for several years. The statistics include the mean, minimum, and maximum average daily values of discharge and also the calculated 7-day minimum flow and information on total runoff in acre-feet and inches of precipitation over the basin. The USGS also maintains gage 15980000 "Hulahula River near Kaktovik, AK" with discharge records from May 2011 to the present.

Water Rights

The Alaska Department of Natural Resources (ADNR) water rights records (ADNR 2019) indicate there are two water right permits issued to North Slope Public Works for water supply. The City of Kaktovik is permitted to use surface water in Navarakpuk Lake on Barter Island as its drinking water source. There are identified drinking water protection areas surrounding the lake.

The USFWS has applied for 152 instream flow reservations in the Arctic Refuge and program area to ensure the protection of aquatic habitats and wildlife. These reservations have been pending ADNR adjudication since 1994 and have seniority over any new application for water use.

Water Quality

Most freshwater systems in the program area are pristine; however, fecal contamination above State of Alaska water quality standards may occur in areas with dense avian, caribou, and lemming populations. Cold water temperatures tend to prolong the viability of fecal coliform. Most freshwater bodies in the program area have low turbidity and dissolved oxygen near saturation, except during spring breakup. According to the ADEC, no freshwater in the program area has been documented as impaired by pollutants (ADEC 2018).

Winter freeze and summer recharge cycles cause contrasting effects in water quality. During winter freezing, major ions of calcium, magnesium, sodium, potassium, chloride, sulfate, and nitrate and other impurities are excluded from downward-freezing ice and forced into the underlying sediment and in pockets of water under the ice in both streams and lakes. As the winter continues, dissolved oxygen concentrations in these pockets decrease, due to demands of decomposing organic matter (Prentki et al. 1980).

Spring snowmelt and resulting water flowing across the surface of the ice removes the cover from lakes, allowing the wind to mix the water column throughout the summer. Recharge of lakes through sheet flow during spring counteracts the effects of water loss and ion concentration caused by evaporation in the summer. The net result of the input of snowmelt waters and spring sheet flow in deeper lakes is to refresh their existing water chemistry. Lakes in the program area generally have lower pH and alkalinity values that slowly increase in the winter; this reflects the ice exclusion process, which occurs during freeze-up (Trawicki et al. 1991).

Spring breakup in streams typically increases turbidity as sediments, plant material, and other organic materials are flushed into the water system. During the peak discharge, Alaskan Arctic streams can transport more than 80 percent of the total suspended sediments for the year (Rember and Trefry 2004). The suspended solids and sediments transport on their surfaces trace metals and organic carbon downstream during this important part of the hydrological cycle in this region (Trefry et al. 2009). This period of high sediment load can temporarily decrease dissolved oxygen concentrations. The sediments and organic carbon reach the still ice-covered lagoons of the Beaufort Sea, trapping terrestrial debris in the nearshore environment (Dunton et al. 2012).

Climate Change

Climate variability would affect water resources by a longer open water season in the nearshore environment. Snow would melt sooner, which could lead to a more protracted melt and less intense runoff. Flood frequency and severity would increase. The magnitude and frequency of high flows would decline while low flows would increase, as changes in climate continue. Flows in glacier-fed streams in the ARCP would likely increase due to glacier recession. Annual runoff would vary widely from year to year (Stuefer et al. 2017). Permafrost and ice wedge degradation due to increasing temperatures is likely to have hydrological changes that would likely result in differential ground subsidence and would expand and amplify in rapidly warming permafrost regions (Liljedahl et al. 2016).

These effects on water resources are described in more detail in the GMT2 Final SEIS (BLM 2018a, Section 3.2.4).

Direct and Indirect Impacts

Issuance of oil and gas leases under the directives of Section 20001(c)(1) of PL 115-97 would have no direct impacts on the environment because by itself a lease does not authorize any on the ground oil and gas activities; however, a lease does grant the lessee certain rights to drill for and extract oil and gas subject to further environmental review and reasonable regulation, including applicable laws, terms, conditions, and stipulations of the lease. The impacts of such future exploration and development activities that may occur because of the issuance of leases are considered potential indirect impacts of leasing. Such post-lease activities could include seismic and drilling exploration, development, and transportation of oil and gas in and from the Coastal Plain; therefore, the analysis considers potential impacts on water resources from on-the-ground post-lease activities

Hydrology and water quality are closely linked, and the discussion regarding potential impacts on water resources is combined in this section. Future development activities that can affect water resources include the following:

- Gravel mining
- Placement of gravel fill for infrastructure, such as roads, pads, and airstrips
- Installation of culverts and bridges
- Construction of pipelines and VSM footers
- Construction of ice roads and pads
- Extraction of water supply from local lakes or rivers for ice roads, construction, drilling, and operation
- Wastewater discharge

The following potential future impacts on surface water quality would be similar to some of those reported for the NPR-A, as described in BLM 2012, Section 4.5.4.2, and 2004, Section 4F.2.2.2:

- Shoreline disturbance and thermokarst (marshy hollows and small hummocks formed by thawing permafrost)
- Blockage or convergence of natural drainage
- Increased stages and velocities of floodwater
- Increased channel scour
- Increased bank erosion
- Increased sedimentation
- Increased potential for overbank flooding
- Changes in recharge potential from removal or compaction of surface soils and gravel
- Produced-water spills
- Petroleum hydrocarbon spills
- Demand for water supply

The effects of climate change described under *Affected Environment* above, could influence the rate or degree of the potential direct and indirect impacts.

Alternative A

Under Alternative A, no federal minerals in the program area would be offered for future oil and gas lease sales. Current management actions and resource trends would continue, as described in the Arctic Refuge CCP (USFWS 2015a). Changes to water resources would continue to occur along current trends (climate change). No direct or indirect impacts on water resources would result from post-lease oil and gas leasing activities under Alternative A.

Impacts Common to All Action Alternatives

Changes in Surface Water Flow

Changes to surface water flow would result from the various aspects of future development and include short-term, long-term, and permanent changes to water resources from exploration, construction, and production. The effects from these activities vary in intensity and scope and involve alterations to stream stage (water level) and velocities, water quality and water volume, and surface runoff processes and drainage networks.

Sand and gravel would be mined for future construction of pads, roads, and air strips (**Appendix B**). Removing gravel from areas near (or in) streams and lakes would change stream or lake configurations, stream hydraulics, lake shoreline flow patterns, erosion, sedimentation, and ice damming (NRC 2003). Gravel extraction from streams and rivers would mobilize sediment and would increase turbidity or sedimentation at downstream locations (BLM 2012, Section 4.5.4.2, pp. 12 and 13). No specific gravel mining sites have been identified associated with the proposed leasing program; however, estimated volumes of the hypothetical development scenarios are summarized in **Appendix B**.

Gravel pits (removed from rivers or lakes) are another option for gravel and many potential sources exist at rock outcroppings in the program area. Development of these sources would create dust that could be deposited on tundra vegetation, water bodies, or the snowpack, accelerating melting. The water in a flooded gravel pit would likely remain unfrozen near the bottom, altering the thermal regime and creating a thaw bulb around and beneath the pit, potentially resulting in localized thermokarst. The steep side slopes of excavation pits would likely slough as they thaw, becoming more gradual over time and causing some slight infilling. BLM-approved reclamation plans would be required when the pit is decommissioned.

Future exploration and construction, such as the placement and construction of gravel pads, roads, air access facilities, culverts, and bridges, could affect natural drainage patterns. This would come about by creating new channels, inundating dry areas, causing ground surface subsidence under some seismic trails, and starving wetlands of water on the downstream side of roads. Stream stage (water level) and stream flow (volume) could either increase or decrease, depending on road/pad alignment. The resulting changes in stream velocity would influence erosion and sedimentation rates.

Groundwater flow can be interrupted by placing fill and compressing the active layer, potentially resulting in pooling on the upslope side of roads and pads, leading to thermokarst and blocking recharge to lakes. Groundwater flow beneath roadway embankments may increase the thaw of permafrost, thus requiring appropriate mitigation measures for flow beneath and through embankments (Darrow et al. 2013). Potential disturbance of the vegetation or water and wind erosion could initiate thawing of the upper ice-rich zones and trigger the development of thaw-lakes.

Modification of the natural surface water drainage patterns would block or redirect flow resulting in some water courses experiencing increased flow while others may experience reduced flow. Disruption of streambeds and stream banks could remove protective shoreline vegetation and lead to channel erosion and sedimentation, formation of meltwater gullies, plunge pools from perched culverts, and formation of alluvial fans in streams and lakes (BLM 2012, Section 4.4.4.2. p. 377).

An example of future construction that could affect hydrology is the displacement of a lake or pond by fill or placing fill (such as an airstrip or road) transversely across grade, thereby blocking the natural drainage patterns when the snow melts. Placing fill transversely across grade or the predominant wind direction may also change snow accumulation patterns, which, in turn, may change drainage patterns when the snow melts. Impacts on drainage patterns would increase inundation or drying of affected areas. Increased inundation may in turn increase thermokarst action in the affected areas.

Placing gravel fill on tundra would change recharge potential, block natural drainage, and change the existing hydrologic regime; erosion of roads and pads could increase sedimentation onto the tundra or into waterways. During construction, sediments and dust would be disturbed and deposited on snow and ice during the winter or on tundra and open water during the summer. The sediments and dust would be introduced into the water column, increasing turbidity and sedimentation. A road or airstrip aligned perpendicular to stream channels and the direction of sheet flow would have a greater potential to impound sheet flow and shallow groundwater than a road or airstrip aligned parallel to existing drainage patterns. Detailed descriptions related to erosion and sedimentation during the construction phase are provided in BLM 2004, Section F4.2.2.2.

Future mining pads, airstrips, and roads would be designed to account for thermal criteria (minimum thickness to prevent permafrost degradation) and hydrologic criteria to minimize potential impacts on the surrounding area, as discussed in ROPs 21 and 22.

Where gravel fill is placed in wet areas to construct a future road, pad, or airstrip, the receiving waters would temporarily have higher suspended solids concentrations, greater turbidity, and contaminant concentrations (depending on the underlying geology). Fugitive dust that enters surface water bodies would also increase turbidity and sedimentation. Further information regarding turbidity during the construction phase is provided in BLM 2004, Section F4.2.2.2.

Culverts would likely be used extensively under all action alternatives in the future for access road water crossings and to provide cross drainage. The design criteria for all culverts is such that they would avoid restricting fish passage or adversely affecting natural stream flow (ROP 22). Culverts would be installed at regularly spaced intervals to mitigate the risk of sheet flow interruption and thermokarst action. Final design of culverts depends of the spring ice breakup and snow melt characteristics for those drainages that could affect the road.

The potential impacts of increased stream velocities through culverts during floods are addressed in BLM 2004, Section F4.2.2.1. Constricting flows would increase stream velocities and a higher potential for ice jams, scour, and stream bank erosion. Impeding flows would result in a higher potential for bank overflows and floodplain inundation. These potential impacts need to be minimized by incorporating design features to protect the structural integrity of the road- and pipeline-crossing structures to accommodate all but the low probability floods. Once installed, aboveground pipelines (i.e., VSMs) would have nearly no effect on stream and water flow characteristics.

The configuration of gravel fills also affects impacts; a linear gravel pad (runway) running perpendicular to the hydraulic gradient would result in a larger extent of hydrological impacts than those running parallel to the drainage or a consolidated, square pad of similar acreage. The duration of potential impacts would be long term because the roads and pads would remain during operations and likely permanently change flow patterns.

Future pipeline construction in the program area would have effects on water resources related to ice road construction and associated water withdrawals from local lakes. Narrow drainages are typically crossed using elevated pipelines on suspension spans. Pipelines would be routed to avoid lakes. Once installed, aboveground pipelines would have nearly no impact on water flow characteristics but would affect water resources quality in the event of an oil spill.

Potential impacts on hydrology associated with construction of gravel pads, roads airstrips, and ice roads would persist through the life of an individual project, including natural drainage patterns, stream stage and stream flow, stream velocity, groundwater flow, and lake levels, as described previously. The duration of impacts would be long term because the gravel infrastructures would remain during operation. Ice roads and ice pads would be used extensively in the future for seasonal vehicle access and would require removal, breaching, or slotting stream crossings if fish passage is a concern during spring break up and their location would be controlled to avoid undue vegetation damage (ROP 11). Reclamation has not been proven for gravel removal in the arctic environment once operations have ceased. There is the potential to reclaim the gravel mines into water reservoirs suitable to support fish and wildlife habitats and potential water sources for further water use needs, if the gravel mines are near waterways (BLM 2004).

Water Withdrawals

Future water withdrawals to support components of the action alternatives would affect the water levels of lakes used as water sources and any connected water body, such as streams or wetlands. Only permitted lakes or reservoirs (under ADNR Temporary Use Authorizations and, if required, ADFG Fish Habitat Permits) would serve as water sources. Typical consumptive water use would involve the following:

- Seasonal construction of ice roads and pads
- Drilling, hydraulic fracturing, and waterflooding
- Hydrostatic testing
- Dust abatement on roads, pads, and airstrips during summer
- Potable water
- Fire suppression and maintenance

Surface water withdrawals in the future for construction of ice roads, dust abatement, and operations would affect shallow groundwater levels, surface water levels, and drainage patterns during summer season. Lakes would be the principal supply for freshwater during construction with alternatives to include a seawater desalination plant or approved withdrawals from rivers or flooded gravel extraction sites. Ice roads and ice pads would be constructed to support construction under all action alternatives for access during the winter season. Although estimates of water use for oil and gas activities on the North Slope have been made in literature, the actual amount of water used would be project specific and would be based on approved North Slope BMPs, new technology, and the specific needs of the project, such as the width of ice roads, number of camps, number of crew, and ice pad size. Under all action alternatives, no potential long-term impacts on lakes and ponds are anticipated from ice roads, ice pads, or ice bridges, as discussed in BLM 2012, Section 4.5.4.2.

The impacts of water withdrawals are likely to include changes in the active layer groundwater levels, potential drying of vegetation, changes in lake shoreline location and exposure of lakebed to wind and water erosion, changes in the local drainage pattern near lakes and interconnectivity of lakes due to water level changes. These impacts would be mitigated through ROPs 8 and 9 which require water withdrawals to be conducted in such a manner as to maintain natural hydrologic regimes in order to conserve fish and wildlife and their habitats. While analysis of potential impacts would occur in this EIS it also must be noted that for any future development to occur, the stipulations and ROPs in the lease sale would require future analysis of water use, water sources, and how much water would be allowed to be withdrawn from the source.

Future ice road construction over lakes that do not freeze to the bottom could affect dissolved oxygen concentrations. An ice road that crosses such an intermediate-depth lake could freeze the entire water column below the road, isolating portions of the lake basin and restricting circulation. With mixing thus reduced, isolated water pools with low oxygen would result. Details related to dissolved oxygen concentrations during ice road construction are provided in BLM 2004.

Changes to Surface Water Quality

Changes to water quality could occur during the exploration, construction, and operation phases of a future oil and gas development project. After construction is complete, gravel from roads, pads, and airstrips would be the main dust source; dust fallout from vehicle traffic could increase turbidity and contaminant loads in ponds, lakes, creeks, streams and rivers, and wetlands that are next to roads and construction areas. Water quality would also be degraded in the short term due to increased turbidity resulting from dust fallout, flooding, erosion, or bank failures, which could lead to changes in dissolved oxygen or other water quality changes. Changes to water quality would be subject to ADEC's water quality standards and potentially their wastewater discharge permit requirement. In atmospheric deposition, air pollutants are removed from the atmosphere and subsequently deposited in aquatic and land-based ecosystems. This can occur through precipitation or through the dry gravitational settling of particles onto soil, water, and vegetation. A primary issue of atmospheric deposition is the formation of acids, particularly nitrogen and sulfur species. This can happen as acid rain and snow, and results in the subsequent deterioration of lakes, streams, soils, nutrient cycling, and biological diversity.

A potential direct impact from winter road and pipeline construction would be disturbance of tundra soils and vegetation (see **Section 3.2.8** and **Section 3.3.1**). Disturbed and exposed soils are more susceptible to erosion and subsequent sedimentation during spring breakup of ice and subsequent flooding than undisturbed areas; however, Lease Stipulation 1 and ROPs 9, 11, and 12 dictate permissible locations and elevations of pads and other infrastructure that would mitigate the potential of disturbed soil entering the spring breakup flooding. Fugitive dust from construction could also be deposited on snow and ice during the winter. When melting occurs, this dust can accelerate melting and enter surface water bodies, increasing turbidity and contaminant concentrations, depending on the underlying geology.

Freshwater would be withdrawn from lakes in the program area in the future for several primary uses: construction of ice roads and pads, pipeline maintenance, production drilling, and potable water at camps. Water would also be used for dust control on roads. This water would be recharged in the spring when snow and ice melt increase flow volumes in connected water bodies, assuming that withdrawal rates would not exceed recharge rates, based on Lease Stipulations, ROPs, and permitting requirements.

There is a potential for wastewater discharge from future oil and gas activities, such as sanitary/domestic, secondary containment, gravel mine dewatering, and hydrostatic test water, and could increase pollutant loads to water bodies. These discharges would occur under the appropriate Alaska Pollutant Discharge Elimination System (APDES) authorization including Facilities Related to Oil and Gas Exploration, Production, and Development in the North Slope Borough GP (AKG32000), sanitary/domestic wastewater treatment facilities (AKG572000, AKG573000); however, it is more likely that wastewater would be placed in underground injection control wells under Class 1 Underground Injection Control (UIC) Well GP (2016DB0001). A thorough discussion of the water quality effects resulting from development can be found in BLM 2004, Section 4F.2.2.2.

It is likely that only treated (secondary treatment) domestic wastewater would be discharged to water bodies/wetlands with authorization from the applicable APDES permits; it is not anticipated that there would be an increase in fecal coliform counts over the naturally occurring concentrations outside of authorized mixing zones.

Drinking water resources are unlikely to be affected because not only would they have to meet State of Alaska Water Quality Standards for drinking water, the drinking water resources are located on Barter Island for Kaktovik. Barter Island is off limits to the lease sale in all alternatives. Permitting, permit authorizations, and BMPs of any oil and gas activities around the drinking water resources would mitigate any potential impacts on the resources.

Oil spills could occur in the future from pipelines, storage tanks, production facilities and infrastructure, drill rigs, and vehicles during the drilling and operation phases. Spills occurring from pipelines or oil leaving pads and roadbeds could enter water sources, reaching tundra ponds, lakes, creeks, or rivers. Spills can occur at any time during the year, but have the highest likelihood of entering the water during spring breakup flooding; however, the required Lease Stipulations 1 and 4 and several ROPs (e.g., 9, 11, 12, and 19) that require practices to be undertaken to minimize spills would decrease the likelihood that spilled contaminants would enter the water column throughout the year. The potential impacts associated with oil spills are described in **Section 3.2.11**, Solid and Hazardous Waste.

Changes to Groundwater Quantity and Quality

UIC wells are required to be used to dispose of pumpable wastes as stated in ROP 2. These wells are required by the EPA to be drilled thousands of feet below the lowermost underground source of drinking water and into deep confined rock formations. In the ACRP the permafrost ranges from 600 to 1,300 feet thick. The Class 1 UIC Wells permitted on the North Slope range in depths of 2,000 to 8,700 feet deep depending on the formation being drilled and injected into. Groundwater in the ACRP is likely to be found in thaw bulbs under rivers and lakes. The springs are thought to be fed high up in the mountains along fault lines and with the thick permafrost layer being an impenetrable layer underneath, it is unlikely that the pumpable waste products being injected into a UIC well would come into contact with the groundwater feeding springs and streams in the ACRP.

During future gravel mining, it is probable that shallow taliks and supra-permafrost water zones would be temporarily eliminated in the immediate vicinity of a gravel mine. The effect of this loss on water resources is localized if the talik network is discontinuous. Supra-permafrost water zones may be reestablished over time if the ground does not refreeze after the mine is decommissioned. The subsurface water-bearing zone would be permanently eliminated in the immediate footprint of the mine and would be replaced by surface water that is connected to the shallow groundwater. Many of these impacts would be mitigated through proper drainage design and adherence to the Lease Stipulation 1 and ROPs 9, 12, and 24.

Changes to Marine Waters

There is a potential for impact on marine water from barge docking sites, dependent on the design and mitigation efforts employed. During construction, the turbidity and TDS concentrations could increase and be short term. If dredging is required to allow boats with bigger drafts to dock, then greater turbidity and TDS concentrations are likely to be experienced short term. During all phases of the project the main impact of concern is of an oil spill. The extent of such contamination would be related to the size, nature, and timing of the spill. If a spill were to happen during the open-water or broken-ice seasons, hydrocarbons dispersed in the shallow estuarine water column could exceed acute-toxic criteria during the initial spill period but would be short term and localized. Impacts on marine waters are more thoroughly described in BLM (2018). To mitigate these impacts, the operator would be required to follow Lease Stipulation 4 preventing surface occupancy of various oil and gas infrastructure in coastal waters, lagoons, or barrier islands, and Lease Stipulation 9 requiring development of avoidance and monitoring plans, comprehensive prevention and response plans, including Oil Discharge Prevention and Contingency Plans and spill prevention, control, and countermeasure plans. Further, the operator would be required to maintain adequate oil spill response capability to effectively respond during periods of broken ice or open water.

A seawater treatment plant could be constructed on the coast to source saline water for waterflooding, reservoir pressure support, or other subsurface uses. While the nearshore marine environment has lower salinity, there are byproducts of the desalination process that include brine, filter backwash water, and rinse/cleaning water. These byproduct streams could increase salinity, iron, turbidity, total suspended solids and biochemical oxygen demand in the water body in which it is being discharged. At the discharge point before mixing can occur, the salinity would spike, creating a habitat that only marine life that can tolerate the higher salinity to survive in the discharge zone. Typically, once the discharge is allowed to mix, the water quality returns to the typical levels of the water body. Discharges of the byproducts in the future from an STP would be required to follow ROP 2 and to meet standards in the treatment plant's APDES discharge permit, including a requirement for further treatment, and potential mixing zone requirements.

Alternative B (Preferred Alternative)

Alternative B includes approximately 1,563,500 million acres available for lease sale. Lease Stipulation 1 provides setbacks (0.5 mile to 1 mile) and prohibits permanent oil and gas facilities and supporting infrastructure in the streambeds of the Canning, Hulahula, Aichilak, Okpilak, Jago, Sadlerochit, Tamayariak, Okerokovik, Katakturuk Rivers and Marsh Creek; however, essential pipelines androad crossings would be permitted through the setback areas in accordance with PL 115-97. Gravel mines could also be permitted in setback areas. The operator would be required to demonstrate that there are no practicable alternatives to locating facilities in the area, the proposed actions would maintain or enhance the resource functions, and the facility would be designed to withstand a 100-year flood event.

These actions are designed to minimize the disruption of natural flow patterns and changes to water quality for these specific water bodies. Additionally, ROPs 2, 3, 8, 9, 11, 12, 15, 16, 19, 20, 21, 22, and 24 would minimize potential impacts on water resources under Alternative B.

Alternative C

Alternative C includes 1,563,500 million acres available for lease sale. The lease stipulations and ROPs would be the same as those discussed under Alternative B, except for the inclusion of additional protections from Lease Stipulations 1 and 9. Under Alternative C, Lease Stipulation 1 increases the setback distance for the Canning, Hulahula, and Okpilak floodplains to 2 miles. Lease Stipulation 9 does not allow exploratory well drill pads, production well drill pads, and central processing facilities in coastal waters, lagoons, or barrier islands in the boundaries of the program area or 1 mile inland from the coast.

Similar to Alternative B, essential pipelines and road crossings would be permitted through the setback areas in accordance with PL 115-97. Gravel mines could also be permitted in setback areas. The operator would be required to demonstrate that there are no practicable alternatives to locating facilities in the area, the proposed actions would maintain or enhance the resource functions, and the facility would be designed to withstand a 100-year flood event. Also, ROPs 2, 3, 8, 9, 11, 12, 15, 16, 19, 20, 21, 22, and 24 would minimize potential impacts on water resources under Alternative C.

Alternative D

Alternatives D1 and D2 provide the most protections for water resources impacts by both increasing setbacks, by decreasing the total acreage allowed for lease sales, and restricting the timing of certain activities. Alternative D1 includes 1,037,200 million acres available for lease sale while Alternative D2 has been reduced from 1,037,200 to 800,000 acres. This revision maximizes high potential areas available for lease, while considering additional considerations for caribou calving and post-calving habitat. Lease Stipulation 1 increases the setback distances on rivers from Alternative B (1-4 miles) and adds additional rivers to the list for setbacks with a minimum setback of 0.5 miles from the ordinary high water mark. Lease Stipulation 2 reduces impacts on water quality by prohibiting permanent oil and gas facilities and infrastructure within 0.5 mile of the ordinary high-water mark of any water body in Townships 8 and 9 north of the Canning and

Tamyariak watersheds. Lease Stipulation 3 further protects water quality by removing areas offered for lease sale within 3 miles of the Sadlerochit, Fish Hole 1, Tamayariak, and Okeravik Springs and the east bank of the Canning River as well the area within 1 mile of the aufeis deposits created by these springs. Lease Stipulation 5 removes polar bear river denning habitat within 5 miles of the coast on selected rivers and Lease Stipulation 9 does not allow exploratory well drill pads, production well drill pads, and central processing facilities in coastal waters, lagoons, or barrier islands in the boundaries of the program area or 2 miles inland from the coast.

Transboundary Impacts

It is not envisioned that any potential oil and gas activities within the program area would impact water resources quantity or quality across the international boundary other than potential spills in the coastal zone.

Cumulative Impacts

The geographic area relevant for assessing cumulative impacts for water resources is the program area. No other past, present, and reasonably foreseeable future actions that could affect water resources have occurred or would occur in the program area. It is likely that past, present, and reasonably foreseeable future oil and gas activities in the Prudhoe Bay area may increase the quality and quantity of infrastructure that would make oil and gas development in the program area more profitable or likely. Alternative A would not contribute to cumulative impacts on water resources from post-leasing oil and gas activities, as there would be no direct or indirect impacts associated with this alternative. All alternatives, including Alternative A, would have impacts associated with climate change. These would include permafrost thaw, changes in surface water quantity and quality, and changes in groundwater availability and quality.

3.2.11 Solid and Hazardous Waste

Affected Environment

The Coastal Plain has had limited human or industrial activity that could result in solid or hazardous wastes being introduced into the environment. Kaktovik is the only community in the Coastal Plain; however, it is excluded from the program area boundary under PL 115-97. Solid, human, and hazardous wastes identified in the Coastal Plain are related to industrial activities or community development typically along the coast.

Industrial activity consists of past Department of Defense (DOD) Distant Early Warning (DEW) line facilities and Long-Range Radar Sites (LRRS) at Brownlow Point, Collinson Point, Barter Island, Griffin Point, and Nuvagapak Point. Construction of these facilities began as early as 1947, with the main installations built in 1952 and 1953. Brownlow Point was abandoned in 1958, Collinson Point and Nuvagapak Point were active between 1953 and 1962. Griffin Point was active between 1953 and 1957, and Barter Island White Alice Communications System was deactivated in 1979 and replaced with a minimally attended radar in the mid-1980s.

Most of the DOD's cleanup and building demolition occurred in 1994, 2000, and 2006. Community development is associated with public facilities in Kaktovik. Most facilities and sites are on the coast at Brownlow Point, Collinson Point, Barter Island, Griffin Point, and Nuvagapak Point. See **Section 3.4.1**, Landownership and Use, for a further discussion of Kaktovik facilities and DOD facilities and activities.

Appendix I identifies the facilities near the program area that are required to be registered with the EPA or ADEC for discharges associated with the Clean Air Act or the Clean Water Act; identifies ADEC authorized solid waste facilities closest to the program area; identifies ADEC documented contaminated sites, all of which are shown on **Map 3-14**, Hazardous Waste Sites, in **Appendix A**; and lists of spills near Kaktovik, Alaska.

Direct and Indirect Impacts

Issuance of oil and gas leases under the directives of Section 20001(c)(1) of PL 115-97 would have no direct impacts on the environment because by itself a lease does not authorize any on the ground oil and gas activities; however, a lease does grant the lessee certain rights to drill for and extract oil and gas subject to further environmental review and reasonable regulation, including applicable laws, terms, conditions, and stipulations of the lease. Such post-lease activities could include seismic and drilling exploration, development, and transportation of oil and gas in and from the Coastal Plain; therefore, the analysis considers potential impacts on solid and hazardous materials from on-the-ground post-lease activities.

Potential impacts from the future development and operation of facilities identified in the hypothetical development scenarios (**Appendix B**) include the generation of solid waste, wastewater, produced fluids, drilling muds, fire-fighting foams, and spills of oil, saltwater, and hazardous substances. Analysis of these impacts is tiered from information contained in the GMT2 Final SEIS (BLM 2018a), and the NPR-A IAP/EIS (BLM 2012); the updated information from the spills database were used to supplement the analysis below.

Spills can originate from pipelines, storage tanks, production facilities and infrastructure, drilling rigs, heavy equipment or vehicles, and marine transport of supplies. Impacts from spills vary, based on material type, size, and season. For this analysis, the materials that could be spilled associated with post-lease activities are categorized and described as follows:

- Produced fluids are composed of crude oil, natural gas, and brine and formation sand.
- Crude oil is oil separated from the brine, natural gas, formation sand, and other impurities and would be transported in the proposed pipeline.
- Refined oil is Arctic diesel, Jet-A 50, unleaded gasoline, hydraulic fluid, transmission oil, lubricating oil and grease, waste oil, mineral oil, and other products.
- Saltwater is treated water from the STP.
- Other hazardous materials are methanol, propylene and ethylene glycol (antifreeze), water soluble chemicals, corrosion inhibitor, scale inhibitor, fire-fighting foam (aqueous film forming foam), drag reducing agent (e.g., DRA Flo XL), and biocides.

Spill impact quantities are categorized and described as follows (taken from BLM 2004, Section 4.3.2.3):

- Very small spills, less than 0.24 barrels (10 gallons)
- Small spills, 0.24 to 2.37 barrels (10 to 99.5 gallons)
- Medium spills, 2.37 to 23.7 barrels (100 to 999.5 gallons)
- Large spills, 23.8 to 2,380 barrels (1,000 to 100,000 gallons)
- Very large spills, greater than 2,380 barrels (100,000 gallons)

Based on the GMT2 Final SEIS (BLM 2018a), more than half of the North Slope spills were less than 0.24 barrels (10 gallons) and approximately 98 percent of the total volume released resulted from spills larger than 2.37 barrels (99 gallons) (BLM 2014, Section 4.5.2). The probability of a spill over 2,380 barrels (100,000 gallons) is low, one event per 1,000 wells (BLM 2004, Section 4.3.1 and Section 4.3.2.2)—only three documented spills have been greater than 2,380 barrels (100,000 gallons) (BLM 2014, Section 4.5.2). Upon detection, spills have been contained and cleaned up, as required by federal, state, and NSB regulations (NRC 2003). ADEC recorded an annual average of nearly 400 spills between 1995 and 2018. During this same time period a total of 44 spills were greater than 238 barrels (10,000 gallons) and six were greater than 2,380 barrels (100,000 gallons) (Appendix I, ADEC 2018d).

Spills as a result of the development and operation of facilities identified in the hypothetical development scenarios (**Appendix B**) would occur on or close to oil field infrastructure (BLM 2004, Section 4.3.2.3). Most Alaskan North Slope industry spills have been contained on gravel pads and roadbeds (BLM 2012, Section 4.2.2), and most of the spills that reach the tundra have affected fewer than 5 acres (BLM and MMS 1998). Natural or anthropogenic-assisted restoration from these spills has generally occurred within a few months to years (NRC 2003).

The season in which a spill occurs can dramatically influence its behavior, impacts, and the cleanup response actions (BLM 2004, Section 4.3.2.3). The active soil layer in the program area ranges from less than 1 foot to 5 feet and is on average 2 feet thick; it consists of poorly drained, unconsolidated sediments, transected by fluvial deposits of rivers and streams. Dispersal of spilled materials would likely occur at or near the ground surface, as permafrost would likely inhibit infiltration of oil, saltwater, or hazardous substances. Permafrost is at least 1,000 feet thick, except in isolated areas of natural thaw near deep lakes, springs, or rivers and areas of thaw worsened by climate change and anthropogenic earth-disturbing activities. **Table 3-16** describes potential spill behavior during the four seasons and has been taken from the Alpine Satellite Development Plan EIS (BLM 2004).

Table 3-16
Spill Characteristics by Seasons

Season	Conditions[16]	Description
Summer (ice-free)	Most rivers and creeks are ice-free or flowing; ponds and lakes are open water; tundra is snow-free; and biological use of tundra and water bodies is high. Open water in the Beaufort Sea.	Currents, winds, and passive spreading forces would disperse spills that reach the water bodies, including the sea. Spills to tundra would directly affect the vegetation, although the dispersal of the spilled material is likely to be impeded by the vegetation. Spills to wet tundra may float on the water or be dispersed over a larger area than would spills to dry tundra or to snow-covered tundra. Spills under pressure that spray into the air may be distributed downwind over substantial areas and affect the tundra vegetation and water bodies. Spills in flooded areas, especially flowing waters would distribute spilled materials to adjacent and/or distant terrestrial and tundra pond/lake habitats.
Fall (freeze-up)	Water bodies are beginning to ice over, but the ice cover might vary, depending on temperature, wind, currents, and river flow velocities. Snow begins to cover tundra, and most of the migratory birds are leaving the North Slope.	Spilled material could be dispersed when it reaches flowing water but slowed or stopped when it reaches snow or surface ice. The spilled material could be contained by the snow or ice but dispersed if the ice breaks up and moves before it refreezes. The spilled material also could flow into ice cracks to the underlying water, where it could collect.

[16] Beaufort Sea characteristics are based on two seasons summer (July to September) and winter (October to June)

Season	Conditions[16]	Description
Winter (ice cover)	Water bodies, including the Beaufort Sea, are covered by mostly unbroken ice, and snow covers the tundra.	Dispersal of material spilled to the tundra generally would be slowed though not necessarily stopped by the snow cover. Depending on the depth of snow cover as well as temperature and volume of spilled material, it may reach the underlying dormant vegetation or tundra ponds and lakes. Similarly, spills to rivers and creeks generally would be restricted in distribution by the snow and ice covering the water body, compared to seasons when there is no snow or ice cover. Spills under the ice to creeks, rivers, and tundra ponds and lakes might disperse slowly, as the currents are generally slow to nonexistent in the winter. Barge transports would not occur during the winter.
Spring (breakup)	Thawing begins in the higher foothills of the Brooks Range and river flows increase substantially and quickly, often to flood stages. This is a short period of the year. These increased flows cause river ice cover to break up and flow downriver. River floodwaters usually flow over sea ice, which hastens the breakup of the sea ice. Snow cover begins to melt off the tundra and many migratory species, especially birds, return to the tundra.	Spills to water bodies during breakup are likely to be widely dispersed and difficult to contain or clean up. Spills to the tundra might be widely dispersed if the flooding overtops the river and creek banks and entrains the spilled material. Spills in flooded areas, especially flowing waters would distribute spilled materials to adjacent and/or distant terrestrial and tundra pond/lake habitats.

The rate of potential oil, saltwater, and hazardous substance spills from the hypothetical development scenario (**Appendix B**) is likely to be lower than the history of the past 30 years of oil exploration, development, production, and transportation on the North Slope. The combination of federal and state regulations, continually improving industry operating practices, and advancements in best available control technology reduce the probability and size of future spills (BLM 2004, Section 4.3.1).

Alternative A

Under Alternative A, current management actions would be maintained, as described in the Arctic Refuge CCP (USFWS 2015a). There would be no generation of solid waste, wastewater, or spills of oil, saltwater, or hazardous substances in the Coastal Plain associated with future post-leasing oil and gas activities under Alternative A.

Impacts Common to All Action Alternatives

The hypothetical development scenario (**Appendix B**) identifies development activities in the program area and the potential timing of these activities that would require the management of solid waste, wastewater, and hazardous waste.

All action alternatives would generate solid waste, consisting of food wastes, sewage sludge, fire-fighting foam, and other nonhazardous burnable and unburnable wastes from future oil and gas exploration, development, production, abandonment and reclamation. Solid wastes would be separated and stored in large trash receptacles or approved containers, as part of the CPF, until they are incinerated or transported to an approved landfill outside the Coastal Plain, such as the landfill near Prudhoe Bay. Wastes that cannot be incinerated would be transported to approved offsite landfills. Burning waste would temporarily affect air quality.

Use of injection wells (Class I or Class 2) in the future would be used to dispose of wastewater, produced water, spent fluids, and chemicals, as approved by the EPA, the AOGCC, or ADEC. Injection wells would be used to dispose of wastewater generated from the estimated field use of 2 million gallons per day. As a result, injection of wastewater reduces potential impacts on surface waters or the land by injecting wastewater deep underground into zones isolated from drinking water sources.

The potential occurrence of spills does not depend on any alternative chosen, as spills are not a planned activity and are unpredictable in cause, location, size, time, duration, and material type (Mach et al. 2000). **Table 3-17**, taken from the Alpine Satellite Development Plan EIS, describes the relative rate of occurrence for spills from main sources.

Table 3-17
Relative Rate of Occurrence for Spills from Main Sources

Source	Spill Size				
	Very Small (< 0.24 barrels (10 Gallon))	Small (0.24–2.37 barrels (10—99.5 Gallons))	Medium (2.38–23.8 barrels (100—999.5 Gallons))	Large (23.8–2,380 barrels (1,000—100,000 Gallons))	Very Large (>2,380 barrels (100,000 Gallons))
Produced fluids	H	H	M	L	VL
Saltwater	H	H	M	L	VL
Diesel	H	M	L	VL	0
Sales oil	M	M	M	L	VL
Bulk storage tanks and containers of pads	L	L	L	VL	0
Tank vehicles	H	M	L	VL	0
Vehicle and equipment operation and maintenance	VH	VH	M	VL	0
Other routine operations	VH	VH	H	L	VL
Drilling blowout	VL	VL	VL	VL	VL
Production uncontrolled release	VL	VL	VL	VL	VL

Notes:
VL = Very low rate of occurrence
VH = Very high rate of occurrence
L = Low rate of occurrence
M = Medium rate of occurrence
H = High rate of occurrence
0 = Would not occur

Likewise, the potential discharge of fire-fighting foams does not depend on any alternative chosen, as the use of fire-fighting foams would be for planned training events or unplanned emergency response events (see ROP 2).

Alternative B (Preferred Alternative)

Potential impacts on solid and hazardous waste from post-leasing oil and gas activities under Alternative B would be the same as identified above for all action alternatives.

Alternative C

Impacts on solid and hazardous waste from post-leasing oil and gas activities under Alternative C would be the same as identified above for all action alternatives.

Alternative D

Impacts on solid and hazardous waste from post-leasing oil and gas activities under Alternative D would be the same as identified above for all action alternatives.

Transboundary Impacts

There would be no direct or indirect transboundary impacts associated with solid and hazardous waste other than potential spills occurring in the coastal zone.

Cumulative Impacts

Cumulative impacts include the existing 34 spills of approximately 388.4 barrels (16,313 gallons) of oils, saltwater, or hazardous substances near the developed areas of Kaktovik, and potential spills from the hypothetical development scenario. Over half of documented spills associated with oil and gas operations are less than 10 gallons, and detected spills are promptly contained and cleaned up to federal, state, and borough regulations. Because there are no direct or indirect impacts on solid and hazardous wastes associated with Alternative A, there would be no contribution to cumulative impacts under that alternative.

3.3 BIOLOGICAL RESOURCES

3.3.1 Vegetation and Wetlands

Affected Environment

The program area encompasses much of the broad, treeless ARCP, including portions of the northern foothills of the Brooks Range and the Beaufort Sea coast, between the Canning and Staines Rivers to the west and the Aichilik River to the east (**Map 1-1** in **Appendix A**). This area includes portions of two broad ecoregions, the Beaufort coastal plain and the Brooks foothills (Nowacki et al. 2003; Jorgenson and Grunblatt 2013, **Map 3-15**, Ecoregions, in **Appendix A**). The Beaufort coastal plain generally is characterized by flat and very gently sloping tundra and the Brooks foothills by increasingly undulating terrain inland toward the Brooks Range. Within these two ecoregions are four subregions or eco-subsections: coastal lagoons, lowland peatlands (wet tundra), well-drained colluvium (upland moist tundra), and broad floodplains (shrub thickets) (Jorgenson and Grunblatt 2013; USFWS 2015a).

Vegetation

The vegetation mapping chosen to quantify the coverage of each vegetation type in the program area (**Map 3-16**, Vegetation, in **Appendix A**) was prepared by the Alaska Center for Conservation Science (ACCS) (ACCS 2016; Boggs et al. 2016); the development of vegetation mapping is discussed further in **Appendix J**. **Table J-1** in **Appendix J** provides estimates of the area covered by each vegetation class, based on the ACCS (2016) land cover mapping reproduced for the program area (see **Map 3-16** in **Appendix A**).

The vegetation type descriptions below were developed using data sources that provide information at the plant community level for the specific vegetation types in the program area (Viereck et al. 1992; USFWS 2015a). **Table J-2 in Appendix J** provides detailed tabular information on characteristics of each mapped vegetation type within the program area.

<u>Waters</u>

The Freshwater or Saltwater vegetation type comprises 9 percent of the program area, primarily consisting of nearshore water in the coastal lagoons between the mainland and the barrier islands (**Table J-1** in **Appendix J**). Freshwater lakes and ponds comprise a smaller proportion of this type, which include permanent waters occupying lowland basins and in the river deltas and abandoned floodplains, where flooded oxbow lakes are common. Perennial riverine waters are also included in the broad waters category and are typically upper or lower perennial rivers and streams ranging from small, meandering low-gradient streams to wide braided glacial rivers.

Wet Herbaceous Meadow

Wet herbaceous vegetation types include freshwater and brackish water aquatic (marsh) vegetation, and saturated and semi permanently flooded freshwater wetlands. The Herbaceous (Wet-Marsh/Tidal), Herbaceous (Marsh) types combined account for less than 2 percent of the program area (**Table J-1** in **Appendix J**).

The Herbaceous (Wet) vegetation type accounts for 16 percent of the program area (**Table J-1** in **Appendix J**). It is primarily found in low-lying drained lake basins, intermingled with moist tundra and ponds. The surface indicators of permafrost may be present and include low-centered polygons or strangmoor; this type has a limited occurrence on headwater stream floodplains (USFWS 2015a). See **Appendix J** for individual species that characterize this vegetation type.

Moist Herbaceous Meadow

Moist herbaceous meadow types are dominated by graminoids[17] and forbs,[18] often growing alongside dwarf shrubs. Moist herbaceous meadow comprises the most common group of vegetation types in the program area. These types grow on reasonably well-drained but low-lying Coastal Plain substrates in flat or gently sloping terrain and undulating terrain in the northern Brooks Range foothills. Surface indicators of permafrost (ice wedges in particular) in the form of polygonized patterned ground are often present in flat or gently sloping areas. In such areas, raised centers of high-centered polygons or raised ridges of low-centered polygons support moist tundra habitats, while the low troughs or polygon basins support wet herbaceous types (see *Wet Herbaceous Meadow* above) (USFWS 2015a).

Moist herbaceous meadow types include Herbaceous (Mesic) and Tussock Tundra (Low Shrub or Herbaceous); combined, these types account for 59 percent of the program area (**Table J-1** in **Appendix J**). See **Appendix J** for individual species that characterize this vegetation type.

Dwarf Shrub

Dwarf Shrub and Dwarf Shrub-Lichen, combined, encompass less than 1 percent of the program area (**Table J-1** in **Appendix J**). Dwarf prostrate shrub communities (heights of less than 8 inches) have a dry to mesic moisture regime. Dry sites are characterized by lichens or bare ground, or both, throughout the understory, whereas moist sites tend to support grasses, sedges, and mosses throughout the understory. Dry dwarf shrub typically occupies raised and well-drained topographic features in the Coastal Plain, such as steep riverine banks and alluvial fans where little snow accumulates during winter. Moist sites generally have less topographic relief and a deeper snowpack that protects the vegetation from abrasion and desiccation by winter winds (USFWS 2015a). See **Appendix J** for individual species that characterize this vegetation type.

Low and Tall Shrub

Tall Shrub (Open-Closed) communities are most often associated with riparian zones along rivers and streams and account for less than 1 percent of the program area (**Table J-1** in **Appendix J**). Shrub heights in tall shrub communities are variable, ranging from 60 to 118 inches tall. Shrub density also varies, depending on the frequency of overbank flooding and drainage of the substrate. The low and tall shrubs are primarily deciduous, dominated by willows (*Salix* spp.).

[17]Grass-like plants, including sedges, rushes, and grasses
[18]Herbaceous, broad-leaved, vascular plants

Low Shrub communities 8 to 60 inches tall also occur in riparian zones and in the larger expanses of tussock-shrub tundra in upland areas. This community accounts for 15 percent of the program area (**Table J-1** in **Appendix J**). See **Appendix J** for individual species that characterize this vegetation type.

Bareground

The Bareground type covers approximately 1 percent of the program area (**Table J-1** in **Appendix J**). Vascular plants are scattered or absent, and bare soil is the dominant feature. This land cover type is most commonly found on exposed riverine surfaces or intertidal beaches; it occurs on a limited basis at higher elevations in the Brooks Range foothills.

Rare Plants

There are no federally listed, threatened, or endangered plant species known to occur in the program area (USFWS and NMFS 2014). The ACCS maintains a listing of ranked, rare vascular plant species in Alaska, provides updates to a rare plant field guide, and manages a database of rare plant occurrences (ACCS 2018a; 2018b). To obtain a preliminary listing of rare plants, the BLM searched the ACCS rare plant occurrence database for all known records in the program area; this search resulted in 14 vascular plant species with Alaska state rankings, 5 of which are BLM watchlist species and 4 that are BLM sensitive species (**Table J-4** in **Appendix J**).

The BLM monitors a list of 31 vascular plant species that are considered rare on the North Slope, including on the ARCP (Cortés-Burns et al. 2009). Based on the presence of appropriate habitats, there are 19 additional taxa on the BLM list not already documented as occurring in the program area in **Table J-2** in **Appendix J** that could occur in the program area.

Nonnative and Invasive Plants

The spread of nonnative plants is limited on the North Slope of Alaska due to the short growing season, low summer temperatures, and the relative rarity of disturbed areas (Carlson et al. 2015). Historically, the region has been thought of as a low-risk area for invasive plant infestations but there is concern that invasives may become established in the program area in the near future. Disturbance vectors for transporting propagules[19] to remote locations on the North Slope are still limited but are expected to increase with industrial development in remote areas, such as the program area. Vector pathways for invasive plants are closely tied to human disturbance, primarily at regional airport hubs, along road and highway corridors, and in areas with foot traffic (Carlson et al. 2015; ACCS 2018c). With a warming climate and an increase in commercial activity on the North Slope, damage caused by invasive plants is expected to increase in the coming decades (Carlson and Shephard 2007; Carlson et al. 2015).

A review of Alaska’s statewide invasive plant database, the Alaska Exotic Plants Information Clearinghouse (ACCS 2018c), revealed no documented occurrences of nonnative plant species in the program area. The search area was then expanded to the broader ARCP and Brooks Range foothills, where infestations were documented along the Dalton Highway and at Umiat (ACCS 2018c); documented nonnative species in the broader search area were Canada thistle (*Cirsium arvense*), narrowleaf hawksbeard (*Crepis tectorum*), herb Sophia (*Descurainia sophia*), white sweetclover (*Melilotus albus*), common dandelion (*Taraxacum officinale*), and foxtail barley (*Hordeum jubatum*). These infestations were associated primarily with disturbances, such as fill importation, or extraction associated with the construction of gravel roads and pads.

[19]Any structure that can propagate a new plant, such as a shoot, root mass, or seed.

All of these species have the potential for establishing in the program area during the construction and operation phases, which may have adverse effects on the native vegetation and wetlands. According to the BLM REA the two invasive species with the highest potential for invasion in the near future are *H. jubatum* and *T. officinale*, both of which are cold tolerant, requiring 120 to 130 growing degree days (Carlson et al. 2015). *H. jubatum* has a moderate invasiveness rating, whereas *T. officinale* tends to specialize in disturbed areas and does not persist once native species become reestablished.

Also of concern in recent years is invasion by the submerged aquatic vascular plant, *Elodea canadensis*. It has recently colonized lakes throughout Alaska, although this was outside the expanded search area for this study. *Elodea* has a high invasiveness rating of 79, according to the AKEPIC database (ACCS 2018c). Recent rapid spread in lower latitudes is causing increased concern for Arctic lakes, where the primary vector for transmission is float planes.

Wetlands and Other Waters of the US

The BLM used coarse-scale National Wetland Inventory (NWI) mapping for the North Slope of Alaska (USFWS 2018) to assess the extent of wetlands and wetland types in the program area. Each coarse-scale class includes numerous specific wetland types classified according to Cowardin et al. (1979). These are presented in **Table J-3** in **Appendix J**, along with hydrologic and vegetation characteristics of each broad wetland category.

Most of the landscape in the program area is considered to be jurisdictional wetland (USFWS 2018), and NWI data indicate that at least 96 percent of the program area is classified as wetlands or waters of the US; the 4 percent of the program area that is unmapped is also likely to consist of wetlands or waters (**Table 3-18**; **Map 3-17**, Wetlands, in **Appendix A**).

Table 3-18
Wetland Types Mapped in the Arctic Refuge Program Area by the National Wetland Inventory Program

Wetland Class	Area (Acres)	Percent of Program Area
Estuarine and Marine Deepwater	71,300	5
Lake	12,300	1
Freshwater Pond	5,700	<1
Riverine	53,500	4
Estuarine and Marine Wetland	9,700	1
Freshwater Emergent Wetland	1,258,300	83
Freshwater Forested/Shrub Wetland	98,000	6
Unmapped	54,700	4
Total area	1,508,800	100

Source: USFWS 2018

Wetland hydrogeomorphology in the region is driven by the combination of continuous permafrost, which impedes drainage and contributes to extensive riverine and tidal flooding, and the flat and gently sloping or undulating landscape. Isolated and possibly non-jurisdictional wetlands may be present in specific geomorphic locations; however, because of the broad extent of interconnected wetlands with subsurface hydrologic connectivity, the likelihood of isolated wetlands occurring is very small.

In the NWI mapping, 83 percent of the acreage in the program area is classified as Freshwater Emergent Wetland (**Table 3-18**); this includes all of the vegetation types dominated by herbaceous species (Herbaceous Marsh, Herbaceous Mesic, Herbaceous Wet, and Tussock Tundra). Freshwater Forested/Shrub Wetlands account for 6 percent of the program area and include Dwarf Shrub, Dwarf Shrub Lichen, Low Shrub, and Tall Shrub vegetation types. Estuarine and Marine Wetlands account for 1 percent of the program area and include the Herbaceous (Wet-Marsh and Tidal) vegetation types; vegetation types are described in the *Vegetation* section above and in **Appendix J** and **Table J-1**.

The program area is largely undisturbed, and wetland structure and function are intact. Climate change poses the most significant threat to the stability of wetlands in the program area (BLM 2018a; USFWS 2015a). As described below in the *Climate Change* section, climate change is generating a drying trend on the North Slope for lake, pond, and wetland habitats, and this is predicted to continue in the program area.

estuarine and marine deepwater, lake, freshwater pond, and riverine classifications combined account for approximately 10 percent of the program area (**Table 3-16**). Tidally influenced unvegetated mudflats may be classified estuarine and marine wetlands. Estuarine and marine deepwater habitats are all located on the Bering Sea coast.

Lakes and freshwater ponds account for only approximately 1 percent of the program area and typically occur in the low-lying areas in the large river deltas in the northwest section (**Table 3-18**). Riverine wetlands include tidal, upper, and lower perennial and intermittent waters, including instream and side-channel bars. These may be composed of unconsolidated, unvegetated alluvial material or they may support emergent vegetation. Riverine waters account for 4 percent and occur throughout the program area (**Table 3-18**).

Wetland Functions and Values

Most of the land cover types in the program area are likely to be wetlands or waters of the US subject to permitting under Section 404 of the Clean Water Act or Section 10 of the Rivers and Harbors Act. Because wetlands are ubiquitous in the program area, any development project proponent would find it difficult to avoid the loss of wetlands from the placement of fill or excavation.

Wetland functions are the chemical, physical, and biological processes that occur in the ecosystem. Wetland values or ecosystem services are the benefits that a wetland provides to human communities and ecosystems. They are used in the mitigation process to avoid and minimize losses of important functions.

ROPs designed to mitigate impacts to wetlands and wetland functions include ROPs21, 22, and 35. The reclamation plan required under ROP 35 would address the return of some ecological function to wetlands destroyed by placing fill. Programs would be developed to monitor the recovery of wetlands from indirect effects, such as fugitive dust accumulation and thermokarst development.

Section 404 of the Clean Water Act, ROP management objectives, and the Ramsar Convention (Ramsar Convention Secretariat 2010) have an interest in maintaining wetland health and function, while considering opportunities for developing undisturbed areas. The programs require regionally specific and standardized functional assessment methods to assess baseline conditions.

Statewide, Alaska has very few formally developed and regionally specific methods to systematically quantify wetland functions. Recently, however, the USACE developed a wetland conditional assessment method for the North Slope (Berkowitz et al. 2017). This method may rely on field data or be conducted remotely using off-site data. It assesses three functional groups: habitat, hydrology, and biogeochemical cycling along a gradient of anthropogenic disturbance. This method was developed to standardize the calculation of mitigation compensation metrics for the North Slope. It is most suitable in areas where development has already occurred and may be useful only in the development phase. Existing suitable methods for assessing baseline conditions would have to be modified to address specific regional characteristics of North Slope wetlands.

Wetlands in the program area are largely undisturbed by human development; thus, they remain in the reference standard condition where they are functioning normally, according to individual wetland characteristics. In general, the Freshwater Emergent Wetlands and the Freshwater Forested/Shrub Wetlands (83 percent of the program area) provide important functions that are limited in large part by the presence of permafrost. It acts as an impermeable layer, perching water within the active layer and contributing to the wetland characteristics of a large proportion of vegetation types in the program area. These wetlands do provide limited hydrologic and biogeochemical function but are typically most important for wildlife habitat functions, particularly nesting, brood-rearing, and migration staging habitat for avian species (**Table J-2** in **Appendix J**).

The wetter vegetation types in this broad class are equivalent to the Herbaceous (Wet), Herbaceous (Marsh), and Herbaceous (Wet-Marsh) (Tidal) vegetation classes. These are typically associated with freshwater or estuaries and also provide spawning and rearing habitat for fish.

Depressional wetlands such as Lakes and Freshwater Ponds are also typically most important for habitat function, providing both avian and fish habitat but also important hydrologic function, such as floodwater storage. Estuarine and Marine Wetlands, which correspond to the Herbaceous (Wet-Marsh and Tidal) vegetation type, provide important coastal erosion protection function. They also provide habitat support for saltwater-tolerant wildlife species (Berkowitz et al. 2017).

Uplands

Upland areas that do not have the hydrology, vegetation, and soils to be classified as a wetland (Environmental Laboratory 1987; USACE 2007) likely are present, but detailed field observations and fine-scale mapping would be required to assess the extent of uplands in the program area. Uplands are typically rare on the North Slope and are limited to well-drained ridge crests and other exposed areas that are typically blown free of snow in the winter; these areas accumulate little moisture throughout the year (see the descriptions of Dwarf Shrub and Bare Ground vegetation types above and in **Appendix J, Table J-2**).

Climate Change

Climate change is expected to alter vegetation and wetlands on the North Slope in the direction of more well-drained and drier habitat types characterized by a greater dominance of shrubs, and dwarf trees in protected areas. In the reasonably foreseeable future, alterations to vegetation and wetlands from climate change would also occur during the time in which the activities described above contribute to cumulative impacts. Despite projections for increased precipitation, the longer growing season and increased temperatures due to climate change are predicted to result in greater evapotranspiration rates, which in turn are expected to produce landscape-scale drying; by mid-century, the landscape may be 10 to 12 percent drier in the Coastal Plain (USFWS 2015a). This drying would alter vegetation and shallow-water systems, such as palustrine wetlands, ponds, and lakes directly, and these wetlands and water bodies are likely to be reduced in number and extent. These transitions may result in substantial changes in wildlife species assemblages, depending on the extent of habitat change (see **Section 3.3.3**, Birds, and **Section 3.3.4**). Coastal erosion would result in the continued loss of coastal vegetation and wetlands, and gradual reductions in the extent of the barrier island-lagoon system on the North Slope are also likely.

The longer growing season and increased summer temperatures are expected to promote the expansion of shrub vegetation in the program area, as has been found elsewhere on the North Slope (Tape et al. 2006) and throughout Alaska. Warming and a longer growing season is also expected to promote the northward expansion of the ranges of some plant species more typically associated with the boreal forest, such as balsam poplar (*Populus balsamifera*) (USFWS 2015a).

Additionally, increasing soil temperatures could release stored carbon to the atmosphere, thus exacerbating warming (Sturm et al. 2001a) and further promoting the direct and indirect changes to vegetation and wetlands described above. The combined effects of the drying of wetlands and water bodies and an increase in shrub plant cover would reduce the extent of sedge-dominated wetlands and lacustrine water bodies that are used for nesting and brood-rearing by many waterbird and shorebird species.

Coastal erosion and the direct loss of coastal vegetation and wetlands on the North Slope also has increased due to climate change. Increasing ocean temperatures, sea level rise, and an increase in wind-driven storm surges has resulted in a substantial increase in coastal erosion rates (Jorgenson and Brown 2005). It is expected that increasing water temperatures, reduced sea ice, sea level rise, permafrost degradation, increased storm surges, and changes in river discharge and sediment transport rates (see drying trend noted above) would continue to alter coastal habitats. A recent analysis of data for the North Slope coastline from the Canadian border to Icy Cape indicates that although some areas show accretion, the mean values across the region and a substantial majority of the shoreline transects analyzed, including barrier islands, have been eroding between the 1940s and 2010s (Gibbs and Richmond 2017). Erosion rates along the Beaufort Sea coast also were substantially greater than along the coast of the Chukchi Sea.

Lastly, the degradation of permafrost and multi-year sea ice could release persistent organic contaminants and mercury to aquatic ecosystems and wetlands (Schiedek et al. 2007).

Direct and Indirect Impacts

Issuance of oil and gas leases under the directives of Section 20001(c)(1) of PL 115-97 would have no direct impacts on the environment because by itself a lease does not authorize any on the ground oil and gas activities; however, a lease does grant the lessee certain rights to drill for and extract oil and gas subject to further environmental review and reasonable regulation, including applicable laws, terms, conditions, and stipulations of the lease. The impacts of such future exploration and development activities that may occur because of the issuance of leases are considered potential indirect impacts of leasing. Such post-lease activities could include seismic and drilling exploration, development, and transportation of oil and gas in and from the Coastal Plain; therefore, the analysis considers potential impacts on vegetation and wetlands from on-the-ground post-lease activities

Potential impacts on vegetation and wetlands were evaluated for all areas available for development under each alternative, as identified in **Table 2-3** in **Chapter 2**, and for areas of high, medium, and low HCP (**Tables J-5** through **J-12** in **Appendix J**). The quantification of potential impacts on specific vegetation and wetland types using a geographically explicit project footprint (the typical scenario for a proposed development) was not possible for this EIS because no on-the-ground actions have been authorized. Instead, the most vulnerable resources that could be affected were identified by calculating the proportions of each vegetation and wetland type occurring in each lease stipulation category and HCP zone.

The hypothetical direct footprint for one anchor development oil field (consisting of a CPF, roads connecting to six satellite drill pads, a STP pad, and a 30-mile access road) was estimated at approximately 750 acres. The anchor development footprint was buffered by 328 feet, based on a dataset developed by Walker and Everett (1987). It is composed of another 6,607 acres with indirect effects on vegetation and wetlands. While some limited indirect effects may occur beyond the 328-foot buffer, this width was chosen because the best available data suggest that most measurable effects would occur in this zone.

The analysis associated with this assessment is limited by a number of factors. First, the mapping information used as the basis for the analysis are at a very coarse scale and were prepared with very little or no ground verification data. Second, the RFD provides estimated acreages per impact type for a typical anchor development; however, it was not located at specific locations, so a comparison of specific vegetation and wetland types under the alternatives was not possible. Third, much of the scientific literature conducted on impacts of oil and gas development are from the Beaufort Coastal Plain and the National Petroleum Reserve-Alaska (NPR-A). These areas have a wetter ecological regime with numerous thaw lakes, interspersed with wet meadows and marshes. The program area has some limited lowlands near the coast and in the larger river deltas but most of the area is composed of mesic and tussock tundra on gently rolling terrain.

Considering these limitations, the following analysis is constrained to evaluating total acres of vegetation types and wetlands within land use categories and hydrocarbon potential. The overall assumption is that the total 2,000 acres of development would be reached under any scenario, and vegetation and wetlands would likely be affected in the same relative proportions as on the undisturbed landscape. An additional, location-specific evaluation would be necessary, using higher resolution mapping, before any development.

The effects of climate change described under *Affected Environment* above, could influence the rate or degree of the potential direct and indirect impacts.

Alternative A

Under Alternative A, no federal minerals in the program area would be offered for future oil and gas lease sales. Current management actions would be maintained and resource trends would continue, as described in the Arctic Refuge CCP (USFWS 2015a). There would be no direct or indirect impacts on vegetation or wetlands from post-lease oil and gas activities under Alternative A.

Impacts Common to All Action Alternatives

Seismic exploration could occur across the entire program area, regardless of whether the area is available for lease., although it would be unlikely to occur in areas closed to leasing Geophysical exploration could occur on a lease by lease basis and additional NEPA analysis would be required for any proposed work. Future seismic exploration is proposed to occur during winter. Direct surface impacts would occur in a grid pattern from heavy, tracked, seismic vibrator vehicles and camp trains on skis pulled by a tracked trailer directly over the snow-covered tundra (see **Appendix B**, **Section B.7.2**). Impacts are visible in a systematic grid pattern on the tundra surface and impacts on vegetation and wetlands include changes in plant community composition and structure, altered hydrology, compacted soil, and by direct damage to aboveground structures, such as tussocks or woody stems and branches (Walker et al. 2019; Jorgenson et al. 2010).

Long-term studies have shown that the overall long-term impact of seismic vehicle traffic on tundra is low, but in some cases, impacts can still be measured up to 33 years after exploration (Jorgenson et al. 2010). Seismic vibrator lines and camp train trails on the North Slope may be visible. During summer , they would appear as a grid of green tundra that supports a higher cover of graminoid species (i.e., herbaceous plant with a grass-like morphology) than the surrounding undisturbed tundra; in the winter, they would show as depressed troughs that accumulate snow in the microtopographic low created by the passage of heavy vehicles.

Vegetation was found to be most affected during all vegetation types the first 5 years after disturbance. Long-term effects were most pronounced in the Dwarf Shrub Lichen and Tussock Tundra vegetation types, where there are lasting effects on species composition. Areas where the passage of heavy vehicles produces a deep microtopographic depression may show increasing disturbance in the form of thermokarst features that may never recover (Jorgenson et al. 2003a; Jorgenson et al. 2010). The most susceptible vegetation types to seismic impacts correspond to drier tundra types, typically saturated wetlands or possibly uplands.

Potential effects on vegetation and wetlands from seismic operations are prevented or mitigated through ROP 11, 12, and 15 (**Table 2-3**). These procedures reduce impacts by limiting surveys to the winter, when ground temperatures are below 23°F, using low ground pressure vehicles, prohibiting bulldozing, making only single passes, planning the seismic paths to vegetation types that are least sensitive, and providing monitoring follow-up with interested agencies.

Studies on BMPs for winter off-road vehicle traffic suggest that the impacts could be mitigated by using vehicles that exert fewer pounds per square inch and performing seismic operations later in the winter, when there is more snow cover and soils are frozen deeper (Bader and Guimond 2004; Bader 2005).

The overall effects of seismic exploration ,may be difficult to eliminate in part because the program area is in an area of overall low snow accumulation. (Walker et al. 2019). While impacts to sensitive vegetation types can be limited with planning, Tussock Tundra is prevalent in the area and cannot be entirely avoided. Overall, impacts on the program area, particularly in areas of sensitivity, have the potential to be measurable and sustained or even worsen over the long term. According to a long-term study on the effects of ice road construction and operation in the NPR-A, ice roads cause measurable damage to the vegetation in the short term (0 to 5 years) but would recover to pre-construction conditions after approximately 20 years. Similar to seismic train impacts, ice roads disturb the drier, shrub-dominated vegetation types (Herbaceous [Mesic], Tussock Tundra, and Low Shrub) to a greater degree than wetter graminoid-dominated communities (Herbaceous [Wet], Herbaceous [Marsh]). The damage was found to be due to the freezing of plant tissues in ice, in those species not adapted to inundation in water and then ice during winter, as well as the clipping of high microsites, such as raised tussocks that form in tussock tundra or shrub branches in low shrub vegetation types (Guyer and Keating 2005).

Compaction of the soil and surface organic layers is also a potential effect of ice-road construction. BMPs include building ice roads along the wettest routes and avoiding the clipping of vegetation above the ice surface and avoiding multi-season ice road construction along the same path. The most vulnerable wetland types to ice road construction and use are in the broad category of Freshwater Forested/Shrub wetlands.

The primary impact on vegetation and wetland types from construction (development) is permanent loss of those types due to the placement of fill for the construction of roads, pads, VSMs for pipeline footings and gravel excavation. The removal of surface layers for gravel extraction in material sites also results in permanent loss of vegetation and wetlands. No vegetation or wetland types are more or less vulnerable to gravel fill, but the routing for roads and pads is preferentially located in drier vegetation types such as tussock tundra, herbaceous (mesic) tundra, and low shrub. Ice roads and pads also continue to be used during the construction phase to transport and stockpile materials. The effects of ice roads and pads would be the same as described in the *Exploration* section above.

During construction, vegetation and wetland plant community composition can be altered through the deposition of dust and gravel spray from vehicle traffic, alterations to drainage patterns from drifted snow, impounded drainages, the potential for introduction of invasive or noxious nonnative plants, and the potential for oil, water, and drilling mud spills to the tundra surface (see **Section 3.2.11** for a discussion of spills). Dust fallout due to traffic on gravel road surfaces has been shown to occur up to 328 feet from the edge of the footprint (Myers-Smith et al. 2006). Dust particles may reduce plant growth by smothering the vegetation and may reduce wetland function by introducing pollutants.

Gravel roads and pads tend to increase the occurrence of thermokarst next to the footprint edge, with ponded areas extending into the adjacent tundra and altering the vegetation and wetland plant community structure (Raynolds et al. 2014). Ponding also may occur if existing subsurface drainage is impeded at the edges of roads or if changes to patterns of snow drifting increases meltwater.

Invasive species infestations are a growing threat to the relatively pristine vegetation and wetland types on the North Slope and in the program area. Gravel sources and vehicle tracks contaminated with invasive plant propagules have been shown to be the most likely way for invasive plants to be dispersed (ROP 43) (Carlson and Shephard 2007).

Gravel excavation on the North Slope results in an open pit that gradually fills with water. Abandonment and reclamation of such areas typically involves recontouring the pit edges and stabilizing the resulting shore with planted vegetation.

Due to continuous permafrost, pipelines are typically constructed aboveground, which introduces the potential for damage due to oil spills and less severe long-term effects of shading and snow accumulation on vegetation and wetlands below the pipeline. Spill effects would range in severity and impacts would be evaluated on a case-by-case basis. Lease Stipulations 4 and 9 and ROP 33 require operators to develop adequate spill response plans before construction begins.

Little to no data are available on the effects of pipeline shading and snow drifting on vegetation and wetlands. Pullman and Lawhead (2002) evaluated the effect of snow drifting on wildlife passage and concluded that the snow drifts were not continuous and were related to the orientation of the pipeline with respect to prevailing winds; however, snow drifts do accumulate and shading would be present throughout the year, providing late thaw in the spring and cooler temperatures throughout the growing season. Changes to the vegetation communities could be expected due to cooler soil temperatures and a decreased active layer thickness.

Impacts during future project operations (production) typically would include all the effects described for construction, except for the placement of fill and gravel extraction. In addition to preservation, avoidance, and minimization measures taken in advance of project initiation, proponents would prepare an abandonment and reclamation plan to comply with ROP 35 and the Clean Water Act, Section 404b (1). Impacts resulting in permanent loss of wetlands or vegetation through the placement of fill or excavation are not expected to recover naturally, so specialized treatments would be proposed to recover some ecological function (NRC 2003).

Through a combination of gravel removal, fertilization, and sometimes seeding, most vegetated surfaces can be returned to a functioning community within 10 to 15 years from the beginning of the reclamation project (Kidd et al. 2006). Long-term studies show that, while a self-sustaining plant community can be created that provides specific ecosystem function, the structure is still not equivalent to the surrounding undisturbed tundra 30 or more years after revegetation (Kearns et al. 2015; Jorgenson et al. 2003b).

Much of the available research to date is in the active oil field near Prudhoe Bay, which generally has a much wetter hydrologic regime than much of the program area; however, the principal challenges in that area relate to the presence of continuous permafrost and slow recolonization. The most difficult problem with disturbances caused by the placement of fill is preventing subsidence when gravel is removed. If subsidence cannot be stabilized, thermokarst may continue to worsen and the site may never recover (Kidd et al. 2006). Disturbances associated with placement of gravel fill and excavation may be unavoidable, and they represent significant impacts on sensitive wetland and tundra vegetation in the long term, even after rehabilitation.

The available data for rare plants are not sufficient to determine the range of individual species across the program area, nor are the mapping data sufficient for identifying specie-specific habitats. Impacts on monitored rare plant populations are considered to potentially occur under all proposed action alternatives. An isolated rare plant population or rarely occurring habitat is one that is at risk for loss or degradation. Updated mapping and risk analysis would be required for future proposed projects to ensure avoidance measures are taken.

Species- and location-specific data on invasive plants in the program area are also lacking. The assumption is that, since each alternative includes similar exploration, construction, and operations methods and the area of the anchor development is the same, there is an equal chance of new infestation across all alternatives.

According to the ecological risk analysis conducted by Carlson et al. (2015), none of the documented species listed in *Affected Environment* above are regarded as a significant ecological threat. The species with the greatest ecological risk is thought to be *Hordeum jubatum,* which may be an Alaska native plant. It has been spreading rapidly through the state over recent decades in straw and agricultural seed (Carlson et al. 2015). *H. jubatum* is a salt-tolerant species with extreme cold tolerance and is capable of invading a range of Coastal Plain ecosystems, including coastal-influenced plant communities. It thus has some potential to spread along with development in the program area.

The aquatic invasive species *Elodea canadensis* could invade freshwater inland lakes in the project area with increased water-based air traffic in the area. Once established, *Elodea* can alter the water flow patterns, increase turbidity and pH of the water and accumulate nutrients while reducing availability in the substrate (ACCS 2018c). Due to the remoteness of the program area *Elodea* infestations would be difficult to detect until it is well established; moreover, eradication is cost prohibitive and ineffective (Carey et al. 2016). ROP 43 is designed to prevent the introduction or spread of nonnative invasive species within the Coastal Plain.

Alternative B (Preferred Alternative)

The most common vegetation type across all areas available for lease under Alternative B is Herbaceous (Mesic) tundra, ranging from 16 percent to 43 percent of the areas open for leasing in three HCP zones (**Table J-5** in **Appendix J**). The exception is the NSO areas in the high HCP zone, where Herbaceous (Wet) vegetation is more common than Herbaceous (Mesic) Tundra and accounts for 22 percent of the area open for leasing.

The NSO requirements under Alternative B prohibit construction of permanent oil and gas facilities at stream or river crossings, unless it is unavoidable; thus, the disturbances mentioned under *Impacts Common to All Action Alternatives* would likely occur throughout the NSO/high HCP areas, but to a slightly lesser extent in these riparian areas than in the standard terms and conditions or TL areas. Vegetation and wetland types most likely to occur in riparian areas would be a higher proportion of wetter types, such as Herbaceous (Marsh) and Herbaceous (Wet) vegetation types and Freshwater Emergent wetlands. Wetter vegetation types tend to provide important wildlife habitat function, as noted above; thus, the NSO protections preferentially preserve some high functioning wetlands from impacts of road and pad construction in limited riparian areas. Furthermore, the NSO areas in the High HCP includes 31,800 acres, or 22 percent of Herbaceous (Wet), which is the most common vegetation type win that land use category. The high HCP zone for Alternative B includes a large area in the Staines and Canning River deltas and the wettest terrain in the program area (**Maps 3-6** and **3-16**).

The TL areas and areas with only standard terms and conditions in Alternative B closely match the proportion of vegetation types throughout the entire program area (**Table J-5** in **Appendix J**) and overall may be preferable for construction of gravels roads and pads. This is because they are dominated by drier types, such as tussock tundra and low shrub. The TL area (comprising inland areas of caribou calving and post-calving habitat) in the low HCP zone notably has the highest proportion of low shrub (32 percent of the area open for leasing; **Table J-5** in **Appendix J**). The percentage of low shrub in this inland area is higher than the overall proportion in the full program area.

The lease stipulations in the TL areas restrict construction between May 20 and July 20 to reduce disturbance to calving and post-calving caribou. This restriction, however, would not preserve vulnerable vegetation or wetland types because construction would be permitted outside the TL period and would still affect vegetation and wetlands. Because of the higher incidence of low shrub vegetation in the central and eastern portion of the program area, potential winter seismic and ice road impacts, as described under *Impacts Common to All Action Alternatives* above, likely would be more pronounced in the TL area under Alternative B. The predominant wetland type in all areas open for leasing under Alternative B is freshwater emergent (ranging from 42 percent to 96 percent of the areas available for leasing; **Table J-6** in **Appendix J**). This broad category includes wetlands with a range of hydrologic conditions, from marsh to saturated classes. The wetter types occurring in the broad freshwater emergent class often provide valuable wildlife habitat function but were not delineated separately in the NWI mapping used in this analysis. The NWI mapping provides information on high-value estuarine and marine deepwater wetlands and waters, which typically are high functioning as habitat for a variety of avian species that rely on estuarine wetlands and coastal lagoons during the post-breeding and fall migratory staging periods. The NSO areas in all HCP zones include a relatively high proportion of estuarine and marine habitats (**Table J-6** in **Appendix J**). As described in the *Affected Environment* section above, the estuarine wetlands in the program area tend to be wetter saltmarsh habitats that are high value primarily for geese in the post-breeding and migratory staging periods. The high-value freshwater wetland habitats that are encompassed in the freshwater emergent wetland class (**Table J-6** in **Appendix J**) have protection through the construction restrictions along rivers and streams.

Alternative C

The most common vegetation types in all areas available for lease under Alternative C are Herbaceous (Mesic), ranging from 21 percent to 56 percent of the areas open for leasing, and Tussock Tundra, ranging from 5 percent to 44 percent of the areas available for leasing (**Table J-7** in **Appendix J**). The exception is the NSO area in the high HCP zone where Herbaceous (Wet) tundra (24.6 percent of the area available for leasing), Freshwater or Salt water (29.4 percent), and Sparse Vegetation (12.0 percent) are the dominant broad-scale vegetation types (**Table J-7** in **Appendix J**).

The high habitat value, wet tundra types in the NSO riparian areas under Alternative C may still be affected, subject to approval of the specific design of an anchor field development with stream crossings. While impacts on riparian areas are still likely, the approval process may provide additional opportunity for designing avoidance and minimization measures for the most valuable wetlands.

The relative proportions of wetland types in the areas available for leasing under Alternative C generally are equivalent to the overall proportions occurring in the full program area, with Freshwater Emergent wetlands accounting for the greatest areal coverage (**Table J-8** in **Appendix J**). The NSO requirements for Alternative C have the potential to preserve, minimize, or avoid some of the highest wildlife habitat value wetlands (estuarine and aquatic vegetation). This would come about through the evaluation and approval process for stream and river crossings.

Alternative D

Alternative D1. Large areas of caribou calving habitat and springs and aufeis areas, especially in the southeastern portions of the program area, are not available for leasing under Alternative D1 (**Table J-9** in **Appendix J**). Added restrictions for the NSO stipulation include larger setbacks for riparian areas, coastal areas, caribou calving habitat, polar bear denning areas, springs and aufeis areas, the Canning River delta and lakes, and the Mollie Beattie Wilderness boundary on the southern and eastern edges of the program area (see **Table 2-3** in **Chapter 2**). The added NSO restrictions, however, would provide limited protection to common or high-value vegetation types except for the Lease Stipulation 10, which does not allow development within 3 miles of the southern and eastern boundaries of the program area where they are next to designated Wilderness.

The most common vegetation types in all areas open to leasing under Alternative D1 are Herbaceous (Mesic), ranging from <1 to 61 percent of the areas available for leasing, and Tussock Tundra, ranging from 10 to 59 percent (**Table J-9** in **Appendix J**). In the NSO/high HCP zone, the most common vegetation types are Herbaceous (Mesic) at 25 percent of the area, Freshwater or Saltwater at 24 percent, and Herbaceous (Wet) at 23 percent (**Table J-9** in **Appendix J**). The area identified in Lease Stipulation 10 as NSO is farther inland and is dominated by Tussock Tundra. Lease Stipulation 8 includes TLs for caribou post-calving habitat but would have no effect on the preservation of high-value vegetation types occurring in that area. Similarly, the TLs for Alternative D1 outside of the CSU would have no effect on the preservation of vulnerable vegetation types. Lease Stipulation 10 provides the only full protection for all vegetation types. because under Alternative D1 no development is allowed within the 3-mile setback from the Wilderness boundary (see **Table 2-3** in **Chapter 2**).

Most of the high-value estuarine and marine deepwater wetlands, as described above for Alternative B, occur in the NSO area. Outside of the NSO areas and the Wilderness boundary setback, the other lease stipulations for Alternative D1 would provide limited protection for the loss of wetlands from post-leasing oil and gas activities.

Alternative D2. Restrictions and stipulations under Alternative D2 would restrict the leasable area to 800,000 acres, primarily in the high and medium HCP zones. The most common vegetation types in these zones are Herbaceous (Mesic) Tundra, ranging from 25 to 61 percent, and Tussock Tundra, ranging from 10 to 48 percent of areas open for development (**Table J-11** in **Appendix J**). Among the wet herbaceous vegetation types Herbaceous (Wet) is most likely to be affected, ranging from 2 to 23 percent of the high and medium HCP zones. Other wet types with high wildlife habitat values, including the Herbaceous (Marsh) and Herbaceous (Wet-Marsh Tidal) occur relatively infrequently and could be avoided through avoidance and minimization planning in project design.

The area not offered for lease sale is dominated by Herbaceous (Mesic) (23 to 51 percent), Tussock Tundra (5 to 30 percent), Low Shrub (4 to 29 percent), and Herbaceous (Wet) (14 to 22 percent) vegetation types. These roughly represent the relative proportions of vegetation types throughout the program area.

The high value estuarine and tidal influenced (Estuarine and Marine Deepwater) and Riverine wetlands have the greatest probability of impacts, with the NSO land use category in the high and medium HCP zones (14 to 10 and 11 to 2 percent respectively). This is a higher proportion than the CSU and TL land use categories that are dominated by Freshwater Emergent Wetlands (**Table J-12** in **Appendix J**). As noted previously, the NSO requirements for evaluation before any streams are crossed may allow for additional avoidance and minimization planning to preserve some Riverine wetlands.

Transboundary Impacts

There would be no transboundary direct or indirect impacts on vegetation and wetland resources.

Cumulative Impacts

The oil and gas development impacts described in *Direct and Indirect Impacts*, are common on the North Slope, and any development resulting from lease sales in the program area would increase the occurrence and intensity of these common impacts. Proposed projects, such as SAE geophysical exploration in the program area, the LNG pipeline, and additional oil and gas development in the NPR-A, would have a cumulative effect on impacts. Synergistic effects may occur, where the combined effects of oil and gas developments result in the permanent loss of a rare plant population or the transmission of an invasive species results in widespread infestations throughout the North Slope.

The impacts under all alternatives would contribute to cumulative impacts on vegetation and wetlands. Alternative B would contribute the greatest potential effect and Alternative D2the least, due to restricting the leased area to a maximum of 800,000 acres. The effects of climate change described under Affected Environment above, could influence the rate or degree of the potential cumulative impacts.

3.3.2 Fish and Aquatic Species

Affected Environment

Fish Habitat

There are three primary aquatic habitats available to marine, anadromous, and freshwater species in and next to the program area: the lagoon and nearshore brackish waters of the Beaufort Sea; the rivers, streams, and springs emanating from the Brooks Range or Arctic Coastal Plain[20] (ACP) tundra; and lakes or ponds that are concentrated mostly near the Beaufort Sea coast. The quantity and distribution of these habitats throughout the program area are summarized in **Table 3-19**, **Map 3-18**, Fish Habitat and Distribution, and **Map 3-13** in **Appendix A.**

As described in **Section 3.2.10**, freshwater habitat is limited in the program area; this is the case especially during the winter, when aquatic habitat is reduced to approximately 5 percent of that available during summer. This reduction in habitat results in fewer freshwater and anadromous fish species in the program area, relative to other parts of the ACP along the Beaufort and Chukchi Seas (USFWS 2015a) (**Map 3-18** in **Appendix A**).

<u>Lagoons and Nearshore Brackish Waters</u>

Lagoons and shallow, brackish coastal waters are well understood to provide refuge/nursery habitat for juvenile fishes and for providing significant invertebrate prey for juvenile and adult fishes alike (Craig et al. 1984; Dunton et al. 2006). The nearshore brackish and marine waters within the boundary of the Arctic Refuge, included the program area, are composed of a mix of open coastline, bays, and lagoons, bounded on the north by barrier islands. There are 16 bays and lagoons along the program area coastline, representing 593 miles of coastline and nearshore aquatic habitat potentially home to aquatic species (**Map 3-18** in **Appendix A**). These productive, shallow nearshore waters provide ample foraging and refuge opportunity for smaller fish and rich feeding grounds for larger migratory fish. During summer, these waters become brackish due to freshwater input from rivers along the ACP (Dunton et al. 2006; USFWS 2015a). Many of the inside barrier

[20]The Arctic Coastal Plain is a physiographic province that includes all of the North Slope of the Brooks Range north of the Foothills province. It extends across all of northern Alaska from the Chukchi Sea to the BS. (Wahrhaftig GIS 1965)

Table 3-19
Anadromous Fish Habitat in Streams of the Program Area and Surrounding Area

Freshwater Streams	Total Anadromous Fish Habitat by Basin (Miles) [a]	Anadromous Fish Habitat in the Program Area (Miles) [a]	Streams in the Program Area (Miles) [b]
Aichilik River	51	1	–
Akutoktak River	13	13	18
Angun River	8	8	33
Canning River	125[c]	46	41
Carter Creek	13	13	22
Hulahula River	73	27	27
Jago River	35	27	37
Katakturuk River	20	20	22
Kimikpaurauk River	4	4	5
Kogotpak River	12	12	20
Marsh Creek	1	1	20
Nataroarok Creek	11	8	21
Nularvik River	3	3	3
Okpilak River	43	31	33
Sadlerochit River [d]	0	0	?28.5
Sikrelurak River	11	11	21
Siksik River	5	5	7
Staines River	18	18	18
Tamayariak River	26	26	29
West Canning River	15	15	15
Unnamed Stream Total	47	26	–
Total Streams	**587**	**316**	**392**

Other Waters	Miles	Acres
Total Lake Area [b]	–	19,000
Unfrozen Lake Area [e]	–	6,400
Coastline [f]	593	–

Notes:
[a] Johnson and Blossom 2017. Data do not exist to quantify overwintering habitat by stream; the locations of overwintering habitat in the program area are depicted in **Map 3-18** in **Appendix A**.
[b] USGS GIS 2018. Data may conflict with Johnson and Blossom 2017; some streams may show fewer miles of stream than anadromous waters in the stream. These are the best available data for stream miles and anadromous fish habitat miles.
[c] Includes Marsh Fork Canning River
[d]The Sadlerochit River has been identified as providing habitat for anadromous Dolly Varden (see **Map 3-18** in **Appendix A**), but the ADFG AWC has not been updated to reflect its addition to the catalog; thus, there are no AWC miles in this table.
[e] NSSI 2018. Dataset indicates the presence of liquid water, but not depth of water; thus, this data set overestimates potential fish overwintering habitat (unfrozen water may be range from a few inches to over 7 feet), though it is the best available information for this topic. Numbers are surface area of lakes with any portion unfrozen.
[f] NOAA GIS 2018; USFWS 2015a

island lagoons are shallow and experience reduced currents and a small tidal flux of less than or equal to 1 foot, resulting in waters that are warmer and fresher than those outside the barrier islands.

Summertime mixing of marine waters with freshwaters produces conditions favorable to many marine and anadromous fishes,[21] as well as invertebrates (USFWS 2015a); however, by late fall the lagoons become saline again as freshwater input declines. As ice forms on the lagoons the water below becomes hypersaline and very cold, the result of ion exclusion during ice formation, restricted flow between the lagoons and the open sea beyond, and freezing point depression with greater salinity. These cold, hypersaline lagoon environments become unsuitable habitats for both anadromous and marine fishes during winter (USFWS 2015a).

[21]Fish species that inhabit the ocean mostly but return to inland waters to spawn

Rivers, Streams, and Springs

The program area is underlain by continuous permafrost, which limits infiltration of surface water, resulting in a high ratio of stored water at the surface, rather than in the ground (USFWS 2015a). Data on these water resources are limited, with few datasets going back more than 5 years.

All flowing surface waters in the program area drain to the Beaufort Sea. There are at least 10 major rivers and many smaller streams in the program area, though most flow only during summer, because of snowmelt, rainfall, perennial springs, and, in some cases, glacier melt (McCart 1980; Lyons and Trawicki 1994; Rabus and Echelmeyer 1998; Kane et al. 2013; USFWS 2015a) (**Map 3-18** in **Appendix A**). During winter, stream flow ceases due to freezing. The exception to this rule is in areas with perennial spring flow, which offer the only available overwintering habitat outside of summer (Kane et al. 2013; USFWS 2015a) (**Map 3-18** in **Appendix A**). Rivers with springs provide the only available fish overwintering habitat in freshwater streams in the program area. Though there are 392 miles of streams in the program area, only 5 percent (roughly 20 miles) are habitable in winter (**Table 3-19**).

Lakes

A large portion of the program area is classified as wetlands, but lakes constitute very little of the total surface area of water for the region. Lake density from the Staines and Canning Rivers to the Aichilik River, which mark the western and eastern bounds of the program area, is lower than the ACP west of the Arctic Refuge (White et al. 2008; Arp and Jones 2009; USFWS 2015a). The central portion of the program area in particular has very few lakes. Most program area lakes are near the delta areas of the Canning, Sadlerochit, and Jago Rivers (**Map 3-18** in **Appendix A**) (USFWS 2015a). As noted in **Section 3.2.10**, Water Resources (Lakes and Rivers), as much as 80 percent of the estimated volume of liquid water during winter is concentrated in just seven lakes in the Canning River delta.

These lakes vary in surface area from less than 1 acre to approximately 1,500 acres, though most are less than 12 acres (USFWS 2015a). Most are shallow and freeze solid during winter (Lyons and Trawicki 1994). Only a fraction of the program area lakes have a small volume of unfrozen water in winter because they are shallow (less than 7 feet) and freeze to the substrate (USFWS 2015a). The lakes with remaining liquid water at the end of winter (generally deeper than 7 feet) occur mostly in the Canning River delta; thus, fish overwintering habitat is extremely limited in area lakes. The total lake surface area is 22,100 acres, with only 6,400 acres available as potentially deep, overwintering water (**Table 3-19**; overwintering acres are likely overestimated).

Fish Species

There are approximately 17 to 21 species of fish that use the program area regularly on a seasonal basis (**Table 3-20**); however, only Dolly Varden, round whitefish, burbot, ninespine stickleback, and arctic grayling overwinter in freshwater habitats in the program area (**Table K-1** in **Appendix K**). Some species are described as overwintering in other parts of the Arctic Refuge (USFWS 2015a), but they have not been confirmed in studies in the program area (USFWS 2015a); thus, a range of likely species is presented in this EIS, based on the best available information. It is also likely that additional marine species, which are not listed in **Table 3-20**, may use waters north of the program area (USFWS 2015a; BLM 2012).

Round whitefish and burbot are present in the Canning River at the western boundary but not elsewhere in the program area (Fruge and Palmer 1994; USFWS 2015a). Dolly Varden are present in three resident freshwater populations—a resident dwarf form, a lake and spring form, and residual dwarf males of otherwise anadromous populations that stay in freshwater—and several anadromous populations (McCart and Craig 1973; USFWS 2015a).

Table 3-20
Fish Species that May Use the Program Area

FAMILY	Common Name	Scientific Name	Freshwater	Anadromous	Marine
Cottidae: sculpins	Fourhorn Sculpin	*Myoxocephalus quadricornis*	-	-	+
Gadidae: cods	Arctic Cod	*Boreogadus saida*	-	-	+*
	Burbot	*Lota lota*	+	-	-
	Saffron Cod	*Eleginus gracilis*	-	-	+*
Gasterosteidae: sticklebacks	Ninespine Stickleback	*Pungitius pungitius*	+	+ brackish	-
Osmeridae: smelts	Rainbow Smelt	*Osmerus mordax*	-	+	-
Pleuronectidae	Arctic Flounder	*Pleuronectes glacialis*	-	-	+
Salmonidae: salmonids	Arctic Char [a]	*Salvelinus alpinus*	+	-	-
	Arctic Cisco [b]	*Coregonus autumnalis*	-	+	-
	Arctic Grayling	*Thymallus arcticus*	+		-
	Broad Whitefish	*Coregonus nasus*	+	+	-
	Chinook Salmon	*Oncorhynchus tshawytscha*	-	+*	-
	Chum Salmon	*O. keta*	-	+*	-
	Dolly Varden	*Salvelinus malma*	+	+	-
	Humpback Whitefish	*Coregonus pidschian*	+	+	-
	Lake Trout [a]	*Salvelinus namaycush*	+	-	-
	Least Cisco	*Coregonus sardinella*	+	+	-
	Pink Salmon	*Oncorhynchus gorbuscha*	-	+*	-
	Round Whitefish	*Prosopium cylindraceum*	+	-	-

Source: BLM 2012; USFWS 2015a
- = not applicable
* Species with designated essential fish habitat (EFH) in the program area
[a] Species that may be extremely rare or unconfirmed as present in program area waters.
[b] Some subsistence users have reported harvest take of Bering cisco (*Coregonus laurettae*), though this has not been confirmed, based on taxonomic features, such as gill raker count.

Arctic grayling occur in some lakes and in rivers with perennial springs (Fruge and Palmer 1994; USFWS 2015a). Most of the anadromous species described in **Table 3-20** use the nearshore marine area for migration or rearing. Various marine species also use the nearshore marine area, but only four are present in large numbers next to the program area (USFWS 2015a): fourhorn sculpin, arctic flounder, saffron cod, and arctic cod. Additional information on the life history attributes for fish of the program area are provided in **Appendix K**.

Aquatic Invertebrates

Though data for aquatic invertebrates in the program area are limited, it is well understood that invertebrates provide the bulk of food resources for both fish and bird communities of the ACP (Howard et al. 2000). The most productive waters for invertebrates are in coastal marine environments, where benthic and pelagic organisms are plentiful and diverse. The distribution and density of invertebrates depend on the types and quantities of habitats, including sediment and vegetation types (Dunton and Schonberg 2000). In freshwater habitats, benthic invertebrates and zooplankton are most prevalent, with the former dominating food sources for fish (Howard et al. 2000). Terrestrial insects likely contribute to freshwater invertebrate food resources for fish. For a more complete understanding of aquatic invertebrate communities in the program area and the ACP, refer to *The Natural History of an Arctic Oil Field* (Truett and Johnson 2000); however, surface freshwaters are a limited resource throughout the program area, so aquatic macroinvertebrate assemblages in freshwater would be reduced and perhaps less diverse by comparison to flowing or lacustrine waters of the ACP west of the Canning River.

Aquatic Invasive Species

An "invasive species" is defined as "a species whose introduction does or is likely to cause economic or environmental harm or harm to human health where it is introduced" (EO 13112 of February 3, 1999: Invasive Species). EO 13112 requires federal agencies to prevent the introduction of invasive species and provide for their control and to minimize the economic, ecological, and human health impacts that invasive species cause. Potential vectors for introducing aquatic invasive species include ballast-water discharge, fouled ship hulls, and equipment placed overboard (e.g., anchors, seismic airguns, hydrophone arrays). The USCG developed regulations (33 CFR 151) that implement provisions of the National Invasive Species Act of 1996. Vessels brought into the State of Alaska or federal waters are subject to these USCG regulations, which are intended to reduce the transfer of invasive species. The regulations require operators to remove "fouling organisms from hull, piping, and tanks on a regular basis and dispose of any removed substances in accordance with local, state, and federal regulations" (33 CFR 151.2035(a)(6)).

An additional concern is the potential invasion by the submerged aquatic vascular plant, *Elodea canadensis*, which has recently started to colonize lakes throughout Alaska (ACCS 2018c) (see **Section 3.3.1**).

Essential Fish Habitat

The 1996 Sustainable Fisheries Act enacted additional management measures to protect commercially harvested fish species from overfishing. Measures were added to the Magnuson-Stevens Fishery Conservation and Management Act Reauthorization (16 USC 1801–1882), including one to describe, identify, and minimize adverse effects on EFH. Pacific salmon are found in the program area in both marine water and freshwater, though at this time NMFS officially lists Pacific salmon in only freshwater.

Freshwater EFH consists of the lower reaches of some larger rivers in the western portion of the program area (**Map 3-19** in **Appendix A**). Because there is no identified spawning habitat for these species, EFH does not extend to the upstream reaches of these rivers. Pacific salmon (particularly pink and chum salmon) are found in marine waters along the entirety of the Beaufort Sea coastline; however, recent data indicate that EFH for these species on the ACP could be refined to just freshwater habitats (Echave et al. 2012; Simpson et al. 2017). Arctic cod EFH includes the marine, nearshore, and coastal lagoon waters in and next to the program area, but they may also extend into the lower, brackish reaches of larger rivers during summer.

Saffron cod are not officially listed under NMFS guidelines for EFH in the program area but are a common species in nearshore and offshore marine waters of the Beaufort Sea. It is likely that a future review of EFH would include the entirety of the Arctic Alaska coastlines as saffron cod EFH. Snow crab EFH is found in nearshore coastal marine habitats throughout the Beaufort Sea coastline to Canada, including the program area. See **Appendix P** for a more complete analysis of program area EFH relative to lease stipulations and required operating procedures found in **Table 2-3**. Additional relevant information on EFH for the Arctic, including the Beaufort Sea coastline, can be found in the NPR-A IAP/EIS (BLM 2012).

Climate Change

As discussed in BLM 2018a, climate change is affecting many variables that then affect aquatic species and habitats; such variables are precipitation, timing of ice formation, permafrost degradation, and changes to hydrologic functions and water quality, such as temperature and dissolved oxygen. Increasing temperature is expected to change climate patterns and lengthen the ice-free season, degrade permafrost, and increase evaporation, processes that contribute to surface water hydrology and may reduce (Laske et al. 2016) or increase (Stueffer et al. 2017) surface water connectivity. Reductions in connectivity from, for example drying of channels or ponds, may in turn reduce colonization opportunities for fish by limiting dispersal pathways and movement between habitats (Laske et al. 2016). This could change local species assemblages or species richness. Additionally, climate change may result in expansion or contraction of species ranges, the timing of the spawning run, and susceptibility to disease or competition for many species, including Pacific salmon (Logerwell et al. 2015; Crozier 2016)

Direct and Indirect Impacts

Issuance of oil and gas leases under the directives of Section 20001(c)(1) of PL 115-97 would have no direct impacts on the environment because by itself a lease does not authorize any on the ground oil and gas activities; however, a lease does grant the lessee certain rights to drill for and extract oil and gas subject to further environmental review and reasonable regulation, including applicable laws, terms, conditions, and stipulations of the lease. The impacts of such future exploration and development activities that may occur because of the issuance of leases are considered potential indirect impacts of leasing. Such post-lease activities could include seismic and drilling exploration, development, and transportation of oil and gas in and from the Coastal Plain; therefore, the analysis considers potential impacts on fish and aquatic species from on-the-ground post-lease activities. For a more detailed description direct and indirect impacts from post-lease activities, see Chapter 4 of the NPRA/IAP EIS (BLM 2012), GMT2 EIS (BLM 2018a), and Nanushuk EIS (USACE 2018).

As a proxy for a geographically explicit project footprint, potential impacts on fish and fish habitat are described by types of available fish habitat, scarcity of those habitats in the program area, and importance of those habitats to aquatic species.

The effects of climate change described under *Affected Environment* above, could influence the rate or degree of the direct or indirect impacts.

Alternative A

Alternative A (No Action Alternative) would not establish an oil and gas program for the leasing, development, production, and transportation of oil and gas in and from the Coastal Plain in the Arctic Refuge. Resource trends and management actions would continue as described in the Arctic Refuge CCP (USFWS 2015a). There would be no potential direct or indirect impacts on fish and aquatic species under Alternative A.

Impacts Common to All Action Alternatives

Post-oil and gas leasing activities that could affect fish and fish habitat would occur under all action alternatives, though their locations could vary. The leasing phase would have no direct or indirect impacts on fish or aquatic species, but it would likely lead to future exploration, including seismic activity and potentially construction and operation of oil and gas facilities. Potential effects on aquatic species and habitats from other phases—exploration, development, production, and abandonment and reclamation—are summarized below; locations that would incur more or fewer impacts are described by alternative in the following sections. Note that many areas with the most species diversity and density of freshwater fish—the Canning and Staines Rivers and coastal marine fish (nearshore marine, lagoon, and river delta environments)—are in portions of the program area that are designated as the areas of —high and medium hydrocarbon potential under the hypothetical development scenario (**Map B-1** in **Appendix B**).

Direct Habitat Loss or Alteration

Activities with the potential to affect fish and aquatic species include the construction and operation of new gravel roads, gravel pads, airstrips, pipelines, culverts, bridges and barge landings or docks, and gravel mining. Infrastructure would be constructed mainly during the development phase of the post-leasing program and would result in localized permanent loss or alteration of aquatic habitats due to the placement of fill. Fill for infrastructure would directly and permanently remove aquatic habitat within the fill footprint. Gravel fill would likely not be placed in water bodies due to practicability; however, fill placed near water bodies could alter aquatic habitats and indirectly affect fish, as described below in *Indirect Habitat Alteration*. Bridge piers could be located in water bodies or floodplains.

During construction of docking sites, short-term water quality changes, such as increased turbidity, could alter habitat for fish and aquatic species and disturb and displace fish. Use of culverts could directly alter aquatic habitats by replacing substrates, banks, or both with metal pipe. This would adversely affect the habitat in the long term by removing the capacity of the fill footprint to contribute nutrients or organic matter to the water body and by altering hydrology in the immediate area.

Buried pipelines, such as the STP pipe, would alter marine sediments in the fill footprint due to trenching to bury the pipe. This would adversely affect the habitat in the short term by removing invertebrate food sources and potential algal cover in the trench footprint until the invertebrate and algal resources regenerate. It would also increase sedimentation and turbidity, which may decrease habitat suitability for some species.

Gravel would be mined and transported over gravel or ice roads or both. No specific gravel mining sites have been identified under the proposed leasing program, but estimated volumes of the hypothetical development scenarios are summarized in **Appendix B**. Because gravel is often most abundant in water bodies, gravel may be mined in water bodies and directly adjacent floodplains, which would alter aquatic habitats. Existing habitats in potential mining sites would be adversely affected in the long term by the removal of substrate and the capacity of the mining footprint to contribute nutrients or organic matter to the water body.

Following gravel extraction in or next to water bodies, the excavation can then serve as a water reservoir for industrial activities. This is common practice in other North Slope gravel mines farther west (BLM 2012). If gravel is mined next to water bodies or floodplains, these impacts would be reduced, compared with those constructed directly in water bodies.

A BLM-approved abandonment and reclamation plan would be required once an excavation pit is decommissioned and would comply with ROP 35 and the Clean Water Act, Section 404b (1) guidelines. Impacts resulting in permanent loss of aquatic habitat through the placement of fill or excavation are not expected to recover naturally; thus, specialized treatments would be proposed to recover some ecological function (NRC 2003). Disturbances associated with placement of gravel fill and excavation may be unavoidable and represent significant impacts on aquatic habitat in the long term, even after rehabilitation.

Indirect Habitat Alteration: Dust and Gravel Spray

Activities associated with the post-leasing program that could cause potential dust and gravel spray effects include construction and operation of new gravel roads and gravel pads and vehicle traffic on gravel infrastructure. These activities and the impacts described below could mainly occur during the development and production phases of the post-leasing program; impacts from road use would last until the road is removed or decommissioned.

Dust and gravel spray would be generated during future gravel placement, gravel compaction, and vehicle traffic on gravel roads and pads. Road dust accumulation is greatest within 35 feet of roads, but deposition may occur over a broader area. Roughly 95 percent of dust settles within 328 feet from the road surface (Myers-Smith et al. 2006; Walker and Everett 1987). Walker et al. (2015) found even at 656 feet from the road, the underlying organic material has a gray color indicating leached dust. Dust could increase turbidity in water bodies next to roads and construction areas. This could inhibit normal physiological function in fish, such as oxygen uptake across gill membranes, and could increase sediment and gravel inputs to existing substrates. This would also have a long-term adverse effect on aquatic habitats and species by decreasing habitat quality, including through mobilization of possible contaminants specific to the underlying geology of gravel pits where sediment is mined. These sequestered chemicals or elements are not necessarily harmful themselves but could be harmful, in combination with other water chemistry attributes, such as pH.

Dust abatement would require the use of additional water resources, which are already limited in the program area, compared to other areas to the west in the ACP. For additional information on construction activities that could increase post-lease dust and gravel spray in the program area water bodies, refer to **Section 3.2.10**, Water Resources.

Indirect Habitat Alteration: Flow Alteration and Fish Passage

Post-leasing oil and gas activities that could affect flow alteration and fish passage include construction of ice roads, snow management activities, use of exploration vehicles or other off-road vehicles for seismic surveys, maintenance, and the placement of bridge piers or piles in water bodies. These activities and the impacts described below could occur during all phases of the post-leasing program; in the case of new infrastructure, they would last until removal. Flow alteration can result from obstructions in the natural flow path, either by infrastructure or by compacted ice. Compacted ice over and surrounding water bodies can delay ice melt and temporarily alter aquatic habitats. Compacted ice can change natural drainage patterns or cause water impoundments during spring break up. Delayed melt of ice roads or pads can also temporarily block fish passage, which can impede Arctic fish attempting to migrate from overwintering areas to feeding habitat during the early part of the open-water season.

As discussed in BLM (2012), many fish move upstream during breakup to access productive feeding habitat or to reach locations only accessible during spring flooding. Energy reserves in spring are typically low for most fish and additional stress or delayed access to feeding habitats could have adverse impacts. A barrier to movement could alter migration patterns to lower quality feeding habitat and increase energetic demands, which could compromise survival. Ice compaction would temporary alter aquatic habitats near ice infrastructure or near where off-road activities would occur. This could have longer-term adverse effects on fish if their migration is annually delayed.

Culverts would likely be used extensively under all action alternatives to access road water crossings and provide cross drainage. The design criteria for all culverts would follow USFWS and ADFG requirements, such that they would avoid restricting fish passage or adversely affecting natural stream flow (ROP 22). Bridges would be required at any stream crossing with anadromous fish use; however, bridge piers or piles could also alter flow due to ice blockage during spring break up. Effects would be the same as those described above for flow alteration due to ice compaction.

Indirect Habitat Alteration: Water Quantity

Post-lease oil and gas activities that could affect water quantity include water withdrawal from lakes or streams for ice roads, water supply, dust suppression, and other uses. Withdrawals would mainly occur during the development and production phases of the post-leasing program.

Water withdrawal from lakes can affect the amount of habitat available to overwintering fish, summer habitat accessibility, and habitat characteristics. Removal or compaction of snow can also increase the depth of freezing on lakes. As a result, the water quantity available in a lake during the winter can be greatly reduced.

Because unfrozen freshwater in winter is scarce in the program area, any future withdrawal from these areas would have the most adverse effects on fish. These springs and deep lakes are sensitive areas, in part because there are so few of them that they limit the distribution of fish in the program area.

ROPs 8 and 9 require water to be withdrawn to maintain natural hydrologic regimes in order to conserve fish and wildlife and their habitats. For additional information on current liquid water availability in the program area versus typical requirements for post-lease oil and gas activities, refer to **Section 3.2.10**, Water Resources.

Indirect Habitat Alteration: Water Quality

Activities that could affect water quality would mainly occur during the development and production phases of the post-leasing program. They would be as follows:

- Water withdrawal from lakes or streams for ice roads, water supply, dust suppression, and other uses
- STP discharge to marine waters
- General construction in or near water bodies
- Vehicle traffic on gravel infrastructure
- Gravel mining

Future water withdrawal from lakes in the winter could temporarily alter lake water chemistry (until spring breakup and recharge) by depleting oxygen, increasing solutes, and changing pH and conductivity. Reducing water quantity in a lake during the winter can increase the salinity of the water beneath the ice.

Construction or gravel mining that disturbs soils can increase sediment runoff, turbidity, and contaminant concentrations in streams. During future construction or mining, this would have a short-term effect on aquatic habitats and species around or immediately downstream of soil-disturbing activities. Fugitive dust from vehicle traffic could also increase local turbidity in streams around gravel infrastructure. Dust effects on aquatic habitats and species would be long term and adverse.

Discharge from a STP, such as brine, filter backwash water, and rinse/cleaning water, could alter water quality, such as by increasing the salinity and reducing dissolved oxygen in the water body into which it is discharged. Alterations would be highest at the discharge point before mixing can occur and would alter habitat conditions for aquatic species, potentially displacing them from this area.

The effects of brine discharge may be highest in the winter, when freshwater may be frozen. Effects would be particularly pronounced if the discharge is in the brackish lagoon waters that are hypersaline in winter. Anyone discharging STP byproducts would be required to follow ROP 2 and to meet standards in the treatment plant's APDES discharge permit, including a requirement for further treatment and those for potential mixing zones.

Disturbance or Displacement: Noise and Human Activity

Post-lease oil and gas activities that could cause effects related to noise and human activity are seismic surveys (use of vibroseis to image the subsurface) during the exploration phase and gravel mining (dredging or explosives) and pile driving for bridges or VSMs during the development and production phases.

Future seismic exploration is proposed for during winter (**Appendix B**, **Section B.7.2**). Seismic surveys generate increased sound pressures in water bodies. The high-intensity acoustic energy produced by seismic surveys can damage auditory sensory hair cells in fish, reducing their ability to hear (McCauley et al. 2003; Popper 2003; Smith et al. 2004). Underwater shock waves can also injure the swim bladder and other organs and tissue, which could injure or kill fish. Increased sound pressures in unfrozen springs in winter could stress fish because they would not have alternate habitats where they could move to avoid effects; thus, seismic surveys could disturb, injure, or kill fish in unfrozen water bodies (springs) in the winter. Vibroseis rigs operating on the ice overhead can create sound pressures great enough approximately 33 feet from the source to cause avoidance behavior (Greene 2000, and Nyland 2002, as cited in BLM 2012). While vibroseis has been shown to disturb fish and cause avoidance, the impacts are thought to be minimal if careful guidelines are followed (Morris and Winters 2005). Effects are further detailed in BLM 2012 and USACE 2018.

Noise generated by vehicles, machinery, and ships, the use of marine barge routes in the future could have local impacts on fish, such as disturbance, displacement, and stress-induced fleeing. Fish have exhibited avoidance behaviors when confronted with noisy vessels (refer to Chapter 4 of the NPRA/IAP EIS [BLM 2012] for more information on noise impacts).

Noise associated with vehicles and machinery would be greatest during construction but would occur to a lesser degree throughout the program area during the life of any development projects. Because most construction would occur in the winter when water bodies would have ice cover, noise effects on fish would be reduced during that time.

Noise associated with shipping would be more infrequent. The hypothetical RFD scenario (**Appendix B**) anticipates two vessels per year on average. It is well known that noise associated with shipping, or even noise from onshore activities being projected to offshore environments, may increase stress cortisol levels, inhibit intraspecies communication, and even contribute to hearing loss in fish (Thomsen et al. 2006; Vasconcelos et al. 2007). These effects may be more pronounced in areas with alternating sound wave amplitude and frequency—that is, quiet followed by loud noises—versus areas with continuous noise (Wysocki et al. 2006). The hypothetical RFD scenario is applicable to the program area, and speculation beyond where marine vessel traffic would go is beyond the scope of this analysis.

Injury or Mortality: Noise

Post-lease oil and gas activities that could affect fish and aquatic species from noise include seismic surveys (use of vibroseis to image the subsurface), gravel mining (dredging or explosives), and pile driving for bridges or VSMs. Impacts from seismic surveys would mainly occur during the exploration phase, while gravel mining and pile driving would mainly occur during development and production.

As described above in *Noise and Human Activity*, noise can disturb fish, and, at higher dB or in greater intensity, it can injure or kill fish. Restricting seismic surveys to winter when water bodies (except springs) are frozen and avoiding areas around springs would minimize effects on fish.

Pile driving can also create sound levels that affect fish. Assuming that piles would be installed in winter, if the bridge or VSM sites freeze to the bottom, the ice would diminish the sound, and the potential impact on fish in any adjacent overwintering habitats would be negligible.

Entrainment

Post-lease oil and gas activities that could cause effects related to entrainment include gravel mining and water withdrawal from lakes or streams or from marine waters, such as the STP, during development and production.

Though injury or mortality of fish from entrainment or impingement at water intake could occur, the effect would be minimized by ROP 9 that ensure that intakes be screened. As is described in BLM 2012, it is unlikely that fish would be entrained in the water intake.

Contaminants

Post-lease oil and gas activities that could cause effects related to contaminants would mainly occur during the production phase of the post-leasing program. Hazards include potential spills from storage, use, and transport of waste and hazardous materials, potential spills from wells, pipelines, or other infrastructure, and mobilization of contaminants into aquatic or terrestrial systems from erosion, fugitive dust, and permafrost degradation. As described in detail in BLM 2012, spills can adversely affect aquatic habitats and species by exposing them to contaminants. Spills can injure or kill fish and effects can be long or short lived depending on the type, size, duration, and season of the spill. See **Section 3.2.11** for more discussion of spills.

Aquatic Invasive Species

The aquatic invasive species *Elodea canadensis* could invade freshwater inland lakes in the project area with increased water-based air traffic in the area. Once established, *Elodea* can alter the water flow patterns, increase turbidity and pH of the water and accumulate nutrients while reducing availability in the substrate (ACCS 2018c), which could have impacts to fish and aquatic species. ROP 43 is designed to prevent the introduction or spread of nonnative invasive species within the Coastal Plain.

Alternative B (Preferred Alternative)

Under Alternative B, five streams described in Lease Stipulation 1 would have a 0.5-mile setback and five streams would have a 1-mile setback for surface development, though bridges, roads, and pipelines could still be built in the setbacks. Some streams would have no setbacks, and fish-bearing streams and other fish-bearing water bodies would have a 500-foot setback. .Effects on unprotected streams and coastal areas and the species that use them would be most pronounced under this alternative, and the types of impacts would be the same as those described under *Impacts Common to All Action Alternatives*. No development would be allowed in the coastal waters, lagoons, and barrier islands under any alternative. No special protections are included in Alternative B for the springs in the areas offered for lease, beyond what is protected under Lease Stipulation 1. Withdrawal of unfrozen water from springs would be allowed during summer. Withdrawal of unfrozen water from lakes may be permitted. Alternative B would also have the most potential adverse effects on EFH since some anadromous streams would not be protected and could be developed.

Alternative C

Under Alternative C, the same select streams as Alternative B would have 0.5- to 1-mile setbacks for surface development, with similar exceptions for roads and pipelines; however, the Canning, Hulahula, and Okpilak River setbacks would be increased to 2 miles from the active floodplain, except where the Canning River floodplain is outside of the Arctic Refuge. Some streams would have no setbacks. As with Alternative B, fish-bearing streams and other fish-bearing water bodies would have a 500-foot setback. There would be a 1-mile NSO setback from the coast (although exceptions would be allowed for various facilities, including docks and barge landings), and no development would be allowed in the coastal waters, lagoons, and barrier islands. As with Alternative B, no special protections are included in Alternative C for the springs in the areas offered for lease. Such springs are vital overwintering habitat for fish beyond the 500-foot setback for fish-bearing waters; they are protected from surface development and from water or ice withdrawal; thus, long-term survival and distribution of freshwater fish in the program area could be affected. These lease stipulations are similar in magnitude of potential impact on fish and aquatic resources as under Alternative B, though greater protections are offered for select rivers and streams under Alternative C, and streams in the southeastern portion of the program area would be in areas not offered for lease.

Alternative D

Alternative D1 includes 1,037,200 million acres available for lease sale, while Alternative D2 limits the acres available to a maximum of 800,000 acres. This revision maximizes high potential areas available for lease, while considering additional considerations for caribou calving and post-calving habitat. Lease stipulations under these two sub-alternatives provide the most protections for aquatic habitats.

Under Alternatives D1 and D2, 17 streams would have setbacks for surface development, although exceptions would be allowed for roads and pipelines. Setbacks for the Canning River east of the Arctic Refuge boundary and for the Aichikik and Okpilak river floodplains would be 3 miles; setbacks for the Hulahula River floodplain would be 4 miles; setbacks for the Sadlerochit and Jago River floodplains would be 1 mile; and the remaining 11 streams would have 0.5-mile setbacks.

Permanent facilities would be prohibited within 0.5 mile of the ordinary high-water line of all water bodies in the Canning River delta, which would protect most lakes in the program area. Additional 1- to 3-mile setbacks would be provided for four specific springs and aufeis areas, which would reduce potential effects on aquatic species and habitats, as described under *Impacts Common to All Action Alternatives*. There would be a 2-mile NSO setback from the coast, though exceptions would be allowed for barge landings, docks, and pipelines. No development would be allowed in coastal waters, lagoons, and barrier islands, as with all alternatives. Withdrawal of unfrozen water from lakes may be permitted.

Future gravel mining would not occur in the active floodplain or channel of the Canning, Sadlerochit, Hulahula, and Aichilik Rivers. Potential impacts on fish and aquatic species would be reduced under Alternatives D1 and D2, compared with Alternatives B and C, and would occur mostly in the western portion of the program area. Impacts would be predominantly indirect, such as in changes to hydrology associated with infrastructure outside river and lake buffers or where infrastructure crosses river corridors. Protecting spring habitat via TLs and NSOs would reduce the likelihood of disrupting groundwater that supports fish habitat.

Transboundary Impacts

Marine and anadromous fish species using the program area would cross the international boundary, and changes in a species' population would have cascading ecological effects on other fish species in the area. As described above and in *Cumulative Impacts*, the alternatives that allow more development near aquatic habitats and more potential obstacles to movement would have more potential for population-level impacts on fish species across the international boundary.

These potential impacts would be most pronounced on anadromous species, such as whitefish (*Coregnoid* spp.), which make frequent summertime use of nearshore marine habitats along the Beaufort Sea coast, including in the program area. For example, Arctic cisco spawn in Canadian waters but are transported as young-of-the-year to Alaskan waters, where they overwinter in the Colville River delta. They feed extensively in Beaufort Sea nearshore environments until they are sexually mature (approximately age 8). Upon reaching maturity, they return to their natal water bodies in tributaries of the Mackenzie River in Canada (Moulton et al. 2010). Impacts on Arctic cisco (and other highly migratory species) in Alaskan waters can have population level impacts on the species in Canadian waters.

Cumulative Impacts

Past and present actions in the program area have been limited and thus have had limited effects on aquatic species and habitats. Past, present, and reasonably foreseeable actions that may contribute to cumulative impacts are infrastructure development, area-wide geophysical exploration, future oil and gas activities in the Prudhoe Bay area, and climate change. Impacts from these actions would generally affect fish and aquatic species through habitat alterations and disturbance, as described below, and would have a cumulative effect.

Infrastructure developed for the community of Kaktovik may have indirectly affected or may be affecting aquatic habitats and species by contributing dust and gravel spray to streams, altering habitat by withdrawing water, and disturbing or displacing fish due to noise. Impacts from area-wide geophysical exploration, including seismic activities, may change hydrology and water quality, potentially affecting fish habitat, if surface damage results in thermokarst and water channel formation.

It is likely that past, present, and reasonably foreseeable future oil and gas activities in the Prudhoe Bay area may increase the quality and quantity of infrastructure. This would make oil and gas development in the program area more profitable or likely to occur. and would add to the cumulative effect of habitat alteration and disturbance to aquatic species. This would come about by increasing the potential for impacts on fish and aquatic species.

The effects of climate change, described under *Affected Environment* above, could influence the rate or degree of the potential cumulative impacts. These would include alterations to fish and aquatic species habitats due to changes in surface water quantity and quality. These impacts would worsen and add to impacts from other past, present, and reasonably foreseeable actions by further reducing habitat suitability for fish and aquatic species.

Cumulative impacts on some fish species would come from the combination of certain activities, such as habitat alterations lead to movement of fish and further effects from habitat compression. For example, fish species such as Dolly Varden which do not show site-fidelity in their spawning or overwintering behavior may experience long-term deleterious stock related genetic impacts resulting from migrations from non-affected areas into affected areas (Brown et al. 2019).

All action alternatives would incrementally contribute to potential cumulative impacts on fish and aquatic resources from post-leasing oil and gas activities. Alternative B would have the greatest incremental contribution to potential cumulative impacts. This is because the entire program area could be offered for lease sale and there would be the fewest acres with NSO stipulations. Alternative D2 would contribute the leastto potential cumulative impacts because the amount of land available for leasing would be reduced to a maximum of 800,000 acres.

3.3.3 Birds

Affected Environment

According to the USFWS (USFWS 2015a, Appendix F), 157 bird species have been recorded in the Arctic Refuge on the northern foothills of the Brooks Range, in the ACP (an area inclusive of the program area), and in adjacent marine waters (**Table J-13** in **Appendix J**). Sixty-eight of those species (46 percent) are confirmed breeders or permanent residents, or both; 11 are possible breeders, 40 species use the ARCP during staging or migration (29 of which are breeders or possible breeders), and 65 species occur as casual, accidental, or rare visitors.

With some exceptions described below, birds in the program area are migratory and are only present May to September (Young et al. 1995; Kuletz et al. 2015; Kuletz and Labunski 2017). Winter residents include small numbers of ravens and ptarmigan, dippers near open running water, and occasional gyrfalcons. The migration routes and wintering areas of ARCP birds encompass much of the North American and South American continents and central and southern Pacific islands; some species may winter in southern Africa, Australasia, east and southeast Asia, and coastal Antarctica.

Shorebirds and passerines[22] are the most abundant guilds of nesting birds on the ARCP (Bart et al. 2012). Waterfowl, loons, grebes, and cranes also use the ARCP in large numbers (Bart et al. 2013). Jaegers occur in relatively high densities in ARCP. Raptors, other larids (gulls, terns), and seabirds are less abundant but important components of the bird community.

Of the species considered likely to occur on the ARCP, 39 are classified as common, fairly common, or abundant in one or more seasons, and all are breeders or possible breeders on the ARCP. Most of the 53 species considered casual and accidental visitors were seen outside the normal range of the species, as were many of the species listed as uncommon or rare; however, 40 of the 65 species listed as uncommon or rare are breeders or possible breeders in the ARCP, and many of these are species of conservation concern (Pearce et al. 2018; **Table J-13** in **Appendix J**).

Additional waterbirds, larids, and seabirds occur along the marine vessel route to Dutch Harbor, Alaska, including Steller's and spectacled eiders, which are discussed under *Special Status Species*, below (see **Table J-15** in **Appendix J**). Many bird species are present where there is open water in these marine habitats during all seasons of the year; however, concentration areas are particularly important during the fall open water season (Kuletz and Labunski 2017). A number of species, including eiders and brants, rely almost exclusively on marine habitats and coasts of the Bering Sea during migration, molting, or wintering.

The ARCP represents a substantial portion of the Beaufort Sea coastline in Alaska. Accordingly, it also supports a large number of birds during the important pre-breeding, nesting, rearing, and migration staging periods. For these reasons, the ARCP and adjacent marine waters are recognized as important bird areas by the American Bird Conservancy, Audubon, and Birdlife International. Prior studies (summarized in USFWS 2015a; Pearce et al. 2018; and USFWS and BLM 2018) have demonstrated that at least several hundred thousand breeding and nonbreeding birds use the ARCP and program area during spring migration, summer breeding, and fall staging and migration.

A few bird species have been relatively well studied on the ARCP, such as golden eagles and fall-staging snow geese, but even for these species recent data are lacking (summarized in USFWS 2015a). Although there are historical survey data for the ARCP, as described in USFWS and BLM (2018), detailed distribution and abundance data for the program area are lacking for many species, and contemporary data are lacking for most bird species. In addition, much of the contemporary data were collected for only 1 or 2 years, cover only a small portion of the program area, or were collected at low survey intensity. The program area contains far fewer water bodies, compared with sites farther west, such as Prudhoe Bay and the NPR-A. Because of this,

[22]Perching birds.

many waterbirds and shorebirds are patchily distributed, which increases the difficulty in estimating numbers. Information about the various bird species and species groups found in the program area is summarized below.

Special Status Species

The Migratory Bird Treaty Act and the corresponding Migratory Bird Convention Act and Canada Wildlife Act in Canada protect all migratory birds (see **Tables J-13**, **J-14** and **J-15** in **Appendix J** [Birds on the Arctic Refuge Coastal Plain Listed as Canadian Wildlife Species At Risk). Of the 156 species known to occur in the program area, 12 are recognized as BLM sensitive species (BLM 2019), 11 are USFWS birds of conservation concern (USFWS 2008a), and 45 are recognized as at-risk species by the ADFG (**Table J-15** in **Appendix J**). ADFG at-risk species are those with a small population size or range, a declining population, or a population facing documented threats. ADFG at-risk rankings also incorporate the conservation concern listings prepared by other agencies and specialist groups focused on the conservation of Alaska birds (ADFG 2015). Listings by the US Shorebird Conservation Plan Partnership, Partners in Flight, the International Union for Conservation of Nature Red List of Threatened Species (IUCN 2018), and Audubon Alaska (Warnock 2017a and 2017b) are also included in **Table J-15**.

Steller's eiders, the smallest of the four eider species, are tundra-nesting sea ducks. Their primary present-day breeding range is in eastern Siberia, where they nest in wet tundra near freshwater ponds with and without emergents[23] (Fredrickson 2001; Safine 2013, 2015; Graff 2016). The Alaska-breeding Steller's eider, belonging to a larger Pacific population, was listed under the ESA as a threatened species in 1997 (62 FR 31748–31757). Critical habitat was designated for Steller's eiders in western Alaska (including Kuskokwim Shoals, Sea Islands, Nelson Lagoon, and Izembek Lagoon, all of which are next to the marine transportation route), but no critical habitat was designated on the North Slope. Although the nesting distribution on the North Slope once extended eastward to Demarcation Bay, most Steller's eiders nest in the Utqiaġvik area (Quakenbush et al. 2002). Steller's eiders are considered to occur only as rare visitors in the program area (**Table J-13** in **Appendix J**) and are not expected to nest that far east on the ACP. As with other eiders, they spend the entire non-breeding season in coastal marine waters. In the winter, most of the world's Steller's eiders are located along the Alaska Peninsula and Aleutian Island chain.

The spectacled eider is a medium-sized eider, breeding on tundra in arctic and western Alaska and eastern Siberia and spending the rest of the year at sea, after young can fly (Petersen et al. 2000). The spectacled eider was listed as threatened in 1993, after a severe decline of the species on the Yukon-Kuskokwim Delta (58 FR 27474–27480). Critical habitat was designated in 2001 in Ledyard Bay in the Chukchi Sea and in other areas of western Alaska next to the marine transportation route (66 FR 9146–9185). No critical habitat occurs in the program area. The spectacled eider breeds primarily on the Arctic coast from Point Lay and Utqiaġvik to the Sagavanirktok River (USFWS 1996). The program area is in the breeding range, but in the lowest density class for pre-nesting spectacled eiders as measured by ACP aerial surveys. Between 2012 and 2015 surveys of waterbird habitats in the ARCP recorded low densities (0 to 0.07 birds per 0.39 square miles) of pre-nesting spectacled eiders (**Map 3-20**, Nest Sites, Observations, and Density of Pre-Nesting Spectacled Eider, in **Appendix A**). The spectacled eider is an uncommon breeder in the program area (USFWS 2015a). Nests have been documented on the Canning River delta (USFWS unpublished data), but contemporary systematic ground surveys have not been conducted. Low numbers of spectacled eiders are expected to occur in the program area during the pre-nesting and nesting periods, where suitable habitat is available.

[23]A water plant whose leaves and flowers appear above the surface

Waterbirds

As treated in this EIS, waterbirds on the ARCP are waterfowl (ducks, geese, and swans), loons, grebes, and cranes. Thirty-seven species of waterbirds have been observed on the ARCP, 19 of which are confirmed breeders and 4 are possible breeders; 19 species occur as migrants, 14 of which are also breeders, and 9 are visitors (**Table J-13** in **Appendix J**). The group of 24 species considered breeders and possible breeders on the ARCP are 14 species of ducks, 3 geese, 3 loons, 2 swans, 1 grebe, and 1 crane. Five of these 24 species are on at least one of four agency conservations lists, 2 are listed as threatened under the ESA (Steller's and spectacled eiders), another 2 are listed as sensitive species by the BLM (red-throated and yellow-billed loons; BLM 2019), both of which are also USFWS birds of conservation concern (USFWS 2008a); the ADFG lists these and a fifth species (black scoter) as at-risk species (ADFG 2015) (**Table J-13** in **Appendix J**).

Waterbirds, especially ducks and geese, are an important subsistence resource for residents in Kaktovik (summarized in USFWS 2015a). The North American Waterfowl Management Plan (USFWS 2012) and updates (USFWS 2018a) outline the population status and abundance objectives of agency wildlife managers for waterfowl (ducks, geese, and swans).

Thirteen waterbird species are fairly common to abundant seasonally in the program area: greater white-fronted goose, snow goose, brant, cackling goose, tundra swan, northern pintail, king eider, common eider, white-winged scoter, long-tailed duck, red-breasted merganser, red-throated loon, and Pacific loon (Pearce et al. 2018). All occur as breeders or possible breeders.

Using aerial-survey breeding waterbird data collected across the ACP from 1992-2016 for 20 species, Amundson et al. (2019) found that density on the ARCP was greater than average for jaeger (pomarine, parasitic, and long-tailed combined), tundra swan, red-throated loon, and cackling geese, and lower than average for greater white-fronted geese, pacific loon, Steller's eider, white-winged scoter, yellow-billed loon, and Sabine's gull. There was no difference in density between areas surveyed in NPR-A and the ARCP for snow geese, black brant, northern pintail, scaup, spectacled eider, king eider, long-tailed duck, red-breasted merganser, glaucous gull, and Arctic tern. Most of the 9 species of waterbirds that are casual or accidental visitors and several of the 15 uncommon and rare species are outside their historical ranges; however, 9 of 15 uncommon or rare species breed on the ARCP, and several of these are species of conservation concern (**Table J-13** in **Appendix J**).

Breeding waterbirds generally arrive on the coastal plain of the North Slope in late May and June and begin nesting from late May through June (Johnson and Herter 1989). Most waterbird species nest at highest densities in wet and moist tundra habitats, often on water body shorelines, islands, and peninsulas, but some species primarily nest in drier habitats (for example, see *Common Eider* below). The distribution of high-value waterbird nesting habitats in the ARCP is roughly represented by the areas included in annual USFWS waterfowl breeding population surveys (Larned et al. 2011; see **Map 3-20**).

In July and August, most waterbirds occupy lakes and ponds to rear their young, although geese and cranes graze in tundra wetlands. In the late summer, large numbers of post-breeding and molting (temporarily flightless) sea ducks, primarily long-tailed ducks, and other waterfowl and loons use coastal lagoons behind the barrier islands. In aerial surveys conducted in late June/early July 1999–2011, surf scoters were the most abundant species in the ARCP barrier island/lagoon system (mean 2,857 birds, range 544 to 8,855 birds), followed by long-tailed ducks (mean 1,445 birds, range 220 to 3,199) and white-winged scoters (mean 1,340, range 31 to 4,192) (Dau and Bollinger 2012, USFWS unpublished data).

Common eiders, glaucous gulls, and red-breasted mergansers were abundant and loons and swans were common in the lagoon systems in late June/early July. By late July/early August, long-tailed ducks become the dominant species in the lagoons, where they spend the molting period flightless. In surveys conducted in the ARCP lagoons in 2002 and 2003, 12,000 and 27,965 long-tailed ducks were counted, making up 92 and 95 percent of birds observed (Lysne et al. 2004).

The peak in numbers of long-tailed ducks in the lagoons are in late July or early August. This is followed by a decline into mid-September, by which time the flightless molt has ended (Garner and Reynolds 1986; Johnson and Gazey 1992). Other species present in much lower numbers (fewer than 450 birds) during the late July/early August surveys were common and king eiders, surf scoters, scaup, northern pintails, and all three species of loons. Sea ducks and other waterbirds continue to forage in the lagoons in the fall as they stage for the southward migration. Migratory waterbirds may be present in the marine environment through October and into November, leaving with advancing sea ice (Kuletz et al. 2015).

Various migration routes and wintering areas are used by different species of waterbirds. Most geese and dabbling ducks migrate through the Pacific and Central Flyways after leaving the ARCP to wintering areas across the continental US. Tundra swans cross the continent to winter on the Atlantic coast, largely in Chesapeake Bay. Primary migration routes of brant, eiders, and loons from the ARCP are coastal across northern Alaska and along the coasts of the Chukchi and Bering seas. Eiders winter primarily in the Bering Sea, with some species also occurring in coastal areas of southern Alaska. Brant, Pacific loons, and yellow-billed loons from the ARCP winter primarily along the Pacific coast of North America, while red-throated loons from the ARCP winter in East Asia (McCloskey at al. 2018).

Common Eider and King Eider

Common and king eiders are an important subsistence resource for North Slope residents. The USFWS conducted 12 years of aerial surveys during the nesting period of common eiders (1999–2009, 2011) and estimated the number, distribution, and population trend of common eiders in coastal habitats on the North Slope, including Arctic Refuge lands (Dau and Bollinger 2012, summarized in USFWS 2015a) (**Map 3-21** top panel, Common Eider Locations in Late June/Early July, in **Appendix A**). During that period, USFWS estimated between 75 and 445 breeding pairs annually, suggesting that common eiders have increased in abundance on their barrier island breeding grounds in the Arctic Refuge since 1976, although the reasons are uncertain (USFWS 2015a). In a 2015 ground-based survey conducted across most Arctic Refuge barrier islands, over 800 common eider nests were found (USFWS, unpublished data).

Common eiders from the Beaufort Sea winter primarily in the Bering Sea, apparently using the closest available ice-free habitats (Petersen and Flint 2002). Common eiders use the lagoon system into late July/early August prior to migration (**Map 3-21** bottom panel, Common Eider Locations in Late July/early August). Migration routes of common eiders in the Beaufort Sea are generally within 30 miles of shore, and routes are affected by the occurrence of open water leads in spring. Common eiders undertake spectacular spring migrations of several hundred thousand birds between the Beaufort Sea and coastal areas in western Alaska, along the coast of the Chukchi Sea.

From systematic observations of the spring and fall migrations past Point Barrow, common eider numbers declined by 53 percent between 1976 and 1996 (Suydam et al. 2000) but subsequently increased from 72,606 in 1996 to 114,996 in 2002 and 110,561 in 2003 (Quakenbush et al. 2009). Westward fall migration of eiders is protracted by comparison with spring, and common eiders move out of the Beaufort Sea between July and October, after molting. They use a corridor paralleling the northern coast of the Yukon Territory and Alaska, past Point Barrow and southwest across the Chukchi Sea to wintering areas in the Bering Sea south to the Aleutian Islands.

King eiders are abundant in the Beaufort Sea area, including the program area (Johnson and Herter 1989). They nest primarily in tundra wetlands, and low densities (0.3–0.8 nests/0.39 square mile) have been documented in the Arctic Refuge (Johnson and Herter 1989) (**Map 3-22**, King Eider, in **Appendix A**). Barry (1974) estimated that about a million king eiders migrated into and through the Beaufort Sea area in the early 1970s; however, estimated numbers from systematic observations at Point Barrow in spring and fall declined for unknown reasons by more than 50 percent between 1976 and 1996, to about 350,835 birds (Suydam et al. 2000). At Point Barrow in 2002 and 2003, 304,966 and 591,961 king eiders, respectively, were estimated, suggesting that numbers increased from 1996 to 2003 (Quakenbush et al. 2009).

Most of these birds nest on high arctic islands of Canada. Spring migrating king eiders come close to land only as they pass specific points, including Point Barrow and sites primarily in the Northwest Territories of Canada; offshore lead systems in pack ice are the primary determinant of routing and timing. Similar to common eiders, spring migrations of king eiders past Point Barrow in May can be spectacular, with king eiders typically first and closely followed by common eiders.

King eiders undertake a molt migration between July and September leaving the breeding grounds and the Beaufort Sea for staging areas in the Chukchi Sea and then to molting and wintering areas in the Bering Sea (Phillips et al. 2006). As in spring, much of this migration occurs offshore and is most conspicuous at Point Barrow and Cape Bathurst in the eastern Beaufort Sea, and less conspicuous along much of the intervening coast (Johnson and Richardson 1982). King eiders are not abundant during fall surveys of coastal lagoons in the Arctic Refuge (Lysne et al. 2004).

Waterbird Use of Coastal Lagoons

Many waterbirds in the post-breeding period use the coastal lagoons between the barrier islands and the program area's coast (see **Appendix A**, **Map 3-21**,Common Eider, **Map 3-22**, King Eider, **Map 3-23**, Surf Scoter, **Map 3-24**, Long Tailed Duck, and **Map 3-25**, Yellow-Billed Loon).

In aerial surveys of nearshore waters and barrier islands conducted 1999–2009 and 2011 during late June and early July (early incubation for common eiders and the early post-breeding period for most other species surveyed), 17 waterbird species were recorded regularly (Dau and Bollinger 2009, 2012). The most abundant species recorded was surf scoter (average of 2,173 individuals), followed by long-tailed duck (average of 819 individuals), common eider (average of 593 individuals), and glaucous gull (average of 553 individuals). In aerial surveys conducted later in the season (late July and early August 2002 and 2003), thousands more long-tailed ducks were observed, with over 28,000 birds recorded in one year (Lysne et al. 2004). These numbers likely far exceed the number breeding in the Arctic Refuge, indicating that long-tailed ducks from a larger geographic area move to coastal lagoons in the Arctic Refuge to molt in late summer and fall (Lysne et al. 2004; USFWS 2015a).

During those same aerial surveys conducted in fall 2002 and 2003, up to 20 percent of yellow-billed loons, 28 percent of red-throated loons, 29 percent of long-tailed ducks, 33 percent of scaup, and 41 percent of Pacific loons counted across the entire North Slope survey area were in the lagoons and nearshore areas along the Arctic Refuge coast (Lysne et al. 2004).

Snow Geese

The entire western Arctic population of snow geese assembles for fall migration on the coastal plain of Alaska and Canada during late August and early September (Garner and Reynolds 1986; USFWS 2015a). In surveys conducted between 1973 and 2004, as many as 325,760 snow geese were recorded on the ARCP (**Map 3-26**, Frequency of Occurrence of Snow Goose Flocks with >500 Birds observed During Aerial Surveys, 1982–2004, in **Appendix A**). They come primarily from the large nesting colony on Banks Island (Canada) and from much smaller nesting colonies on the North Slope and in western Canada to graze in upland and coastal tundra habitats (Hupp et al. 2002).

The ARCP east to the Canada border is part of a larger assembly area that extends east another 310.7 miles to the Bathurst Peninsula in Canada (Pearce et al. 2018). The breeding population on Banks Island more than doubled, from 200,000 in the early 1990s to 500,000 in 2013 (Pacific Flyway Council 2013). The population breeding across the entire coastal plain of the North Slope also increased dramatically in that time (Burgess et al. 2017; Hupp et al. 2017).

The numbers of birds on the ARCP during the 1973 to 2004 USFWS surveys were highly variable, with the proportion of the population staging in Alaska ranging from 0 to 49 percent. In some years, no staging snow geese were recorded as far west as the ARCP; numbers in Alaska may depend on weather conditions (wind and the timing of onset of snow cover) and may be affected by changes in food availability caused by foraging (Kendall 2006). In the last surveys of staging snow geese on the ARCP conducted in 2004, 189,636 individuals were recorded (USFWS 2015a). If trends in staging reflect population trends in breeding areas, the number of geese staging in the program area was likely much higher in recent years. Snow geese depend on this staging period to build energy reserves for their southward migration (Brackney and Hupp 1993). Following staging on the coastal plains of northeastern Alaska and northwestern Canada, snow geese migration takes birds south through Alberta and Manitoba and to wintering areas primarily in central California.

Shorebirds

Thirty-three shorebird species have been recorded on the ARCP, 19 of which are confirmed breeders and 3 possible breeders. Fourteen species are migrants, 12 of which also breed or possibly breed on the ARCP, and 9 are rare or casual visitors (**Table J-13** in **Appendix J**). The group of 22 breeders and possible breeders includes 17 sandpiper species, 3 plovers, and 2 phalaropes.

As a group, shorebirds are of increasing conservation concern, as many species have been undergoing population declines over the past several decades (US Shorebird Conservation Plan Partnership 2016; Alaska Shorebird Group 2019). Of the 23 shorebird species not considered rare or casual visitors, 11 are listed as species of conservation concern by at least one of four agencies; 5 are BLM sensitive species (BLM 2019), these and one additional shorebird are USFWS birds of conservation concern (USFWS 2008a), and the ADFG lists these additional shorebirds as at-risk species (ADFG 2015) (**Table J-13** in **Appendix J**). Fourteen of 22 species (64 percent) that breed or possibly breed on the ARCP are considered shorebirds of conservation concern (US Conservation Plan Partnership 2016), including 7 species of moderate concern, 6 species of high concern, and 1 species of greatest concern (**Table J-13**).

Eight shorebird species are fairly common to abundant in the program area as both breeders and migrants: American golden-plover, semipalmated plover, ruddy turnstone, pectoral sandpiper, semipalmated sandpiper, long-billed dowitcher, red-necked phalarope, and red phalarope (Pearce et al. 2018). Upland sandpipers are listed in **Table J-13** in **Appendix J** as “fairly common (inland)” and are typically found more in the foothills, which are primarily are outside the program area. The 9 rare or casual visitors and several of the rare or uncommon breeders/migrants are outside the normal ranges of those species; however, 13 of 16 species considered rare or uncommon are confirmed or likely breeders on the ARCP, as follows: black-bellied plover, whimbrel, bar-tailed godwit, stilt sandpiper, sanderling, dunlin, Baird's sandpiper, white-rumped sandpiper, buff-breasted sandpiper, western sandpiper, Wilson's snipe, spotted sandpiper, and wanderling tattler. Most species of shorebirds are of conservation concern due to ongoing population declines (Bart and Johnston 2012); not considering relative abundance in the ARCP, these include 2 species of greatest concern (bar-tailed godwit and red knot) and 8 species of high concern (American golden-plover, whimbrel, Hudsonian godwit, dunlin, buff-breasted sandpiper, pectoral sandpiper, semipalmated sandpiper, and lesser yellowlegs).

Shorebirds arrive on the North Slope in mid-May through June. Most begin nesting in June, though a small number begin laying eggs in late May and into early July (Saalfeld and Lanctot 2015). In surveys of breeding shorebirds in June 2002 and 2004, Brown et al. (2007) recorded 14 shorebird species and estimated that 230,000 shorebirds (95 percent confidence interval (CI) of 104,000 to 363,000) occupied the program area during the breeding season. For the five most abundant shorebird species on the ARCP (pectoral sandpiper, semipalmated sandpiper, red-necked phalarope, red phalarope, and American golden-plover), numbers breeding in the program area were estimated to comprise between 1.4 percent (semipalmated sandpiper) and 13.2 percent (pectoral sandpiper) of global populations.

Shorebirds use a wide range of tundra habitats for nesting. Most species nest in wet and moist habitats, but some prefer drier uplands and riverine habitats. Wetland and riparian habitats, particularly deltas and coastal areas, have higher shorebird density and diversity, and shorebird density appears to be highest in wetland areas in the Canning River delta region (Brown et al. 2007).

Shorebirds generally are more abundant near the coast than farther inland, with American golden-plover and long-billed dowitcher less restricted by such elevational differences (Saalfeld et al. 2013). Species richness was highest to the west, in the NPR-A (Johnson et al. 2007, Saalfeld et al. 2013). however, several species were more common in the east (Johnson et al. 2007), reflecting differences in distribution among individual species across the coastal plain of the North Slope.

After hatching, most shorebirds use open tundra and shorelines to rear their young; as the young become flight capable, they begin to forage on the coast. In late July through September, shorebirds stage on river deltas across northern Alaska, including in the ARCP, for the fall migration to wintering areas in the Americas and Asia. Shorebird abundance on river deltas varies among sites and years (Taylor et al. 2010; Brown et al. 2012) and individuals move among multiple sites during the year (Taylor et al. 2011). Up to 4,000 shorebirds were counted on daily surveys at the Jago and Okpilak River deltas in 2011 (Churchwell 2015). Most of the deltas on the North Slope are used by large numbers of foraging shorebirds, with the Jago River and Hulahula River deltas being among the most heavily used areas in the ARCP (summarized in USFWS 2015a and Pearce et al. 2018). These deltas are among an interconnected network of post-breeding sites, all of which are important to multiple species of shorebirds (Taylor et al. 2011). Most of the shorebirds foraging in the river deltas in late summer and fall are juveniles hatched earlier in the summer. After staging, shorebirds continue migrating to coastal wintering areas in Central and South America (e.g., semipalmated sandpipers) and Asia (e.g., dunlin), using various flyways and migration routes, with both eastward and westward movements along the Alaska coast (Taylor et al. 2011; Brown et al. 2017).

Larids

Larids that occur on the ARCP are gulls, jaegers, and terns. Sixteen larid species have been recorded, 7 of which are confirmed breeders or migrants: The 7 breeding species are pomarine jaeger, parasitic jaeger, long-tailed jaeger, Sabine's gull, mew gull, glaucous gull, and arctic tern (**Table J-13** in **Appendix J**). Three larids occur only as rare migrants (ivory gull, Ross's gull, and herring gull) and 6 species occur as rare, casual, or accidental visitors.

None of the larids that occur on the ARCP are BLM sensitive species (BLM 2019), one is a USFWS bird of conservation concern (arctic tern; USFWS 2008a), and none are ADFG at-risk species (ADFG 2015) (**Table J-14** in **Appendix J**). At-sea surveys have recorded glaucous gulls, black-legged kittiwakes, Ross's gulls, and Sabine's gulls in waters next to the ARCP (Kuletz et al. 2015). At least 17 larid species occur along the marine vessel route to Dutch Harbor, including 4 listed as USFWS species of conservation concern (red-legged kittiwake, Aleutian tern, Caspian tern, and arctic tern; **Table J-15** in **Appendix J**).

Larids arrive on the North Slope roughly at the same time as shorebirds, in mid-May through June (Johnson and Herter 1989). They breed across the ARCP in a range of habitats, including open tundra (primarily jaegers), shores and islands on tundra lakes, and on the barrier islands (primarily gulls and terns). During the breeding season, the smaller gulls and terns generally feed on aquatic invertebrates and small fish, whereas jaegers largely prey on small mammals, birds, and eggs.

The single larger gull species (glaucous gull) is omnivorous and can prey on small birds and eggs. Local residents report that glaucous gull populations on the ARCP have been increasing, and there is some evidence of increases in gull populations in the Arctic generally (NRC 2003). These increases could be due to global changes in their populations or increased human development in the area (Weiser and Powell 2010). There are numerous accounts of glaucous gulls foraging in North Slope landfills. Distribution maps from aerial surveys indicate that gulls tend to concentrate in the vicinity of human development on the coastal plain of the North Slope, including Kaktovik on the Arctic Refuge (summarized in USFWS 2015a).

Raptors

As treated in this EIS, raptors on the ARCP include eagles, hawks, falcons, and owls. Thirteen raptor species have been recorded on the ARCP, 6 of which are confirmed breeders and 2 are possible breeders (**Table J-13** in **Appendix J**). Five species occur as casual visitors, including the bald eagle. Only 3 raptor species are considered abundant: golden eagle, snowy owl, and short-eared owl, and the other 5 breeding or possibly breeding species are uncommon or rare (northern harrier, rough-legged hawk, merlin, gyrfalcon, and peregrine falcon).

None of these are BLM sensitive species or USFWS birds of conservation concern (BLM 2019; USFWS 2008a), and 6 of the ARCP raptors are listed by the ADFG as at-risk species (ADFG 2015) (**Table J-13** in **Appendix J**). Several raptors on the ARCP are cliff-nesting, occurring primarily in mountainous terrain or on steep river bluffs: golden eagle, rough-legged hawk, gyrfalcon, and peregrine falcon. Ground-nesting species are northern harriers, snowy owls, and short-eared owls. Bald and golden eagles are protected under the Bald and Golden Eagle Protection Act. The arctic peregrine falcon subspecies, which breeds on the ARCP, was previously listed as endangered under the ESA, but it has been delisted (USFWS and NMFS 2014).

In the Arctic Refuge, nesting of raptors begins from late March to early May (Young et al. 1995). Some snowy owls winter on Arctic breeding grounds, but most arrive on the North Slope during April and May, with most egg laying in mid-May (summarized in Holt et al. 2015). The remaining raptors arrive and begin nesting in May and early June (Johnson and Herter 1989).

Golden eagles nest almost exclusively in cliff habitats and, in the program area, they nest primarily in the Brooks Range foothills, as cliff habitat appropriate for eagles is rare elsewhere on the ARCP. Breeding golden eagles return to Alaska, presumably including the Arctic Refuge, from late February to mid-April, with nonbreeders arriving later (summarized in Kochert et al. 2002). Golden eagles are commonly observed on the ARCP in late June and early July, when calving and post-calving caribou herds are present; these are primarily subadult birds that are preying on or scavenging caribou calves (summarized in USFWS 2015a). In a 1983–1985 study, golden eagles were the main predators of caribou calves on the calving grounds (Whitten et al. 1992; Griffith et al. 2002). It also appears that golden eagles from other regions in the state use northern Alaska, including the Brooks Range and ARCP. Eagles that hatched in the Alaska Range were found in the Arctic Refuge during at least two subsequent summers (summarized in USFWS 2015a).

Surveys on the ARCP were conducted on the Canning, Hulahula, and Kongakut rivers in the 1990s and early 2000s to monitor cliff-nesting raptors (summarized in USFWS 2015a). Raptors nesting on cliffs along these rivers are golden eagles, peregrine falcons, gyrfalcons, and rough-legged hawks. In the program area, cliff nest habitats occur primarily in river corridors; outside of these areas the overall abundance of nesting raptors is low.

The two owl species that breed on the ARCP, snowy owl and short-eared owl, are variable in abundance among years. As in other regions on the North Slope, both species are substantially more common as breeders in years of high vole or lemming abundance (Johnson and Herter 1989).

Landbirds

As treated in this EIS, landbirds on the ARCP include a diversity of species that are strongly dominated in abundance by passerines[24] (primarily Lapland longspurs) and two species of ptarmigan. Of the 50 landbird species occurring on the ARCP, 18 are confirmed breeders and 2 possible breeders (**Table J-13** in **Appendix J**).

Thirty landbird species occur only as rare, casual, or accidental visitors. Eleven landbird species are fairly common to abundant: willow ptarmigan, rock ptarmigan, eastern yellow wagtail, American pipit, common redpoll, hoary redpoll, Lapland longspur, snow bunting, American tree sparrow, common raven, and savannah sparrow. The 7 accidentals and many of the rare and uncommon breeding or possible breeding species comprise mainly birds observed outside of their historical ranges; however, 10 of 17 rare or uncommon landbird species are confirmed or possible breeders on the ARCP. None of the 20 breeding or possibly breeding landbird species are BLM sensitive species or USFWS birds of conservation concern (BLM 2019; USFWS 2008a), and 8 are listed by the ADFG as at-risk species (ADFG 2015) (**Table J-13** in **Appendix J**).

Most landbirds on the coastal plain of the North Slope are migrant species that arrive in mid-May through June and begin nesting shortly thereafter (Johnson and Herter 1989). The American dipper, willow ptarmigan, rock ptarmigan, and common raven are year-round residents. By far the most abundant landbird species on the ARCP is Lapland longspur, which nests throughout the area in wet and moist tundra habitats. Other relatively common species on the ARCP are rock ptarmigan (found throughout the area), willow ptarmigan (more common inland), common raven (found throughout the area), eastern yellow wagtail (most common in riparian areas), common and hoary redpoll (found throughout the area), snow bunting (more common on the coast), savannah sparrow (more common inland), and American tree sparrow and white-crowned sparrow (more common inland) (Pearce et al. 2018).

Seabirds

Seabirds occurring in marine waters next to the ARCP are fulmars, shearwaters, and alcids. Eight seabird species have been recorded in marine waters off the ARCP, but 6 of those species are rare or casual visitors,

[24] Perching birds

including Kittlitz's murrelet, which have been recorded during at-sea surveys by the USFWS (Kuletz et al. 2015). Only two seabird species occur as summer residents or migrants in the region: the black guillemot occurs as a rare breeder on barrier islands and an uncommon resident of marine waters, where the thick-billed murre also occurs as a rare migrant (**Table J-13** in **Appendix J**). Neither is listed by any of the four agencies as a species of conservation concern (ADFG 2015) (**Table J-13** in **Appendix J**).

Thirteen additional seabird species are present along the marine vessel route to Dutch Harbor, including alcids (auklets, murres, and puffins), cormorants, and albatrosses (Audubon Alaska 2017) (**Table J-15** in **Appendix J**). Short-tailed, black-footed, and Laysan albatrosses all have increased in abundance and shifted their ranges northward in the Bering Sea in recent decades (Kuletz et al. 2015). The short-tailed albatross is federally listed as endangered, and individuals have been found as far north as the southern Chukchi Sea in recent years (Day et al. 2013).

Climate Change

The changing climate has varied impacts on different bird species; impacts would depend on how quickly and dramatically the vegetation and hydrology change. Some bird species could benefit from longer breeding seasons and expansion of shrub and coastal habitats, while others could lose habitat, food, or prey and could experience seasonal mismatches in breeding and plant/insect phenology (seasonal timing of events) (i.e., trophic mismatches; see Doiron et al. 2015). It is possible that birds are unable to adapt to trophic mismatch (Dawson 2008; Kumar et al. 2010). The historically dominant landbirds and waterbird species may be displaced northward or into shrinking remnant habitats. Kubelka et al. (2018) suggested predation is increasing in the Arctic and is linked to climate-induced shifts in predator-prey relationships, which could adversely affect both numbers and productivity of nesting birds. However, Bulla et al. (2019) argues that there is no robust evidence for a global disruption of nest predation rates due to climate change.

Climate change is expected to increase temperatures, increase precipitation, and lengthen the snow-free season (see **Section 3.2.1**). Summer temperatures above freezing could occur for 6 weeks longer by 2099 (SNAP 2011). Warmer temperatures and earlier snowmelt would likely change the timing of seasonal events on the North Slope, but it is unclear how bird populations would respond. For birds, climate change would affect phenology, habitat and forage availability, and alteration of ranges.

A species may experience both beneficial and adverse effects, as outlined below, with outcomes uncertain; however, many species that nest on the ARCP already are experiencing decreasing populations, and many could suffer catastrophic consequences from the effects of global climate change in one or more of their seasonal continental or even global habitats. These effects combined with development-related impacts across the ranges of many bird species may result in extinction during the 85-year scope of this analysis (IPBES 2019). This is particularly the case for the 69 of 157 total bird species on the ARCP (44 percent) that are listed as species of conservation concern by at least one of eight major government or conservation entities (see **Table J-13** in **Appendix J**).

Earlier and warmer spring and fall temperatures may have positive effects on some species. Geese are known to initiate nests as soon as snow-free sites are available, and they may benefit from earlier and longer breeding seasons (Dickey et al. 2008). Common eiders may benefit from earlier ice-melt around barrier islands, which has been correlated with earlier laying and larger clutch sizes (Love et al. 2010; Chaulk and Mahoney 2012). Delayed freeze-up in fall may be advantageous to the slow-growing young of such species as loons and swans, which are not always flight capable by the time of freeze-up (Johnson and Herter 1989; Ritchie and King 2000).

Shorebirds and passerines have been shown to have altered their breeding phenology, initiating nests up to 0.80 days earlier each year over 9 years, 2002–2011 (Liebezeit et al. 2014). Many of the 65 species considered visitors and many historically rare or uncommon breeders on the ARCP are at the northern edge of their typical range, and some, particularly landbirds and waterbirds, may expand their ranges, potentially enriching the community or displacing currently abundant species.

With earlier thaws and snowmelt, insect populations would hatch earlier (McKinnon et al. 2012). Some insect-feeders (shorebirds and songbirds) can initiate nests earlier with early snowmelt; however, it is unclear if birds relying on insects to feed their young (songbirds and shorebirds) could adapt to arrive at the appropriate time to initiate nesting and hatch eggs at the optimum time as insect hatch continues to advance (McKinnon et al. 2012; Grabowski et al. 2013). Saalfeld et al. (2019) noted that long-term climatic changes resulting in earlier snowmelt have the potential to greatly affect shorebird populations, especially if shorebirds are unable to initiate nests sufficiently to keep pace with seasonal advancement of their insect prey. Shorebird chicks in northern Alaska are particularly dependent on synchronous hatching with large hatches of craneflies and may experience reduced growth and survival if phenological events are decoupled.

Plant biomass is predicted to increase with warmer temperatures, but forage quality is seasonal. Mismatches in forage quality with timing of bird reproduction may have adverse effects on growth rates of young of plant-eating species, particularly geese (Dickey et al. 2008; Doiron et al. 2015). Models suggest that increasing dominance of shrubs in tussock tundra habitats may result in northward shift of white-crowned sparrows and a reduction in habitat for Lapland longspurs (Boelman et al. 2014); these species currently dominate the passerine community throughout the ARCP. Water bodies in the program area may shrink or disappear, depending on the balance of precipitation, evapotranspiration, and drainage from thermokarsting and a deeper active layer in soils (Smith et al. 2005). Melting permafrost would result in widespread thermokarst in the ARCP, because of large volumes of ground ice present (Walker et al. 2019). Ice-wedge degradation and consequent surface subsidence already has resulted in widespread drying of tundra, significantly altering the water balance of lowland tundra by reducing inundation, increasing runoff, and changing snow distribution (Liljedahl et al. 2016). With the drying of tundra habitats, some shorebirds (particularly phalaropes), waterfowl, and loons could face reduced availability or quality of nesting and brood-rearing habitats (Martin et al. 2009).

Thermokarst may also mobilize contaminants, including heavy metals, such as mercury, into surface waters from the thawed sediments. Such contaminants could pose health risks to birds, particularly to shorebirds that feed on aquatic invertebrates.

Increases in shrubs and trees have been documented (Sturm et al. 2001b; Tape et al. 2006) and are expected to continue with increasing summer temperatures. If available wet sedge and graminoid meadows are reduced by invading shrubs and decreasing moisture, it may result in shifts in the breeding bird community. Shrub- and tree-nesting birds (passerines, such redpolls, sparrows, and thrushes) may become more numerous, and tundra nesting birds (longspurs, savannah sparrows, shorebirds, geese, and eiders) may decline. With a longer breeding season and increases in shrub and tree cover, breeding species more typical of boreal forest areas to the south may extend their ranges northward and possibly compete with current tundra breeders for resources.

Shrubification (the expansion of shrubs across the Arctic) of tundra habitats is likely to increase gradually with climate change, but coastal areas may change rapidly in response to erosion and deposition. Coastal areas are historically dynamic in the arctic, and some areas, such as river deltas and barrier islands, would be increasingly dynamic. River deltas may shift in size from deposition of sediment, while barrier islands, which form the lagoon areas important to post-breeding birds, may be losing area to increasing storm surges, while accreting less material from ice-push events in the future. Erosion of coastal shorelines could increase inundation of tundra by salt water; the resulting salt-killed tundra may be colonized by salt-tolerant species and develop into salt marsh, a rare but important post-breeding habitat for geese (Flint et al. 2003). Glaciers in the Arctic Refuge are receding and may disappear within a few decades with potential drying of late summer delta habitats of shorebirds (Kendall et al. 2011).

Coastal habitats are likely to change quickly with increased water temperature, reduced sea ice, rising sea level, and increasing storm surges and wave action (Gibbs and Richmond 2017). Erosion of barrier islands and ice-rich coastlines from mechanical process and thawing can happen rapidly; current rates of loss along the Beaufort Sea coastline is 6.5 to 59 feet per year (see Martin et al. 2009 for review).

Some species nesting on barrier islands, such as common eiders, could be adversely affected by predicted sea level rise and increasing storm surges that could flood nests and decrease productivity (Liebezeit et al. 2012). Climate-mediated changes in the Beaufort Sea nearshore environment may result in changes in benthic prey[25] communities and increasing sea level, along with reductions in sea ice. These conditions may dramatically alter coastal physiography, possibly eliminating the barrier island-lagoon systems across the entire Arctic coast (see **Section 3.2.4**, Physiography).

Offshore, the increasing water temperatures and loss of sea ice in the Beaufort Sea are associated with increased primary production (Moline et al. 2008; Arrigo and van Dijken 2011) and range expansion of seabird species from the Pacific and Atlantic Ocean basins into the Beaufort Sea (Bluhm et al. 2011; Day et al. 2013; McKeon et al. 2016). The reduction in sea ice removes physical barriers to movement and access to prey, possibly increasing opportunities for seabirds to use waters offshore of the program area. Most notable has been an increase in the abundance and diversity of zooplankton-eating species, including ancient murrelets and short-tailed shearwaters (Day et al. 2013). Conversely, there is concern that the reduction in sea ice would result in larger waves and more swell (Thomson and Rogers 2014), which could disrupt seabird foraging behavior in the Beaufort and Chukchi Seas.

Along the marine route, climate change has resulted in unusually warm water. This has been associated with seabird die-offs, which previously have been rare in the Bering Strait region (USFWS 2017, 2018b; Jones et al. 2019).

Direct and Indirect Impacts

Issuance of oil and gas leases under the directives of Section 20001(c)(1) of PL 115-97 would have no direct impacts on the environment because by itself a lease does not authorize any on the ground oil and gas activities; however, a lease does grant the lessee certain rights to drill for and extract oil and gas subject to further environmental review and reasonable regulation, including applicable laws, terms, conditions, and stipulations of the lease. The impacts of such future exploration and development activities that may occur because of the issuance of leases are considered potential indirect impacts of leasing. Such post-lease activities could include seismic and drilling exploration, development, and transportation of oil and gas in and from the Coastal Plain; therefore, the analysis considers potential impacts on birds from on-the-ground post-lease activities.

As outlined above, there would be no impacts on birds as a direct result of the proposed leasing action; however, leasing may overlap with other exploration and development phases of ongoing activities. For example, pre-leasing seismic exploration could occur across the entire program area, and additional post-

[25]Bottom-dwelling species

leasing seismic exploration could occur with any specific lease that may be issued. Potential impacts of oil development on birds are four primary categories of effects: habitat loss and alteration, disturbance and displacement (including alteration of behavior), injury and mortality, and attraction of predators and scavengers (including both mammals and birds) to human activity or facilities, with subsequent changes in predator abundance (Eberhardt et al. 1982; Truett et al. 1997; Burgess 2000; Stickney et al. 2014). The season in which activities occur would either moderate or accentuate the effects on birds. Winter activities would affect low numbers of year-round residents (ravens and ptarmigan, dippers near open running water, and gyrfalcons) and potentially golden eagles and snowy owls, whose presence may overlap with some winter activities. Summer activities would affect breeding birds during the nesting, brood-rearing, molting, and fall migration-staging seasons, when many species are present in high numbers and potential population-level consequences of impacts are greatest.

Although many future activities, such as vehicle traffic, would occur during exploration, construction, drilling, and operations of a development project, the potential intensity of impacts on birds differs among phases. Seismic exploration and exploratory drilling occur during the winter and would have little effect on most birds; indirect effects would occur from ice roads and exploration vehicle traffic on vegetation and terrain surfaces and impacts on habitat quality from water removal.

Habitat loss and human-caused disturbance and displacement would occur from road and facility construction. This would happen during the development phase, which involves the largest number of people, temporary construction camps, and the highest levels of vehicle, machinery, heavy-haul equipment, and aircraft traffic. Most habitat loss would occur during construction, including the building of ice roads to support gravel extraction, gravel hauling, gravel road and pad construction, bridge construction, and pipeline construction.

Indirect effects could occur throughout the life of the proposed action; possible indirect effects are changes to permafrost dynamics, erosion, alteration of vegetation communities, hunting and recreation access, and changes to predator dynamics causing changes in bird habitat and disturbance.

Future barging and in-field transport of CPF modules would occur early in the construction phase of any development project and would also affect birds through habitat loss and disturbance. The drilling phase of a development project would require less personnel and traffic than during early construction, but still higher levels than during operations or production. Air traffic and vehicle traffic would peak during construction and drilling (the development phase), because personnel numbers peak during construction and materials transport during drilling. Traffic rates would be lower during the production phase.

Schedules of development projects in the program area are unknown, but foreseeable hypothetical scenarios indicate overlap of exploration, construction, drilling, and production or operation phases of potentially several different projects with different operators. In terms of impacts on birds, activities and areas affected would increase until the limit of 2,000 acres of surface —development roads, pads, and pits—is reached in years or perhaps decades after initial project construction. All tundra habitat-related disturbance impacts would, therefore, be long term or permanent; however, development activities likely would be dispersed in different parts of the area available for lease over that period. The abandonment and reclamation phase would follow the production phase, when wells, pads, and roads associated with particular project sites have been retired and reclamation activities undertaken. Reclamation activities would also disturb and displace birds, such as from vehicle traffic and heavy machinery, but probably at lower levels than during other phases. Eventually would result in the restoration of some habitat values for birds.

For most actions, potential impacts can be described only qualitatively, either because resource and impact data are unavailable or because project-specific details are uncertain or unknown at the time of this preliminary analysis; however, for some habitat impacts and for some types of behavioral disturbance, semiquantitative estimates of areas affected are possible, with some assumptions regarding the likely configuration of a development project.

Potential direct effects resulting from future on-the-ground actions on avian habitats would occur in the footprint of gravel fill, whereas indirect effects on habitat would occur at varying distances, depending on the source. Fugitive dust, gravel spray, thermokarsting, and impoundments may affect soils and vegetation up to 328 feet from roads and pads (see **Section 3.3.1**). Bird disturbance and displacement could occur over a larger area. When estimating the incidental take of spectacled eiders that would be caused by the construction and operation of oil field infrastructure, the USFWS considers the direct loss of habitat due to gravel fill plus indirect loss in an adjacent zone of influence (estimated to be 656 feet wide), where disturbance could prevent spectacled eiders from nesting. Implicit in this method of estimating impacts is the assumption that displaced pairs would not move and nest successfully elsewhere, which has not been shown.

Using the conceptual 750-acre layout of a stand-alone oil development facility (see **Appendix B**, **Figure B-1**),[26] the BLM examined the area within 328 feet (6,607 acres) of the facility to estimate the extent of indirect impacts on habitat due to dust fallout, gravel spray, thermokarsting, and impoundments. It also examined the area within 656 feet (11,820 acres) of the facility to estimate the extent of behavioral disturbance and displacement (see *Impacts Common to All Action Alternatives*, below). Using these standardized footprints and extrapolating to a 2,000-acre maximum footprint, the BLM estimated the additional total acres indirectly affected by habitat alteration (17,600 acres, about 8.8 times larger than the gravel footprint) and by disturbance and displacement (31,500 acres, about 15.8 times larger than the gravel footprint).

These estimated areas of potential indirect habitat alteration and direct disturbance are intended to be conservative, or the potential effects overestimated, for most species (exceptions discussed below); however, the effects of climate change described under *Affected Environment* above, could influence the rate or degree of the potential indirect impacts of habitat alteration.

Alternative A

Under this alternative, current management actions would be maintained, and resource trends would continue, as described in the Arctic Refuge CCP (USFWS 2015a). No direct or indirect impacts on birds from post-leasing oil and gas activities would occur under Alternative A.

Impacts Common to All Action Alternatives

The following actions and types of potential effects would be common to all action alternatives, but the avian resources affected (e.g., total area, specific habitats, bird species, and bird densities) would vary based on the location of facilities in each action alternative.

Habitat Loss and Alteration

Under all action alternatives, winter seismic exploration and other winter activities would result in temporary and potentially some longer-term modification of avian habitats (see **Section 3.3.1**, Vegetation and Wetlands). Degradation of avian habitats by winter surface activities would be minimized under all action alternatives by ROP 11, setting standards for winter tundra travel. Tussock tundra, which is the most widespread avian habitat

[26]One CPF and 6 radiating 8-mile access roads to 6 drill pads, including an STP pad and a 30-mile access road, totaling 750 acres

in the program area, and shrub tundra types are more sensitive to the physical damage caused by tundra travel and ice roads.

Visible old (10 to 35 years old) seismic lines reduced the abundance of four species of passerines in both upland tussock tundra and in low-center polygon habitats (Ashenhurst and Hannon 2008). Seismic lines less than 1.5 years old, however, did not have measurable effects on bird abundance, despite demonstrable effects on vegetation structure and composition. It should be noted that the sample sizes in this study were small due to low bird abundance and a low number of seismic lines. Additionally, old lines may have more of an impact because they were created using different methods and practices than new lines, or possibly that adverse alterations to vegetation communities resulting from seismic lines take a long time to develop. For example, thermokarsting and the resulting increases in surface water may require years or decades to develop or to stabilize. Clear long-term changes to microtopography and vegetation structure and plant species composition from seismic exploration may affect the abundance and composition of bird communities. These effects would be greatest in drier upland habitats, in areas of higher microrelief, such as stream banks and ravines, and in tussock and shrub vegetation types (Jorgenson et al. 2010; Walker et al. 2019).

Additional short-term and potentially long-term habitat alteration would occur during exploration phases of any specific project, including both additional seismic surveys and exploratory drilling. Both of these would occur primarily during winter, with the support of approved tracked vehicles and ice roads. In addition to the exploration and construction phases, ice roads would be used during the production phase for winter pipeline maintenance and other activities. Ice road alignments are unavailable for calculating areas affected, but proposed use of ice roads is extensive under all action alternatives, including an annual ice road between the program area and the Prudhoe Bay/Deadhorse road system.

Ice roads and pads can interfere with natural drainage of spring runoff; additional habitat alteration can occur through vegetation damage, including reduced live and dead cover due to crushed standing plant cover, stem and blade breakage, compaction, freezing, and physical damage (see **Section 3.3.1**). Although recovery of sedges, grasses, and forbs may occur in two to three growing seasons (Pullman et al. 2005), tussocks and woody shrubs often take longer to recover (Yokel et al. 2007). Vegetation damage is most severe and takes longer to recover in well-drained areas, including moist tundra and shrub habitats, which support higher densities of passerines, ptarmigan, and some shorebirds, like whimbrel and American golden-plover. In contrast, aquatic and wet tundra habitats, which are favored by most waterbird species (Derksen et al. 1981; Johnson et al. 2003, 2005, 2007), generally are damaged less by ice roads and recover more quickly (Guyer and Keating 2005; Pullman et al. 2005). Habitat alterations from ice roads are likely, and their impacts would be short to long term, depending on the types of vegetation affected and whether routes and pad sites are reused in multiple years.

Water resources are relatively limited in the ARCP, as compared to northeastern NPR-A, and large water removals could have adverse impacts on nesting habitats of many species of waterbirds, including loons, eiders, and other waterfowl. Drawdown of water source lakes may change the abundance of foods on which birds rely and may also affect shorelines and islands. For example, lower water levels could eliminate important nesting sites on islands and peninsulas.

Beginning in the exploration phase of any future project and continuing through development and production for the life of the project, water for ice roads would be withdrawn annually, beginning with the first proposed development project on the ARCP. Drawdowns would take place between the ARCP exploration and development infrastructure and the existing support infrastructure in Deadhorse and Prudhoe Bay. Water withdrawals are therefore likely to affect large numbers of waterbirds, with many water bodies affected annually, beginning with the first proposed development project and continuing through the 85-year time frame for analysis; many others would be for shorter terms during specific project development. Effects may be short term in some water bodies, but long-term effects are likely to occur and may be widespread, considering the low abundance of surface water in the ARCP.

Under all action alternatives, ROP 9 would set limits on percent volume removed and other standards for summer and winter withdrawals from lakes and ponds that specifically protect bird nesting sites and fish. Despite these restrictions, water withdrawals could exceed the natural recharge rate, resulting in lower long-term water levels (see **Section 3.2.10**). Few lakes have been surveyed in the ARCP, so the distribution of fish-bearing lakes is unknown. Withdrawing water from under ice could affect water chemistry and turbidity and possibly result in fish mortality and impacts on aquatic invertebrate communities (see **Section 3.3.2**, Fish and Aquatic Species). The resulting decrease in fish abundance would make such lakes less suitable for breeding Pacific loons. Lower invertebrate abundance or a downward shift in invertebrate diversity may affect the quality of ponds as a food source for birds in general, particularly waterbirds and shorebirds. The long-term loss of nesting lakes would have potential local population consequences for Pacific and red-throated loons (yellow-billed loons in the Arctic Refuge nest primarily in the northern foothills of the Brooks Range and outside of the program area).

In the earliest part of the development phase of any future project and continuing through drilling and production phases, gravel would be mined during winter at several unidentified material sites and transported over gravel roads or ice roads or both. Reclamation would consider the potential use of gravel pits for enhancing fish and wildlife habitat. Some pits remaining from excavation would be used as water sources during drilling and operations, which could reduce the impact of other sites being developed for water withdrawal. The original avian habitats would be permanently lost to material sites, but rehabilitated sites would likely be used by some species of nonbreeding, breeding, and brood-rearing waterbirds. The potential habitat loss or alteration from gravel excavation would affect 280 to 300 acres of surface disturbance; the impact on birds would be long term and somewhat lessened by reclamation plans; for example, terrestrial breeding habitats could be replaced by aquatic habitats.

Under all action alternatives, ROP 30 would minimize the loss of nesting habitat for cliff-nesting raptors by prohibiting the removal of more than 100 cubic yards of material from cliffs or from an active channel, unless studies indicate no effects on adjacent bluffs.

Potential future construction of gravel pads and roads would result in long-term direct loss of habitat and indirect alteration of adjacent habitat. Direct losses from gravel coverage would last as long as development projects are active, or until gravel is partially removed from retired roads and pads to restore some habitat functions.

As described in the hypothetical development scenarios (**Appendix B**), the estimate is that facilities would be abandoned and reclaimed 85 years after the first lease. Natural recovery of disturbed sites on the North Slope has been estimated to require 600 to 800 years for upland mesic sites and 100 to 200 years for marsh sites (NRC 2003). When the insulating vegetation mat is disturbed, thermokarst results in permanent alteration of vegetation and morphology.

Rehabilitation activities may speed recovery on lightly disturbed sites, but reclamation and restoration of original habitat value has not been proven for gravel removal in the arctic environment once operations have ceased (see **Section 3.2.10**). It is unlikely that avian habitats could be restored to their original values, although rehabilitated sites may provide adequate breeding habitats for some species, such as waterfowl, and foraging habitats for some geese, passerines, and shorebirds (Bentzen et al. 2018).

Potential indirect habitat modification would result from fugitive dust (i.e., dust shadow) and gravel spray, changes in drainage resulting in impoundments and vegetation desiccation, thermokarsting, and delayed melt of snow in snow drifts or berms created by snow removal. Fugitive dust would generally affect the largest area, extending as much as 328 feet from gravel roads (see **Section 3.3.1**; Walker and Everett 1987). Using the 750-acre conceptual layout of a stand-alone oil development facility (**Appendix B**, **Figure B-1**), the area within 328 feet for impacts of dust fallout, gravel spray, thermokarsting, and impoundments was estimated to be about 6,607 acres. The actual area potentially affected would depend entirely on the configuration of roads; however, these numbers indicate that indirect impacts of gravel roads and pads and material sites would affect an additional area about 8.8 times larger than the total project footprint. Under all action alternatives, potential loss or alteration of habitat from direct effects of gravel deposition and indirect effects of dust, thermokarsting, and impoundments would be long term. They would occur over about 19,600 acres (2,000 acres total footprint plus approximately 17,600 acres within 328 feet), or about 1 percent of the program area (1,563,500 acres).

Potential effects on birds would be minimized by minimizing footprints in wetlands, where densities are generally highest (Bart et al. 2012), to the extent possible; instead, routes and pad sites in uplands and well-drained habitats would be selected, including abundant tussock tundra. Such habitats are important to land birds, such as passerines and ptarmigans, and to some species of waterbirds and shorebirds (Bart et al. 2012); however, any impacts on these species could be greater as a result.

Under all action alternatives, ROP 19 prohibits permanent facilities within 500 feet of fish-bearing water bodies (see exceptions), further protecting birds in those habitats. Habitat alteration caused by fugitive dust, thermokarsting, and water impoundments intensifies with time. As dust and gravel spray accumulate, vegetation is slowly affected, and thermokarsting deepens or spreads. Dust fallout into wet and aquatic habitats also can mobilize contaminants specific to the geology of pits where the gravel was mined. Thermokarst and resultant erosion can have similar effects on the mobilization of metals, including mercury (see **Section 3.3.2**, Fish and Aquatic Species), with potential adverse effects on aquatic invertebrates and waterbirds and shorebirds.

Direct and indirect habitat alteration displaces individuals from locations where they might otherwise nest. Shorebird densities are lower near roads and gravel pads than at distant sites, although there is also evidence that nest densities of shorebirds are higher in the dust shadows of roads (NRC 2003). Some individual shorebirds and passerines whose nest sites were covered by gravel over the winter, have been shown to be displaced to adjacent similar habitats in subsequent nesting seasons (Troy and Carpenter 1990; Johnson et al. 2003). The impact of displacement on population dynamics is uncertain, but direct and indirect impacts of habitat loss and alteration from gravel placement are not anticipated to affect population sizes of any bird species.

The species most likely to be affected by nearshore barge activity is long-tailed duck. The USFWS conducted nearshore sea duck and loon surveys across the Arctic coast of Alaska in late July/early August 2002 and 2003 (Lysne et al. 2004); 92 and 95 percent of birds recorded in ARCP lagoons were long-tailed ducks, 12,000 in 2002 and 27,965 in 2003. Sixteen percent of long-tailed ducks observed across the entire coasts of the Beaufort and Chukchi Seas occurred in ARCP lagoons in 2002 and 29 percent in 2003. Those surveys were timed to coincide with peak numbers of molting long-tailed ducks, but other species were reported.

The next most common species were common eider (199 in 2002 and 327 in 2003), surf scoter (308 and 381), and scaup (79 and 434). For other species, fewer than 150 individuals were recorded in either year, including king eiders, northern pintail, Pacific loons, red-throated loons, and yellow-billed loons. Birds affected by this temporary and long-term loss of feeding habitat would be displaced (see *Disturbance and Displacement*, below), and the effects would be site-specific to local.

Disturbance and Displacement

The impact of disturbance refers to behavioral and potential physiological reactions to perceived disturbing stimuli, which may be visual or aural. Displacement occurs when the individual moves to another site or area that is free from the disturbing stimulus. For example, alert postures, concealment postures, and escape all are potential behavioral reactions and may or may not be accompanied by changes in heart rate, endocrine states (including stress), and increased energy expenditure. For nesting birds, displacement is less available as an option than it would be for non-nesting birds that are not attached to a nest site. The population-level consequences of displacement are greater for breeding birds, however, because it leads to the abandonment and failure of the nest. Many types of human activities in bird habitats would result in either disturbance or displacement of birds.

Noise pollution can affect birds in many ways, although human noise is almost always associated with other confounding disturbance variables, such as visual and physical disturbance. Short duration but very loud sounds can damage birds' ears, although, unlike mammals, birds can regenerate sensory hair cells to some extent (Niemiec et al. 1994). Chronic stress may cause physiological responses, including elevated heart rate, reduced immune response, and decreased reproductive success, although little is known about these responses outside of the laboratory (Ortega 2012).

Avoidance may be the most common response to noise, although many bird species are tolerant of noise and readily habituate to many types of disturbance (Ortega 2012). For example, simulated gas compressor noise was found to have no measurable effects on nest density or reproductive success of longspurs (Gollop et al. 1974b; nevertheless, tundra camp activity, including aircraft, personnel, and vehicle activity, may have affected reproductive success (Gollop et al. 1974c. In studies in New Mexico and in boreal forest in Canada, however, many passerines avoided gas compressor noise (Ortega 2012). Sound transmission lessens with distance, and the effects of loud stationary facilities on birds are localized.

Road and air traffic produce both noise and visual disturbance. Investigations of the behavior of waterfowl in areas of high-density oil development in Prudhoe Bay showed almost no effects of traffic level on habitat use or distance from roads for any species of geese or swans (Murphy and Anderson 1993); the exception was brant, which occurred farther from roads with high traffic levels during construction but not during post-construction development phases. ROP 34f would avoid operation of aircraft over snow goose staging areas between August 15 and September 30 to minimize potential noise and visual disturbance.

Aircraft overflights can temporarily reduce the numbers of waterfowl on lakes (Schweinsburg 1974), but nesting birds show variable reactions; for example, brant were observed to flush from nests in response to some aircraft overflights, while nesting common eiders were rarely observed to show any visible reaction in response to such activities (Gollop et al. 1974a). In industrial areas at Pruhdoe Bay, routine oil field activities, such as road traffic, noise, and aircraft flying at the prescribed minimum altitude of 500 feet typically do not cause nesting geese to react (Murphy and Anderson 1993). Human activity, in contrast, is a consistently strong disturbance and people in the vicinity of nests typically cause incubating birds to flush and to remain off nests as long as people remained in the vicinity (Gollop et al. 1974a; Murphy and Anderson 1993).

The most important indirect effects of such disturbance on reproduction are increased exposure (i.e., exposure of adults to predators) and loss of eggs and nests to avian and mammalian predators.

Future gravel transport and placement and pipeline construction would take place in winter from ice roads and, after initial construction, from existing gravel roads. Winter activities, including ice roads and gravel mining and transportation, would occur annually throughout exploration, development, and production phases of any future development project; however, traffic levels and activity would decrease after the construction phase to relatively low levels during production. During all project phases, winter activities would cause disturbance, behavioral alterations, and displacement to small numbers of resident wintering birds. In the event that ice road use is permitted into April, some early arriving breeding birds could also be affected, primarily golden eagles and snowy owls.

Future construction activities during summer would occur on gravel roads and pads, which could cause short-term behavioral changes or displacement of breeding birds in adjacent habitats. Summer construction would involve gravel grading and compacting, module and pipeline hookups, and construction of the camp, operations center, and CPF. Summer construction would have higher levels of machine, heavy equipment, and vehicle traffic and more human activity than during drilling or operations, thus higher rates of disturbance-caused behaviors and displacement of birds. During drilling and operations, similar types of disturbance and displacement would continue, probably at lower levels. Additional fixed-wing aircraft, helicopter, boat, and human activity likely would occur throughout the life of any project, associated with pipeline inspection and maintenance, surveying, tundra cleanup (i.e., stick-picking), and spill prevention and response activities, such as equipment deployment and maintenance and boom placement on waterways.

Human-caused disturbance could cause behavioral changes in birds, ranging from alert postures to flush or flight behaviors (Murphy and Anderson 1993; Johnson et al. 2003; Livezey et al. 2016). At low levels, disturbance could increase the occurrence of concealment postures, interfere with resting and feeding activities, and increase energetic costs. At higher levels, escape behaviors could affect reproduction through increased absences from nests and nest abandonment, thereby increasing the likelihood of predation leading to nest failure (Uher-Koch et al. 2015; Stien and Ims 2015) or disintegration of broods and chick predation.

Although foot traffic on the tundra would be uncommon with most development activities, reduced productivity due to disturbance by foot traffic is the most consistently reported effect of human presence at nesting sites (Meixell and Flint 2017). Human disturbance can lead to displacement of breeding birds (Johnson et al. 2003), which may or may not affect reproduction. Studies of bird responses to human disturbance in oil fields indicate that responses vary among species, by season and breeding status, by type of human disturbance, and by distance to the source of disturbance (Anderson et al. 1992; Murphy and Anderson 1993; Johnson et al. 2003, 2008).

As discussed previously, for assessment of potential effects of disturbance and displacement by future road traffic, the area within 656 feet of roads, pads, and pipelines was used as a conservative estimate of the area affected by disturbance and displacement for all species of birds. This overestimates the area of disturbance for nesting shorebirds and passerines, which respond at very close distances (43 to 72 feet; Livezey et al. 2016); however, it likely underestimates the area for more sensitive birds, such as nesting tundra swans (at least 1,640 feet or more; Monda et al. 1994). Disturbance and displacement could affect nesting birds within 0.8 miles of active roads (Johnson et al. 2003). A review of literature on reported distances from various motorized and nonmotorized human activities, at which nesting birds initially respond and take flight, found all species studied reacted and flushed at mean distances of less than or equal to 656 feet, except for falcons, hawks, and eagles; these species reacted at greater distances to some disturbance types (Livezey et al. 2016).

During fall migration, staging flocks may also be subject to disturbance and displacement, such as shorebirds in river deltas, molting long-tailed ducks and other birds in lagoons, and snow geese in tundra habitats.

Similar to estimates of potential habitat impacts, above, the 750-acre conceptual layout of a stand-alone oil development facility (**Appendix B**, **Figure B-1**) was used to estimate the area within 656 feet for impacts of disturbance and displacement. The actual area affected would depend entirely on the configuration of roads, but with that standardized footprint of 750 acres, an additional 11,820 acres of tundra within 656 feet was calculated, an additional area about 15.8 times larger than the gravel footprint. Under all action alternatives, with a 2,000-acre footprint at peak development, disturbance and displacement of breeding birds in tundra habitats could occur over about 31,500 acres, or about 2 percent of the program area (1,593,500 acres). Potential impacts of disturbance and displacement by summertime construction and operations would be long term and may affect nest density or nesting success for some birds near facilities; however, they are unlikely to affect regional or global population sizes of breeding birds.

Lease stipulations and ROPs under all action alternatives would help to avoid disturbing nesting Steller's and spectacled eiders. Tundra (ground-level) and construction activities with high noise levels, such as placement of fill and alteration of habitats, would be prohibited within 656 feet of occupied nests. Clearance surveys would be required prior to any tundra activities during the nesting season. ROP 19, prohibiting permanent facilities, including roads, within 500 feet of fish-bearing water bodies, also would reduce the potential for disturbing birds nesting or feeding in those lakes, ponds, or rivers.

Barging would be required to transport modules to Camden Bay early in the construction period of each development project. This could displace and disturb normal behavior of birds in the nearshore marine environment. Barging would involve slow-moving vessels (7 knots for barges) and would produce noise and visual disturbance. Boat operations for other activities may also occur. Common eiders, which may be on nests into late July, and other birds that nest on barrier islands may be disturbed by barging, if they occur during the nesting period; however, of all species studied, common eiders appear to exhibit the fewest behavioral reactions to various types of disturbance (Gollop et al. 1974a).

The potential for disturbance and displacement of birds is greater between early July and late September, when many waterbird species use the nearshore and lagoon waters of the Beaufort Sea, which attracts them because of its shallow water for feeding and protection from wind and waves (Flint et al. 2004).

Lysne et al. (2004) recorded over 23,000 long-tailed ducks along the Arctic Refuge coast during a survey in late summer 2003. They also reported a substantial portion of yellow-billed loons, red-throated loons, scaup, and Pacific loons counted during the entire Alaska North Slope survey, which was done along the Arctic Refuge coast during some years. Johnson (1982) reported displacement of long-tailed ducks in response to aircraft, boats, and human disturbance. Schwemmer et al. (2011) reported ship traffic affected flight reactions in sea ducks and the distribution of loons. Flint et al. (2004) reported that molting long-tailed ducks using lagoons in the Beaufort Sea had low but variable fidelity to sites inside barrier islands, averaging 39 percent. Sites were occupied consistently, but turnover of individuals was high as flightless ducks moved among sites. Site fidelity was not clearly affected by seismic surveys and little evidence was found for disturbance-related displacement of individuals (Flint et al. 2004); aerial surveys did not find a difference in density of long-tailed ducks between industrial and control sites (Fischer et al. 2002).

Potential behavioral disturbance by barging vessels and displacement of birds by associated vessel activity would occur annually in a relatively small area. There may be other boating activities also; those would be short-term events, but they may occur over a broad area and for the duration of a development project.

Additional low levels of disturbance and displacement of waterfowl and seabirds could occur along the marine vessel route between the ARCP and Dutch Harbor, Alaska. Periodic disturbance and displacement from the Camden Bay landing site is not anticipated to result in population-level effects on any bird species.

Air traffic forecasts are provided in **Section 3.4.9**. The effects of air traffic on the acoustic environment are discussed in **Section 3.2.3**. All types of air traffic could disturb and displace both breeding and non-breeding birds. Flight paths would depend on locations of infrastructure, but air traffic supporting oil and gas development would include fixed-wing aircraft into the Deadhorse, Kavik, and Barter Island airports, and helicopters would move people and supplies from airports to sites in the program area. It is possible that additional landing strips would be built in the program area as well. Potential impacts on birds would be widespread across the program area and would be both short and long term.

Under all action alternatives, ROP 34(c and d) would require flight altitudes above 1,500 feet within 0.5 miles of raptor cliff-nesting sites. Similar altitude restrictions plus minimizing helicopter landings from May 20 to June 20 for caribou calving range would temporarily reduce disturbance of nesting birds in some areas. Use of the Deadhorse airport, where traffic levels already are high and which is the primary hub for the North Slope oil industry, would increase both for passenger and freight flights. This would increase the potential to disturb birds, although birds in this area already experience high levels of disturbance. Additional use of the Deadhorse airport would add to disturbance levels locally, and potential impacts on birds would be long term.

Under all action alternatives, helicopters would be used in the future to support ice road layout, survey, and summer cleanup and possibly for spill-response equipment deployment and maintenance. These activities usually take place in July or early August and last approximately 4 weeks, with daily helicopter traffic during that time, involving departures from the helipad and landings at various tundra locations. Helicopter flights during July and August would occur during nesting, brood-rearing and molting, and fall migration-staging periods for most of the species in the program area. Helicopter landings on tundra could cause displacement from nests and separation of broods, which could allow predators to take eggs or chicks and thus reduce reproductive output. As young grow and become more mobile or even flight capable, helicopter landings and low-level flights would cause escape movements or flight behavior and interfere with feeding and resting; however, such effects are usually very short term. The intensity of impacts of helicopter flights would vary, depending on number of landings on tundra, landing locations, and seasonal timing. Impacts would occur during all development phases and would be extensive in geographic scope.

Noise and air traffic could disturb and displace staging snow geese that visit the eastern coastal plain of the North Slope in large numbers in late August and September of most years. As many as 325,760 snow geese have been documented using the ARCP, including the program area and east to the Canada border, for several weeks, foraging for Equisetum (cottongrass) in both coastal and upland habitats and building energy reserves needed for fall migration (Kendall 2006).

In a 2-day experiment, simulated gas compressor noise appeared to decrease the numbers of staging snow geese within 3 miles (Gollop and Davis 1974), although some evidence of habituation was noted even over that short period. Snow geese are easily disturbed by aircraft and other human intrusions during staging, making them vulnerable to displacement and potentially significant impacts. In experimental overflights, flushing distances of staging snow geese on the North Slope have been recorded up to 9 miles from passing aircraft and from overflights at altitudes up to 10,000 feet (Davis and Wisely 1974; Salter and Davis 1974).

In these short-term disturbance studies, mean distances of flushing for various types of overflights ranged between 1.2 and 2.5 miles and durations averaged between 5 and 6 minutes, depending on overflight category, such as aircraft and altitude, and frequent disturbance was found to drive geese away from feeding sites. Boothroyd (1985) found similar results and that staging snow geese were the waterfowl species in their area most sensitive to aircraft overflights. The primary concerns regarding disturbance of staging snow geese are decreased feeding time, increased energy expenditure, and displacement from preferred high-quality feeding areas. These all could affect their ability to accumulate adequate energy reserves to fuel their fall migration (Davis and Wiseley 1974) or could displace them to staging habitats east of the US-Canada border.

Disturbance and displacement by air traffic would occur during all phases of any future development project. Helicopter support would be an important aspect of exploration and development phases but may be much less important during production. Fixed-wing and commercial air traffic may similarly peak during construction but then would level out with regular personnel transportation throughout the production phase; however, with the likelihood that development phases of different projects overlapping, air traffic in general is likely to continue to increase from current levels throughout the 85-year time frame of this analysis.

Mortality and Injury

Vehicle and aircraft traffic and tall structures, including communication towers and drill rigs, pose collision hazards that could kill or injure birds. Little information is available on rates of mortality or injury from collisions in the North Slope oil fields. Collisions with vehicles and aircraft would probably be correlated to bird densities and traffic rates. Vehicle collisions might increase during breeding, when birds are less focused on hazards, and during brood-rearing, when flightless birds would be crossing roads. Reduced speed limits and driver awareness of seasonal bird vulnerability could reduce collision risk from vehicles.

Collisions with tall structures increase with tower height, bright lighting, and the presence of guy wires (Manville 2005; Gehring et al. 2011). Such structures are particularly hazardous when located in movement corridors or in or adjacent to high-value habitats, such as wetlands (Manville 2005). In the ARCP, major movements of migratory birds occur along the coast, many associated with the barrier island and lagoon system, but movements also occur onshore and in marine waters. Although facilities in the coastal environment are limited or prohibited (depending on the alternative), all action alternatives include a coastally located STP and docking facilities, both of which could pose hazards to migratory birds.

Weather conditions, such as fog, rain, and low light, increase collision mortality of common eiders at towers and transmission lines (MacKinnon and Kennedy 2011). On the North Slope, birds often migrate at low altitudes and in foggy conditions; migrating eiders averaged 40 feet aboveground level at Point Barrow (Day et al. 2002).

Collisions with vehicles, aircraft, or structures in the future would likely injure or kill birds. Although the risk of collisions is low, the consequences are high, resulting in serious injury or death. Unknown numbers of collisions would be expected to occur annually, and mortalities would be a particular concern if flocks of birds of conservation concern are involved. The potential impacts of collisions would occur throughout the life of the project; however, they would be infrequent and seasonal and would be restricted to roads and facilities. BMPs for maintaining records of vehicle and tower strikes would be useful for assessing the magnitude of this impact. Under all action alternatives, ROPs 27 and 31would minimize bird collisions by placing utility lines on VSMs (minimizing poles and overhead lines), marking overhead lines for high visibility where they are unavoidable, and designing towers to reduce both bird strikes and raptor/raven nesting. Under all action alternatives, ROP 26 would reduce collisions of birds with structures by directing exterior lighting down and inward during fall migration, August 1 to October 31.

Oil spills and other releases of contaminants pose well-documented risks of injury or death to birds and their eggs (NRC 1985, 2003). Birds may be killed by hypothermia from oil directly through feather oiling and through ingestion while preening or consuming contaminated foods. In experiments, ducks exposed to low concentrations of Prudhoe Bay crude oil on water transferred contamination to their eggs (Albers 1980); eggs exposed to even minute quantities of crude or fuel oil had markedly reduced hatchability and increased prevalence of diseased embryos (Albers and Szaro 1978; Szaro et al. 1978; Couillard and Leighton 1991). In additional to direct mortality (Piatt et al. 1990), spills can have long-term toxicological effects with direct and indirect effects on avian reproduction and habitat use (Szaro 1977; Wells et al. 1995). Spills also affect birds indirectly, through changes in habitat and food supply and by exposure through the food chain.

During seismic exploration, the primary potential for contaminants to be released would be accidental fuel spills from vehicles, storage tanks, aircraft, and equipment during transport or fueling. Such spills would be medium to small (see **Section 3.2.11**) and would continue to be the most common types of spills throughout any future development project.

Most small spills would involve refined oils and fuel, antifreeze, or saltwater used in hydro-testing. Crude oil spills would not be a risk until drilling and operation, when there is greater risk of large or very large spills (see **Section 3.2.11**), due to well blowout or pipeline failure. During project development, construction in or next to the shore of Camden Bay for the STP and barge landings and annual barge traffic (two barge transports per year are anticipated) would increase the risk of medium to large fuel spills in the nearshore marine environment and on the barge route. The rate of occurrence of spills would increase with levels of human activity, including both traffic levels and volume of crude oil production and with the age of any particular development, through the 85-year time frame for this analysis.

Although the risk of spills would be reduced in the various NSO areas designated under each alternative, the frequency of spills would not differ. Under all action alternatives, setbacks from rivers and streams (Lease Stipulation 1) would provide some protection from accidental fuel spills for important avian habitats in riparian and delta habitats, although all action alternatives include exceptions for essential pipelines, roads, and gravel mines. Spills in water would be more difficult to contain, but important coastal and lagoon habitats for migratory birds are NSO under all action alternatives (Lease Stipulation 4, with exceptions for barge landings and pipelines). This would somewhat reduce the potential area that would be affected by small or medium spills in the coastal and nearshore marine environment.

Under all action alternatives, ROPs 1 and 2 would minimize the generation and hazards of hazardous waste. ROP 3 would provide protection from some types of fuel spills for avian habitats associated with water bodies and in riparian areas (fueling equipment and fuel storage over 210 gallons would be prohibited within 100 feet of the active floodplain of any water body; see exceptions). ROPs 16 and 19 would reduce the likelihood of fuel or other spilled materials in fish-bearing water bodies, which are important to some species of birds.

Small spills are likely, medium-sized spills are less common, and large and very large spills are uncommon. Most spills would be fewer than 100 gallons and would be restricted to ice or gravel roads and pads, never reaching the tundra and having no impacts on birds. Spills that reach tundra are less common; they typically affect fewer than 5 acres (BLM and MMS 1998), but they could affect numbers of nesting or foraging birds, depending on location and timing. Habitats affected by such spills are subject to short-term or long-term alteration, depending on the type of spill and rehabilitation required.

Although large and very large spills are uncommon, they do occur—three larger than 100,000 gallons have occurred on the North Slope (see **Section 3.2.11**)—and such spills could pose substantial risks to migratory birds and their habitats, depending again on location and timing. Large spills may take days to weeks to clean up and could pose contamination and disturbance risk to large numbers of molting, feeding, or migrating birds (see NOAA 2002). Large spills from blowouts or from pipeline leaks could reach rivers and streams and the nearshore lagoon system. Spill containment at strategic points on waterways would likely keep oil from flowing downstream into lagoons. Nonetheless, if oil escaped, many species would be vulnerable.

Fuel spills in the marine environment may affect birds during construction and operation of docking facilities and the STP on Camden Bay. Most fuel spills would be medium to small, would occur during mid to late summer open water seasons, and would be localized to the STP and docking facilities, assuming adequate response and containment. Barge traffic also increases the risk of fuel spills along the marine transport route (**Map 3-17** in **Appendix A**). Eiders migrating along the coasts of the Beaufort and Chukchi Seas may be particularly vulnerable to spilled oil that reaches the marine environment. Spills along the marine transport route along the west coast of Alaska could affect critical habitat for Steller's and spectacled eiders. Medium to very large spills in the ocean would be possible in the event that a vessel runs aground and its fuel tanks or containment compartments are breached. This could occur in the shipping lanes leading to the docking or STP pads, similar to the Kuroshima oil spill, which killed many hundreds of birds on Unalaska Island in November 1997 through March 1998; cleanup activities lasted through summer 1999 (NOAA 2002).

Attraction to Human Activities and Facilities

Both birds and mammals may be attracted to human activities. Future oil development projects in the program area would likely increase the numbers of scavengers and predators in the area, beginning in the construction phase and continuing through operations. Effective food and garbage control, wildlife interaction plans, and personnel training (see ROPs 2, 4, and 25) should minimize the attraction of predators to oil field facilities; however, the potential for development to attract scavengers and predators is a concern in part because increased predator abundance can decrease productivity and increase mortality of nesting birds (Truett et al. 1997; Johnson et al. 2010).

On the North Slope, ravens and, to a lesser degree, peregrine falcons, gyrfalcons, and rough-legged hawks nest on human-made structures, including buildings, elevated pipelines, bridges, towers, drill rigs, and wellheads (Ritchie 1991; Frost et al. 2007; Powell and Backensto 2009; Sanzone et al. 2010). Some species of songbirds (e.g., snow buntings, common redpolls) also are attracted to human structures for nest sites. For these few avian predators and passerines, infrastructure may increase the occurrence of breeding sites on the ARCP, and the effects would be widespread and long term.

Two avian predators, glaucous gulls and common ravens, are attracted to human food (Day 1998; NRC 2003), and populations of these species have increased on the coastal plain of the North Slope (Stehn et al. 2013). Foxes and bears also prey on birds and their eggs and are attracted to areas of human activity, where they readily feed on garbage and handouts (Eberhardt et al. 1982; Follmann and Hechtel 1990; Savory et al. 2014 see also **Section 3.3.4**, Terrestrial Mammals). Arctic foxes in oil-development areas occur at higher densities and experience reduced population fluctuations, compared to foxes in undeveloped regions, increasing potential levels of predation of nesting birds and their eggs (Eberhardt et al. 1983; Burgess 2000). Foxes also use human structures (gravel berms and empty pipes) for denning and shelter (Eberhardt et al. 1983; Burgess et al. 1993). Future development projects would attract foxes throughout the year and grizzly bears in summer and fall.

Impacts on nesting birds include long-term reduction in nesting success, and such effects would be widespread. Liebezeit et al. (2009) detected reduced nest survival among Lapland longspurs from predation up to 3.1 miles from oil field infrastructure, although no similar effect was detected for shorebirds. Increased predation may be an important factor limiting the abundance of some bird species.

Alternative B (Preferred Alternative)

In Alternative B, the entire program area is available to lease. Alternative B includes 359,400 acres designated NSO to protect nearshore marine and lagoon waters and barrier islands (Lease Stipulation 4) and to protect rivers and streams (Lease Stipulation 1), although barge landings, docks, pipelines, and road crossings would be allowed. These restrictions offer some protection to birds in riparian areas by limiting potential habitat loss, alteration, disturbance, and displacement and by reducing the risk of accidental spills. Riparian NSO setbacks of 1 mile from the active floodplain of the Canning and Hulahula Rivers, in particular, may protect cliff-nesting raptors known to occur near those rivers. Important waterbird habitats in the adjacent lakes district within 1 mile of the Canning River floodplain are included in this NSO.

In addition, Alternative B includes 721,200 acres of caribou calving habitat in which construction activity using heavy equipment would be halted between May 20 and June 20 (Lease Stipulation 7). In the same area, road and air traffic restrictions would be applied when caribou are present. These traffic restrictions for caribou would offer negligible protection to birds by potentially limiting disturbance and displacement, but only when caribou are present.

The most abundant vegetation types in the program area are herbaceous (mesic) (31 percent total cover), tussock tundra (26 percent), herbaceous (wet) (16 percent), and low shrub (15 percent). No other vegetation type comprises more than 2 percent of the program area. Freshwater or salt water (primarily salt water, as all lagoons are included) comprises 9 percent of the program area. Breeding birds use all these vegetation types, but the abundance and species richness of nesting birds is greatest in wetter habitats and in delta areas; abundance and richness decrease with distance from the coast.

Areas available for lease under Alternative B include 427,900 acres in the area of high HCP, 658,200 in moderate HCP, and 477,100 in low HCP. Areas of high, medium, and low HCP have similar cover by vegetation types overall, although areas of medium and low HCP include greater proportions of inland habitats. This is reflected in an increase in occurrence of more well-drained tussock tundra and low shrub and decreasing occurrence of herbaceous (mesic) and freshwater or salt water (again almost entirely salt water) (see **Section 3.3.1**). Also, two relatively high-quality bird habitats, herbaceous (marsh) and herbaceous (wet-marsh) (tidal) occur primarily in areas of high HCP in the program area.

Alternative C

In Alternative C, the entire program area is open to lease, but 932,500 acres are subject to NSO to protect rivers and streams (Lease Stipulation 1), nearshore marine lagoon and barrier islands (Lease Stipulation 4), coastal areas (Lease Stipulation 9), and caribou calving habitat (Lease Stipulation 7). Exceptions would be made for roads, pipelines, barge landings, and docks, but not in 606,200 acres of caribou calving habitat, where no surface occupancy would be allowed. Habitat loss and alteration for birds would be reduced relative to Alternative B in these additional NSO areas, as would disturbance and displacement and the risk of accidental spills.

Alternative C includes some larger setbacks than Alternative B for riparian areas (Lease Stipulation 1) and is, therefore, somewhat more protective of avian habitats in riparian areas. A setback of 2 miles from the active floodplains may protect a larger amount of cliff-nesting habitat on the Canning River and more of the lakes district next to the Canning River delta than under Alternative B. The barrier island and lagoon habitats are protected similarly under Alternatives B and C, but under Alternative C 145,100 acres within 1 mile of the coast (inland of the barrier islands) are designated NSO (Lease Stipulation 9). The coastal and riparian setbacks in Alternative C would protect important bird habitat, together including a large portion of the lakes district east of the Canning River delta, although as described above, future roads and pipelines would be allowed, including docking pads and the STP in the coastal setback.

The 606,200 acres closed to surface occupancy to protect caribou calving habitat (Lease Stipulation 7) comprises entirely inland habitats and nearly all in the area of Low HCP. Although protective of birds, this closure affects mainly drier and inland habitats with lower density of breeding birds, although these habitats are important for landbirds, including passerines, ptarmigan, and some shorebirds, like whimbrel and American golden-plover. Fall staging snow geese are an important exception, as the area of NSO overlaps extensively with areas historically used by the largest numbers of fall staging snow geese in the program area. Cliff-nesting raptors may also benefit, as the headwaters of many rivers and creeks are in the NSO area for caribou calving habitat.

Alternative C also includes large areas subject to TLs, including 115,000 acres of caribou calving habitat (in addition to the 606,200 that are NSO), with restrictions from May 20 to June 20, and 985,700 acres of caribou post-calving habitat, which overlaps the entire calving habitat area, with restrictions from June 15 to July 20. During this period, traffic controls would be implemented when caribou are present.

NSOs and TLs to protect caribou habitat would offer negligible protection to breeding birds, again primarily in inland and drier habitats; however, lower levels of aircraft traffic in NSO areas would result in much lower potential for disturbance and displacement of staging snow geese, by comparison with Alternative B.

Under Alternative C, although the entire program area is open for lease sale, large portions would be NSO (exceptions allowed), including caribou calving habitat (largely tussock tundra) and some potentially higher value avian habitats (wet, riparian, and tidal areas) within 1 mile of the coast and in buffers around some river channels that are larger than under Alternative B. Although the 2,000-acre development footprint and the area open for leasing would be the same, under Alternative C the direct and indirect effects of gravel deposition would be somewhat less than under Alternative B, to the extent that some higher value avian habitats are NSO.

Alternative D

Avian habitats under Alternatives D1 and D2 would be protected in 526,000 and 763,000 acres, respectively, that are closed to leasing. This would be done to protect springs and aufeis locations (Lease Stipulation 3) and caribou calving areas (Lease Stipulation 7), and, under Alternative D2, caribou post-calving areas (Lease Stipulation 8) and a buffer for the wilderness boundary (Lease Stipulation 10). An additional 708,600 acres of avian habitats, under Alternative D1, or 505,800 acres, under Alternative D2, would be subject to NSO to protect the following:

- Rivers and streams (Lease Stipulation 1)
- The Canning River delta and adjacent lakes (Lease Stipulation 2)
- Additional areas around springs and aufeis
- Nearshore marine, lagoon, and barrier islands (Lease Stipulation 4)
- Polar bear denning habitat (Lease Stipulation 5)
- Additional caribou calving habitat (Lease Stipulation 7)

- The coastal zone (within 2 miles of the coast, Lease Stipulation 9)
- The wilderness boundary (3 miles from wilderness boundary, Lease Stipulation 10)

Exceptions would be made for roads, pipelines, barge landings, and docks; however, there would be no exceptions in areas not offered for lease (calving habitat and springs/aufeis) or in NSO-designated calving habitat.

In addition to large areas closed to leasing under Alternatives D1 and D2, these alternatives would protect important avian habitats by including larger setbacks than other alternatives for NSO areas associated with rivers and streams. This would be up to 3 or 4 miles, depending on the stream, and would affect more streams (Lease Stipulation 1).

Unlike other alternatives, Alternatives D1 and D2 would protect high-value waterbird habitats in the entire Canning River delta and adjacent lakes district with an NSO designation (Lease Stipulation 2). Also under Alternatives D1 and D2, and absent from other alternatives, the NSO setbacks from spring and aufeis locations (Lease Stipulation 3), polar bear denning habitat (Lease Stipulation 5), and the boundary of the Mollie Beattie Wilderness Area would protect important bird habitats.

Although all action alternatives designate as NSO the nearshore marine, lagoon, and barrier islands (Lease Stipulation 4) and the coastal zone (Lease Stipulation 9), Alternatives D1 and D2 include additional restrictions that may reduce disturbance of migratory birds in nearshore and coastal habitats, including a prohibition on exploration (including seismic) in nearshore and barrier island areas between May 15 and November 1 (Lease Stipulation 4). For birds, habitat loss and alteration would be reduced, relative to Alternatives B or C, in these additional NSO areas, as would disturbance and displacement and the risk of accidental spills.

All of these no lease areas, NSO areas, and CSU areas would potentially reduce impacts on birds. Nearly all of the lands closed to leasing are in the area of low HCP and in inland and drier habitats that are important to landbirds and some shorebirds and are used extensively by fall staging snow geese. As with Alternative C, cliff-nesting raptor habitat that could occur in the upper reaches of rivers and streams would be NSO under Alternatives D1 and D2 in caribou calving habitats (Stipulation 7).

Additional potential cliff-nesting habitat may be protected in a 3-mile buffer next to the Mollie Beattie Wilderness Area (Lease Stipulation 10). The various NSO areas under Alternatives D1 and D2 would protect many of the most important avian habitats: riparian and stream habitats and adjacent wetlands, Canning River delta water bodies and wetlands, lagoon and barrier island habitats, and coastal habitats. Setbacks for springs and aufeis under Alternatives D1 and D2 would provide some protection to several specific sites that are important providers of surface water during summer and thus very important to tundra birds. Although exceptions would be allowed for road and pipeline crossings and for siting an STP on the coast, the NSO areas under Alternatives D1 and D2 would protect many important avian habitats.

Under Alternatives D1 and D2, ROP 3 would provide greater protection from some types of fuel spills than under other alternatives. This would protect avian habitats associated with water bodies and in riparian areas (a 500-foot versus 100-foot setback for fueling equipment and fuel storage over 210 gallons; see exceptions).

Under Alternatives D1 and D2, monitoring and modeling lake and pond recharge after water withdrawals may be required, specifically to ensure aquatic habitat for birds (ROP 9).

Winter tundra travel under Alternatives D1 and D2 would require dense snow cover (only depth is considered under other alternatives) and probably would result in lower and shorter-term impacts of seismic exploration and other winter activities on avian habitats. This would be the case particularly in tussock tundra, which is more sensitive to such damage and is the most abundant avian habitat in the program area.

Timing limitations and CSU areas designed to minimize disturbing caribou under Lease Stipulations 6 and 8 would provide some protection to nesting birds. Under Alternatives D1 and D2, the requirement that aircraft flight altitudes be above 1,500 feet would be extended to post-calving ranges. Limited helicopter landings would be extended to July 20 (ROP 34) or through the bird nesting season, both of which could reduce the potential for disturbing nesting birds somewhat, relative to other alternatives. These TLs to protect caribou would reduce potential disturbance of breeding birds, primarily in inland habitats that are important for landbirds, including passerines and ptarmigan, and some shorebirds.

Although protective of all birds, areas closed to leasing and adjacent areas with NSO or CSU restrictions that are intended to protect caribou habitat under Alternatives D1 and D2 also overlap extensively with areas known to be used intensively by fall-staging snow geese. By comparison with other alternatives, the lower levels of future aircraft traffic in these areas under Alternatives D1 and D2 would result in reduced potential for disturbance and displacement of staging snow geese. As mentioned above, air traffic and other disturbances would likely be low in areas used by the largest numbers of staging snow geese in the southeast portion of the program area, which is closed to leasing under Alternatives D1 and D2; however, potential disturbance and displacement of staging snow geese also would occur during fall in areas north and west of protected calving habitat. These areas also are used by large numbers of staging snow geese in fall, and the TLs to protect caribou would not be protective. Fall-staging snow geese occur throughout these areas and air traffic and other activities there likely would result in potential disturbance and displacement.

Transboundary Impacts

Impacts of the proposed action on birds are not anticipated to reduce populations or regional abundance and density. No transboundary effects of leasing and subsequent development are anticipated for most bird species. One exception could be the displacement of fall staging snow geese. In the event that air traffic or other disturbance displaces them without habituation,[27] numbers of snow geese using staging habitats in Alaska may decrease. There would be a resulting increase in geese using those habitats on the other side of the border in Canada.

Limiting factors for the western Arctic population snow geese are unknown, and the species' numbers continue to increase across North America. This suggests that staging and other habitats remain abundant for the species. While the degree to which snow geese would be displaced cannot be predicted, observations suggest that the primary impact would be on the seasonal distribution of geese and that populations would not be affected. In contrast, migratory birds that use habitats in the ARCP face myriad impacts in migration, staging, and wintering areas beyond the program area.

Transboundary impacts in other locations may significantly affect the abundance of birds in the program area. Species such as brant and eiders may be particularly vulnerable because entire populations depend on specific and potentially vulnerable habitats in migration and wintering areas (Ward et al. 2005; Leach et al. 2017). The worldwide abundance of brant appears to be decreasing (Sedinger et al. 2018), and there are concerns about

[27]The diminishing response to frequent disturbance.

the changing distribution of eelgrass, the primary forage species in staging and wintering areas (Shaughnessy et al. 2012).

Unlike most other waterbirds that winter primarily in North America, red-throated loons from the ARCP winter in East Asia (McCloskey et al. 2018), where they are exposed to polychlorinated biphenyls (PCBs) (Schmutz et al. 2009) and habitat loss to development in coastal wintering areas.

Outside of Alaska, shorebird habitats are seriously threatened, and important habitats for Alaska's shorebirds during nonbreeding seasons are being lost in many parts of the world (Alaska Shorebird Group 2019). Shorebirds wintering in East Asia, such as dunlin, have lost much of their mudflat habitats to shoreline reclamation and industrial development (Weidensaul 2018). The loss of tidal habitats is a worldwide problem, caused not only by industrial development, but also by beach recreation, poaching and subsistence hunting, and agriculture and aquaculture.

Shorebird numbers in general have decreased by half since 1974 (Weidensaul 2018), with the steepest declines among long-distance migrants that nest in the Arctic, including ruddy turnstones, red knots, whimbrel, and Hudsonian godwits; however, other arctic-nesting species also are in decline (US Shorebird Conservation Plan Partnership 2016).

Many landbirds of the ARCP face similar challenges in migration and wintering areas. Many neotropical migrant passerines are of high conservation concern, due to habitat loss and alteration from industrial development, recreation, and land use changes in Central and South America. Although specific causes for population declines often are unknown, many conservation listings for landbirds (see **Table J-9**) are the result of threats to habitats or survival in wintering areas (ADFG 2015).

Cumulative Impacts

The cumulative effects of past, present, and reasonably foreseeable future actions (see **Appendix F**) would be similar to the direct and indirect impacts on birds that were described previously for the program area lease sales. Such proposed projects as SAE geophysical exploration in the program area, the LNG pipeline, the increased transportation network, and additional oil and gas development in Alaska would have cumulative effects on birds and their habitats. Future oil and gas developments and other actions would occur in both terrestrial and marine environments and would affect birds. Because materials for ARCP development would arrive by ice road or barge from the west, cumulative effects would occur across northern Alaska. This includes NPRA development areas and coastal and marine areas through transportation and shipping corridors (Sullender 2018).

The National Research Council (NRC 2003) identified higher predator densities and increased predation on nests as the most apparent effect of oil development on birds. The effects of increased predation on birds and their nests are likely to increase in association with RFD scenarios and combined with other projects in the program area. For uncommon or rare species and for some colonially nesting species, such impacts could be more acute. Populations of gulls and ravens would continue to increase on the North Slope as human presence increases. Also, foxes and bears would continue to be attracted to developed sites, with adverse consequences for nesting birds.

All RFD scenarios would increase the loss and alteration of avian habitats across much of Alaska's North Slope and in combination with other projects in the region. In most areas, particularly in oil fields, the density of development would be relatively low and would have little effect on the abundance or distribution of birds; however, some types of projects may result in higher density development. This could adversely affect or exclude breeding birds from larger areas, particularly near villages and in land owned by entities other than the BLM.

All types of direct habitat loss are long term to permanent, although some habitat function may be restored with rehabilitation. The impacts under all alternatives would contribute to cumulative impacts on birds and their habitats. Alternative B has the greatest potential for effects and Alternative D2 would contribute the fewest, due to restricting the leased area to a maximum of 800,000 acres. The effects of climate change described under *Affected Environment* above, could influence the rate or degree of the potential cumulative impacts.

With documented impacts on reproductive success and predation rates, industrial areas on the Arctic Coastal Plain may become a population sink for many species of birds (NRC 2003), meaning that local reproduction is inadequate to maintain the species and local densities are maintained by immigration from source areas where reproduction exceeds mortality. Although overall densities do not appear to have decreased in industrial areas, such species would be extremely vulnerable to the effects of impacts in other parts of their seasonal range.

Transportation activities are anticipated to increase in support of both oil and gas development projects and of coastal villages, along with increases in research and recreational transportation. Increased transportation would include overland movement as the road system increases in size, barge and boat traffic, and passenger and cargo air traffic. Future surface, boat, and air traffic would increase the levels of disturbance of birds and the occurrence of fuel and other contaminant spills in both terrestrial and marine environments important for birds. Road development associated with past, present, and reasonably foreseeable future projects could increase access for hunters, recreationists, and predators. It also would and increase disturbance and mortality of birds, especially in remote areas, as previously described. Subsistence activities involving bird hunting and egg harvesting would continue with similar types of activities and areas used.

If residents of adjacent villages are allowed access to roads, harvest of birds may increase. Such impacts would be localized and, future subsistence activities and scientific research are unlikely to adversely affect bird populations.

Recreation and tourism could adversely affect birds, depending on locations and seasons, intensity, and types of transport. Air-based sightseeing could cause widespread disturbance, as could cruise ships. Community development projects, such as airport improvements, roads and ports, telecommunication, and energy projects, all would result in habitat loss and alteration, disturbance, and displacement of birds in the vicinity of such communities; it also would result in small increases in impacts on bird populations.

The large magnitude of climate change effects, accompanied by increases in already high climate variability in the Arctic, are likely to overshadow smaller magnitude impacts of oil development. It would be difficult to differentiate among direct, indirect, and cumulative impacts. Extinctions, predicted to increase dramatically and particularly among birds, may alter the avian community with or without oil leasing and development in the ARCP and irrespective of habitat alterations anticipated to result from global climate change.

3.3.4 Terrestrial Mammals

Affected Environment

Thirty-nine species of terrestrial mammals are known or expected to occur in the Arctic Refuge, 18 of which occur regularly in the Coastal Plain physiographic province in the Arctic Refuge (MacDonald and Cook 2009; USFWS 2015a; **Table J-16** in **Appendix J**). The occurrence and distribution of terrestrial mammals in the program area have been described in detail previously (Clough et al. 1987; Douglas et al. 2002; USFWS 2015a; Pearce et al. 2018); those discussions are incorporated here by reference, and relevant information is summarized below, supplemented with updates from more recent research.

Special Status Species

None of the terrestrial mammals in the program area are listed under the federal ESA or the BLM list of sensitive species (BLM 2019). (Polar bears do occur on land in the program area, but they are discussed in **Section 3.3.5**). The Alaska tiny shrew[28] was on the previous BLM list of sensitive species (BLM 2010).

Caribou

Caribou are the most abundant large mammals in the program area and are an important subsistence and cultural resource for Iñupiaq, Inuvialuit, Gwich'in, and other groups who hunt the Porcupine Caribou Herd (PCH) and Central Arctic Herd (CAH) in Alaska and Canada. They also are an important species for other hunters who do not live in the PCH range and for nonconsumptive uses, such as tourism and wildlife viewing. Because caribou exhibit high fidelity to calving grounds, the ADFG defines herds based on their use of calving grounds.

Four herds of barren-ground caribou occur in Arctic Alaska: (proceeding from west to east) the Western Arctic Herd (WAH), the Teshekpuk Herd (TCH), the CAH, and the PCH. These four herds differ in their use of seasonal ranges, especially during the calving, insect-relief, and winter seasons (Russell et al. 1993; Murphy and Lawhead 2000). The program area is primarily used by the PCH and the CAH and is outside the range of the WAH (Dau 2015; Joly and Cameron 2017). The program area is also outside the primary range of the TCH, although an estimated 5,000–10,000 TCH caribou moved into the northern portion of the Arctic Refuge in the fall of 2003 (Carroll 2005; Person et al. 2007; USFWS 2015a), following a large rain-on-snow event in the TCH winter range in October 2003 (Bieniek et al. 2018). That unprecedented movement was highly unusual, has not been repeated, and resulted in high mortality of TCH caribou wintering near the program area (Carroll 2005).

Some caribou in the PCH give birth in the program area during most years, although the amount of calving in the area depends on spring conditions, including May snow depth (Russell and Gunn 2019). PCH caribou use the coastal areas and ridges in the adjacent foothills and mountains for relief from insect harassment during summer, a period when some CAH caribou also use the program area. For these reasons, this discussion focuses on the PCH and CAH.

Herd Sizes and Trends

The PCH was estimated to number about 100,000 animals in 1972 and increased to 178,000 in 1989, before declining to 123,000 animals in 2001 (Caikoski 2015). Due to unsuitable conditions of weather and herd distribution, another census could not be conducted until 2010, when the herd was estimated at 169,000 animals. It increased to 197,000 animals by 2013 and reached a herd size of 218,000 animals in July 2017 (Figure 3-5, Population Size of Three Caribou Herds in Arctic Alaska, 1977-2017, in Appendix A; Caikoski 2015; ADFG 2018a). Although caribou populations are naturally cyclical and population dynamics are complex, population growth of the PCH has been correlated with phases of the arctic oscillation (an index of oceanic temperature and sea level pressure over the Arctic Ocean), which may affect snowfall and summer growing conditions (Joly et al. 2011).

[28] *Sorex yukonicus* has since been reclassified as the holarctic least shrew, *S. minutissimus* (Hope et al. 2010; Bradley et al. 2014).

The CAH was estimated at approximately 5,000 animals when it was first described as a separate herd in the mid-1970s. The herd grew to its estimated peak of 68,000 animals by July 2010, then declined steeply to 23,000 by July 2016; the most recent estimate was 28,000 individuals in 2017 (**Figure 3-5** in **Appendix A**; Lenart 2015b, 2018; ADFG 2017). The herd decline between 2010 and 2016 was thought to be due to high adult mortality and to the emigration of some CAH caribou to the PCH and TCH (ADFG 2017). Some level of herd interchange occurs among the four Arctic herds in Alaska, but the larger herds, WAH and PCH, tend to have higher herd fidelity than the two smaller TCH and CAH (Prichard 2016).

Life History and Habitat Use

Caribou behavior and habitat use in northern Alaska vary substantially on a seasonal basis (Russell et al. 1993; Murphy and Lawhead 2000). This is because caribou efficiently travel long distances (Fancy and White 1987) to maximize access to areas of accessible, nutritious forage plants, to minimize the risk of predation, and to limit their exposure to insect harassment.

Caribou of the PCH and CAH generally spend the winter in or south of the Brooks Range (Griffith et al. 2002; Lenart 2015b; Nicholson et al. 2016), where the winter ranges of the two herds overlap in some years (Caikoski 2015; Lenart 2015b), although some CAH caribou winter north of the Brooks Range in some years (Lenart 2015b; Nicholson et al. 2016). Many PCH animals migrate to winter range in the Yukon. During winter, the availability of lichens and other winter forage is influenced strongly by snow depth, snow hardness, and ice (Collins and Smith 1991). Winter snow depth is negatively related to population growth (Aanes et al. 2000), calf birth mass (Adams 2005), and birth rate (Ferguson and Mahoney 1991). Deep winter snow may delay the timing of births and reduce birth rates for a year (Adams and Dale 1998a, 1998b).

In spring, pregnant females migrate northward to calving grounds ahead of non-pregnant females, with males arriving later, after most calving is complete (Russell et al. 1993; Murphy and Lawhead 2000). Spring migration tends to coincide with snowmelt, and caribou often calve farther south when snowmelt is delayed (Carroll et al. 2005) or, in the case of the PCH, farther east (Griffith et al. 2002). In northern Alaska, most adult females older than 2 years of age give birth to a single calf in late May or early June. Caribou calving grounds in Arctic Alaska are in areas with few predators and with abundant, early emerging forage plants (especially tussock cotton grass, *Eriophorum vaginatum*), which are high in protein, are highly digestible (Kuropat 1984; Griffith et al. 2002; Johnstone et al. 2002), and have high levels of some trace minerals (Oster et al. 2018). Because of the delayed plant phenology, use of the Coastal Plain during summer appears to extend the period when caribou can find forage with adequate digestible nitrogen (Barboza et al. 2018). Forage plants on the ACP have higher digestible concentrations of nitrogen than in inland areas and the period that usable nitrogen is available is more extended (Barboza et al. 2018). The highest forage nitrogen concentrations occur during the post-calving period when peak lactation occurs (Johnson et al. 2018) and nutritional demands of parturient caribou are greatest (Parker et al. 1990).

The calving grounds of the PCH and CAH are near coastal mosquito-relief habitat, requiring relatively short movements once mosquitoes become active (Walsh et al. 1992; Murphy and Lawhead 2000; Nicholson et al. 2016). During the summer insect season (late June to mid-August), caribou are harassed heavily by mosquitos (*Aedes* spp.) and parasitic oestrid flies (warble fly, *Hypoderma tarandi*; nose-bot fly, *Cephenemyia trompe*). The longest distances traveled per day throughout the entire year typically occur in July, when mosquito harassment peaks (Fancy et al. 1989; Prichard et al. 2014; Dau 2015). In response to severe mosquito harassment, caribou form large groups and move to relief habitat near the coast or to remnant snowfields, patches of aufeis, and mountain ridges farther inland, where temperatures are lower and wind speeds are higher (Downes et al. 1986; Walsh et al. 1992; Murphy and Lawhead 2000; Yokel et al. 2009; Wilson et al. 2012).

Oestrid flies emerge in July and exert strong effects on caribou behavior and body condition (Murphy and Lawhead 2000; Hughes et al. 2009). In response to fly harassment, large caribou herds break up and disperse widely in small groups, seeking relief in unvegetated habitats, such as river bars, dunes, drained-lake basins, pingos,[29] and ridgetops. In areas of northern Alaska with industrial development, caribou often use elevated sites on gravel roads and pads and in shaded areas under buildings and pipelines when flies are active (White et al. 1975; Pollard et al. 1996; Murphy and Lawhead 2000). Hot summers with severe insect harassment can substantially decrease caribou conditions in fall, causing them to enter the winter in poor condition (Helle and Tarvainen 1984; Colman et al. 2003; Weladji et al. 2003; Couturier et al. 2009) and potentially leading to lower productivity (Cameron and Ver Hoef 1994).

During late summer and fall, caribou feed heavily to restore body reserves before the onset of winter (Haskell and Ballard 2004; Gustine et al. 2017). The birth rate for female caribou in spring is strongly related to body mass in the previous autumn (Cameron and Ver Hoef 1994; Cameron et al. 2000). On the range of the CAH, the length of the growing season has increased by 15 to 21 days as the climate warmed between 1970 and 2013 (Gustine et al. 2017); despite a 9- to 10-day increase in the fall growing season during that period, no significant change in seasonal forage quality was evident. Caribou migration to winter ranges in the fall coincides with the breeding season (rut) in October, a period when male caribou experience high energy demands. In one study, adult males lost 23 percent of body protein and 78 percent of body fat during the rut (Barboza et al. 2004).

Compared with the conditions experienced by other arctic migratory herds, the range of the PCH has warm spring conditions and cool moist summers, which likely result in longer periods of high plant quality and lower mosquito harassment (Russell and Gunn 2017). The winter range has relatively high snow depths, but diverse terrain provides a wide range of wintering locations. PCH animals accumulate less back fat and get pregnant at higher fall body weights (indicating lower productivity) than other herds, but pregnancy rates change less dramatically with changing fall body weights (indicating lower vulnerability). The PCH has had a more stable population size than other herds in recent decades (Fauchald et al. 2017; Russell and Gunn 2017).

PCH Use of the Program Area

Caribou use of the program area varies greatly throughout the year. The principal use by the PCH occurs in the spring and summer, during spring migration and the calving, post-calving, and insect seasons (**Map 3-28**, Seasonal Distribution of the Porcupine Caribou Herd, in **Appendix A**). The PCH give birth from the northern portion of the Arctic Refuge into northern Yukon, an area of 8.9 million acres (Griffith et al. 2002), but, the extent of use of those areas varies substantially among years (Map 4-9 in USFWS 2015a; **Maps 3-28**, **3-29**, and **3-30** in **Appendix A**).

Four terms are used to describe the use of calving grounds by caribou, as follows (Griffith et al. 2002):

- Annual calving ground—the calving ground for a particular year
- Extent of calving—the outer perimeter of all known annual calving grounds

[29]A dome-shaped hill formed in a permafrost area when the pressure of freezing groundwater pushes up a layer of frozen ground

- Annual concentrated calving area—the area of higher than average calving density in an annual calving ground
- Extent of concentrated calving—the outer perimeter of all known annual concentrated calving areas

Early descriptions of range use of the PCH are complicated by the lack of telemetry data and the unknown status of the CAH (CAH movements could have been attributed to the PCH); nevertheless, the available historical information shows the entire program area has been used for calving at times but with large inter-annual, and perhaps decadal, variability in distribution. Skoog et al. (1963) surveyed the area in 1961 and estimated that 60,000 caribou were between the Canning and Kongakut Rivers during calving; approximately one-third were between the Canning and Katakturak Rivers. Hemming (1971) describes the calving range as between the Katakturuk and Kongakut Rivers.

Between 1983 and 2001, the annual percentage of PCH females calving in the ANILCA 1002 Area (essentially the program area) averaged 42.7 percent (a portion of the concentrated calving area was in Alaska each year from 1983 to 1999; **Maps 3-29** and **3-30** in **Appendix A**). The percent calving occurring in the area was highest in years with early spring conditions (as measured by the Normalized Difference Vegetation Index [NDVI] calculated from satellite imagery during calving; Griffith et al. 2002). In 8 of the 12 years from 2000 to 2011, the annual concentrated calving areas occurred in the Yukon or near the Yukon-Alaska border, largely outside the program area (USFWS 2015a). The PCH calved predominantly in the Yukon in 2012/2013 (**Map 3-30** in **Appendix A**; Caikoski 2013, 2015) but predominantly in Alaska between 2014 and 2017, and calving was widely dispersed in 2018 (**Maps 3-29** and **3-30** in **Appendix A**; Caikoski 2015).[30] In 2017, much of the PCH concentrated calving area was west of the Sadlerochit River.[31] Russell and Gunn (2019) found that use of the program area for calving is higher in years with shallower snow in mid-May.

The annual calving grounds were in areas with higher rates of increase in NDVI, which is thought to indicate higher quality forage. The annual concentrated calving areas in those annual calving grounds were characterized by higher forage biomass, as measured by NDVI (Griffith et al. 2002). PCH caribou feed primarily on immature flowers of tussock cottongrass early in June, in wet sedge meadows, herbaceous tussock tundra, and riparian vegetation types; then later in June they forage primarily on willows and herbaceous plants (Griffith et al. 2002; Johnstone et al. 2002).

Between 1983 and 1985, PCH calf mortality during June averaged 29 percent, and 61 percent of that mortality was due to predation, primarily by golden eagles, grizzly bears, and wolves. Predation rates and predator densities were higher in the foothills south of the program area (Whitten et al. 1992; Young and McCabe 1997), and calf survival was lower for calves born in the foothills (Griffith et al. 2002). Mean annual calf survival was higher when the forage biomass at peak lactation (estimated by NDVI on June 21) was higher (Griffith et al. 2002); hence, calving grounds for the PCH varied annually, at least in part due to spring weather and vegetation growing conditions; calving location and vegetation growing conditions appear to affect calf survival. The USFWS (2015a) concluded that, due to the annual variability in the calving area, the PCH needs a large region from which to select the best conditions for calving in a given year.

During the post-calving season (last week of June and first week of July), most locations of PCH caribou were in the program area; even if they calved outside of it, PCH caribou moved west toward the program area (Griffith et al. 2002; **Map 3-31** in **Appendix A**). Sixty-seven percent of all caribou outfitted with radio collars

[30]Jason Caikoski, ADFG, phone call to Alex Prichard, ABR Inc., on September 11, 2018, regarding annual calving distribution of the PCH.
[31]Ibid.

(1985-2017) spent time in the program area in a year (Russell and Gunn 2019). Of those caribou, the ones that calved in the program area spent an average 26.5 days there, while caribou that calved outside the program area spent an average of 9.8 days in the program area. Five percent of caribou using the program area remained there for more than 5 weeks (Russell and Gunn 2019).

PCH caribou may use both coastal areas and inland ridgetops for insect relief (Walsh et al. 1992; USFWS 2015a). Most PCH caribou move out of the program area by mid to late summer. During the summer insect season (July 7–August 14) in the years before 2000, caribou spread out across the Coastal Plain and in the Brooks Range in Alaska and Yukon, with few remaining in the program area (**Map 3-31** in **Appendix A**; Russell et al. 1992; Griffith et al. 2002). From 2000 to 2014, PCH caribou generally left the Coastal Plain by the end of June (USFWS 2015a), but between 2015 and 2018 caribou used the program area later in the summer (see comments in **Appendix S**).

CAH Use of the Program Area

Roby (1978) and Shideler (1986) describe the observations of biologists working in the area of the CAH range before the advent of telemetry collars. Females in the CAH calve in two areas west of the Arctic Refuge: one south and southwest of the Kuparuk oil field, between the Colville and Kuparuk Rivers, and the other between the Sagavanirktok and Canning Rivers in an area with little development (**Map 3-32**, Seasonal Distribution of the Central Arctic Herd, in **Appendix A**). Since construction of the Alaska North Slope oil fields, the CAH has been exposed to some level of development for about 40 years (Cameron et al. 2005). During most years since at least 2003, a portion of the CAH has moved through the program area during the summer insect season (**Map 3-32** in **Appendix A**; Lenart 2015b; Nicholson et al. 2016; Prichard et al. 2017), but the proportion of the summer individual caribou spend in the area varies widely among years. The proportion of collared CAH females using the program area at some point during the summer (June–August) has varied annually between 39 and 100 percent (2003–2018), but the average proportion of locations in the program area for individual collared caribou varied between 3 and 23 percent during that period (**Table J-21** in **Appendix J**). The program area is the only portion of the primary CAH mosquito-relief habitat that does not currently contain some development.

Coastal movements by large groups of caribou occur during periods of mosquito harassment, with caribou typically moving into the wind (which tends to be easterly); however, those groups tend to break up and disperse when oestrid flies become the dominant insect pests (Murphy and Lawhead 2000).

The number of CAH animals using the program area varies annually, likely in response to weather conditions and the resulting levels of insect harassment and longer time scale shifts in CAH summer movement patterns.

Muskox

This native species became extinct in Alaska in the nineteenth century; the history, distribution, and habitat preferences of muskoxen were described previously (BLM 2012, Section 3.3.6.2, page 293; USFWS 2015a). The current population in northeastern Alaska was reestablished by translocation when 64 animals from Greenland stock were released at Barter Island and the Kavik River in 1969 and 1970 (USFWS 2015a). As their numbers increased, they expanded westward on the ACP to the Colville River drainage and eastward across the international border to the Babbage River in northern Yukon.

The population in northeastern Alaska and northwestern Canada was estimated at 700–800 animals in the mid-1990s, but it subsequently declined to approximately 300 animals from 2007 to 2014; about 200 were located west of the Arctic Refuge and 100 were located east of it in northern Yukon (Lenart 2015c; Arthur and Del Vecchio 2017). The decline was especially steep in the Arctic Refuge, where only one muskox was observed in 2006. A group of fewer than 20 animals, moved back and forth across the Canning River into the program area (Lenart 2015c).

Another group of approximately 24 muskoxen inhabits the northwestern Yukon Territory. It is commonly found near the Alaska-Yukon border and frequently accesses the refuge (USFWS, see **Appendix S**). Predation by grizzly bears accounted for 58 percent of calf mortality and 62 percent of adult mortality from 2007 to 2011 (Arthur and Del Vecchio 2017), although pathogens and mineral deficiencies may have been contributing factors (Afema et al. 2017).

Moose

The program area is near the northern extent of moose range, but moose are found in low numbers on the ACP where suitable forage plants occur, primarily in riverine habitats dominated by willow shrubs (**Map 3-34** in **Appendix A**; Lenart 2014; USFWS 2015a). Late-winter aerial surveys in 2014 found only 22 moose in a series of drainages that included the program area, a sharp decrease from the fairly stable number of 47–61 moose found in the same survey area from 2002 to 2010 (Lenart 2014). Moose exhibit large fluctuations in population size on the North Slope but appear to be expanding their range farther north in response to climate warming and corresponding northward expansion of tall shrubs (Tape et al. 2016).

Moose are an important resource for local subsistence hunters. Moose numbers east of the Canning River watershed are currently low, but numbers in tributaries of the Canning River, on both its east and west sides, are larger; some of these could be in the program area, and other moose just outside the area to the west could be affected by activity in the area. Moose aggregate in tall shrub riparian areas during winter, but they disperse more widely across the ACP during summer, particularly pregnant cows.[32]

Carnivores

Three large- to medium-sized terrestrial carnivores—grizzly bear, wolf, and wolverine—inhabit the program area, occurring in lower densities on the coastal plain of the North Slope than father inland in the foothills and mountains (Young et al. 2002). The USFWS (2015a) summarized information on these species.

Grizzly bears and wolves are important predators of caribou and other ungulates. Grizzly bears occupy dens during winter dormancy, whereas wolves and wolverines remain active year-round. Grizzly bear density in Game Management Unit (GMU) 26C, which covers much of the program area, was estimated to be 3.8 bears per 100 square miles in 1993 (Lenart 2015a). Due to the distribution of suitable landforms and substrates, wolf den sites are more common in the foothills and mountains than on the coastal plain of the North Slope (Young et al. 2002; USFWS 2015a). Wolf density in GMU 26C was estimated to be 5.7–8.3 per 1,000 square miles in the 1980s (Garner and Reynolds 1986; Caikoski 2012).

Two species of foxes and two species of weasels inhabit the program area, all which feed on small mammals year-round and on birds and their eggs when available during summer. Arctic foxes inhabit the Coastal Plain during the summer denning season to rear pups but move long distances to forage extensively on sea ice during winter (Pamperin et al. 2008), although arctic foxes may have a significantly reduced winter range and higher survival rates in areas with access to anthropogenic food sources near development (Pamperin et al. 2008; Lehner 2012). Red foxes do not generally inhabit sea ice and are increasing in numbers on the ACP, in concert with climate warming and increased availability of human food sources in industrial areas (Savory et

[32]Stephen Arthur, USFWS, personal communication with Alex Prichard, ABR Inc., on February 5, 2019, regarding distribution of moose during calving.

al. 2014; Elmhagen et al. 2017). Red foxes are aggressive toward arctic foxes and can kill or otherwise displace them from den sites (Pamperin et al. 2006; Stickney et al. 2014).

All species of terrestrial carnivores can be attracted to areas of human activity if food or rotting waste are improperly handled or disposed of. This can lead to habituation and food-conditioning, thus increasing the risk of injury or mortality to humans or the carnivores themselves (Burgess 2000; Shideler and Hechtel 2000). Increasing predator populations, with the associated higher predation rates on prey populations (especially migrant birds), has been a perennial concern around the North Slope oil fields (Day 1998).

Small Mammals

Small mammals provide important prey resources for predatory mammals and birds in the region, and arctic ground squirrels are especially important prey for grizzly bears and foxes (Babcock 1986). Arctic ground squirrels hibernate during winter, whereas lemmings, voles, and shrews remain active under the snow cover. Most species of small mammals exhibit cyclical population fluctuations, which have pronounced effects on local ecological systems (USFWS 2015a). Snowshoe hares appear to be expanding their range farther onto the ACP in response to climate warming and corresponding northward expansion of tall shrubs (Tape et al. 2015). Beavers also are expanding their range into parts of Arctic Alaska and the northern Yukon (Tape et al. 2018).

Climate Change

Climate change is likely to result in a northward expansion of some mammal species, such as moose, beaver, and snowshoe hare (Tape et al. 2015, 2016, 2018); a potential increase in red foxes due to warming could cause a decline in arctic foxes. Some species with low reproductive output in the Arctic, such as grizzly bears, may benefit from increased productivity and a more diverse prey base. Wolverine maternal dens could be affected by the depth and distribution of snow (McElvey et al. 2011). Muskoxen and other herbivores may be adversely affected by increasing frequency of ice formation or rain-on-snow events (Berger et al. 2018) and the spread of pathogens (Kutz et al. 2015). The current circumpolar status of muskoxen and potential impacts of climate change are summarized by Cuyler et al. (2019).

Climate change in the Arctic is predicted to have multiple, sometimes counteracting, effects on barren-ground caribou (Martin et al. 2009; Albon et al. 2016; Mallory and Boyce 2017). Caribou body condition and population fluctuations have been found to be influenced by large-scale climate oscillations, such as the Arctic Oscillation (Griffith et al. 2002; Joly et al. 2011; Mallory et al. 2018). Climate change is expected to increase temperatures, increase precipitation, and lengthen the snow-free season (see **Section 3.2.1**). Summer temperatures above freezing could occur for 6 weeks longer by 2099 (SNAP 2011). Vegetative biomass in the arctic has generally increased since 1984, although the increase in Alaska has been lower than the increase in eastern Canada (Ju and Masek 2016). An increase in shrub cover and a decline in lichens growing on soil has been documented in the western Canadian Arctic (Fraser et al. 2014).

A longer snow-free season can increase access to forage (Cebrian et al. 2008; Tveraa et al. 2013), but warmer summers could increase insect harassment (Weladji et al. 2003), increase the incidence of parasites, and speed the annual decline in forage quality (Gustine et al. 2017). These factors could cause an earlier decline in forage nitrogen, which may already be limiting for parturient caribou (Barboza et al. 2018; Johnson et al. 2018). Changes in vegetation composition could result in increased abundance of shrubs and deterioration of forage quality (Fauchald et al. 2017), but could increase forage quality for other species, for example moose, hare, beaver. Increased moose densities could increase predator densities and alter predator distributions. Increases in wildfire could lower lichen availability on the winter range (Joly et al. 2010).

Changes in winter precipitation could change access to forage and energetic demands for cratering through snow. Increases in rain-on-snow events are expected to increase dramatically on the ACP (Bieniek et al. 2018). This could greatly decrease access to winter forage (Hansen et al. 2011; Albon et al. 2016; Loe et al. 2016) and increase mortality (Forbes et al. 2016). Changes in timing of snowmelt and vegetation growth could create a phenological mismatch[33] between timing of calving and the emergence of highly nutritious forage (Post and Forchhammer 2008). Gustine et al. (2017) found no evidence of a spring nourishment mismatch for caribou in Alaska but suggested that one may occur in fall with increased warming. If mosquitos emerge closer to calving, it could result in a higher rate of separation of calves, poorer body quality of maternal caribou, and higher calf mortality. Earlier melting of ice and snow and earlier river breakup could alter the timing or difficulty of caribou migrations (Sharma et al. 2009; Leblond et al. 2016).

Russell and Gunn (2019) summarized climatic conditions for the PCH and CAH and identified correlations among climate variables and PCH demographic parameters. The PCH appears to be especially sensitive to freezing rain and rain-on-snow events (negative correlation with parturition, spring condition, and June calf survival), July temperatures (positive correlation with body condition the following spring), fall temperatures (positive correlation with parturition, although longer oestrid fly seasons had a negative correlation with parturition), spring temperatures (positive correlation with June calf survival), and snow depth (negative correlation with late June calf:cow ratio). Because climate change could involve both adverse and beneficial effects on caribou, it is difficult to predict the impacts on the PCH and CAH; however, climate change may have been a factor in a 56 percent decline in populations of migratory caribou and wild reindeer across the Arctic over the last 2 decades (Russell et al. 2019).

The PCH calving distribution varies with the onset of spring seasonal changes and is typically farther west during warmer springs (Griffith et al. 2002; Russell and Gunn 2019); hence, climate warming could result in a western shift in concentrated calving areas and more frequent calving in the program area. Climate change would introduce additional uncertainty into projections of impacts due to development. Alternatives that limit development to a smaller portion of previously used PCH calving grounds would allow caribou greater flexibility to adapt to changing conditions.

Direct and Indirect Impacts

Issuance of oil and gas leases under the directives of Section 20001(c)(1) of PL 115-97 would have no direct impacts on the environment because by itself a lease does not authorize any on the ground oil and gas activities; however, a lease does grant the lessee certain rights to drill for and extract oil and gas subject to further environmental review and reasonable regulation, including applicable laws, terms, conditions, and stipulations of the lease. The impacts of such future exploration and development activities that may occur because of the issuance of leases are considered potential indirect impacts of leasing. Such post-lease activities could include seismic and drilling exploration, development, reclamation, and transportation of oil and gas in and from the Coastal Plain; therefore, the analysis considers potential impacts on terrestrial mammals from on-the-ground post-lease activities.

Post-lease activities in the program area have the potential to affect terrestrial mammals through habitat loss and alteration, behavioral disturbance and displacement, and injury or mortality as a result of oil and gas exploration and development (**Table 3-21**). The impacts of oil and gas development on caribou have been

[33]The phenomenon of food and habitat being available at different times than those to which the species was formerly cued.

Table 3-21
Summary of the Type, Context, and Duration of Potential Effects of Oil and Gas Exploration, Construction, and Drilling and Operations on Terrestrial Mammals

Project Component	Potential Effect	Type	Context	Duration
Exploration	Elimination of under-snow habitat for small mammals	Adverse	Site-specific	Short term
	Disturbance of active or denning mammals during winter	Adverse	Local	Short term
	Change in phenology or damage to forage plants	Adverse	Site-specific	Short term/ long term
Gravel and pipeline infrastructure	Habitat loss from gravel fill placement	Adverse	Site-specific	Long term
	Habitat alteration due to drifted snow, gravel spray, and dust deposition adjacent to gravel infrastructure	Adverse	Local	Long term
	Early snowmelt due to dust deposition	Beneficial	Local	Long term[1]
	Displacement of caribou from infrastructure during calving	Adverse	Program area-wide	Long term
	Attraction of caribou to roads and gravel pads during oestrid fly harassment	Beneficial	Local	Long term
	Disturbance and altered behavior due to noise and activities associated with construction and drilling and operation	Adverse	Local	Long term
	Alteration of normal movement patterns and fragmentation of habitat due to roads and pipelines	Adverse	Local	Long term
	Injury or mortality of large mammals due to vehicle strikes on gravel roads	Adverse	Site-specific	Long term
	Injury or mortality of small mammals due to vehicle strikes on gravel roads	Adverse	Site-specific	Long term
	Contamination of roadside forage due to dust	Adverse	Local	Long term
	Injury or mortality of small mammals in subterranean burrows	Adverse	Site-specific	Long term
Ice roads and pads	Habitat alteration due to drifted snow, delayed ice melt, vegetation compression, and hydrologic alteration from ice roads	Adverse	Local	Short term
	Displacement from ice roads and ice pads due to noise and activity	Adverse	Local	Short term
	Injury or mortality due to vehicle strikes on ice roads	Adverse	Site-specific	Short term
	Injury and mortality of small mammals in under-snow habitats	Adverse	Site-specific	Short term
Gravel Mine	Habitat loss due to gravel mining	Adverse	Site-specific	Long term
	Habitat alteration from dust, water displacement, and hydrologic alteration at gravel mine	Adverse	Local	Long term
	Displacement from gravel mine due to noise and activity	Adverse	Local	Long term

summarized in various reviews, along with appropriate mitigation measures (Shideler 1986; Cronin et al. 1994; Murphy and Lawhead 2000; Lawhead et al. 2006), which are incorporated here by reference and are summarized below. Because specific project plans are not available for analysis, the areas available for leasing with and without restriction under each alternative were summarized in relation to the available data on terrestrial mammal distribution and in relation to predicted oil potential and the hypothetical development scenario (**Appendix B**). The effects of climate change described under *Affected Environment* above, could influence the rate or degree of the potential direct and indirect impacts.

Alternative A

Under this alternative, current management actions would be maintained, and resource trends would continue, as described in the Arctic Refuge CCP (USFWS 2015a). There would be no direct or indirect impacts on terrestrial mammals from post-lease oil and gas activities under Alternative A.

Impacts Common to All Action Alternatives

This section discussed potential impacts on terrestrial mammals from future post-lease activities. ,for Future seismic exploration could occur in all portions of the program area (described under *Cumulative Impacts*), but it is most likely to occur in specific areas of lease sales. Seismic exploration has the potential to affect terrestrial mammals by eliminating below-snow habitat or limiting movements for small mammals, reducing forage availability during winter through compaction of snow and underlying vegetation, and disturbing muskoxen, wolves, wolverines, and denning grizzly bears. Occupied dens of grizzly bears detected during den surveys would be avoided by at least a half-mile, although complete detection of dens is unlikely (Amstrup et al. 2004a).

The program area is used very little by caribou during winter (Clough et al. 1987; Porcupine Caribou Technical Committee 1993; Ryder et al. 2007), so direct impacts on that species during that time frame would be negligible, although caribou that are present in the winter are important to subsistence hunters.

Potential localized disturbance of the small number of muskoxen along the western boundary of the program area could result from seismic exploration in areas of High HCP. Seismic activity has been shown to temporarily displace muskoxen as far as 2 miles away (Clough et al. 1987). Reynolds and LaPlant (1985) found that muskoxen did not leave areas of traditional use following seismic activities, but two herds moved 1.2–3.4 miles, following a close approach of seismic exploration vehicles. Two herds ran when vehicles were over 1.9 miles away, but three herds did not run until vehicles were about 330 to 1,300 feet away.

Potential indirect effects of seismic exploration would include short-term compaction of snow cover in foraging habitats for herbivores. The timing of snowmelt during the spring following seismic exploration would change as a result of snow compaction and changes in snow drifting. Delayed snowmelt in the spring could decrease or alter the timing of forage available to caribou and other herbivores.

Some potential habitat alterations and long-term damage to forage plants for herbivores, such as tussock cotton grass and riparian willow shrub, is also likely to occur, as described in the **Section 3.3.1** and in NRC (2003). Most trails recover within 8 years, but the amount of long-term[34] damage to vegetation that occurs would depend on snow depth, topography and habitat types (NRC 2003; Walker et al. 2019). The program area typically has higher topography with more variable snow cover than areas to the west. This could result in more long-term vegetation damage (Walker et al. 2019).

Trails associated with camp moves may result in more vegetation damage than seismic trails (NRC 2003; Walker et al. 2019). Some cleanup and other activities associated with seismic activities may occur during the summer, resulting in disturbance and displacement to calving caribou and other mammals. The timing of these activities could be managed to minimize these impacts.

All action alternatives could result in up to 2,000 acres of direct surface impact from future placement of gravel infrastructure on leased land, in addition to associated development on adjacent land owned by ANCSA corporations in the program area, but not subject to PL 115-97. The amount of future construction activity is

[34]Long-term refers to impacts lasting over 5 years.

expected to be similar across action alternatives, although the spatial distribution and extent of the activities would differ, as described separately for each alternative later in this section.

Using the hypothetical schematic anchor-field footprint (one CPF and 6 radiating 8-mile access roads to 6 drill pads, including an STP pad and a 30-mile access road, totaling 750 acres), the BLM calculated estimates of the area within 2.49 miles for potential displacement of calving caribou. Using these schematic footprints and extrapolating to a 2,000-acre maximum gravel footprint, it estimated the total acres of potential disturbance and displacement is 633,000 acres; however, this number would vary with different road and pad scenarios, and some portion of this area could be overlapping the buffer from other development, outside of the program area, or in the ocean. This potential displacement area is compared with areas available for lease under each alternative.

During winter, future construction activities would affect mammals that are active all year or are denning in the area. Wolverine may avoid areas of infrastructure (May et al. 2006; Gardner et al. 2010). Future summer construction activities could potentially disturb all mammal species using the area in that season. Increased disturbance could result in increased energetic costs, decreased time spent foraging, or displacement from preferred habitat.

Future construction activities would result in potential loss and alteration of terrestrial mammal habitats due to gravel placement for roads, pads, and airstrips, as well as from gravel extraction from mine sites. Direct habitat loss would reduce forage availability for herbivorous terrestrial mammals. For most terrestrial mammals, foraging habitat is abundant across the program area. Habitat loss also would eliminate denning and burrowing habitat for some species of small mammals, but the availability of denning habitat does not appear to be a limiting factor for those species. Gravel fill occasionally may be used for artificial den sites by small numbers of bears and foxes and as oestrid fly relief areas for caribou.

Injury and mortality of terrestrial mammals is possible as a result of potential vehicle strikes on gravel roads and ice roads during construction. Caribou and other mammals attracted by early vegetation greening along gravel roads during spring snow melt would be at increased risk of injury or mortality. Caribou move unpredictably during the oestrid fly season and often use gravel roads and pads as travel routes and as relief habitat, increasing the risk of vehicle-related injury and mortality during that period. Small mammals in under-snow burrows may be killed because of gravel placement, gravel mining, and ice road construction during winter, or they may be killed by vehicles while crossing roads. Humans may haze bears and foxes attracted to infrastructure or, in extremely rare situations, may kill them in defense of life or property.

Potential indirect impacts on terrestrial mammals would include habitat alteration, fragmentation, and loss of use because of disturbance and displacement. Habitat near gravel infrastructure is likely to be affected by physical alteration caused by dust deposition, gravel spray, thermokarst, flow alteration, and impoundments. The magnitude of these impacts varies, depending on species, habitat type, volume of ground ice, and hydrologic regime (Brown and Grave 1979; Walker et al. 1987). Habitat alteration would reduce local forage availability for herbivorous mammals, such as caribou, muskox, moose, and some small mammals. Snowdrifts along roads would reduce the availability of winter forage locally for herbivores and delay its availability in the spring. Deposition of fugitive dust on snow, caused by vehicle traffic on gravel roads, would lead to early snowmelt and green-up in affected areas, attracting some caribou in spring before calving and increasing access to early emerging forage.

Few data are available on the effects of noise and light on caribou. Tyler et al. (2018) suggested that caribou may avoid power lines in winter due to their ability to detect light in the ultraviolet range. Noise and light associated with vehicles, aircraft, and other human activity is likely to increase the level of disturbance associated with those activities, which could result in adverse effects on terrestrial mammals, due to increased disturbance, altered behavior, and displacement.

Vegetation damage from future ice-road construction could reduce the abundance and quality of forage for terrestrial mammals, particularly caribou. The compaction of vegetation could reduce concealing cover for small mammals. Some long-term habitat damage would result from the repeated annual use of ice roads and pads. Tussock tundra and sedge/grass meadow are preferred cover classes for caribou. Moose generally prefer tall shrub and riverine landcover types. Drier habitat classes are preferred by arctic ground squirrels and denning foxes. Many other terrestrial mammals in the program area are opportunistic and do not have restrictive habitat preferences (**Table J-16** in **Appendix J**).

Disturbance by future vehicle traffic, structures, and construction activities, including blasting associated with gravel mining, causes a variety of potential impacts on the behavior and movements of terrestrial mammals. Human activity could displace moose from calving locations if moose calve in the area. Some species, particularly bears and foxes, may be attracted to areas of human activity in the program area due to the availability of food or shelter, although waste management plans would limit food availability. An increase in red foxes due to human food sources could result in a decline in arctic fox densities; an increase in grizzly bears could result in higher predation on prey species, including caribou and moose calves. Construction may disturb grizzly bears in dens that are not found by preconstruction denning surveys.

Potential behavioral effects of disturbance on caribou include displacement of maternal caribou during calving and early lactation (late May to late June), deflection and delays in caribou movements across roads and pipelines during the summer insect season (late June to mid-August), and potentially during spring and fall migrations for the smaller numbers of caribou present in those seasons. Potential disturbance could result in behavioral responses, such as reduced foraging rates, increased movements, and energetically costly flight responses, potentially displacing animals from suitable habitat (Shideler 1986; Cronin et al. 1994; Murphy and Lawhead 2000; Murphy et al. 2000).

Under all alternatives, terrestrial mammals are more prone to displacement from areas with consistently high levels of activity, such as near CPFs, airstrips, active construction, and busy sections of trunk roads. The most common disturbing stimulus associated with roads is vehicle traffic; 15 vehicles per hour or more has been shown to deflect caribou movements and delay road crossings, even in the absence of pipelines (Curatolo and Murphy 1986; Cronin et al. 1994). Studies of CAH caribou have demonstrated that behavioral reactions are most common when caribou are within 656 feet of roads, but the strongest reactions, as measured in displacement distance, occur in response to humans on foot (Curatolo and Murphy 1986; Lawhead et al. 1993; Cronin et al. 1994).

Observation in existing northern Alaska oil fields indicates that caribou and other terrestrial mammals may habituate to low-level constant noise and oil field activities on roads and pads (maternal caribou with young calves, being a notable exception). CAH caribou show less displacement after the calving season, and some use of roads for oestrid fly relief later in the summer (Smith et al. 1994; Noel et al. 1998; Lawhead et al. 2004; Haskell et al. 2006).

PCH caribou have had much less exposure to human development and activities than have CAH caribou, however, so they would be expected to have stronger reactions to infrastructure than CAH caribou for some years. The PCH currently encounters some infrastructure. Johnson and Russell (2014) estimated avoidance responses of PCH caribou to different types of infrastructure during winter and calculated Zones of Influence

(ZOI) for an early period (1985–1998) and a later period (1999–2012). They found ZOIs were larger (e.g., 18.6 miles and 11.5 miles from main roads for the early and late periods respectively; 6.8 miles and 3.7 miles for wells, trails, winter roads, and seismic lines for the early and late periods respectively) than those reported for the CAH during calving (2.49 miles). Although the ZOIs declined in the later period, they concluded there was inadequate information to conclude it was due habituation (Johnson and Russell 2014).

Research in the Kuparuk and Milne Point oil fields on the central North Slope has demonstrated that, during and immediately after calving, maternal caribou with young calves tend to avoid areas within at least 1,640–3,281 feet of active roads and pads (Johnson and Lawhead 1989; Cronin et al. 1994). They also tend to avoid roads and pads by as far as 1.25 to 3.1 miles (Dau and Cameron 1986; Lawhead 1988; Cameron et al. 1992; Cronin et al. 1994; Lawhead et al. 2004; Vistnes and Nellemann 2008). They avoided areas with high density of infrastructure (Nellemann and Cameron 1996), although some calving still occurs in these areas. Aerial surveys conducted before and after construction of the Milne Point road indicated that caribou densities within 0 to 2.49 miles of the road decreased, while densities within 2.49 to 3.75 miles from the road increased (Cameron et al. 1992). The PCH currently encounters some infrastructure, but the PCH caribou have had much less exposure to human development and activities than have CAH caribou and would be expected to have stronger reactions to infrastructure than CAH caribou during some years.

These reported distances of lower densities near development (ZOI) have varied widely by study, area, and disturbance type. Vistnes and Nellemann (2008) reviewed the literature on displacement distances and found that most regional studies have reported that caribou reduce their use of areas within 3.1 miles of development by 50 to 95 percent. A recent study of two approximately 15-square-mile open-pit mines, with extensive activity and substantial dust deposition, recorded a ZOI of 6.8–8.7 miles (Boulanger et al. 2012). The PCH currently encounters some infrastructure, but the PCH caribou have had much less exposure to human development and activities than have CAH caribou and would be expected to have stronger reactions to infrastructure than CAH caribou during some years.

Plante et al. (2018) found that ZOI varied widely by disturbance type and year. They reported summer ZOI of 12.4 to 14.3 miles for mines, 0 to 5 miles for roads, and 1.2 to 2.5 miles for human settlements. In winter ZOI for roads with hunting ranged from 0 to 9.3 miles, and ZOI for roads without hunting ranged from 0 to 1.9 miles.

Johnson and Russell (2014) estimated avoidance responses of PCH caribou to different types of infrastructure during winter and calculated ZOI for an early period (1985–1998) and a later period (1999–2012). They found ZOIs were larger (e.g., 18.6 miles and 11.5 miles from main roads for the early and late periods respectively; 6.8 miles and 3.7 miles for wells, trails, winter roads, and seismic lines for the early and late periods respectively) than those reported for the CAH during calving (2.49 miles). Although the ZOIs declined in the later period, they concluded there was inadequate information to conclude it was due to habituation (Johnson and Russell 2014). However, it is not anticipated that large numbers of caribou will be present in the program area during the winter.

The ZOI is likely to vary with the type, frequency, and distribution of human activity. A level of displacement of approximately 2.49 miles observed at existing North Slope oil fields would be expected in the program area with similar development and mitigation design; however, the presence of subsistence hunting from roads adds additional uncertainty to this estimate. For that reason, hunting could result in additional displacement during the calving season and more displacement and lower tolerance of roads during other seasons. This effect would depend on the location, timing, and frequency of hunting.

Displacement observed in the CAH lasts from calving (late May to mid-June) up to when calves are approximately 3 weeks of age, when the level of displacement declines (Smith et al. 1994; Lawhead et al. 2004; Haskell et al. 2006; Prichard et al. 2019). This corresponds to the calving and post-calving periods for the PCH.

Of the 1,563,500 acres in the program area, 728,300 acres (49.0 percent) are in areas used for annual calving grounds of the PCH at least 40 percent of years; 882,500 acres (59.4 percent) are in areas used for annual calving grounds of the PCH at least 30 percent of years; and 1,031,400 acres (69.4 percent) are in areas used for annual calving grounds of the PCH at least 20 percent of years (**Table J-17** in **Appendix J**). All of the area in the annual calving grounds of the PCH (at least 30 percent of years) is thought to have low or medium HCP (**Map 3-35** in **Appendix A**).

Although several potential demographic impacts of development on CAH caribou have been reported (NRC 2003; Cameron et al. 2005; Arthur and Del Vecchio 2009), the CAH increased in size between 1978 and 2010 before declining in size between 2010 and 2016 (Lenart 2015b). The patterns of CAH demography and behavior following development should be applied to the PCH with caution for the following reasons:

- Movements and demography of the PCH are different from the CAH
- Concentrated calving density of the PCH is much higher than the CAH
- The PCH is at a historical high population
- The PCH has lower population growth rates and productivity and may be more dependent on summer forage than the CAH (Russell and Gunn 2019)
- Some hunting by local residents is likely to occur from roads in the program area
- The ACP is much narrower in the program area than near the CAH calving range
- Alternative calving areas next to the PCH calving grounds contain less high-quality forage, higher predator densities, and different climatic conditions, and they exhibit more topographic relief than do the current PCH calving grounds (Clough et al. 1987; Griffith et al. 2002; Russell and Gunn 2019).

If future development causes large-scale displacement of the PCH from the calving grounds in the program area, the calving distribution would most likely shift to the east or southeast (Griffith et al. 2002) and displacement would be most likely to occur in years of early snowmelt when the PCH is more likely to calve in the program area in the absence of development (Griffith et al. 2002). Comparison of mean annual survival rates of PCH calves during June 1985 and between 1987 and 2001 showed that calf survival was lower in years when higher proportions of calves were born off the coastal plain and when less vegetative biomass (based on NDVI) occurred on the annual calving ground at the time of peak lactation (June 21; Griffith et al. 2002).

Using this model and previous hypothetical development scenarios (Scenarios 2–5 from Tussing and Haley 1999) and assuming that the calving distribution would be displaced 2.49 miles from development, Griffith et al. (2002) predicted that calf survival would decline linearly with the distance that the annual calving ground was displaced and predicted an 8 percent decline in annual calf survival if there were full development of the current program area. This predicted decline in mean annual calf survival during June would have been large enough to halt herd growth, based on random population simulations of the PCH (Walsh et al. 1995).

This analysis assumed no change in the shape of the calving distribution. It was developed from annual comparisons of mean calf survival but has not been tested for a spatial shift in calving in a given year. An eastward shift in the calving distribution would move the calving distribution into areas with higher predator densities (Young et al. 2002), into areas with lower quantity and quality of common caribou forage species, and into lower proportions of the preferred tussock tundra and moist sedge-willow tundra vegetation types (Jorgenson et al. 2002).

Russell and Gunn (2019) conducted a similar analysis, using growing degree days instead of NDVI. They estimated that the decline in calf survival from developing unconstrained the program area would be 10 percent. Any decline in the PCH would also have indirect impacts on predators and other prey species.

Large aggregations of PCH and CAH moving in midsummer through the program area during periods of mosquito harassment would have to navigate any infrastructure they encounter. Caribou may expend more energy, take more time, or exhibit reduced crossing success where traffic rates exceed 15 vehicles per hour and pipelines are within 300 feet of roads (Curatolo and Murphy 1986; Cronin et al. 1994; Murphy and Curatolo 1987; Johnson and Lawhead 1989; Lawhead et al. 1993); however, requiring the 7-foot minimum height at VSMs, placing elevated pipelines at least 500 feet from adjacent roads, and designing and orienting roads and pipelines to minimize crossings have been found to be adequate to maintain caribou passage. There would be some delays and deflections for caribou previously exposed to development in the oil fields west of Prudhoe Bay (Johnson and Lawhead 1989; Cronin et al. 1994; Lawhead et al. 2006).

CAH caribou continued to use a coastal area during midsummer, with small changes in movement patterns, following the construction of a roadless elevated pipeline (Prichard et al. 2018). Caribou crossed the pipeline repeatedly, but also tended to move parallel to it when it was orientated in a direction similar to their mosquito-relief movements resulting in fewer crossings than expected in the absence of the pipeline (Prichard et al. 2018). GPS-collared caribou in the Kuparuk oil field crossed roads or pads (and associated pipelines) an average of 1.1 times per day (based on straight-line distances between locations 2 hours apart) during the mosquito season and 1.8 times per day when mosquitoes were thought to be active, based on weather conditions (Prichard et al. 2019).

PCH post-calving aggregations can be much larger than CAH aggregations, but how that would affect crossing success is unknown. Russell and Gunn (2019) estimated that, between 2014 and 2017, seven PCH post-calving aggregations to be between 21,000 and 121,000 animals. Caribou in these large aggregations used a large area in the central portion of the program area (**Map 3-35** in **Appendix A**).

Some evidence suggests that large caribou groups have more difficulty crossing pipelines (Smith and Cameron 1985), but comparisons can be confounded by insect activity and limited by small sample sizes (Curatolo and Murphy 1986; Lawhead et al. 1993; Lawhead et al. 2006). Data are lacking on groups of over 100,000 caribou crossing oil field infrastructure (Russell and Gunn 2019).

In addition, if hunting occurs from the roads during these movements, crossing rates may be lower and tolerance of roads is likely to be lower (Paton et al. 2017; Plante et al. 2018), although this would depend on the frequency, timing, and location of hunting. Hunting from motorized vehicles during the summer in the program area would likely be limited to roads and would be conducted only by local residents, which would limit the adverse effects on caribou distribution and movements.

The annual harvest of caribou by Kaktovik residents is outlined in **Table M-3** in **Appendix M**. Some portion of this harvest could shift to program roads or the total harvest could increase. Changes in caribou distribution during the calving or post-calving season could alter PCH distribution patterns during other periods of the year in unpredictable ways.

During the oestrid fly season (mid-July to mid-August) elevated gravel roads and pads and shaded areas under buildings and pipelines may provide relief from insect harassment (Curatolo and Murphy 1986; Cronin et al. 1994; Noel et al. 1998; Prichard et al. 2019).

The presence of roads and pipelines in the program area could also delay and deflect movements during spring and fall. Research has found varied responses of caribou to roads during such migrations. Approximately 30 percent of collared female caribou (8 of 24 individuals) encountering the Red Dog Mine road in northwestern Alaska during fall migration experienced long delays in crossing the road corridor, with the delays of these "slow crossers" averaging 11 times longer than those of "normal crossers" (33.3 days vs. 3.1 days; Wilson et al. 2016). Wild reindeer (the same species as caribou) in Norway were delayed approximately 5 days during spring migration at a highway corridor experiencing high levels of human activity, but when human activity was low during fall migration, the road did not appear to pose an obstruction (Panzacchi et al. 2013).

Similar delays have not been observed in caribou in the existing North Slope oil fields, where most movements occur during the summer insect season when movement rates and motivation to cross are much higher (Cronin et al. 1994; Murphy and Lawhead 2000; Prichard et al. 2019).

Some collared TCH caribou, with little exposure to infrastructure, experienced multiple day delays crossing the Trans-Alaska Pipeline in fall and spring. This was during an unusual migratory movement to the program area in 2003–2004, although flooding of the Sagavanirktok may have also delayed spring movements (Carroll 2005).

Caribou crossing success in the program area would vary by season, behavioral motivation, level of habituation, and human activity levels. Alteration of the timing of fall migration could affect some subsistence hunters by delaying access until caribou bulls are in rut and are no longer selected by subsistence hunters.

Aircraft noise during take-offs and landings could result in the inability of nearby terrestrial mammals to hear biologically important sounds, such as predators, prey, or interspecific communication (Barber et al. 2010) and could lead to increased stress levels near the airstrip. Low-level aircraft may cause flight responses or temporary changes in caribou behavior (Maier et al. 1998; Reimers and Colman 2006), which could temporarily deflect or alter caribou behavior, potentially affecting hunting activities and hunting success for subsistence hunters (as described in **Section 3.4.3**, Subsistence Uses and Resources).

Most program-related aircraft operators would maintain minimum flight altitudes which would reduce disturbance of wildlife and subsistence hunters. In addition, habituation appears to lower the response of caribou to aircraft activity (Valkenberg and Davis 1985). Some of the limited research on aircraft disturbance on caribou involved military jets. Military jets are louder than the typical aircraft likely to use the program area, but they are also faster, potentially resulting in more intense disturbance for a shorter duration. Although the effects of military aircraft on caribou behavior may differ somewhat from the effects of more typical aircraft using the program area, these studies provide useful information on the range of caribou behavior likely to be encountered. Maier et al. (1998) found that caribou responses to low-level military jet overflights were low in late winter, moderate in midsummer, and strongest during post-calving, with females accompanied by young showing the strongest responses. During the post-calving season, caribou subjected to direct overflights at low altitudes by military jets moved farther and were more active than animals that were not overflown. Lawler et al. (2005) found that responses to military overflights during calving were variable but generally mild, and overflights did not result in higher calf mortality or increased movements of cow/calf pairs.

All alternatives would be subject to ROP 23 and portions of ROP 34. ROP 23 incorporates oil field design specifications that have been found to minimize disruptions to caribou movements in existing oil fields (Shideler 1986; Cronin et al. 1994; Murphy and Lawhead 2000; Lawhead et al. 2006). These include requirements relating to pipeline height, pipeline road separation distance, road and pipeline orientation, caribou crossing ramps, and pipeline coating, and would require a vehicle management plan to be developed. ROP 34 requires an aircraft use plan and would place limits on aircraft altitude and landings near known subsistence hunting camps and cabins and in the PCH calving area (all action alternatives) and the PCH post-calving area (Alternative D only).

Given the 2,000-acre limit on gravel placement, the amount of activity during future development drilling and operations is expected to be similar among alternatives, although the spatial distribution and extent of the activity would differ among the alternatives, as described separately below.

Many of the same impacts that occur during construction would persist throughout future drilling and operation, although some activities, such as gravel hauling, gravel fill placement, pipeline construction, would end and others, such as vehicle and air traffic volume, would continue at a lower frequency. Drill rigs and associated activity would introduce additional noise disturbance. Because of the relative levels of activity associated with each phase, the potential impacts during development drilling would be greater than during production after drilling ceases.

The potential effects of habitat loss are long term and would continue throughout drilling and operations. Additional habitat alterations from the impacts of snowdrifts, dust, thermokarst, and ponding would continue during operations. Accidental oil discharges in the program area may affect terrestrial mammals, depending on the location and size of the spills (see **Section 3.2.11**). During exploration and construction, the primary releases would be accidental spills from vehicles, storage tanks, marine barges and docks, aircraft, and equipment during transport or fueling and during pipeline hydrotesting; however, the frequency of spills would be limited by BMPs.

Most potential spills would be fewer than 100 gallons and restricted to ice or gravel roads and pads, never reaching the tundra, but larger tundra spills are possible. Disturbance from human activities and traffic on roads, pads, and airstrips would continue through drilling and operations; however, the frequency of disturbance would decline during operations, in comparison with construction and development drilling.

Throughout future drilling and operations, the assumption is that most maternal female caribou with young calves would continue to avoid active infrastructure by up to 2.49 miles and that caribou moving through the program area during the post-calving and insect seasons could experience delays and deflections when encountering roads and pipelines, especially roads with high rates of traffic.

Vehicles are likely to strike small numbers of mammals throughout future drilling and operations, although a vehicle management plan (ROP 23) would be required and may lower the incidence of vehicle strikes. Dust generated during future creation of and travel on gravel roads may add toxic metals to roadside vegetation that mammals forage (Walker and Everett 1987; Shotyk et al. 2016; Knight et al. 2017).

Roads and well pads would be abandoned, and the sites reclaimed after the wells stop being economically productive. This is expected to occur from 19 to 85 years after the lease sale (**Appendix B**). Equipment and gravel would be removed, and the areas would be revegetated (ROP 35). This would add small amounts of additional terrestrial mammal forage, but it would likely be offset by additional gravel roads and pads under the 2,000-acre limit following reclamation; because of this, there would be no net increase in mammal habitat.

Wildlife habitat quality after reclamation may vary, depending on the effectiveness of reclamation and sensitivity of ecological communities to disturbance. Reclamation could disturb terrestrial mammals in the area, but the impacts would vary, depending on the timing of the activity.

Alternative B (Preferred Alternative)

Alternative B would open the entire program area to lease sales, and lease-sale specific seismic activity with the potential impacts described above. The BLM estimates that the entire federal Coastal Plain could be subject to 3D seismic surveys unrelated to leases (see **Appendix B**). After the first sale, operators would likely conduct smaller scale 3D surveys on their own lease blocks, assuming that seismic information would not already be available.

Under Alternative B, 289,600 acres would be closed to surface occupancy. The 633,000 acres of potential PCH calving displacement area (based on a displacement of 2.49 miles) would affect up to 52.9 percent of the remaining area, although some of this buffer area would likely fall into the locations with NSO or out of the program area (**Map 3-36**, Porcupine Caribou Herd, Alternatives B, C, D1, and D2, in **Appendix A**).

Alternative B would suspend major construction activities and place limits on vehicle traffic, vehicle speeds, and limit flight altitudes in the PCH primary calving habitat area (Lease Stipulation 7 and ROP 23) during the calving period (May 20 to June 20).

Density of infrastructure as well as such activity as vehicle traffic, aircraft, and human foot traffic affects caribou use of calving areas (Curatolo and Murphy 1986; and Cameron 1998; Cameron et al. 2005). Some level of displacement of calving caribou has been shown to occur even with low levels of traffic (Dau and Cameron 1986; Lawhead 1988, Lawhead et al. 2004), while caribou avoidance of roads in other seasons appears to be positively related to the intensity of the disturbance (Leblond et al. 2013). As a result, the limitations on vehicle and aircraft use and construction activity outlined in the Lease Stipulation 7, ROP 23, and ROP 34 would lower the frequency and intensity of caribou disturbance; however, future infrastructure development, even with low levels of human activity in the area of concentrated calving for the PCH, could lead to displacement of calving caribou and decreased calf survival or a decline in caribou body condition, as described above. Calving outside the primary calving area but inside the program area, although expected to occur in fewer years, would be subject only to limitations in ROP 23 and ROP 34. Calving caribou would be likely be displaced from areas of development in those areas in years when calving occurs west of the primary calving area.

The PCH calving habitat area would not be subject to specific lease stipulations after June 20, although the area is used extensively by the PCH during the post-calving period (PCTC 1993); it would still be subject to the limitations in ROP 23 and ROP 34. As a result, some potential impacts on caribou distribution and movements may occur in this area during the post-calving period, although caribou exhibit less displacement from properly designed infrastructure during the post-calving period, compared with the calving period (Smith et al. 1994; Lawhead et al. 2004; Haskell et al. 2006); however, there could be delays and deflections of movements when caribou groups encounter infrastructure, as described above. There is a lack of information on how well groups of over 100,000 caribou navigate oil field infrastructure. Subsistence hunting along program roads could hinder movements, as described above.

A total of 9.4 percent of the preferred Tussock Tundra land-cover type in the program area would be off limits to lease sales or surface occupancy. Of the high use PCH calving area (used in greater than 40 percent of years), Alternative B would place 135,500 acres (18.6 percent) off limits to lease sales or surface occupancy, place TLs on 564,900 acres (77.6 percent) and leave 27,900 acres (3.8 percent) subject only to standard terms and conditions (**Table J-17** in **Appendix J**).

Of the high use PCH post-calving area (used in greater than 40 percent of years), Alternative B would place 113,700 acres (20.4 percent) off limits to lease sales or surface occupancy. It would place TLs on 371,300 acres (66.5 percent) and leave 73,500 acres (13.2 percent) subject only to standard terms and conditions (**Table J-18** in **Appendix J**).

Alternative B would place an area predicted to contain 0.68–4.48 percent of the CAH during different seasons off limits to lease sales or surface occupancy, place TLs on an area predicted to contain 0.02–1.95 percent of the CAH during different seasons and use only standard terms and conditions in an area predicted to contain 1.72–11.55 percent of the CAH during different seasons (**Table J-19** in **Appendix J**). Because these percentages represent seasonal averages, the percentage of the CAH moving through these areas during a season may be substantially higher (**Map 3-33,** Central Arctic Herd Brownian Bridge Movement Model, in **Appendix A**). Much of the seasonally important areas for the CAH and PCH in the program area are open to surface occupancy but subject to TLs under Alternative B; the potential impacts of this alternative on caribou would depend, in large part, on how well these TLs avoid displacement of calving caribou and impediments to caribou movements during other times of year when caribou are present.

Under this alternative, surface occupancy would be excluded from areas within 0.5 and 1 mile of selected river corridors (Lease Stipulation 1); this would limit disturbance on some potentially important PCH calving areas. It would lower potential impacts on moose and muskoxen if these species increase in the program area. Although Young and McCabe (1998) did not test specifically for it in their 1002 study area, they found that the mean distance from rivers was closer than expected for calving PCH caribou but not for grizzly bears. Wilson et al. (2012) found that female Teshekpuk Herd caribou avoided riverine habitats at both the landscape and patch scale of selection during calving. Jakimchuk et al. (1987) found that female CAH caribou avoided riverine habitat during calving but selected it later in the summer; males selected riverine habitats during that period, although use of riparian areas was partially confounded by industrial development in one river corridor.

Future development along coastal areas could cause delays and deflections of coastal movements of the CAH and PCH during midsummer periods of mosquito harassment. Alternative B requires an impact and conflict avoidance and monitoring plan to mitigate effects of exploration and development on wildlife within 2 miles of the coast (Lease Stipulation 9); however, it does not limit infrastructure in coastal areas.

Potential impacts under Alternative B during the production phase would be similar to the construction phases. Many of the same impacts that occur during development would persist throughout production, although some activities, such as gravel hauling, gravel fill placement, and pipeline construction, would end and others, such as vehicle and air traffic volume, would continue at a lower frequency. These potential impacts would be long term, lasting for at least the period of development and range in extent from the area of the gravel footprint to within 2.49 miles of infrastructure, as described above.

Alternative C

Alternative C would not allow surface occupancy on 606,200 acres of the PCH primary calving habitat area (Lease Stipulation 7).Non-lease-associated 3D seismic activity could occur over the entire program area with potential impacts on terrestrial mammals, as described above, such as destruction of under-snow small mammal habitat, disturbance of denning mammals, crushing of forage species, alteration of snowmelt timing. . For smaller, operator-associated 3D surveys following the first lease sale, there would be no sources of sound from ground-based equipment in NSO areas; however, there would be noise impacts in NSO areas resulting from noise sources located outside the NSO areas.

Under Alternative C, 858,000 acres (57.7 percent of the program area) would not allow surface occupancy. The potential 633,000 acres of PCH calving displacement (based on a displacement of 2.49 miles) would affect up to 100 percent of the remaining area, although some of this buffer area would likely fall into the locations with NSO or out of the program area. Because there would be no change from Alternative A, no potential impacts are expected in these areas under Alternative C.

Alternative C would close the areas within 0.5 to 2 miles of selected rivers (Lease Stipulation 1) and 606,200 acres of PCH calving habitat to surface occupancy (Lease Stipulation 7). This could limit potential impacts on caribou in potentially important calving areas as described above.

Alternative C would suspend major construction activities and place limits on vehicle traffic and vehicle speeds in the remaining 115,000 acres of the PCH primary calving habitat area (Lease Stipulation 7) from May 20 to June 20 and would require sections of road to be evacuated whenever large caribou crossings appear to be imminent in the PCH post-calving habitat area (Lease Stipulation 8) between June 15 and July 20. The limitations on vehicle and aircraft use and construction activity outlined in Lease Stipulation 7, Lease Stipulation 8, ROP 23, and ROP 34 would lower the frequency and intensity of caribou disturbance in this area; however, some level of displacement of calving caribou has been shown to occur even with low levels of traffic (Dau and Cameron 1986; Lawhead 1988, Lawhead et al. 2004).

Alternative C would not allow wells or CPFs within 1 mile of the coast (Lease Stipulation 9). PCH and CAH form large, fast-moving aggregations along the coast in response to mosquito harassment. This lease stipulation would lower the potential for infrastructure to hinder these movements. Pipelines and roads could still be allowed by the BLM Authorized Officer, but with proper design, caribou are generally able to navigate these structures, especially following habituation and with low levels of vehicle traffic (Cronin et al. 1994; Murphy and Lawhead 2000; Lawhead et al. 2006); however, there is a lack of information on how well groups of over 100,000 caribou navigate oil field infrastructure. Subsistence hunting along program roads could hinder movements, as described above.

Forty-two percent of the Tussock Tundra land cover type in the program area would be off limits to lease sales or surface occupancy. Of the high use PCH calving area (area used in greater than 40 percent of years), Alternative C would place 631,100 acres (86.7 percent) off limits to surface occupancy, would place TLs on 83,400 acres (11.5 percent), and would leave 13,700 acres (1.9 percent) subject to only standard terms and conditions (**Table J-17** in **Appendix J**).

Of the high use PCH post-calving area (used in greater than 40 percent of years), Alternative C would place 450,400 acres (80.6 percent) off limits to surface occupancy, would place TLs on 108,000 acres (19.3 percent), and would leave 108,000 acres (0.02 percent) subject to only standard terms and conditions (**Table J-18** in **Appendix J**).

Alternative C would place an area predicted to contain 1.52–6.74 percent of the CAH during different seasons off limits to surface occupancy, would place TLs on an area predicted to contain 0.75–3.32 percent of the CAH during different seasons, and would use standard terms and conditions in an area predicted to contain 0.95–7.17 percent of the CAH during different seasons (**Table J-17** in **Appendix J**). Because these percentages represent seasonal averages, the percentage of CAH animals moving through these areas during a season may be substantially higher. Limitations on surface activity near the coast (Lease Stipulation 9) and the Canning River (Lease Stipulation 1) would be the primary stipulations affecting CAH midsummer movements in the program area.

Much of the seasonally important areas for the PCH in the program area is closed to surface occupancy under Alternative C; however, a smaller percentage of the area and some areas used for calving in less than 40 percent of years are subject to TLs or to only standard terms and conditions, except those that apply to all alternatives (ROP 23 and ROP 34). The potential impacts of this alternative on caribou would depend on how well the area off limits to surface occupancy captures the preferred calving area for the PCH, how well these TLs and ROPs avoid displacing calving caribou in areas with surface occupancy, and how well it minimizes impediments to caribou movements during other times of the year.

Additional potential impacts under Alternative C during the drilling and operations phase would be similar to the construction phases. Many of the same impacts that occur during construction would persist throughout drilling and operation, although some activities, such as gravel hauling, gravel fill placement, and pipeline construction, would end and others, such as vehicle and air traffic volume, would continue at a lower frequency. These potential impacts would be long term, lasting for at least the period of development and range in extent, from the area of the gravel footprint to within 2.49 miles of infrastructure, as described above; however, the areas of NSO would have no additional impact relative to Alternative A, except in areas within 2.49 miles of infrastructure outside of the NSO.

Alternative D

The entire program area would be available for seismic exploration, with the potential impacts described above. Alternative D1 would close 476,600 acres of the PCH primary calving habitat area to lease sales and Alternative D2 would close 645,800 acres. Areas closed to leasing would be unlikely to experience seismic surveys due to lack of demand for seismic data. The remaining areas would be subject to lease-specific seismic exploration. There could be impacts on terrestrial mammals, as described above, such as destroying under-snow small mammal habitat, disturbing denning mammals, crushing forage species, and altering snowmelt timing. An additional 244,600 acres under Alternative D1 and 85,700 acres under Alternative D2) of the PCH primary calving area would be NSO and therefore less likely to be subject to lease-specific seismic exploration. This alternative would prohibit winter activity within 1 mile of polar bear denning habitat in some areas (Lease Stipulation 5), these buffers would likely also include some grizzly bear dens, due to similar habitat preferences.

Alternative D would close to lease sales or to surface occupancy those areas within 0.5 to 4 miles of selected rivers (Lease Stipulation 1), areas of the Canning River delta (Lease Stipulation 2), areas within 1 to 4 miles of selected springs and aufeis, the area within 3 miles of the east bank of the Canning River (Lease Stipulation 3), all 721,200 acres of the PCH primary calving habitat area (Lease Stipulation 7), and areas within 3 miles of the wilderness border (Lease Stipulation 10). Because there would be no change from Alternative A, no impacts are expected in these areas for Alternative D. The limits on surface occupancy near rivers and on the Canning River delta would ensure that development would not hinder caribou movements in these areas. The Canning River delta is used by large numbers of CAH caribou during midsummer in some years (**Map 3-33**, Central Arctic Herd Brownian Bridge Movement Model, in **Appendix A**), and one muskox group has often used it in recent years; limiting infrastructure in this area would limit alterations to the movements of this group.

Alternative D would not allow CPFs in the PCH post-calving habitat area and would limit total infrastructure density in this area (Lease Stipulation 8). Sections of road would also be evacuated whenever 100 or more crossings of caribou appear to be imminent in this area (Lease Stipulation 8). The density of infrastructure affects caribou use of an area during calving and creates additional barriers for caribou movements during summer (Nellemann and Cameron 1998; Cameron et al. 2005); hence, limits on the density of development in areas closed to lease sales or with NSO restrictions would allow caribou to retain the ability to navigate through those areas.

Under Alternative D1,158,700 acres (77.9 percent of the program area) would be closed to lease sales or have NSO restrictions. The potential 633,000 acres of PCH calving displacement (based on a displacement of 2.49 miles) is larger than the 328,600 acres of the program area remaining open to surface occupancy.

Alternative D2 would limit major construction (Lease Stipulation 6) from May 20 to July 20. Sections of road would also be evacuated whenever 100 or more crossings of caribou appear to be imminent in the post-calving area (Lease Stipulation 8). These limits would lower the probability of displacement of caribou during calving and lower the frequency of delays in caribou movements or caribou disturbance during summer. Traffic volumes of 15 vehicles per hour or more have been shown to deflect caribou movements and delay road crossings, even in the absence of adjacent pipelines (Curatolo and Murphy 1986; Cronin et al. 1994).

Alternative D would not allow wells or CPFs and would restrict vessel activity within 2 miles of the coast (Lease Stipulation 1). PCH and CAH caribou form large, fast-moving aggregations along the coast in response to mosquito harassment; hence, this lease stipulation would lower the potential for infrastructure to hinder these movements. Pipelines and roads could still be allowed by the BLM Authorized Officer; however, with proper structure design, caribou are generally able to navigate them during the mosquito season, especially following repeated exposure to oil development and with low levels of vehicle traffic (Curatolo and Murphy 1986; Cronin et al. 1994; Murphy and Lawhead 2000; Lawhead et al. 2006). Despite this, there is a lack of information on how well groups of over 100,000 caribou navigate oil field infrastructure. Subsistence hunting along program roads could hinder movements, as described above. Delays and deflections could be more pronounced in the initial years following development.

A total of 66.5 percent of the Tussock Tundra land cover type in the program area would be off limits to lease sales or surface occupancy. Of the high use PCH calving area (used in greater than 40 percent of years), Alternative D1 would place 714,000 acres (98.0 percent) off limits to lease sales or surface occupancy, would control surface use in 5,400 acres (0.1 percent), and would use only standard terms and conditions on the remaining 8,900 acres (1.2 percent; **Table J-17** in **Appendix J**). Alternative D2 would place 722,100 acres (99.1. percent) off limits to lease sales or surface occupancy, would control surface use in 3,400 (0.1 percent), and would place TLs on 2,800 acres (less than 0.1 percent; **Table J-17** in **Appendix J**).

Of the high use PCH post-calving area (used in greater than 40 percent of years), Alternative D1 would place 501,500 acres (89.8 percent) off limits to lease sales or surface occupancy and would control surface use in or use only standard terms and conditions on the remaining 56,800 acres (10.2 percent; **Table J-18** in **Appendix J**). Alternative D2 would place 506,400 acres (91.0 percent) off limits to lease sales or surface occupancy and would control surface use or place TLs in the remaining 52,000 (9.0 percent) (**Table J-18** in **Appendix J**).

Alternative D would place an area predicted to contain 2.21–10.51 percent of the CAH during different seasons off limits to lease sales or surface occupancy, would control use in an area predicted to contain 0.29–1.81 percent of the CAH during different seasons, and would use standard terms and conditions (Alternative D1) or TLs (Alternative D2) on an area predicted to contain 0.66–5.10 percent of the CAH during different seasons (**Table J-19** in **Appendix J**). Because these percentages represent seasonal averages, the percentage of CAH animals moving through these areas during a season may be substantially higher.

Based on the previously recorded calving distribution, most of the seasonally important areas for the PCH in the program area are closed to surface occupancy under Alternative D, but some areas used for calving in less than 40 percent of years would be subject to only standard terms and conditions (Alternative D1) or TLs (Alternative D2); hence, in the absence of large shifts in calving distribution, little displacement of calving PCH caribou is expected during most years. Additional areas closed to surface occupancy would provide additional options for calving caribou to select areas away from infrastructure.

Additional potential impacts under Alternative D during the production would be similar to the development phases. Many of the same impacts that occur during development would persist throughout drilling and operation, although some activities, such as gravel hauling, gravel fill placement, and pipeline construction) would end and others, such as vehicle and air traffic volume, would continue at a lower frequency. These potential impacts would last for at least the period of development and would range in extent from the area of the gravel footprint to within 2.49 miles of infrastructure, as described above; however, the areas of NSO or no leasing would have no additional impact relative to Alternative A, except in areas within 2.49 miles of infrastructure located outside of the NSO.

Transboundary Impacts

Some individuals from most large mammal species using the program area would cross the international boundary; however, because of the consistent movements across the border and the importance for subsistence, the PCH has the most substantial transboundary issues. Dramatic changes in the size of the PCH would also have cascading ecological effects on other terrestrial mammals in the area, most directly on predator species.

The importance of the calving and post-calving season for the PCH means that any potential demographic impacts of development in the program area would have impacts on subsistence and other users in Canada. The PCH is covered by the Agreement between the Government of Canada and the Government of the United States on the Conservation of the Porcupine Caribou Herd. It provides for the coordinated conservation of the herd and established the International Porcupine Caribou Board and the Porcupine Caribou Technical Committee.

The potential impacts of the different alternatives on the demography of the PCH would have transboundary impacts on subsistence hunting by residents, hunting by visitors, recreation, and tourism related to the PCH. As described above and under cumulative impacts, Alternative B allows more development in PCH calving areas, and there would be more potential obstacles to movement in post-calving areas of use. This would have more potential for population-level impacts on the PCH. CAH caribou rarely cross into Canada, with the exception of individuals that have joined the PCH; therefore, there are few transboundary issues associated with that herd.

Cumulative Impacts

Caribou may have used the area for 400,000 years, and subsistence hunting of caribou has occurred in the program area for millennia (Nuttall et al. 2005; USFWS 2015a). Most terrestrial mammals in the program area currently have little interaction with infrastructure. There is permanent development associated with the community of Kaktovik as well as use of the area by subsistence hunters, hunters from outside the ACP, scientists, recreationists, and eco-tourists. Far-ranging species such as caribou may encounter the Dempster Highway and other development in the Yukon (Johnson and Russell 2014; Russell and Gunn 2019), communities south of the program area, or oil and gas development west of the program area. Caribou of the CAH have had some interaction with oil and gas development for approximately 40 years.

A variety of different development projects could occur within the ranges of the CAH and PCH. Future development with the largest potential to affect terrestrial mammals include seismic exploration surveys of the entire program area (see **Appendix F**), resulting in the impacts on terrestrial mammals described above. In a typical square mile, there would be 4 linear miles of receivers and 8 linear miles of source.

The ASTAR project proponents are examining the potential for a network of roads across the ACP, and the Alaska Stand Alone Gas Pipeline proposes a gas pipeline from the North Slope. Infrastructure to support oil and gas development in the program area may facilitate these and other potential development projects.

Road construction under the action alternatives would contribute to effects from an expanded road network that could displace calving, present obstacles to caribou movement, and change hunter access to the region. Additional development west of the program area could alter the behavior and movements of CAH caribou. Based on theoretical models, changes in caribou behavior as a result of disturbance could have demographic impacts, although only at high levels of exposure (Murphy et al. 2000).

Additional development could occur on private land near Kaktovik. Also use of roads by local hunters to achieve summer and winter access to subsistence hunting areas may alter the distribution of hunting in the area and could further displace caribou and other mammals away from gravel roads, potentially lowering tolerance of roads and pads in seasons other than calving (Paton et al. 2017; Russell and Gunn 2017; Plante et al. 2018). Displacement of calving caribou by active roads is likely to persist despite repeated annual exposure, as described above. If a public road is constructed from the Dalton Highway to the program area, it could create additional access for visiting hunters and recreationists, thereby increasing disturbance and mortality from hunting.

The effects of climate change described under *Affected Environment* above, could influence the rate or degree of the potential cumulative impacts. If climate change results in greater frequency of rain-on-snow events or other adverse impacts, it could result in caribou entering the program area in poor condition. In such a case, cumulative impacts from the potential calving displacement could be more pronounced (Murphy and Lawhead 2000). Changes in predator densities as a result of climate changes or increases in alternative prey could affect caribou.

Residents of Kaktovik have expressed concern that eco-tourists viewing the PCH may deflect the leaders of the herd, altering movement routes (Native Village of Kaktovik, see **Appendix S**). Because the PCH requires some degree of flexibility in annual calving areas, depending on spring conditions (USFWS 2015a), the cumulative impacts of the potential development projects would be larger under the alternatives with more potential for development in PCH annual calving areas and with fewer alternative options for calving areas. Alternative B would contribute the greatest potential effects and Alternative D2 would contribute the fewest, because it would restrict the leased area to a maximum of 800,000 acres, largely outside key PCH calving areas. The type and total amount of development in areas used during the post-calving period, on the Canning Delta, and along the Beaufort Sea coast would have cumulative impacts on CAH and PCH movements after calving and during periods of mosquito harassment.

Quantifying the impact of development on caribou populations is difficult because it requires specific assumptions of how development would affect caribou distribution or behavior and how those changes would, in turn, influence specific demographic rates, which is largely unknown. Giffith et al. (2002) and Russell and Gunn (2019) both estimated the potential declines in calf survival if calving were displaced from the PCH primary calving habitat, as described above.

Russell and Gunn (2019) also used previously developed models of caribou movement, energy and protein intake, and demography to model the impact of potential development based on changes in caribou activity budgets in the program area at three levels of climate conditions—adverse, average, favorable—and starting population levels of 100,000 and 218,000 animals, using 414 collar-years of telemetry data locations (1985–2017). They assumed that caribou would not be displaced by infrastructure but instead would lessen the time they spend on foraging and its intensity. The caribou would increase the time spent walking and running when in the program area or within a ZOI of existing infrastructure (the size of the ZOIs was unspecified) in the PCH annual range.

Under these models, changes in behavior would change body condition, leading in turn to differences in survival of calves and the probability of pregnancy for cows. In the models, the decline in time spent foraging was assumed to vary between 3 and 12 percentage points depending on the season and lease stipulations in place (Russell and Gunn 2019); during calving and post-calving they assumed a 12 percentage point decline under standard terms and conditions and controlled surface use, an 8 point decline under timing limitations, a 6 point decline in areas with NSO, and no decline in areas of no leasing.

Based on these assumptions, Russell and Gunn predicted a population decline over the baseline model of 17, 12, 7, and 6 percent after 10 years under Alternatives B, C, D1, and D2, respectively, from a starting population of 218,000 caribou. With a starting population of 100,000 caribou, they predicted population declines of 18, 14, 9, and 9 percent after 10 years under Alternatives B, C, D1, and D2, respectively.[35]

These models provide estimates of potential effects of development and their variability among alternatives with different starting population and climate conditions. As with all modeling, however, the results depend on the assumptions used in the models. In these models, the assumed changes in the time spent foraging and the foraging efficiency are important drivers of the results. Because caribou have a low energetic cost of locomotion, changes in the time spent foraging would have a larger impact on demographic parameters than changes in movement rates (Fancy 1986; Fancy and White 1987).

The assumption that caribou would spend 3 to 12 percent less time foraging during the entire time they are in an area open to leasing, regardless of distance, has limited support in the literature. Research on activity budgets of caribou near infrastructure gives varying results and differs in the distances used. Murphy and Curatolo (1987) observed CAH caribou within 0.6 miles of oil field roads and found that they spent more time running and walking and moved farther per day within 1,969 feet of roads; however, they did not feed less, compared with those at a control site.

Nevertheless, it is possible that the decline in resting observed within 1,969 feet of roads may have resulted in lower feeding rates later because caribou need periods of rest for proper rumination. Fancy (1983) found that estimates of the time spent feeding and lying still were lower near a drill site, compared with a control site 2.49 miles from infrastructure; however, the difference was not statistically significant and feeding was not analyzed separately from lying. Roby (1978) found that CAH caribou with calves spent more time feeding, standing, and walking and less time lying within 100 meters of the Dalton Highway than those over 300 meters away.

Johnson and Lawhead (1989) compared activity budgets of caribou within 1,640 feet and over 1,640 feet from Kuparuk oil field roads. When insects were absent, there was a marginally significant ($P = 0.07$) increase in

[35]Note that Alternative D2 has been changed since Russell and Gunn conducted their analysis.

feeding near roads, but when mosquito harassment was occurring, there was a significant decrease ($P \leq 0.05$) in time spent feeding near roads.

BHP (2004) and Golder (2011) did report a marginally significant ($P = 0.07$) decline of 5.4 percent in time groups with calves spent feeding within 3.1 miles of large open pit mines. This is compared with groups with calves over 3.1 miles away and a significant decline ($P = 0.01$) of 10.4 percent in time spent feeding/resting for caribou groups with calves within 3.1 miles of the mines.

Russell and Gunn (2019) also point to studies showing more rapid movements for caribou crossing roads or moving into or out of ZOIs (size not specified). They estimated that an increase in distance traveled per day of 65 percent would equate to a 14 percentage point increase in time spent walking or running.[36]

This increase in walking or running might result in less time feeding (Russell and Gunn 2019), but this was not always true in other studies (Murphy and Curatolo 1987). Others have also found that caribou move faster when crossing a road (Leblond et al. 2013; Plante et al. 2018), but these effects are limited in extent and can be biased toward higher values. This is because caribou moving faster are more likely to cross a road or boundary. Recent studies of CAH movement rates within 6.2 miles of roads and pads in the Kuparuk oil field indicated only small increases in movement rates during road crossings and when caribou were within approximately 2.49 miles of roads. The largest increases were during the post-calving and mosquito seasons, when results could be confounded by insect activity (Prichard et al. 2019). None of these studies demonstrated changes in feeding behavior on the time or space scale assumed in the models by Russell and Gunn (2019).

The specific differences in model inputs assumed for NSO, CSU, and TL have little support from those with first-hand knowledge. Due to the 2,000-acre limit on gravel infrastructure under all action alternatives, approximately 633,000 acres are expected to be within 2.49 miles of roads, pads, or gravel mines as described above; therefore, approximately 57 percent of the program area could be more than 2.49 miles from roads, pads, or gravel mines.

Because Russell and Gunn (2019) did not specify a ZOI for changing activity budgets in the program area, the assumed decrease in feeding rates in their models extends far beyond 2.29 miles and outside the 3.1-mile zone of lower foraging rates observed in Golder (2011). In addition, the amount of time caribou could be in the program area could be quite extensive, with about 5 percent of caribou using the area for more than 5 weeks (Russell and Gunn 2019). It is not known if time spent foraging would change. In addition, as previously described, some caribou may also react to infrastructure by moving away during some seasons, rather than changing their feeding behavior.

Murphy et al. (2000) used a previous PCH model to examine the impact of changing activity budgets of 600 meters or less from roads in the Kuparuk oil field, based on activity budgets of CAH caribou reported in Murphy and Curatolo (1987). Murphy et al. found that under realistic scenarios of exposure to development (25 percent or less time from June 10 to August 8), the population decline would be 1 percent or less, due to disturbance; however, they acknowledged that their results were preliminary.

One primary difference between these results and those of Russell and Gunn (2019) was that Murphy et al. (2000) assumed no change in time spent feeding, as reported by Murphy and Curatolo (1987). While some models exist to predict the impact of caribou behavior on body condition and parturition and survival (e.g., Russell and Gunn 2019), there is still great uncertainty in values required as input. As described above, there is uncertainty in how caribou will react to infrastructure during different seasons (e.g., foraging rates,

[36]This calculation assumes that the increase in movement distance was not accomplished by moving faster.

movement rates, displacement distance) and how forage quantity and quality vary spatially and temporally for caribou that are displaced or change their feeding behavior. These issues demonstrate the difficulty of modeling impacts from development on caribou demographics, especially before the development of specific project proposals.

3.3.5 Marine Mammals

Affected Environment

All marine mammals found in US waters are protected under the MMPA, as amended (16 USC 1631 et seq.). Some species receive additional protection under the ESA (16 USC 1531 et seq.). Whales, seals, and porpoises are managed by the NMFS, whereas polar bears, sea otters, and walruses are managed by the USFWS. The NMFS and USFWS stockstock assessment reports (SARs) contain detailed information on the status, seasonal distribution, abundance, and life history of marine mammals in the Beaufort Sea. NMFS publishes current SARs for whales, seals, and sea lions (Muto et al. 2018; https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessment-reports-species-stock) and the USFWS publishes current SARs for Pacific walrus and polar bear (www.fws.gov/alaska/pages/marine-mammals).

Additional information on polar bears and Pacific walrus can be found in the Beaufort Sea ITR Final Rule (81 FR 52276). Further, the Final EIS on Effects of Oil and Gas Activities in the Arctic (NMFS 2016a) provides detailed descriptions of marine mammal population status and trends, distribution, seasonal migration and movements, habitat use, reproduction and growth, survival, and mortality. These documents are incorporated into this EIS by reference.

Nine species of marine mammals have been recorded in marine waters within 5 nautical miles of the program area (**Table 3-22**). The bowhead whale is listed as endangered under the ESA, and the polar bear, bearded seal, and ringed seal are listed as threatened.

Table 3-22
Marine Mammal Species Occurring within 5 Nautical Miles of the Arctic Refuge Coastline and Their Status in the Program Area

Common Name	Scientific Name	Status	Occurrence[3]
Bowhead whale	*Balaena mysticetus*	Endangered[1]	Common
Beluga	*Delphinapterus leucas*	Protected[2]	Common
Gray whale	*Eschrichtius robustus*	Protected[2]	Casual
Harbor porpoise	*Phocoena phocoena*	Protected[2]	Casual
Bearded seal	*Erignathus barbatus*	Threatened[1]	Fairly common
Ringed seal	*Phoca (Pusa) hispida*	Threatened[1]	Common
Spotted seal	*P. largha*	Protected[4]	Fairly common
Pacific walrus	*Odobenus rosmarus*	Protected[2]	Casual
Polar bear	*Ursus maritimus*	Threatened[1]	Common

Source: ASAMM 2017; Muto et al. 2018

[1] Under the ESA (ESA-listed species are considered depleted under the MMPA).

[2] Under the MMPA.

[3] Common = recorded in every year; fairly common = recorded in most years; uncommon = recorded once every 3–5 years; rare = in its normal range but recorded less than every 5 years; casual = beyond its normal range, further observations unlikely. Occurrence is based primarily on data from the Aerial Surveys of Arctic Marine Mammals Program funded by BOEM and National Oceanic and Atmospheric Administration (NOAA).

[4] The Bering distinct population segment (DPS) uses the program area and is not listed under the ESA (the Southern DPS is listed as threatened but does not occur in the program area).

Table 3-23 lists additional species of marine mammals that may be encountered in the Bering and Chukchi Seas by post-lease oil and gas activity vessel traffic from Dutch Harbor to the program area (**Map 3-27**, Critical Habitat Along the Marine Transport Route, in **Appendix A**). Species currently listed as threatened or endangered under the ESA are fin, humpback, and right whales, Steller sea lions, and sea otters. The discussion below focuses on the ESA-listed species and the beluga whale, which occurs commonly near shore and is of interest for subsistence harvest. Narwhals (*Monodon monoceros*) and hooded seals (*Cystophora cristata*) are considered extralimital to the program area and are not discussed in this EIS.

Table 3-23
Additional Marine Mammal Species Occurring Along Vessel Transit Routes in the Bering and Chukchi Seas

Common Name	Scientific Name	Status
Steller's sea lion (Western DPS)	*Eumetopias jubatus*	Endangered[2]
Ribbon seal	*Histriophoca fasciata*	Protected[1]
Northern sea otter (Southwest Alaska DPS)	*Enhydra lutris*	Threatened[2]
North Pacific right whale	*Eubalaena japonica*	Endangered[2]
Minke whale	*Balaenoptera acutorostrata*	Protected[1]
Blue whale	*B. musculus*	Endangered[2]
Fin whale	*B. physalus*	Endangered[2]
Humpback whale (Western North Pacific DPS)	*Megaptera novaeangliae*	Endangered[2]
Gray whale (Western North Pacific DPS)	*Eschrichtius robustus*	Endangered[2]
Pacific white-sided dolphin	*Lagenorhynchus obliquidens*	Protected[1]
Killer whale	*Orcinus orca*	Protected[1]
Harbor porpoise	*Phocoena phocoena*	Protected[1]
Dall's porpoise	*Phocoenoides dalli*	Protected[1]
Sperm whale	*Physeter catodon*	Endangered[2]
Baird's beaked whale	*Berardius bairdii*	Protected[1]
Stejneger's beaked whale	*Mesoplodon stejnegeri*	Protected[1]
Cuvier's beaked whale	*Ziphius cavirostris*	Protected[1]

Source: NOAA 2018; Muto et al. 2018
[1]Under the MMPA
[2]Under the ESA; listed species are considered depleted under the MMPA

Polar Bear

Distribution

Polar bears have a circumpolar distribution in the Northern Hemisphere. In Alaska, they occur most commonly within 200 miles of the coast of the Arctic Ocean (Amstrup and DeMaster 1988). Nineteen subpopulations (stocks) of polar bears have been identified throughout their range, ranging from several hundred to several thousand animals each and, in the latest estimate, totaling approximately 26,000 individuals range wide (95 percent Confidence Interval [CI] = 22,000–31,000; Wiig et al. 2015; Durner et al. 2018).

Bears from three stocks occur in US waters off Alaska: the Northern Beaufort Sea stock, the Southern Beaufort Sea (SBS) stock, and the Chukchi Sea stock (Bethke et al. 1996; Amstrup 2003a; Amstrup et al. 2004a; Schliebe et al. 2006; Obbard et al. 2010; Durner et al. 2018). The SBS stock is the subpopulation most likely to occur in the program area, so the analyses below focus on this stock. Based on the distribution and characteristics of sea ice and corresponding population movements (Amstrup et al. 2007), SBS bears either move with the retreating ice or abandon it to spend the summer on land (Durner et al. 2009).

The SBS stock ranges over an expansive area, extending from Icy Cape and Point Hope on the Chukchi Sea coast of Alaska eastward to Cape Bathurst in the Northwest Territories of Canada, and seaward at least 185 miles from the coast (Bethke et al. 1996; Amstrup 2000, 2002; Brower et al. 2002; Schliebe et al. 2006). The core activity area of the SBS stock encompasses a considerably smaller region, from Herschel Island, Yukon, to Point Barrow, Alaska (including the existing oil fields in northern Alaska), and seaward about 85 miles (Amstrup 2000); thus, the program area is within the core activity area of the SBS.

Species Status

The USFWS listed the polar bear as a threatened species under the ESA in May 2008 (73 FR 28212). The ESA listing decision was based on the rapidly diminishing sea ice cover and thickness in the Arctic Ocean due to climate change, primarily during summer (73 FR 28212; Durner et al. 2009). In addition, the polar bear was listed in 2011 as a species of special concern in Canada under the Species At Risk Act (Species At Risk Committee 2012). The special concern designation is used for species that may become threatened or endangered in Canada as a result of a combination of biological characteristics and identified threats. The SBS stock of polar bears is a shared resource and is managed by both the US and Canada (USFWS 2016; Joint Secretariat 2017), and polar bear management is subject to international agreements with other Arctic nations (described in **Appendix D**).

When polar bears were listed under the ESA, the continuing loss of sea ice was judged to put them at risk of becoming endangered throughout their range in the foreseeable future. Subsequent modeling analyses predicted that declining sea ice cover risks significant declines in polar bear populations within three generations (35–41 years; Regehr et al. 2016). Considerable research has focused on changes in population status and survival because of diminishing sea ice habitat. Regehr et al. (2010) documented decreases in vital rates of the SBS stock, including survival and breeding rates, corresponding to increases in the number of ice-free days per year in waters over the Beaufort Sea continental shelf (including waters adjoining the program area).

Sea ice conditions, affected by rising global temperatures, are by far the most influential determinant of population outcomes for polar bears, with continued increases in GHG emissions being the dominant influence leading to worsening population outcomes (Atwood et al. 2016a; USFWS 2016). Atwood et al. (2016a) also evaluated other factors affecting population outcomes, listed in decreasing order of importance: marine prey availability (second only to sea ice), reduced mortality from hunting and defense of life and property interactions (modest influences), and trans-Arctic shipping, oil and gas exploration, and contaminants (negligible influences).

The best available analyses suggest that the SBS stock is declining (Obbard et al. 2010; Bromaghin et al. 2015; USFWS 2017a). The estimated population size of the SBS stock was approximately 900 bears in 2010 (90 percent CI = 606–1,212; Bromaghin et al. 2015), significantly reduced from previous estimates of approximately 1,800 in 1986 (Amstrup et al. 1986) and 1,526 in 2006 (Regehr et al. 2006). Furthermore, analyses of over 20 years of data on the size and body condition of bears in the SBS stock demonstrated declines for most sex and age classes and significant negative relationships between annual sea ice availability and body condition (Rode et al. 2010). Although the authors of the 2010 population estimate noted that suspected biases may have affected the bears' abundance estimate, no better estimate is available; therefore, the estimate of 900 bears is currently used for management purposes (USFWS 2017a).

Human activities that can affect polar bears are regulated by the USFWS under both the MMPA and ESA, with the former law taking precedence in the permitting process regarding unintentional, incidental take. To the west of the Arctic Refuge, leaseholders and other permittees routinely request, and are expected to be granted, incidental take authorizations; these are incidental harassment authorizations and letters of authorization (LOAs) for activities that could result in unintentional, incidental take of polar bears under the MMPA. The regulatory mechanism for LOAs is incidental take regulations (ITRs). These regulations allow industry operators to unintentionally take small numbers of polar bears provided that such take results in negligible impacts on the species and does not have an unmitigable adverse impact on the availability of the species for subsistence use by Alaska Natives.

In addition to a finding of negligible impact under the MMPA, developing new ITRs requires a separate biological assessment and a biological opinionanalysis under ESA Section 7, and may require that is supported by a finding that the activities allowed under the ITRs would not jeopardize the polar bear. The MMPA standard represents a lower threshold for impacts than does the jeopardy standard under the ESA.

The oil and gas projects to the west of the program area (central Beaufort Sea) are operating under a set of ITRs (in effect from August 2016 to August 2021; 81 FR 52276). These ITRs have been established to minimize industry disturbance of polar bears through mitigation, monitoring, and reporting (81 FR 52318; 50 CFR 18.128); however, they do not include the program area because the Arctic Refuge was specifically excluded (50 CFR 18.122(b)); therefore, oil and gas operators would need to apply for an MMPA take authorization before conducting seismic exploration or any other activities on the ground in the program area; with the potential to "take" (e.g., kill, injure, or disrupt the behavioral patterns of) polar bears currently, it is unknown if or when operators would have authorization to take a small number of polar bears in the program area.

Nevertheless, mitigation, monitoring, and reporting measures that have been implemented by the USFWS for over 20 years in the geographic region of the Beaufort Sea ITRs (centered on Prudhoe Bay) have strived to minimize disturbance and take of polar bears. A variety of design features and operational procedures typically are used to mitigate the potential impacts of petroleum activities on polar bears. The BLM assumes that measures such as those would form the foundation for any future stipulations or requirements that may be authorized in the program area under the MMPA.

The BLM understands that mitigation measures associated with the current ITRs managed outside the program area are the best available mechanism to manage industry impacts on polar bears and that such measures are continually being revised or updated. It is anticipated that any future mitigation, monitoring, and reporting measures are likely to be similar to current measures, but they could change on a case-by-case basis to minimize take when incidental take authorizations are promulgated in the program area. Hence, current mitigation measures typically required for activities in the central Beaufort Sea (**Appendix J**) have been used for analysis in this chapter.

In addition to stipulating mitigation measures under ITRs, the USFWS allows trained personnel to haze or otherwise intentionally take polar bears under specific circumstances involving the protection of human life (16 USC 1371 101(a)4(A)). Further, the USFWS has voluntary deterrence guidelines (75 FR 61631) to deter polar bears without causing injury or death. These are focused on passive measures intended to prevent bears from gaining access to property or people, such as fencing, gates, skirting, exclusion cages, and bear-proof garbage containers. They also include preventive measures to discourage bears from interacting with property or people, such as acoustic devices for auditory deterrence using vehicles or boats.

Polar bear harvesting is legal in the US for Alaska Natives under the MMPA (16 USC 1371 101(b)). Polar bear harvests in the southern Beaufort Sea are managed through the Inuvialuit-Iñupiat Agreement, a Native-to-Native (First Nations) agreement between the US and Canada; the agreement is voluntary in the US but mandatory in Canada (Nageak et al. 1991; Brower et al. 2002). Under this agreement, the current annual harvest quota for the SBS stock is 56 bears, or 35 for Iñupiaq hunters in Alaska and 21 for Inuvialuit hunters in Canada (Miller et al. 2018).

From 2008 through 2017, total human-caused removals of polar bears in Alaska (including both the SBS and Chukchi Sea stocks) numbered 420 bears, ranging from 17 to 88 per year and averaging 42 bears, comprising 62 percent males, 19 percent females, and 19 percent sex unknown or unreported (Miller et al. 2018). The subsistence harvest of polar bears in Alaska from 2008 to 2017 (both stocks, including "struck and lost" animals) ranged from 14 to 82 annually, averaging 38 bears (Miller et al. 2018).

Other human-caused removals during that 10-year period totaled 29 in defense of human life, 3 related to industry activities, 1 research-related, 1 by euthanasia, 3 of unknown causes, and 2 orphaned cubs placed with zoos (Miller et al. 2018). The proportional representation of the SBS stock for these mortalities was not reported, but the SBS harvest is lower than that of the Chukchi Sea stock. For example, from 2006 through 2015, the SBS harvest in Alaska averaged 19 bears per year, comprising 50 percent males, 27 percent females, and 23 percent unreported sex (USFWS 2017b). During the same period in Canada, the SBS harvest averaged 14.2 bears per year, comprising 56 percent males and 44 percent females.

Population Movements

Polar bears of the SBS stock range over large areas, with annual activity areas of collared individuals ranging from 2,805 to 230,426 square miles (Amstrup et al. 2000). They are transient throughout the nearshore areas of the Beaufort Sea coast, including the program area. The largest monthly movements occur during early winter and the smallest in early spring; females with cubs move less and cover smaller areas than do males and other age classes.

Movements are increasing as sea ice cover diminishes. From 1979 to 2006, collared female polar bears moving from the pack ice to denning areas onshore experienced an average increase in travel distance of 3.7 miles per year, and future increases of greater than 10 miles per year have been estimated out to 2060, based on ocean circulation models (Bergen et al. 2007). As the rate of westward and northward drift of sea ice has increased with decreasing thickness and extent in the Beaufort Sea (at least 30 percent over 26 years), polar bears have shown corresponding increases in the amount of time spent active and in travel speed and distance, resulting in increased energy expenditure and food requirements (Durner et al. 2017).

Polar bears typically use land only during late summer, autumn, and the maternal denning season in winter; besides denning females, adult females with and without cubs, subadults, and adult males all come ashore. Polar bears begin to appear on the mainland and barrier islands in July and August, during the open-water period (Miller et al. 2006; Schliebe et al. 2008). As seasonal and multiyear pack-ice cover spreads southward in the late fall and winter, polar bears move with it, appearing along the Beaufort Sea coast (Amstrup et al. 2000), although some may remain on pack ice all year, if there is continuous access to prey (Stirling 2009).

The number of bears observed on coastal surveys in the fall is significantly related to the distance of pack ice from shore (Schliebe et al. 2008; Wilson et al. 2017). Except for pregnant females that remain to den, bears using land begin to leave when sea ice develops, usually by late October (Schliebe et al. 2001; Kalxdorff et al. 2002). Rapid environmental changes from lengthening of the ice-melt season and diminished sea ice cover has increased the bears' use of terrestrial habitats: the percentage of collared female SBS bears coming ashore tripled over 15 years since the late 1990s, with bears arriving onshore earlier, staying longer, and departing later (Atwood et al. 2016b). The mean duration of the open-water period increased by 36 days in that period, and the mean length of stay increased by 31 days.

It has been known for a long time, as stated by indigenous hunters (USFWS 1995; Joint Secretariat 2015), that polar bears become increasingly abundant on the mainland and barrier islands during the open-water season in late summer and the fall subsistence whaling season. USFWS biologists flew 53 aerial surveys along the entire Beaufort Sea coast between Point Barrow and the Canada border in fall 2000 to 2014, averaging 64 bears per survey and recording a maximum of 156 bears on a single survey in August 2012 (Wilson et al. 2017). On average, 4 to 8 percent of the bears in the SBS stock were observed on land per survey (Schliebe et al. 2008). Most sightings on those coastal surveys (82 percent) were recorded on barrier islands, with 11 percent on the mainland and 6 percent on landfast ice (74 FR 56068).

Peak numbers of polar bears observed on land generally occurred in late September and early October (USFWS 1995; Schliebe et al. 2001, 2008; Kalxdorff et al. 2002). The number of polar bears on shore is related to sea ice dynamics, although the distribution of bears on shore was influenced most strongly by the availability of food from subsistence whaling (Wilson et al. 2017). Bear numbers on shore have increased in late summer and autumn in certain locations, with the greatest concentrations occurring at Barter Island, Cross Island, and Point Barrow, where bears feed on bone piles of butchered bowhead whales taken during the autumn subsistence hunt (Miller et al. 2006; Schliebe et al. 2008; Atwood et al. 2016b; Lillie 2018).

Polar bears using terrestrial habitats near the program area have shown increases in the amount of bowhead whale consumed in their diets in recent years. This reflects increased foraging on the Kaktovik whale-bone pile, with bowhead whale constituting 50–70 percent of the fall diet of those bears that spent more time on and near the coast than bears farther offshore (Rogers et al. 2015; McKinney et al. 2017). Increased consumption of bowhead whale was associated with better body condition.

Genetic analysis of hair-snare samples estimated that as many as 146 individuals (standard error = 21), representing approximately 16 percent of the most recent SBS stock estimate, visited the whalebone pile in Kaktovik in 2012 (Lillie 2018). In one recent study, the percentage of collared SBS bears spending time along the coast of northeast Alaska ranged from 22 to 33 percent annually, averaging 27 percent, with the area near Kaktovik receiving the most use (Pongracz and Derocher 2017).

Life History

Polar bears are large, long-lived (29–32 years), opportunistic hunters that feed primarily on ringed and bearded seals but also on beached carcasses of marine mammals (whales and walruses) (Smith 1980; Amstrup 2003a; Schliebe et al. 2006; Miller et al. 2006). Adult males and non-pregnant females are active all year. Mating occurs from March to late May. Pregnant females construct and enter snowdrift natal dens in October or November (Amstrup and Gardner 1994; Joint Secretariat 2015) and give birth in late December or early January.

Litter size ranges from one to three cubs, averaging 1.63; litters of two cubs are most common (Amstrup 2003a). Mothers and cubs emerge from natal dens in late March or April, when the cubs are 3 to 4 months old (Lentfer and Hensel 1980; Amstrup and Gardner 1994; Smith et al. 2007; Joint Secretariat 2015). The cubs remain near the dens for up to 2 weeks (Smith et al. 2007) as they adapt to outside temperatures.

Young cubs are vulnerable to predation during the brief period after den emergence and before moving onto sea ice (Richardson and Andriashak 2006). Cubs usually stay with their mothers until they are 1.5 to 2.5 years old (Stirling et al. 1975). Females breed again at about the same time they separate from their young, resulting in a breeding interval of females that successfully wean cubs of 3 years or longer.

Critical Habitat

The USFWS designated critical habitat for polar bears in Alaska in 2011 (75 FR 76086). Three units of critical habitat (all of which occur in the program area; **Map 3-37**, Polar Bear Habitat, in **Appendix A**) were designated, corresponding to the following primary constituent elements of critical habitat described in the final rule:

- Sea ice habitat, used for feeding, breeding, denning, and movements, in US territorial waters;
- Terrestrial denning habitat, on land along the northern coast of Alaska, with characteristics suitable for capturing and retaining snow drifts of sufficient depth to sustain maternal dens through winter, occurring within 20 miles of the coast between the US-Canada border on the east and the Shaviovik and Kavik Rivers on the west (including the program area), and within 5 miles of the coast from the Shaviovik and Kavik Rivers west to Point Barrow;
- Barrier island habitat, used for denning, refuge from human disturbance, and movements along the coast for access to denning and feeding habitats, comprising barrier islands and associated mainland spits, along with the water, ice, and terrestrial habitat within 1 mile of those features, designated as a no-disturbance zone.

Critical habitat excludes human-made structures and the land on which they are located, as well as seven specific areas consisting of the communities of Utqiaġvik and Kaktovik and five US Air Force radar sites (Point Barrow, Point Lonely, Oliktok Point, Bullen Point, and Barter Island). The acreages and percentages of each critical habitat unit in the program area are described below, under *Impacts Common to All Alternatives*.

Habitat Use

Polar bears rely principally on the availability of sea ice habitats to roam, hunt, breed, and rest. Although most of the SBS bears remain on sea ice during summer (Pongracz and Derocher 2017), their use of terrestrial habitats has been increasing as sea ice cover has declined. Between 2000 and 2014, the percentage of collared adult female bears coming ashore tripled (averaging 20 percent and ranging up to 37 percent). The average length of stay ashore increased to 56 days, from 20 days in the 1990s (Atwood et al. 2016b). Given that adult males and subadult bears of both sexes cannot be collared to track their movements, it is not clear what proportion of those bears use land; however, it is clear that they also use land in the summer and autumn (Miller et al. 2015).

Preferred habitats are in the active seasonal ice zone that overlies the continental shelf and associated islands and in areas of heavy offshore pack ice (Stirling 1988; Durner et al. 2004, 2009; Joint Secretariat 2015; Pongracz and Derocher 2017). Adult males usually remain there, rarely coming ashore (Amstrup and DeMaster 1988). Habitat use changes seasonally with the formation, advance, movement, retreat, and melt of sea ice (Amstrup et al. 2000; Ferguson et al. 2000; Durner et al. 2004, 2009; Schliebe et al. 2008; Joint Secretariat 2015).

During winter and spring, polar bears tend to concentrate in areas of ice with pressure ridges, at floe edges, and on drifting seasonal ice at least 8 inches thick (Stirling et al. 1975, 1981; Schliebe et al. 2006); the greatest densities occur in the latter two categories, presumably because those habitats provide greater access to seals. Use of shallow water is greatest in winter, in areas of active ice with shear zones and leads (Durner et al. 2004). Use of landfast ice increases in spring during the pupping season of ringed seals. Multiyear ice is selected in late summer and early autumn as the pack ice retreats to its minimal extent (Ferguson et al. 2000; Durner et al. 2004).

Although travel distance and speed have increased with decreasing sea ice extent and thickness and increased rate of drift, habitat selection by female polar bears on sea ice does not appear to have changed (Durner et al. 2017).

Maternal Denning

In comparison with core denning areas known to support relatively high concentrations of maternal females of other population stocks, such as those on Wrangel Island in the Chukchi Sea and Svalbard in the North Atlantic, the southern Beaufort Sea is an area of widespread, low-density denning by maternal polar bears (Amstrup 2003b; Schliebe et al. 2006; USFWS 2017a). The total number of maternal dens occupied annually by females of the SBS stock has been estimated at 140 to 240 (Amstrup and Gardner 1994; 75 FR 76099), with the most recent USFWS estimate being approximately 153 (see **Appendix J**).

Notable shifts in the distribution of maternal dens in northern Alaska were documented by comparing 124 den locations used by 85 collared SBS bears between 1985 and 1994 and between 1997 and 2004, documenting a landward and eastward shift in maternal denning along the Beaufort Sea coast (Fischbach et al. 2007). The proportion of dens on drifting sea ice decreased from 62 percent in the early period to 37 percent in the later period, and proportionately fewer dens occurred on pack ice in the western Beaufort Sea in the later period. Although female polar bears do not show fidelity to specific den locations, they tend to den on the same substrate (sea ice or land) from year to year and may return to the same general area to den (Amstrup and Gardner 1994; Amstrup 2003b; Schliebe et al. 2006; Fischbach et al. 2007). Fischbach et al. (2007) noted that more females shifted from sea ice to land during both periods studied and that females in the later period showed greater fidelity to land for denning.

This increasing trend of more bears denning on land has continued (Olson et al. 2017). The use of denning substrate (sea ice or land) is significantly related to where bears occur in autumn. Pregnant polar bears in the SBS stock that spent 25 days or more on land in autumn all subsequently denned on land (Olson et al. 2017), and between 1985 and 2013, the percentage of SBS females denning on land increased from 34 to 55 percent, linked to sea ice declines. Terrestrial denning critical habitat composes 76.3 percent of the program area, and 38 percent more potential maternal denning habitat is available in the program area than in the region immediately west of it (Durner et al. 2006).

Polar bears have been shown to den in the program area with greater frequency than expected, based on available habitat (Amstrup 1993). From 2000 to 2010, 22 percent of the known maternal dens of the SBS stock occurred in the program area (Durner et al. 2010). The USFWS estimates that 23.1 percent of terrestrial dens of the SBS stock occur in the program area annually (see **Appendix J**); thus, the program area is known to be an important area for maternal denning and will likely increase in importance as the percentage of bears denning on land increases with continuing sea ice loss (Olson et al. 2017).

Because of bears' greater proximity to settlements, industrial sites, and other coastal areas of human activity, dens on land and land-fast ice are more vulnerable to disturbance by human activity than are dens on sea ice. A few records of female polar bears denning successfully in snow drifts near oil infrastructure have been recorded since development began in the oil fields along the central Beaufort Sea coast.

Pregnant polar bears denning in terrestrial habitats excavate maternal dens in compacted snow drifts next to coastal banks of barrier islands and mainland bluffs, river, stream, and lake banks, and other areas with suitable topographic relief (Amstrup and DeMaster 1988; Durner et al. 2001, 2003, 2006). In the program area, 46 maternal dens have been documented in terrestrial habitats, 18 of which were located between the Katakturuk and Sadlerochit River drainages in the central portion of the program area; 12 additional dens were found on sea ice within 5 miles of the program area and in the Arctic Refuge south of the program area (**Map 3-37** in **Appendix A**).

The dens in this sample were found using a variety of methods; most were found by radio-tracking bears collared with very high frequency radio collars or satellite transmitters from 1989 to 2010, whereas others were found through opportunistic encounters or dedicated searches from as early as 1913 to as recently as 2010 (Durner et al. 2010). Using the best available data on the estimated population of the SBS stock, the proportion of adult females in the population, the breeding probability of adult females, the proportion of dens on land, and the proportion of historical dens in the program area, the USFWS estimates that approximately 20 female bears may den in the program area annually (see **Appendix J**).

The most important characteristic of maternal denning habitat is the presence of topographic features of sufficient height and slope to catch blowing snow and form persistent drifts in early winter, with at least 4.3 feet of vertical topographic relief and steep slopes (mean 40°, range 15.5–50°) (Amstrup and DeMaster 1988; Durner et al. 2001, 2003, 2006). Biologists characterized and mapped landscape features (bank-habitat segments) considered to provide suitable maternal denning habitat along the Alaska Beaufort Sea coast, from the NPR-A to the Canada border (Durner et al. 2001, 2003, 2006, 2013; **Map 3-37** in **Appendix A**). Based on interpretation of aerial imagery by Durner et al. (2006), approximately 1,769 miles of suitable bank habitats have been delineated in the program area (see **Table 3-24** below). Since then, synthetic aperture radar also has been used to detect maternal denning habitat, producing similar results (Durner and Atwood 2018).

Other researchers recently developed a three-dimensional (3D) spatial model, integrating snow physics, weather data, and a high-resolution digital elevation model, to predict the occurrence of potential denning habitat along the Beaufort Sea coast (Liston et al. 2015). All of these techniques can provide fine-scale results to focus aerial surveys of denning habitat using thermal imaging equipment (forward-looking infrared radiometry [airborne FLIR; Amstrup et al. 2004b], also known as aerial infrared [AIR; Owyhee Air Research 2018]). This method is the most suitable for searching large areas for maternal dens in advance of seismic exploration or other potentially disturbing activities (Amstrup et al. 2004b; York et al. 2004; Owyhee Air Research 2018).

Bowhead Whale

Bowhead whales transit past the program area during spring (April–June) and fall (September and October) migration, traveling along the shelf break and coming close to shore to feed (Quakenbush et al. 2010; Citta et al. 2015; **Map 3-38**, Bowhead and Beluga Whale Sightings, in **Appendix A**). The spring migratory corridor between the Bering Strait and Cape Bathurst in the Amundsen Gulf (Canada) has been relatively distinct and consistent over time (Citta et al. 2015).

During the summer, bowhead whales feed throughout the Beaufort Sea and may occur in the program area throughout the open-water season. Historically, they have largely aggregated in the Canadian Beaufort Sea and Barrow Canyon (US) in deep water, where upwellings concentrate prey species, although some whales remain in the eastern Chukchi and western Beaufort Seas (Ireland et al. 2009; Quakenbush et al. 2010; Clarke et al. 2011). In the last several years, however, increasing numbers of animals have been observed in nearshore, shallow areas (Clarke et al. 2015), and their historical distribution patterns may be changing.

Fall migrating whales typically reach Cross Island in September and October, although some might arrive as early as late August (BOEM 2018b) and continue on to Point Barrow. After passing Point Barrow, the migration paths of individual bowhead whales fan out across the Chukchi Sea, with some heading toward Wrangel Island (Russia) and then the coastal waters of Chukotka, (Russia); others travel across the Chukchi

Sea south of Hanna Shoals toward the Russian coast (Ireland et al. 2009; Quakenbush et al. 2010; Citta et al. 2015). They continue southward through the Bering Strait and overwinter in the Bering Sea (Ireland et al. 2009; Quakenbush et al. 2010; Citta et al. 2015). The distribution of bowhead whales is further described in the Final Environmental Impact Statement for the Liberty Development and Production Plan, incorporated here by reference (BOEM 2018b).

Bowhead whales in the program area and along the shipping corridor belong to the western Arctic stock, also known as the Bering-Chukchi-Beaufort stock, and are the only one of the four stocks that inhabit US waters (Muto et al. 2018). Bowhead whales were listed as endangered under the predecessor of the ESA in 1973, but no critical habitat has been designated. The decline in extent and duration of sea ice over the past 40 years has coincided with an increase in harvest by residents of Kaktovik, who harvested 1–2 whales per year from 1973 to 1994 and 2–4 whales per year from 1995 to 2016 (Koski et al. 2005; Suydam and George 2018). The Western Arctic population of bowhead whales increased at a rate of 3.2–3.7 percent from 1978 to 2011 (Schweder et al. 2009; Givens et al. 2013), and the current population estimate is 16,820 individuals (95 percent CI: 15,176–18,643; Givens et al. 2016).

Bowhead whales have an estimated auditory bandwidth of 7 Hz to 22 kHz (Southall et al. 2007). Going by their vocalizations, bowhead whales should be most sensitive to frequencies between 20 Hz and 5 kHz, with maximum sensitivity between 100 and 500 Hz (Erbe 2002). Subsistence hunters note that bowhead whales are sensitive to noise during the spring whaling season (Noongwook et al. 2007).

Beluga Whale

Beluga whales in Arctic Alaska belong to the Beaufort Sea (BS) and the Eastern Chukchi Sea (ECS) stocks (Muto et al. 2018). They use waters in the eastern Beaufort Sea but stay farther offshore than bowhead whales, typically beyond the shelf break (Hauser et al. 2014). Spring migration eastward through the Beaufort Sea is stock-specific, with BS stock migrating in spring (April and May) and ECS stock migrating in summer (June and July; Suydam et al. 2001, The BS stock continues on to Canadian waters, spending the summer in the eastern Beaufort Sea, Mackenzie River Estuary, Amundsen Gulf, M'Clure Strait, and Viscount Melville Sound (Hauser et al. 2014, 2017). The ECS stock spends the summer primarily restricted to the continental shelf and slope north of Alaska in the northeastern Chukchi and western Beaufort Seas (Suydam 2009; Hauser et al. 2014; Stafford et al. 2016). The BS stock starts moving west and south in September, leading to an overlap of ranges for the two stocks that extends from Prince of Wales Strait in Canada westward to Herald Shoal in the Chukchi Sea (Hauser et al. 2014; Stafford et al. 2017). The main fall migration corridor of belugas is over 54 nautical miles north of the coast; however, they do occasionally approach shallow water in coastal areas, such as lagoons and river deltas, to molt or feed (Suydam 2009).

Belugas have been recorded within 5 nautical miles of the program area in the lagoons (**Map 3-38** in **Appendix A**, Hauser et al. 2017) and are sometimes harvested by Kaktovik residents. The population estimate for the ECS stock is approximately 20,000 belugas (Lowry et al. 2017). Although the BS stock was estimated to be approximately 39,000 whales, based on 1996 information, there is currently no recent reliable population estimate available for the BS stock (Muto et al. 2018); however, trend data suggest that the stock is at least stable (Harwood and Kingsley 2013).

Beluga whales are the most vocal of the toothed whales and have a wide variety of vocalizations. They have as many as 50 different whistles and calls in frequencies, ranging from 0.1 to 12.0 kHz (BLM 2012). They can detect sounds at frequencies as low as 40 to 125 Hz (Richardson et al. 1995).

Other Whales

Whale species that may be encountered by vessels in transit from Dutch Harbor to the Beaufort Sea are described in the EIS for the Liberty development project (BOEM 2018b), incorporated here by reference. Gray whales are grouped into the Eastern North Pacific stock, which feeds in the Beaufort, Chukchi, and Bering Seas in summer, and the Western North Pacific stock, which is listed as endangered and is found in Russian waters.

The Eastern North Pacific stock migrates south from Alaska in the fall to spend winter in waters off California and Mexico. The most recent population estimate for this stock of 20,125 individuals is based on systematic counts of gray whales migrating south along the central California coast (Carretta et al. 2015). Gray whales from the Eastern North Pacific stock regularly occur near Utqiaġvik in both the Chukchi and Beaufort Seas in summer (Moore and DeMaster 1997; Laake et al. 2009). They have been recorded during aerial surveys (ASAMM 2017) and on acoustic recorders (Moore et al. 2000, 2006), rarely ranging past 155.8ºW (Clarke et al. 2015 in BOEM 2018). While no gray whales have been observed within 5 nautical miles of the program area, gray whales have sighted six times in the Canadian Beaufort Sea (Rugh and Fraker 1981; Brower et al. 2015; Clark et al. 2015; Yuka et al. 2016). This suggests that a small, casual proportion of gray whales migrates into Canadian waters and could be encountered during Coastal Plain activities. Gray whales have an estimated auditory bandwidth of 7 Hz to 22 kHz, placing them in the low-frequency hearing group for cetaceans. They produce signals from 100 Hz to 4 kHz, with the most common sounds on the feeding grounds being knocks (BLM 2012).

In addition to the species listed in **Table 3-22**, sub-arctic whales that could be encountered during vessel transit are blue, fin, humpback, minke, North Pacific right, sperm, and killer whales. Blue whales are present in Alaska waters only during their non-breeding season and would be found in the open waters near the Aleutian Islands and the Bering Sea. Fin whales are present in both the Bering and Chukchi Seas in the summer, with greater numbers in the Bering than the Chukchi Sea (Muto et al. 2018). Individual humpback whales from the Western North Pacific Stock could occur in the Bering Sea and possibly in parts of the Chukchi and Beaufort seas (Muto et al. 2018), although sightings are rare. Minke whales are believed to be migratory summer residents of the Chukchi and Bering Seas, and move south of the Bering Sea to overwinter. North Pacific right whales are considered the rarest of all large whale species and among the rarest of all marine mammal species. Critical habitat was designated for the eastern North Pacific right whale in 2008 (73 FR 19000) in the Bering Sea, based on geographic coordinates where they have been consistently sighted in spring and summer.

Ringed Seal

Ringed seals (*Phoca* [*Pusa] hispida*) have a circumpolar distribution and have five recognized subspecies (Kelly et al. 2010). The Alaska stock consists of a portion of the subspecies P. h. hispida found in the US waters of the Beaufort, Chukchi, and Bering Seas (Muto et al. 2018). There is no reliable population estimate for the entire Alaska stock. Surveys conducted from 1996 to 1999 yielded a conservative estimate of at least 300,000 ringed seals in the Alaskan Beaufort and Chukchi Seas (Bengtson et al. 2005; Frost et al. 2004; Kelly et al. 2010). The estimate for the US Beaufort Sea, however, has not been corrected for the number of ringed seals that had not hauled out at the time of the surveys (Kelly et al. 2006; Carretta et al. 2015).

Data from aerial surveys conducted over the Bering Sea in 2010 and 2013 were used to calculate an abundance estimate of 170,000 ringed seals in the US sector of the Bering Sea (Conn et al. 2014). Recent estimates indicate that the Arctic ringed seal population numbers over 1,000,000 (Kelly et al. 2010). The population trends and status of this stock are currently unknown (Muto et al. 2018). The decline in extent and duration of sea ice cover is the primary conservation concern leading to their listing as threatened under the ESA in 2012 (77 FR 76705).

Ringed seals are year-round residents in the Beaufort Sea (Muto et al. 2018). Historically, the population densities of ringed seals have been substantially greater in the eastern Beaufort Sea than in the western Beaufort (Burns and Kelly 1982; Kelly 1988). Ringed seal population densities tend to be greatest in areas of flat ice near the edge of the shore-fast ice zone and decline away from that edge (Frost et al. 2004). They use sea ice as a platform for pupping in the winter and early spring, molting in early summer, and resting throughout the year (Kelly 1988).

Ringed seals can be found in the nearshore areas during the summer and winter (Williams et al. 2002). Optimal wintering areas for ringed seals in the Beaufort Sea are generally in waters 32–115 feet deep; however, under-snow seal structures have been found in waters depths of 5–10 feet in the central Beaufort Sea (Williams et al. 2006), indicating that seals may use portions of the program area in addition to the marine transportation corridor.

During the summer, ringed seals forage along ice edges offshore and in productive open water (Harwood et al. 2015b), including waters within 5 nautical miles of the program area (**Map 3-39**, Seal Sightings, in **Appendix A**). Critical habitat has been proposed for the Arctic ringed seal in US waters; it effectively includes all marine waters within the US Exclusive Economic Zone where sea ice regularly forms during winter (BOEM 2018b). The final determination for ringed seal critical habitat from the NMFS remains pending.

Adult females construct pupping lairs, often on shore-fast ice, and adult males appear to defend their breeding territories around those lairs from other males and subadults (Kelly et al. 2010). Single pups are born in the spring (March to May), with the peak of pupping in early April (Kelly et al. 2010). Mating takes place in April and May while mature females are still lactating (Moulton et al. 2002). Ringed seals molt between mid-May and mid-July. During this time, they remain hauled out on the edge of the pack ice or on remnant land-fast ice until their old pelt dries out and sheds (Reeves 1998). Because of the need for dry skin during the molt, ringed seals refrain from entering the water and forgo foraging, making the molt a particularly stressful time for them (Ryg et al. 1990).

When not whelping, lactating, breeding, or molting, ringed seals travel widely and may occur in waters of nearly any depth, although their distribution remains strongly correlated with the presence of sea ice and with food availability (Simpkins et al. 2003; Freitas et al. 2008).

Polar bear predation remains the largest source of ringed seal mortality (Stirling and Archibald 1977), followed by subsistence hunting (Muto et al. 2018). Ringed seals are an important resource for subsistence communities across the North Slope, including Kaktovik. The number of seals taken annually varies considerably between years due to ice and wind conditions, which affect hunter access to seals.

The ADFG maintains a subsistence harvest database and, as of August 2000, the mean estimate of ringed seals taken annually is 9,567. Data from 2007 to 2012 indicate a reported annual average harvest of 3.5 ringed seals (range of 0 to 10 individuals) taken by Kaktovik subsistence hunters, mainly during the snow-free months of June to August (Harcharek et al. 2018). Data from 2008 to 2012 show an annual average of 4.12 mortalities of Arctic ringed seals from commercial fishing operations in Alaska (Muto et al. 2018). Other sources of mortality among ringed seals are entanglements and predation from Arctic foxes, walruses, wolves, wolverines, and ravens which also occasionally kill ringed seals, and all of which result in very few losses (Allen and Angliss 2013).

Bearded Seal

Bearded seals are associated with offshore pack ice throughout the year, remaining close to the ice edge for as long as the ice is available. They use ice as a platform for breeding, pupping, molting, and resting. In summer, bearded seals may use nearshore areas of the Beaufort Sea (**Map 3-39** in **Appendix A**), and occasionally haul out on land (Muto et al. 2018). Bearded seals are diving bottom feeders of fish and invertebrates (Crawford et al. 2015). A preliminary analysis of diving behavior indicates that they make proportionately more dives in marginal ice (15 to 80 percent) or open water and during the day than in heavy ice or from midnight to 4:00 a.m. They tend to dive in shallow water (0 to 131 feet s-deep) (Quakenbush and Crawford 2019). Young bearded seals use estuary and riverine habitat for foraging and resting, including Dease Inlet and the Colville and Koyuk Rivers (Quakenbush and Crawford 2019). Bearded seals are expected to occur within 5 nautical miles of the program area and along the shipping route.

No reliable population estimate and no reliable data on trends of population abundance are available for the entire Alaska stock of bearded seals (Muto et al. 2018). The most recent abundance estimate for bearded seals in US waters (299,174 individuals; 95 percent CI: 245,476–360,544) applies only to the Bering Sea (Conn et al. 2014). Residents of Kaktovik hunt bearded seals as part of their subsistence activities, but seals are not considered a primary food source (Clough et al. 1987). Harcharek et al. (2018) reported that Kaktovik subsistence hunters harvested an annual average of 3.8 bearded seals (range of 1 to 10 individuals) during the snow-free months of July and August. These seals are important subsistence resources, however, for other communities in the NSB and along the shipping route. The primary conservation concern for this species is the ongoing and projected loss of sea ice cover (Cameron et al. 2010), which led to their listing as threatened under the ESA in 2012.

Other Marine Mammals

Pinniped species that may be encountered by vessels in transit from Dutch Harbor to the Beaufort Sea are described in the EIS for the Liberty development project (BOEM 2018b), incorporated here by reference. Steller sea lions typically occur in coastal areas of the North Pacific and Bering Sea, and are commonly encountered by vessels traveling in and out of Dutch Harbor and near the Pribilof Islands where large breeding rookeries occur. Spotted seals are widely distributed on the continental shelf of the Bering, Chukchi, and Beaufort seas, with pupping and breeding occurring primarily south of Bering Strait (Boveng et al. 2009).

They rely less on sea ice than ringed or bearded seals, using nearshore areas and coastal haul-outs in summer and fall (Quakenbush and Crawford 2019). While extralimital near the program area, Pacific walruses are common in the Bering and Chukchi seas and occasionally range into the Beaufort Sea (Fay 1982; Garlich-Miller et al. 2011). The Southwest Stock of northern sea otters may be encountered by barges near Dutch Harbor, but probably not in offshore areas.

Climate Change

Climate change is a global issue affecting marine mammals in the program area (see **Section 3.2.1**). Climate warming is expected to be most dramatic in the Arctic, with rates of warming nearly twice that experienced globally (ACIA 2005; Wendler et al. 2014). The effects of these global trends are complicated; yet the forecast models—based on current trends—that have been constructed to examine the likely effects on marine mammal habitats point to dramatic declines in the extent and thickness of arctic sea ice cover. This loss of sea ice has serious implications for the future of ice-associated species, such as polar bears, ice-associated whales, and ice seals (Durner et al. 2009; Cameron et al. 2010; Kelly et al. 2010; Species At Risk Committee 2012; Joint Secretariat 2015; Regehr et al. 2016).

Climate change in the Arctic is a rapidly growing concern, especially for the marine environment. Increased air and sea temperatures, longer periods of open water with an earlier onset of melting and later onset of freeze-up, increased rain-on-snow events, warm-water intrusion, and changing atmospheric wind patterns are contributing to overall reduction and changes in sea ice (Kovacs et al. 2011; Chapin et al. 2014; Stroeve et al. 2014; Joint Secretariat 2015). The greatest concern for marine mammals in the reasonably foreseeable future is the continued arctic warming trend and the resulting deterioration of sea ice conditions that are necessary for ice-dependent species and their prey.

Arctic sea ice is changing in the extent of geographic coverage, thickness, age, and timing of melt and is one of the most pronounced changes currently occurring, at rates higher than previously predicted. Analysis of long-term data sets show substantial decreases in both extent (area of ocean covered by ice) and thickness of sea ice cover during the past 30 years (Post et al. 2013; Wendler et al. 2014). These trends are projected to continue, possibly resulting in loss of summer sea ice by mid-century (Chapin et al. 2014; Stroeve et al. 2014) and suggesting that all ice-dependent species may experience conditions that could result in declines of food availability and foraging and breeding habitat.

In addition to changes in sea ice, ocean acidification is occurring as a consequence of increased carbon dioxide in the atmosphere. It is predicted to be amplified in the Arctic, resulting in changes in ecosystem processes and increased effects on organisms (Meltofte 2013). The primary concern with ocean acidification is its effect on prey populations, particularly on bottom-dwelling and free-swimming invertebrates that form shells. A decrease in ocean pH, concurrent with increases in water temperature, may interfere with the ability to form shells (Fabry et al. 2008; Kroeker et al. 2009; Hofman et al. 2010), compromising survival of invertebrates and reducing prey availability for marine mammals (Doney et al. 2012; 77 FR 76708).

The ongoing declines in the extent and duration of sea ice cover present the greatest source for possible population-level impacts on marine mammals over the next 20–40 years, although the impacts are not entirely clear and may vary among species. Bowhead whales appear to be in better body condition in years of light ice cover (George et al. 2015) and the Western Arctic stock is so far adapting to change in ice cover, as demonstrated by their consistent population increase (Givens et al. 2013; Muto et al. 2018); however, the long-term effect of reductions of sea ice on bowhead populations is not known (George et al. 2015).

Beluga whales may be sensitive to changes in Arctic weather, sea surface temperatures, and ice extent and the concomitant effect on prey availability. Arctic cod, a major prey item for belugas, are most prevalent at the 656- to 984-foot depth in the western Beaufort Sea; these are the depths that most belugas dive to (Hauser et al. 2015). Recent evidence for declining growth, body condition, and blubber thickness suggests that ecosystem changes may be affecting belugas through reduced availability or quality of prey, primarily ice-associated Arctic cod (Harwood et al. 2014, 2015a).

Laidre et al. (2008) and Heide-Jørgensen (2010) concluded belugas are probably less sensitive to climate change than other Arctic cetaceans, after considering their wide distribution and flexible behaviors. If salmon or whitefish become more prevalent in the Beaufort Sea, the diet composition of belugas could shift, but to what degree remains speculative; thus, the future effects of climate change on belugas and their habitat could result in fewer or more feeding opportunities, depending on how the populations of prey species respond to the new environmental conditions. This in turn would affect the physical and behavioral state of belugas, as well as their population.

Losses in sea ice could allow marine predators, such as killer whales, to penetrate into the Beaufort Sea for longer distances, increasing the risks of predation on belugas (O’Corry-Crowe et al. 2016). Most belugas, however, prefer feeding in deep water near the shelf break, and are capable of diving to 2,950 feet in the Canadian Basin (Hauser et al. 2015); Miller et al. (2010) recorded the maximum dive depth for a killer whale at 833 feet.

There are indications that ocean conditions have been favorable for ringed seals recently: ringed seals near Kaktovik are growing and maturing faster and at a younger age now than 30 years ago (Quakenbush et al. 2011). The broad distribution, diverse diet, and ability to haul out on land or ice suggest that ringed seals may be resilient to changes in sea ice availability (NMFS 2013), at least in the short term. The greatest impacts on ringed seals from climate change, however, would manifest in reductions of sea ice and less snow cover (77 FR 76708). While winter precipitation is forecast to increase in a warming Arctic (Walsh et al. 2011), the duration of ice cover could be reduced. This could lead to lower snow accumulation on ice (Hezel et al. 2012), particularly over their under-snow lairs. According to NMFS's climate model projections, snow cover is expected to be inadequate for the formation and occupation of lairs during this century over the Alaska stock's entire range (Kelly et al. 2010).

Bearded seals are more strongly associated with sea ice available over bottom habitats in shallow water that is suitable for feeding, suggesting they may be less resilient to reduced sea ice cover (NMFS 2013). Reductions of sea ice in the Bering Sea may require that bearded seals shift their nursing, rearing, and molting areas to ice-covered seas north of the Bering Strait, where projections suggest a potential for the ice edge to retreat to deep waters of the Arctic basin.

There is a moderate to high threat that reductions in spring and summer sea ice would result in spatial separation of sea ice resting areas from bottom feeding habitat (77 FR 76740, December 28, 2012). Such an event would force seals into suboptimal conditions and habitats and likely would compromise reproduction and survival. NMFS (77 FR 76740) concluded the Beringia DPS of bearded seals is under no present threat from climate change, but future changes in sea ice could present an increasing threat, leading to the extinction of the Beringia bearded seal DPS by around 2095.

Recent changes in demography, distribution, habitat use, and behavior of polar bears are attributable primarily to loss of sea ice habitat as a result of climate warming (Atwood et al. 2016a; USFWS 2016). The greatest future declines in optimal polar bear habitat are predicted to occur in the divergent ice ecoregion along the Arctic coastlines of Russia and Alaska. Here, reductions in sea ice habitat are predicted to be most likely to reduce polar bear populations (Durner et al. 2009; Regehr et al. 2016). Based on population size, summer ice loss, length of ice-free period, the amount of habitat over the continental shelf, and prey diversity, the SBS stock has been ranked as one of three having the highest vulnerability to the effects of climate change (Hamilton and Derocher 2019).

An analysis from 1979 to 2014 of sea ice conditions in the annual range of the SBS revealed trends of spring ice retreating 9 days earlier per decade and fall ice advancing 8.8 days later per decade, an increase of length in the ice-free season of 17.8 days per decade (Stern and Laidre 2016). That study also calculated a decrease of 9.3 days per decade in mean sea ice concentration from June to October and a decrease of 17.5 days per decade in the number of days of ice cover. The decreased ability of sea ice to reflect solar radiation (9 percent per decade from 1982 to 2011) has led to significantly increased absorption of solar radiation by ocean waters, especially along the Beaufort Sea coast of Alaska, from May through September. This has lengthened the open-water season and delayed autumn freeze-up (Stroeve et al. 2014).

The increasing difficulty for polar bears dealing with ecological changes, resulting from declining sea ice cover related to climate change, has led in turn to behavioral changes, as follows:

- Increased travel speed and time spent active, and thus energy expenditure, by collared female bears on sea ice as the rate of ice drift has increased due to declining ice thickness and extent (Durner et al. 2017)
- Increased frequency of long-distance swimming, and thus energy expenditure, by collared female bears, peaking during July to September (Durner et al. 2011; Pagano et al. 2012; Pilfold et al. 2017; Pongracz and Derocher 2017)
- Observations of swimming bears and dead bears in open water (Monnett and Gleason 2006; Schliebe et al. 2006)
- Increased percentage of the population coming ashore and spending more time on land, with arrival dates becoming earlier, at a rate of about 5 days per decade, and departure dates becoming later, at a rate of about 7 days per decade (Atwood et al. 2016b; Wilson et al. 2017)
- Higher activity levels while ashore (some of it associated with foraging on bowhead whale carcasses) and more time spent in marginal habitats (on land and on sea ice off the continental shelf) than in preferred habitat (sea ice over the continental shelf) (Ware et al. 2017)
- Increased use of terrestrial habitats for maternal denning (Fischbach et al. 2007; Olson et al. 2017)
- Unusual predation behavior (Derocher et al. 2000; Brook and Richardson 2002; Stirling et al. 2008)
- Polar bear predation and cannibalism (Amstrup et al. 2006a)

Polar bears of the SBS stock experienced twice as many days of reduced sea ice from 2008 to 2011 than did those of the Chukchi Sea stock. The increased frequency of female SBS polar bears denning on land now rather than on pack ice has been attributed to reductions in stable old (multi-year) ice, increases in unconsolidated ice, and lengthening of the melt season (Fischbach et al. 2007; Olson et al. 2017).

Another result of climate change is increasing delays in formation of seasonal sea ice cover in the fall, forcing more bears to spend more time on land where they have difficulty catching prey, spend longer periods fasting, and increasing the chance of human/bear interactions, which increases the risk of bears being killed in defense of life or property (Amstrup 2000; Species at Risk Committee 2012; Whiteman et al. 2015; Joint Secretariat 2015). Despite similar diets, SBS bears were smaller and in poorer condition and exhibited lower reproductive rates than bears of the Chukchi Sea stock, and twice as many were fasting in spring (Rode et al. 2014).

Population-level effects of sea ice loss have been observed in polar bears at the southern edge of their range in western Hudson Bay, and models predict decreased survival (including breeding rates and cub litter survival) of polar bears in the SBS population with reduced sea ice coverage (Regehr et al. 2010; Hunter et al. 2010). Reduced body size, cub survival, and recruitment in polar bears have been documented in years when sea ice availability was reduced (Rode et al. 2010).

Consuming terrestrial foods is judged to be insufficient to offset the loss of ice-based hunting. Given the high metabolic demands and increased movements of polar bears, cascading adverse effects on polar bear populations are predicted as sea ice declines and the availability of preferred, high-energy prey decreases accordingly (Rode et al. 2015; Pagano et al. 2018a; Whiteman 2018). Carcasses of large whales can provide fat- and protein-rich food sources for polar bears, enabling them to store large amounts of fat for long periods of fasting; however, the availability of whale carcasses is not likely to provide a sufficient food source to replace ice seals in polar bear diets as sea ice continues to decline (Laidre et al. 2018).

Although polar bear locomotion on land is relatively efficient at the slow walking speeds they prefer (mean = 2.1 mph, similar to grizzly bears), it becomes less efficient at unusual speeds above 3.3 mph; (Pagano et al. 2018b), potentially increasing energetic demands if polar bears are disturbed while spending time ashore.

Polar bears using terrestrial habitats near the program area have shown increased use of bowhead whale in their diets in recent years, reflecting increased foraging on the Kaktovik whale-bone pile (Rogers et al. 2015; McKinney et al. 2017). Congregations of polar bears on shore around Kaktovik also pose an increased risk of disease transmission (USFWS 2016).

The warming temperatures and increased precipitation year-round and longer growing seasons that are predicted to occur in the future may have negative implications for the stable conditions required for maternal denning by polar bears, especially if warm temperatures prevent snow cover of sufficient depth from accumulating early in the denning season. Recent research predicts that shorter annual periods of snow cover in the future are likely to result from increased air temperatures, later freeze-up in fall, and earlier snow melt in spring; however, snow cover in northeastern Alaska still is predicted to occur in the October to April time frame (Littell et al. 2018; Box et al. 2019), which covers the maternal denning period; however, snow depth is more difficult to predict.

Range expansion of subarctic and temperate species into the Beaufort and Chukchi Seas has been observed in recent years and is likely to continue with changing arctic conditions. Increased observations of gray whales, humpback whales, and fin whales in the northeastern Chukchi Sea and gray and humpback whales in the western Beaufort Sea is a relatively recent phenomenon (Clarke et al. 2015); thus far, potential range expansion into the Beaufort Sea has been limited, but sightings appear to be increasing slowly. Range expansion by more temperate species raise the possibility of resource competition with arctic species (ACIA 2005). Other risks to arctic marine mammals induced by climate change include increased risk of infection and disease with improved growing conditions for disease vectors and from contact with nonnative species, increased pollution through increased precipitation transporting river borne pollution northward and increased human activity through shipping and offshore development (ACIA 2005; Huntington 2009; Hauser et al. 2018).

Direct and Indirect Impacts

Issuance of oil and gas leases under the directives of Section 20001(c)(1) of PL 115-97 would have no direct impacts on the environment because by itself a lease does not authorize any on the ground oil and gas activities; however, a lease does grant the lessee certain rights to drill for and extract oil and gas subject to further environmental review and reasonable regulation, including applicable laws, terms, conditions, and stipulations of the lease. The impacts of such future exploration and development activities that may occur because of the issuance of leases are considered potential indirect impacts of leasing. Such activities could include seismic and drilling exploration, development, and transportation of oil and gas in and from the Coastal Plain; therefore, the analysis considers potential impacts on marine mammals from on-the-ground post-lease activities and associated marine activities.

The Final EIS on Effects of Oil and Gas Activities in the Arctic (NMFS 2016a) provides detailed descriptions of potential impacts of petroleum-related industrial activities on marine mammal populations, including seismic exploration and drilling activities. That analysis is incorporated here by reference. The effects of climate change, described under *Affected Environment* above, could influence the rate or degree of the potential direct and indirect impacts.

Alternative A

Under this alternative, current management actions would be maintained, and resource trends would continue, as described in the Arctic Refuge CCP (USFWS 2015a). There would be no direct or indirect impacts on marine mammals under Alternative A from post-lease oil and gas leasing activities.

Impacts Common to All Action Alternatives

The following potential actions and environmental consequences would be common to all action alternatives, although the extent of activities allowed and the areas affected would differ somewhat under each alternative, as described later in this section. All of the action alternatives would affect large areas of the designated terrestrial denning unit of critical habitat for polar bears. This is because any activities conducted or facilities constructed within 20 miles of the coast would be located in that critical habitat unit. All action alternatives would also affect the marine environment along the shipping corridor, from Dutch Harbor to the program area, and would pose risks associated with vessel traffic: hazardous substance spills, noise, and ship strikes.

Habitat Loss and Alteration

POLAR BEAR

For polar bears, direct loss or alteration of maternal denning habitat would potentially result from such activities as seismic exploration, gravel mining, gravel and ice road and pad construction, changes in natural drainage patterns (impoundment), and off-pad snow disposal. The direct loss of polar bear habitat and indirect loss through altered use of habitat as a result of oil and gas activities would primarily involve the terrestrial denning unit of critical habitat (**Map 3-37** in **Appendix A**). This constitutes 76.3 percent (1,193,600 acres) of the program area (1,563,500 acres). At 4.9 percent (76,500 acres) and 0.1 percent (1,200 acres), respectively, the areas of the sea ice and barrier island critical habitat units potentially affected by program-related activities would be much smaller.

Even though the overall proportion of barrier island critical habitat in the program area is not large, that habitat receives a disproportionately high level of use by polar bears (Wilson et al. 2017); thus, program-related activities affecting that critical habitat unit could have a larger impact on polar bears than is indicated on the basis of proportional representation. Totaling all three units, 81.3 percent (1,271,300 acres) of the program area is designated critical habitat for polar bears.

It is important to note that not all portions of the terrestrial denning unit of critical habitat represent potential maternal denning habitat, however, because of local topography and the distribution of suitable bank-habitat characteristics across the landscape. Durner et al. (2006) calculated that the bank habitats they mapped constituted 0.29 percent of the coastal plain in the entire Arctic Refuge. Specifically, potential maternal den habitat (Durner et al. 2001, 2006; **Map 3-37** in **Appendix A**) totals an estimated length of 1,769.3 miles and an area of 4,530 acres in the program area(assuming an average segment width of 21 feet; Durner et al. 2001) . This constitutes high-priority habitat that would need to be surveyed for dens each winter before exploration or development begins (**Table 3-24**).

To date, the occurrence of maternal dens documented by Durner et al. (2010) has been disproportionately high in the high HCP zone, where 54 percent of known dens occurred in 30 percent of the maternal den habitat mapped (**Table 3-24**). In contrast, the occurrence of dens in the low HCP zone has been disproportionately low, with only 4 percent of known dens occurring in 25 percent of the mapped habitat. The occurrence of dens in the medium HCP zone has been proportional to the amount of mapped habitat.

Table 3-24
Number of Documented Dens and Extent of Potential Terrestrial Denning Habitat for Maternal Polar Bears within the Three Zones of Estimated HCP in the Program Area

Hydrocarbon Zone	Number of Dens	Habitat Metrics	
		Total Length of Bank-Habitat Segments (miles)	Estimated Area of Bank-Habitat Segments (acres)
High	25 (54%)	527.4 (30%)	1,350 (30%)
Medium	19 (41%)	799.4 (45%)	2,047 (45%)
Low	2 (4%)	442.5 (25%)	1,133 (25%)
Total	**46**	**1,769.3**	**4,530**

Notes:
Maternal dens documented by Durner et al. (2010); two more recent den locations were provided by Durner (pers. comm.).
Bank-habitat segments were mapped by USGS (Durner et al. 2006); see **Map 3-37** in **Appendix A.**
Acreage estimates assume an average width of 21 feet per mapped segment of bank habitat (Durner et al. 2001).

During the exploration phase of post-leasing activities, temporary loss or alteration of polar bear denning habitat would result primarily from the tight 330- to 1,320-foot grid spacing used in 3D seismic exploration of the program area. It also would result from the construction of ice roads and pads for exploration drilling, which persist for one winter season. The direct effects of seismic vehicle passage and of building ice roads and pads in potential denning habitat would be temporary until the vehicle trails and ice structures thawed during spring melt; however, annual reconstruction of ice structures in the same locations would result in perennial loss of use of the specific bank-habitat segments affected.

Because seismic exploration and the placement of ice structures would not affect the topographic characteristics that create the favorable denning conditions, no long-term direct effects on habitat suitability would be expected to occur. The effects of seismic exploration, construction of ice and gravel roads and pads, and construction of pipelines also would create the potential for short-term temporary loss of use of suitable denning habitat through behavioral disturbance, as described further in the next section below.

During the development and production phases of post-leasing activities, long-term (essentially permanent), direct loss of polar bear habitat would occur as a result of gravel mining and placement for roads and pads within the 2,000-acre footprint limit, as well as from construction of the barge landing and seawater treatment plant at the coastline. The magnitude of impact would be smaller than the widespread but short-term impacts of activities, such as 3D seismic exploration. This is because the habitat area affected directly would be substantially smaller than during exploration.

After production ceases and gravel infrastructure is abandoned, the presence of remnant gravel berms may provide some short-term bank habitat conducive to snow-drift formation, potentially providing small amounts of suitable denning habitat. Eventual removal and reclamation of human-made gravel berms would eliminate those artificial habitats.

Future water withdrawal from lakes for the construction of ice roads and pads would not be likely to cause adverse effects on denning habitat or its use by bears, provided that no occupied maternal dens occur within 1 mile of the withdrawal sites or ice roads used for access. Similarly, the presence of snow dumps and drifts in the vicinity of oil and gas facilities are likely to have negligible short-term effects on polar bear habitat, inasmuch as they are unlikely to be located on or near bank or bluff habitats.

Disturbance by activities at the barge landing and seawater treatment plant and on ice and gravel roads and pads would likely alter the use of habitats by bears nearby; however, those effects would diminish for facilities located farther inland because they would be less likely to be used by bears than other areas on and near the coastline. Overall, the effects of reduced use of habitats near oil and gas facilities likely would be minor and localized, although they would be long term.

In summary, the potential effects of habitat loss and altered use of denning habitat by polar bears are expected to be minor to moderate, depending on the program phase. Assuming that mitigation measures[37] are implemented during post-leasing activities, those impacts would be reduced to negligible levels. After the placement of gravel pads and roads during the development phase, the attractiveness of potential maternal denning habitat in the vicinity of infrastructure would be diminished for some bears over the long term. This is because of the presence of the facilities and associated human activities.

Seals

Following leasing, direct and indirect loss of habitat may occur for ringed and bearded seals during all phases of the RFD scenario (**Appendix B**). For ringed and bearded seals, potential alteration of local seafloor foraging habitat could result from modifying the seafloor profile caused by activities at a barge landing site. Barge landings are anticipated to occur annually, so this loss would occur throughout the 85-year analysis time frame, starting with the first permitted exploration and development project.

The size of the affected area would be similar among the action alternatives, regardless of which possible landing site is used (one on Camden Bay near the mouth of Marsh Creek and the other farther east, between Griffin and Humphrey points; Clough et al. 1987). The exact amount of habitat to be altered would depend on the local bathymetry and the placement of the barge landing site. Direct effects would be localized to screeded areas, and potential indirect effects would be anticipated to be in the sediment plume.

Ringed seals could overwinter and produce pups in the nearshore program area. Under all action alternatives, the integrity of ringed seal lairs would be threatened by collapse caused by tracked vehicles on sea ice during seismic activity or by the construction of winter roads on the ice. In addition to physically altering potential habitats, tracked vehicles and ice roads in the nearshore environment could disturb and displace individual seals (see *Disturbance and Displacement* section) and could injure or kill pups and females (see *Injury and Mortality*, below).

The occurrence and schedule of seismic activities or ice roads in the nearshore environment is unknown, but seismic exploration would occur in the early phases of any proposed project, while ice roads could occur during any phase of development. Starting with the first permitted development project, seismic and transportation impacts could occur semiannually to annually, depending on the overall pace of development. While potential effects of habitat loss on on-ice traffic could be long term and could extend across the nearshore environment of the program area, it is not likely that a large proportion of available habitat would be affected or that large numbers of seals would be displaced.

Whales

No whale habitat is expected to be lost or altered under any of the action alternatives. Open-water habitats used for migration and feeding may, however, experience a change in the soundscape (see **Section 3.2.3**, Acoustic Environment) that equates to direct habitat loss (see BOEM 2018b). Vessel presence and noise have the potential to disturb and displace whales from transit routes. Belugas and baleen whales, including bowhead whales, can show strong avoidance of moving vessels. Vessel transits between Dutch Harbor and the program area could encounter several species of cetaceans, including those found in the Beaufort Sea and from the

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[37]Similar to those stipulated under the MMPA Beaufort Sea ITRs currently in place west of the program area; see **Appendix J.4.1**.

Bering and Chukchi Seas. Barge shipping is anticipated to occur annually, beginning with the first permitted project, although the number of vessels is anticipated to be low. The NMFS previously determined that the potential for adverse effects of vessel noise were unlikely for cetaceans in this transit route (NMFS 2016; see BOEM 2018b).

Disturbance and Displacement

All three action alternatives would result in a similar level of potential disturbance and displacement of marine mammals in the marine environment. Because vessel transit routes and the number of barge landing locations of hypothetical development scenarios do not differ among the action alternatives, neither would the potential effects of the activities associated with marine transport and STP development and operation (facility noise and transportation) on marine mammals. Polar bears and seals would experience direct behavioral effects and indirect habitat loss from disturbance caused by human activities and noise associated with ice road and barge transportation (vehicle passage and noise), activities at marine barge docks, human activities at camps and the seawater treatment plant, and oil spill response planning and drills. During the seasons of open-water barge transport, large vessel traffic transiting from Dutch Harbor to the program area would have the potential to disturb or displace whales, seals, and possibly polar bears by the temporary disturbance of water and by creating strong low-frequency underwater sounds (Richardson et al. 1995). Terrestrial activities and facilities are not expected to have an effect on the behavior of whales because they do not generally approach within 1 nautical mile of the coast.

POLAR BEAR

Noise and visual disturbance from human activity and operation of equipment, especially aircraft and vehicle traffic, have the potential to disturb polar bears nearby (Blix and Lentfer 1992; MacGillivray et al. 2003; Perham 2005; Schliebe et al. 2006; USFWS 2006, 2008b, 2009; Andersen and Aars 2008). The greatest concern is disturbance of maternal females during the winter denning period, which could result in premature den abandonment and loss of cubs (Amstrup 1993; Linnell et al. 2000; Lunn et al. 2004; Durner et al. 2006). Polar bear dens are known to occur onshore in relatively high numbers in the program area (**Map 3-37** in **Appendix A**) and the incidence of terrestrial denning by the SBS population is increasing (Fischbach et al. 2007; Olson et al. 2017), so the potential for disturbance of maternal dens during the exploration, development, and production phases of post-leasing oil and gas activities is of concern.

Various studies have evaluated the effects of human disturbance on polar bears. Amstrup (1993) reported that 10 of 12 denning polar bears tolerated exposure to a variety of disturbance stimuli near dens with no apparent change in productivity (survival of cubs). Two females denned successfully (produced young) on the south shore of a barrier island within 1.7 miles of an active oil processing facility and others denned successfully after a variety of human disturbances near their dens. Similarly, during winter 2000–2001, two females denned successfully within 1,320 feet and 2,640 feet of remediation being conducted on Flaxman Island (MacGillivray et al. 2003), located just northwest of the Arctic Refuge boundary.

In contrast, Amstrup (1993) found that several females responded to disturbance early in the denning period by moving to other sites, suggesting that females may be more likely to abandon dens in response to disturbance early in the denning period, rather than later. Hence, the initiation of intensive human activities during the period when females seek den sites (October to November) would give them the opportunity to choose sites in less-disturbed locations (Amstrup 1993), at least in areas where oil field activity occurs consistently throughout the year.

In undeveloped areas subject to seismic exploration or winter construction of exploration ice roads and pads during the post-leasing period, dens are likely to have been established and occupied by the time enough snow has accumulated to allow those activities to proceed, raising the risk of den disturbance and abandonment. In January or early February 1985, a collared female polar bear prematurely abandoned her den near the mouth of the Canning River in the Arctic Refuge, possibly in response to the passage of seismic exploration vehicles within 660 to 2,640 feet of the den (Garner and Reynolds 1986: p. 518). Premature abandonment has adverse effects on population productivity; survival is poor for cubs that leave dens early in response to the movement of sea ice (Amstrup and Gardner 1994) and females that remain in dens through the end of the denning period have much higher cub survival than do females that emerge from dens early (Rode et al. 2018).

Experimental studies of noise and vibration in artificial (human-made) “dens” have been used to estimate the distances at which disturbance may occur. Blix and Lentfer (1992) reported that snow cover greatly diminished sounds and concluded that activities associated with oil and gas exploration and development, such as seismic surveys and helicopter overflights, would not be likely to disturb denning bears at distances greater than 330 feet from dens.

In a more rigorous study, however, MacGillivray et al. (2003) compared noise levels inside and outside of artificial dens at sites on Flaxman Island during a variety of industrial remediation activities, including passage by different vehicles and overflights by helicopters at various distances. Snow cover provided an effective buffer, reducing low-frequency noise by as much as 25 dB and high-frequency noise by as much as 40 dB for activities conducted near the artificial dens.

The noise levels produced by various stimuli were detectable above background levels at ranges from 0.3 mile to 1.24 miles, however, depending on the stimulus. Low-frequency vibrations and noises were detected at the greatest distances. The most audible disturbance stimuli measured from inside the dens was an underground blast, detectable in artificial dens up to 0.8 mile from the source, and airborne helicopters directly overhead. Helicopters were detectable above background levels as far away as 0.6 mile, but the authors concluded that noises just above background are not likely to cause biologically significant responses (MacGillivray et al. 2003). The authors noted that high variability in the tolerance of different bears to noise and disturbance, including hazing with acoustic deterrents, was an important factor in evaluating human disturbance.

Some female polar bears have denned successfully in the existing oil fields where industry activities occurred as near as 165 to 330 feet from occupied dens, whereas other females abandoned dens where activities occurred at distances of 330 to 1,640 feet. In the final rule for the current Alaska Beaufort Sea ITRs (81 FR 52292), the USFWS stated that “Known instances of polar bears establishing dens prior to the onset of industry activity within 500 m (1,640 feet) or less of the den site, but remaining in the den through the normal denning cycle and later leaving with cubs, apparently undisturbed despite the proximity of sometimes ongoing industry activity, occurred in 2006, 2009, 2010, and 2011.”

The current Alaska Beaufort Sea ITR/LOA process requires that surveys of potential denning habitat be conducted within a 1-mile buffer zone surrounding the proposed locations of roads and pads, a mitigative measure that is expected to be stipulated under the new ITRs that would be required for the program area. The use of airborne FLIR sensors has proven to be an effective means of locating dens over large areas on such surveys, as has the use of handheld or drone-mounted FLIR sensors and specially trained dogs for confirming the presence of suspected dens[38] (Amstrup et al. 2004b; York et al. 2004; Perham 2005; Shideler 2014; Pedersen 2019).

These survey methods do not provide perfect detection, and variable percentages of occupied maternal dens have been missed in pre-activity surveys in other areas of the North Slope, west of the program area. Using airborne FLIR, the best available data indicate a range of detectability from 50 percent to 83 percent, depending on the experience of the crew,[39] the number of surveys flown, the weather conditions prevailing at the time of the surveys, and seasonal timing and snow depth (Amstrup et al. 2004b; York et al. 2004; Shideler 2014). Data suggested that FLIR surveys conducted during optimal conditions for detection can produce detection rates approaching 90 percent (Amstrup et al. 2004b). The best results are obtained by employing experienced crews to conduct multiple surveys during cold, clear, calm weather early in the denning season, when snow cover is shallower than later in the season (Amstrup et al. 2004b; Owyhee Air Research 2018; Pedersen 2019).

In practice, such conditions can be difficult to achieve and some occupied dens are likely to be missed even under suitable conditions. Those conducting airborne FLIR surveys for the USFWS during late February 2018 over part of the 1002 Area (essentially the program area), plus other portions of the Arctic Coastal Plain in the Arctic Refuge east of the program area, encountered difficulty. This was due to poor weather conditions, and surveys could be conducted on only half of the field days; nevertheless, they detected nine FLIR "hotspots" (Owhyee Air Research 2018). Six of the hotspots were in the 1002 area and two of those may have been fox dens, but no ground verification survey was conducted.

The FLIR operators concluded that conducting surveys earlier in the winter (December/early January) would be better because snow cover would be thinner at that time. By applying the detectability rates described above to the average of 20 maternal dens estimated to occur annually in the program area (see **Appendix J.4.2**), 4 to 10 occupied dens may go undetected during seismic exploration of the entire program area. Given the potential for airborne FLIR detection rates to approach 90 percent (Amstrup et al. 2004b), 2 to 10 dens may go undetected. Assuming that this occurs over a 2-year period, then the number would be one to five dens each year. Because dens are not distributed evenly across the landscape, however, the actual numbers affected would vary among the three zones of hydrocarbon potential: the combined high and medium HCP zones having the most denning habitat (75 percent) and numbers of documented dens (95 percent) (**Table 3-24**). Depending on the specific dimensions of the exploration grid, seismic vehicles would be likely to pass within 165 to 660 feet of all dens in the program area, distances at which some maternal females have been known to abandon dens prematurely.

Multiple den surveys in suitable weather conditions using airborne FLIR sensors, combined with verification of potential den hotspots on the ground using drone-mounted or handheld FLIR or trained dogs, would be conducted annually before seismic exploration and construction of roads and pads begins in the program area. This would be required in the program area after leasing and before activities begin. If dens are detected within a 1-mile buffer zone around the proposed locations of seismic exploration gridlines or ice roads and pads, then activities would be moved outside of that radius to avoid dens to reduce the effects on occupied dens to a negligible level of take. If dens are located after ice roads and pads are built, then traffic restrictions and emergency closures would be instituted. Such discoveries typically trigger emergency road restrictions and 24-hour monitoring until the bears depart the dens, as prescribed in typical polar bear interaction plans. If dens

[38]It is not feasible logistically to use handheld or drone-mounted FLIR or dogs over large areas.
[39]A rate of 22 percent was obtained by one crew due to complications with the helicopter, FLIR unit, and weather effects on the image.

go undetected, however, then they are likely to be disturbed by seismic exploration. Such disturbance would be short term (during the denning period) but widespread, with potentially grave consequences for the bears affected (see *Injury and Mortality*, below).

Blasting at gravel mines and pile-driving of bridge abutments during future winter construction during the development phase would be sources of noise in polar bear denning habitat. Pile-driving would occur at bridge crossings over rivers and would produce strong in-air noise levels (Greene and Moore 1995; Blackwell et al. 2004). Along with gravel blasting, this would be one of the noisiest activities during construction. The level of received sound at any specific distance from pile-driving depends on the density or resistance of the substrate, bottom topography and composition, such as mud, sand, rock, the physical properties and dimensions of the pile being driven, and the type of pile-driver that is used (Richardson et al. 1995; Blackwell et al. 2004).

Winter blasting and pile-driving are likely to disturb some polar bears. Possible impacts on polar bears exposed to noise potentially include disruption of normal activities, displacement from foraging and denning habitats, and displacement of maternal females and young cubs from dens. USFWS-approved mitigation measures for avoidance and minimization of disturbance of dens, as required under the ITR/LOA process, would reduce the potential impacts of blasting and pile-driving on polar bears, however.

Displacement of non-denning bears from preferred coastal habitats would be another potential impact of disturbance by program-related activities in all program phases. In an experimental study on Svalbard, female bears with young cubs reacted to direct approaches by snowmachines nearly 1 mile away, on average (mean distance = 5,033 feet; 95 percent CI = 1,667–9,081 feet; Andersen and Aars 2008). Medium-sized single bears (subadults) also reacted at fairly long distances (mean distance = 3,806 feet; 95 percent CI = 1,230–4,439 feet) and adult males and females without cubs were the least reactive (mean distances = 1,070 and 538 feet, and 95 percent CI = 453–1,627 and 161–1,781 feet, respectively). Besides reacting at longer distances, maternal females and subadults showed stronger responses than did adults without cubs.

Polar bears passing near infrastructure in the program area would be exposed to a wide variety of potentially disturbing stimuli resulting from seismic exploration, drilling exploration and development, pipeline, road, and pad construction. Other stimuli are human activity on pads, vehicles on pads and interconnecting access roads, barge traffic in the lagoon system and associated offloading operations at marine docks, the seawater treatment plant, and spill-response drills (including equipment staging).

A variety of behavioral responses by polar bears is likely to occur, ranging from avoidance by maternal females with young cubs in spring to approach by curious bears attracted by sights, sounds, and odors. Standard industry practice is to allow polar bears moving through areas of infrastructure to cross roads and pads without disturbance, reserving deterrence by hazing for situations in which bears endanger workers or attempt to linger on active pads or roads. The USFWS (2006, 2008b, 2009; 81 FR 52276) has concluded that the types of activities typical of oil and gas exploration, development, and production projects in northern Alaska were not likely to have population-level effects on polar bear populations at the levels analyzed in developed areas west of the Arctic Refuge. This conclusion was based on the fact that the behavioral responses of individual bears were short-term and localized.

Disturbance and localized displacement could occur during seasonal movements by polar bears in the program area. The net direction of movement by maternal females leaving terrestrial denning areas with young cubs is northward, potentially requiring them to cross gravel roads and pipelines during the development and production phases; however, the likelihood of such encounters would be greater near the coast where most maternal dens tend to be concentrated.

The greatest likelihood for bears to encounter program-related infrastructure and activities is along the coast during the open-water season (mainly July–October), as bears move eastward along the coast and congregate near the Kaktovik whale-bone pile in advance of the formation of seasonal ice. Bears traveling along the coastline would be most likely to encounter facilities directly at the coast, such as the barge landing and seawater treatment plant. Early detection of bears by trained bear monitors and detection systems would allow industrial activities to be modified to minimize disturbance of bears moving through the vicinity. The completion of barging in summer would reduce the potential for those activities to disturb bears moving along the shoreline, although some encounters are likely to occur in July and early August. Barge traffic operating in open water may cause some short-term disturbance of bears swimming in the ocean, but the likelihood of such encounters is low.

Polar bears moving along the coast through established oil fields (Kuparuk, Greater Prudhoe Bay, and Point Thomson) routinely encounter human-made obstructions and are able to cross or move past them without difficulty, resulting in short-term disturbance at most (USFWS 2008b, 2009; 81 FR 52276). Short-term behavioral responses are not likely to have population-level effects and thus are considered less problematic than are den disturbance and abandonment (USFWS 2008b, 2009; 81 FR 52276).

Another source of potential disturbance of polar bears during all phases of exploration and potential development would be noise and light generated by industrial camps, such as seismic camps, and large facilities, such as CPFs and seawater treatment plants. Noise from production facilities would be relatively constant, with wind direction affecting the perception of sounds by polar bears. Depending on the individual bear, however, such stimuli could also be attractants.

Although short term, disturbance of denning female polar bears in the program area by 3D seismic exploration has the potential to cause moderate to major impacts by disturbing bears in dens that are not detected during pre-activity surveys. An ITR/LOA process governing post-leasing activities in the program area would be required to reduce those impacts to negligible levels. Judging from experience farther west on the North Slope, the potential effects of short-term behavioral disturbance on polar bears during the development and production phases of the program are likely to be negligible under a future ITR/LOA process.

It may become difficult to maintain that magnitude in the future, if full-scale industrial development proceeds in the program area, polar bears continue to increase their use of terrestrial habitats, and the SBS population continues to decline. The number of polar bears potentially affected by disturbance is likely to increase during the development and production phases as summer sea ice cover continues to diminish. Continuing declines in sea ice are expected to result in more polar bears onshore during the open-water period, traveling the coastline more in summer and fall, and denning onshore. Such increases are expected as a result of the current trends for increasing use of coastal habitats and terrestrial denning habitats (Fischbach et al. 2007; Schliebe et al. 2008; USFWS 2006, 2008b, 2009; Olson et al. 2017; Wilson et al. 2017).

Polar bears spending more time on land and fasting more as sea ice cover diminishes are likely to experience an increase in fasting and adverse effects on energy budgets as a result of reduced access to fat-rich prey (Molnár et al. 2010; Wilson et al. 2017; Pagano et al. 2018a; Whiteman 2018). It is likely that maternal denning will continue to increase in terrestrial habitats in the future, although the presence of operating facilities would probably discourage female bears from denning in suitable habitat nearby; instead, they would be more likely to seek suitable den sites in less-disturbed habitat away from facilities.

WHALES AND SEALS

Potential noise and disturbance from program-related facilities and activities are likely to affect ringed, spotted, and bearded seals annually while they are in the program area. This could be generated by vessel traffic and coastal facilities, such as the STP during the open-water season. Noise also could be generated by activities in the nearshore coastal or lagoon areas, such as seismic programs, during the ice-covered season; this could affect individual seals by exposing them to noise and lair disturbance. In-air noise would be relatively constant, with wind direction affecting the perception of sounds at haul-out locations and in lairs within a radius of 2.5–3.7 miles from facilities (Kelly et al. 1988). Additional noise could be generated vessel traffic during barging operations in summer, ice roads in the nearshore environment and mobilization of modular units in winter, and oil spill drills year-round.

Ringed seals are known to depart subnivean (under snow) breathing holes and lairs in response to human noise, including seismic surveys (Kelly et al. 1986). Incidents observed among radio-tagged ringed seals indicated that they departed lairs in response to snow machines at distances of 0.3 to 1.7 miles, to one occurrence of disturbance by seismic vibroseis at 0.4 miles, and to human footfalls within 660 feet.

Behavioral reactions of individual seals varied substantially; some haul-outs remained in active use despite proximity to seismic survey lines, snow machine routes, and air traffic, while others were abandoned quickly in response to noise at greater distances. For example, seals did not leave haul-out sites in response to helicopter flights at 1,500 feet or higher, but helicopters at 1,000 feet caused just over 50 percent of seals to depart lairs. In an investigation of under snow structures, the rate of abandonment was found to more than double, with industrial noise associated with seismic surveys and island building (Kelly et al. 1988).

Although ringed seals exhibited strong but variable reactions to human noise, the displacement of seals from haul-outs within 660 feet of seismic lines was determined unlikely to increase mortality, given that individuals maintain as many as 4 or 5 lairs each, with little evidence that disturbance resulted in permanent abandonment.

On-ice seismic activity has been found to displace seals from breathing holes and lairs, but the effects were limited to local areas and judged to be of little significance to the population at large (Kelly 1988); however, it is possible that some seals could be displaced from all of their lairs in an area and permanent abandonment of birthing lairs would be harmful to nursing pups. It is clear that seals are aware of sound intrusions and that they react at variable distances by temporarily departing lairs; however, individual variations in reactions make it difficult to define critical distances for noise disturbance (Kelly 1988).

Although marine mammals show overt reactions to noise from industrial activities, individuals or groups may become habituated if the noise does not result in physical injury, discomfort, or social stress (NRC 2003). Based on habituation reported for ringed seals at the Northstar Island facility (Blackwell et al. 2004), it is likely that at least some ringed seals may habituate to the noise and continue to use haul-outs and lairs for pupping near an STP location, but that cannot be predicted with confidence.

For all action alternatives, ROP 10 would minimize disturbance of seals in lairs by establishing a through-ice sound transmission buffer distance from any open water or ungrounded ice in less than 10 feet of water depth before any seismic surveys. ROP 10 also would limit airborne sound levels of equipment to 120 dB and would ensure that noise lessens to below 100 dB in the vicinity of basking seals.

The occurrence and schedule of ice-supported seismic exploration and on-ice vehicle traffic are unknown; however, seals could be disturbed by such activities annually or semiannually, starting with the first permitted exploration and development project and then throughout the 85-year time frame for this analysis. Routes also are unknown, but the extent of such disturbance could be large, including most of the nearshore environment. The primary impact on ringed seals would be temporary displacement and behavioral reactions.

During the summer open-water season, the presence and movement of ships may cause some ringed and bearded seals to abandon preferred feeding and resting habitat in areas of high traffic. Interactions with whales and seals would be reduced somewhat by the seasonal timing of barge transport in mid to late summer. This is a time when ringed and bearded seals also tend to occur farther offshore and when most bowhead and beluga whales are foraging farther east or northeast of the analysis area.

Future vessel traffic is not expected to significantly disrupt normal pinniped behavioral patterns (breeding, feeding, sheltering, resting, and migrating). This is because most pinniped/vessel interactions documented during arctic oil and gas exploration show little to no observable behavioral reactions (NMFS 2018). Pinnipeds typically show limited responses to vessel noise, such as increased alertness, diving, moving from the vessel's path by up to several hundred feet, or by ignoring the vessel. If hauled out, seals typically enter the water when vessels approach.

Seals are quick and agile in the water, making them unlikely to be injured by large, slow-moving vessels. Previous analyses have concluded that there is no indication that vessel strikes are an important source of mortality for seals (NMFS 2013, 2016). Exposure to vessels during the open-water period may affect individual seals and whales, but evidence of habituation to activity and evasion of vessels indicates that activities associated with marine transport to the program area are not likely to affect the reproductive success or survival of seals and whales.

ROP 46 would minimize disturbance of seals by vessel traffic by establishing rules of operation, including dedicated PSOs and setting rules of operation in the vicinity of seal, walrus, and sea lion haul-outs. The vessel noise and presence would be temporary and limited to affecting a few individuals by eliciting small, behavioral responses. Impacts at the population level for all pinnipeds are not expected. Any specific development plans that have the possibility of lethal take of ringed seals would require an incidental take permit under the MMPA.

Whales often show tolerance to vessel activity, but they may react at long distances if they are confined by ice or shallow water or were previously harassed by vessel operators (Richardson et al. 1995). Whale reactions to vessels may include behavioral responses, such as altered headings or avoidance (Blane and Jaakson 1994; Erbe and Farmer 2000), fast swimming, changes in vocalizations (Lesage et al. 1999; Scheifele et al. 2005), and changes in dive, surfacing, and respiration patterns. Beluga whale reactions to vessels depend on whale activities and experience, habitat, boat type, and boat behavior (Richardson et al. 1995).

Baleen whales, considered a low-frequency hearing group, have a hearing range of 7–35 (kilohertz (kHz) (NMFS 2016b). Toothed whales are a mid-frequency group with a hearing range of 150–160 kHz. The primary underwater noise associated with vessel operations is the continuous cavitation noise produced by the propellers on the oceanic tugboats, especially when pushing or towing a loaded barge (NMFS 2018). Oceanic tugboats have a source level of approximately 170 dB at 3.3 feet that is anticipated to decline to 120 dB re 1µPa rms within 1.15 mile of the source (Richardson et al. 1995). Generally, vessels do not produce sound source levels capable of injuring whales (Richardson et al. 1995; NMFS 2016a).

Future vessel traffic associated with the program area activities would result in whales temporarily avoiding vessels and changing vocalizations, diving, swimming, and respiration patterns. None of these potential effects would be chronic or sufficient to produce meaningful energetic losses to individual whales or to their populations. ROP 46 would minimize whale disturbance by vessel traffic by establishing rules of operation, including dedicated PSOs and setting rules of operation in the vicinity of whales. With this mitigation, whales would be expected to have temporary behavioral responses.

Injury and Mortality

Small numbers of accidental injury or mortality of marine mammals may occur under all of the action alternatives. Maternal polar bears would be susceptible to injury or mortality from 3D seismic exploration activities if the dens are not detected in pre-activity surveys, and polar bears crossing roads could be susceptible to vehicle strikes. Other marine mammals could be susceptible to vessel/equipment strikes during barging and in-water work. Additional injury or mortality of marine mammals may occur due to accidental spills or contamination. For polar bears, program-related actions are most likely to result in injury or mortality due to human/bear interactions. Where oil and gas activities may affect these other marine mammals, operators are required to comply with MMPA and may seek an incidental harassment authorization or LOA.

The BLM qualitatively evaluated the potential injury or mortality of marine mammals due to vessel collisions during the open-water season. The assessment was based on documented species behavior, sensitivity to the activity, mobility, and distribution relative to the frequency and seasonality of vehicle and vessel traffic.

Polar Bear

When the polar bear was listed as a threatened species in 2008 (73 FR 28212), the USFWS noted that the factors contributing to the primary threat identified in the listing analysis—rapidly diminishing sea ice habitat—cannot realistically be regulated under their management purview; therefore, in lieu of influencing the causes underlying climate change, such as GHG emissions, the USFWS has focused on factors more amenable to regulation, such as habitat protection and the prevention and reduction of lethal take (USFWS 2016). The result of this approach is that even greater emphasis has been devoted to mitigation through interaction planning to avoid and minimize injury and mortality of polar bears (USFWS 2016).

Under all action alternatives, future oil and gas activities would increase the level of human/bear interactions, creating the possibility for increased injuries or deaths of both bears and, to a much lesser extent, humans. As sea ice cover continues to diminish, the number of encounters between nutritionally stressed bears and humans is expected to increase (DeBruyn et al. 2010). This would raise the likelihood of potentially dangerous encounters, as nutritionally stressed bears are more likely to attack humans (Wilder et al. 2017).

Sightings of polar bears at industrial sites in the Beaufort Sea region of Alaska have increased in recent years, consistent with increasing use of coastal habitats as summer sea ice cover has diminished (Schliebe et al. 2008; USFWS 2008b; 76 FR 47010; 81 FR 52276); however, the incidence of human/bear encounters and harassment by deterrence (hazing) remains relatively low. From 2010 through 2016, the industry reported under ITR LOAs that 395 of 2,373 polar bears (16.6 percent) observed near industrial sites in the North Slope oil fields were disturbed either unintentionally (incidental take) or by intentional deterrence (Miller et al. 2018). The percentage of reported take by intentional deterrence decreased over time, from a high of 39 percent of the bears observed in 2005 to 14 percent from 2010 to 2014 (81 FR 52276). The USFWS attributes the decrease in deterrence events to increased polar bear safety and awareness training of industry personnel, as well as ongoing deterrence education, training, and monitoring programs (76 FR 47010; 81 FR 52276).

Despite increased interactions in the existing oil fields in recent years, lethal take associated with oil and gas activities is rare. Three polar bears have been killed at oil and gas industrial sites in Alaska since the late 1960s: one in winter 1969, another in 1990 at the Stinson exploration site in western Camden Bay, north of the program area (Perham 2005; USFWS 2006), and one bear (killed accidentally during a hazing event in

2011) since the Chukchi Sea and Beaufort Sea ITRs went into effect in 1991 and 1993, respectively (USFWS 2008b, 2009; 81 FR 52276).

Several other mortalities have been associated with military and industrial activity in northern Alaska. A polar bear was killed at the Oliktok Point Long-Range Radar Site in 1993 (USFWS 2010) after attacking a worker who provoked it. In 1988, a polar bear died on Leavitt Island, 5 miles northwest of Oliktok Point, after ingesting a mixture that included ethylene glycol and Rhodamine B dye (Amstrup et al. 1989). In 2012, two polar bears that had been exposed to Rhodamine B (and possibly other chemicals) were found dead on Narwhal Island, northwest of the Endicott offshore islands; although the deaths were human-caused, the source of the chemicals could not be identified (FR 81 52276). In contrast, 33 polar bears were killed at industrial sites in the Northwest Territories from 1976 to 1986 (Stenhouse et al. 1988). Dyck (2006) reported that 618 polar bears (averaging 20 per year) were killed from 1970 to 2000 in the Northwest Territories and Nunavut in northern Canada, 25 (4 percent) of which occurred at industrial sites.

In addition to direct interaction with humans after being attracted to areas of human activity, a second potential source of injury and mortality is premature den abandonment. This is a possible outcome of den disturbance and has been documented to have adverse effects on cub survival (Amstrup and Gardner 1994; USFWS 2008b, 2009; 76 FR 47010; 81 FR 52276). Among program phases, this potential impact is of greatest concern with regard to 3D seismic exploration, which would occur across the entire program area, whether or not areas are open for leasing or surface occupancy; therefore, although the activity would be short term, the impact would be widespread and the magnitude would be the same for all action alternatives. It poses the greatest potential risk of program-related demographic impacts on the SBS stock of polar bears.

The pre-activity denning surveys and related precautions against den disturbance in bear interaction plans, required under the ITR/LOA process, would reduce the likelihood of this potential risk; however, it would not eliminate it, because experience shows that not all occupied dens would be detected. Assuming an annual average of 20 occupied dens in the program area (**Appendix J.4.2**) and a den detection rate of 50 to 83 percent from airborne FLIR surveys, then four to 10 dens may not be detected in pre-activity den surveys.

In view of the tightly spaced grid covered by vehicles during 3D seismic exploration, undetected dens would likely be disturbed, as described above. For example, seismic exploration of the entire program area could be conducted in two successive winters, so two to five dens (each with a female and 1 to 3 cubs, potentially totaling 2 to 5 females and 2 to 15 cubs) may be disturbed in each of those two winters. This would have moderate to major direct impacts on the SBS population of bears if they abandon those dens prematurely and cub deaths result.

Dens are not distributed evenly across the landscape, however, so the number of dens likely to be disturbed would be higher when seismic surveys are conducted in the high and medium HCP zones; in these zones, there is 75 percent more potential habitat, and 95 percent more dens have been found in the past, than in the low HCP zone (see **Table 3-24**). While it is unlikely, it is also possible that one or more undetected dens could be run over by seismic vehicles, resulting in injury or death if the bears do not abandon the dens first.

A third potential source of injury or mortality is vehicle traffic on ice and gravel roads that intersect the movement paths taken by females with young moving from terrestrial denning habitat to hunting areas offshore in late winter (March–April), which poses a risk of vehicle strikes and disturbance-related distributional shifts. No vehicle strikes of polar bears along ice roads in the North Slope oil fields have been reported in agency documents evaluating impacts on polar bears, indicating the risk is very low and the impact is negligible thus far. Because of increasing use of terrestrial habitats by the SBS stock and the greater use of the program area by polar bears than of the oil fields farther west, the risk could increase if development proceeds in the program area. This would have long-term impacts of minor magnitude.

A fourth potential source of injury or mortality is accidental spills, leaks, and other sources of contamination. Polar bears are susceptible to thermal stress if their fur is fouled by direct contact with spilled petroleum products, which reduces body temperature and increases metabolic rate; oil is absorbed through skin contact, through the gastrointestinal tract, and by inhalation (Engelhardt 1983; Derocher and Stirling 1991). Contact and ingestion can lead to severe blood and kidney problems. The direct and indirect effects of spills depend primarily on the seasonal timing and location of the spills and on the volume of material released into the environment. Because of their more limited spatial extent, slower rates of dispersion, and higher likelihood of successful containment, terrestrial spills would have substantially less impact on polar bears than would spills in the marine environment during the open-water period in summer and fall.

The only substantial potential program-related activity occurring in the marine environment would be annual barging of modules in several years during the open-water period, which would pose a low risk of spilled fuel if a vessel were to run aground. In general, because the spill volume and the area affected would be smaller, the number of bears potentially affected by such an accident also would be smaller than the potentially large number that could be affected by modeled, hypothetical, large marine spills from offshore production facilities (Amstrup et al. 2006b; BOEM 2018b; Wilson et al. 2018). Although the likelihood of a program-related spill in the marine environment is low, the greatest susceptibility and risk to polar bears would occur in autumn when polar bears congregate at the Kaktovik whale-bone pile.

To date, large oil spills in the marine environment from industry activities in the Beaufort Sea and coastal regions that would affect polar bears have not occurred, although the interest in, and the development of, offshore hydrocarbon reservoirs has increased the potential for such spills (81 FR 52276).

Spills associated with development projects on the mainland are of much less concern for polar bears than are marine spills. Although the risk of a large spill during the development and production phases of the proposed program is low, several large terrestrial oil spills have occurred in the Prudhoe Bay area, albeit without any known impacts on polar bears (81 FR 52276). The volume of material released and the area affected would likely be small due to the volumes of material being used and the terrestrial base of activities.

Small releases of contaminants also can have effects. As described above, three polar bears have died near industrial sites from chemical ingestion as a result of human activity (Amstrup et al. 1989; 81 FR 52275). Effective control of potentially toxic substances and careful attention to preventing spills of any size are the key to preventing such injuries. Overall, potential impacts on polar bears and their habitat in the program area from oil spills, leaks, and contaminant releases would be lessened through the safeguards specified in required spill prevention and contingency plans, the relatively small amounts of material likely to be released under most scenarios, and the responsible parties' ability to detect and clean up spills quickly on land, where most program-related activities would occur.

Any injury or mortality from oil and gas development-related human/bear conflicts would pose a problem because of the declining status of the SBS population. The attraction of polar bears to facilities and the attendant problems from such attraction may increase through the operational life of the proposed program, as more bears use onshore areas during the open-water season due to declining sea ice, leading to increased use of coastal travel routes past oil and gas facilities.

In summary, although the potential for injury or mortality could be high when developing new oil and gas projects in polar bear habitat, the risks are generally well understood. Effective mitigation is available, based on experience from the ITR/LOA process in the established North Slope oil fields west of the program area; however, that area has less denning habitat and fewer denning polar bears than in the program area. Thus, the greatest risk of injury and mortality from disturbance and premature den abandonment would occur during the short-term but intensive 3D seismic exploration phase. This has not been conducted previously in an area with comparable amounts of denning habitat and numbers of denning female bears.

The combination of seismic exploration with a relatively large number of polar bear dens underscores the crucial importance of developing new ITRs that are effective at mitigating potential impacts on the SBS stock of bears in the program area. Over time, advancements in den detection technology and methodologies may increase den detection rates and thereby reduce impacts associated with 3D seismic surveys and other oil and gas operations. In contrast with the exploration phase, the net effects of program-related activities during the development, production, abandonment, and rehabilitation phases are likely to be minor to negligible in terms of injury and mortality at the population level, with required mitigation in place under the ITR/LOA process. Given the current and predicted continuing decline of the SBS stock of polar bears, maximum emphasis during all program phases would be placed on avoiding injury or mortality, applying current mitigation measures that have been effective at reducing such risks, and applying new mitigation measures as they become available.

Whales and Seals

In summer, vessel collisions could injure or kill whales or seals. The number and speed of ships is related directly to the severity of collisions between vessels and whales (Jensen and Silber 2004). In contrast, seals are less likely than whales to be struck due to their smaller size and higher maneuverability. BOEM estimated that 67 vessels per year associated with oil and gas leasing and exploration could transit the Beaufort Sea (NMFS 2013). Collisions with whales are rare for slow-moving vessels traveling at less than 10 knots (Laist et al. 2001; Vanderlaan et al. 2008). Barge convoys would move slowly, but the vessel operators would be unable to change direction or speed quickly (ROP 46). The low incidence of propeller scars found on bowhead whales landed by Alaska Native whalers indicates that vessel strikes of bowhead whales are rare (Laist et al. 2001; George et al. 2017). Although it is possible that a marine mammal could be struck by a vessel engaged in the barging operation, such incidents are highly unlikely, due to the slow vessel speed and low frequency of barge deliveries (assumed to be two landings per year).There is no indication that vessel strikes would be a major source of mortality for whales during marine transport to the program area (NMFS 2013).

Data recorded by PSOs aboard sound-source and monitoring vessels indicate that ringed and bearded seals in the Beaufort Sea avoid oncoming vessels (NMFS 2016a), and there is no indication that vessel strikes would become an important source of injury or mortality (NMFS 2013).

The absence of collisions involving industry vessels and marine mammals in the Bering, Chukchi, and Beaufort Seas, despite decades of spatial and temporal overlap, suggests that collision probabilities are low along the transit route from Dutch Harbor to the program area (NMFS 2013). More specifically, it is unlikely that vessels would strike subarctic whales because of the following:

- Few blue and sperm whales could be encountered, as they are rare and are found in deeper waters than those in which the transit route would occur
- Approximately 30 North Pacific right whales are known to exist

- Few western North Pacific gray whales have been documented outside their feeding areas in waters around Sakhalin Island, Russia
- Vessel mitigation measures, such as reducing speed, are typically required by NMFS and reduce the likelihood of vessel strikes

Thus, potential ship strikes of marine mammals would be highly unlikely and are not expected to occur.

Any vessels operating in or along transportation corridors to the program area would follow specified procedures for changing vessel speed and direction to avoid collisions with marine mammals. TLs on barging activity would avoid adverse effects on newborn ringed seals, particularly when nursing and molting (NMFS 2016a), because program-related vessel traffic would occur late in the open-water season when pups would be larger.

Under all action alternatives, ROP 46 would minimize impacts of vessel traffic strikes on marine mammals by establishing rules of operation. Besides adhering to other rules of operation in the vicinity of whales or seals, examples of these rules are using dedicated PSOs, prohibiting transit of vessels before July 1, and limiting vessel speed to 10 knots. Because of the slow vessel speeds and the presence of PSOs onboard operating vessels, vessel strikes are highly unlikely under any of the action alternatives.

Another potential source of injury or death is accidental spills, leaks, and other sources of contamination. All of the exploration and development would occur on land, with oil being transported in terrestrial pipelines to the TAPS. The potential effects of accidental releases of hazardous materials, including oil spills, that reach the distributary channels of rivers and streams and adjacent marine waters would be minor to negligible. This would be due to the safeguards in place to avoid and minimize oil spills, provided that containment is successful.

In the unlikely event of a large oil spill reaching open water during summer or fall, small numbers of bearded, ringed, and spotted seals and beluga whales could be adversely affected. The probability, volume, and potential spread of different types of spills are discussed in **Section 3.2.11**. Assuming that no large oil spills reach open water, potential impacts of terrestrial oil spills on marine mammals are expected to be minor to negligible.

Small, accidental fuel spills could occur with refueling at sea. This potential impact would be common to all marine mammals. In previous analyses, the BOEM assumed a vessel transfer spill during offshore refueling to have an estimated volume range from less than 1 to 13 barrels. The 13 barrel maximum spill volume represents a spill where spill prevention measures fail, fuel lines rupture, and no oil remains on the vessel. A spill of less than 1 barrel could persist for up to 30 hours in open water, while a 13 barrel spill could persist for up to 2 days (BOEM 2015). Exposure of marine mammals to this type of spill would be highly unlikely and is not expected to occur.

Attraction to Human Activity and Facilities

Other than polar bears, marine mammals are not likely to be attracted to program-related activities or facilities. Polar bears are curious and opportunistic hunters, frequently approaching and investigating locations where human activity occurs (Stirling 1988; Truett 1993). Proximity to humans poses risks of injury and mortality for both bears and humans and may necessitate nonlethal take through deterrence and hazing or, on rare occasions, lethal take to defend human life (Stenhouse et al. 1988; Truett 1993; Perham 2005; Wilder et al. 2017).

Stirling (1988) reported that curious polar bears commonly approach offshore drilling rigs in the Canadian Beaufort Sea whenever sea ice moved into the area but did not remain nearby for long, unless seals were present in the leads created by the rigs. Similar behavior has been observed at Northstar Island, north of Prudhoe Bay. Sightings of polar bears at industrial sites in the Beaufort Sea region of Alaska have increased in recent years, consistent with increasing use of coastal habitats, as summer sea ice cover has diminished (Schliebe et al. 2008; USFWS 2008b; 81 FR 52276), and this trend is likely to continue.

Encounters between polar bears and humans in the program area are most likely to occur on and near the coastline, as bears move through in late summer and fall (August–October) and as maternal females search for den locations in autumn and early winter (October–November) and depart from dens with dependent cubs in late winter (March–April); however, the latter animals are the least likely to be attracted to industrial facilities, due to their greater sensitivity to disturbance.

The current ITR/LOA process to the west of the program area has proven to be effective at addressing and mitigating the risks of polar bear encounters with humans. Besides denning surveys, the polar bear interaction plans required by operators would stipulate that bear sightings and encounters be monitored and reported by trained observers, as well as training personnel in nonlethal means of protection, if required, such as deterrence and hazing.

Although camps and other areas of human activity have the potential to attract polar bears over the entire life of the post-leasing program, experience in the established North Slope oil fields farther west demonstrates that these risks can be mitigated effectively by following polar bear interaction plans. Examples of preventive and mitigative measures are as follows (Truett 1993; Perham 2005; USFWS 2006, 2008b, 2009):

- Detection systems using bear monitors, motion or infrared sensors, and adequate lighting
- Safety gates, fences, and cages for workers skirting elevated buildings
- Careful waste handling and snow management
- Chain-of-command procedures to coordinate responses to sightings
- Employee education and training programs

All program-related activities must be conducted to minimize the attractiveness of work and facility sites to polar bears and to prevent their access to food, garbage, rotting waste, and other potentially edible or harmful materials, as required by ROPs 1, 2, and 4. Trained bear monitors on-site during all on-the-ground program activities would immediately report all polar bear sightings to safety personnel. Observing these requirements under the ROPs and, if established, under an ITR would reduce impacts on polar bears to negligible levels.

Alternative B (Preferred Alternative)

The types of future program-related activities and facilities would be similar among the action alternatives, but the location and extent of infrastructure and associated activity would differ among alternatives, in accordance with lease stipulations and ROPs, as described in **Appendix B**. The sole exception to this generalization is that, regardless of leasing and NSO restrictions, the entire program area would be open to 3D seismic exploration under each of the action alternatives; however, after the first lease sale, operators would likely conduct smaller-scale 3D surveys on their own lease blocks, assuming that seismic information would not already be available. .

Differences that would alter effects on marine mammals among alternatives primarily are those in the distribution and acreage of potential denning habitat for maternal polar bears, as well as the extent to which activities and facilities would be permitted in coastal and nearshore marine habitats used as travel routes by polar bears and for birthing lairs by ringed seals.

The potential impacts among action alternatives cannot be quantified accurately without knowing the future locations of program-related activities and facilities, so this evaluation assesses impacts by comparing the number of historical dens, amount of potential maternal denning habitat mapped, and likelihood of use by polar bears of the areas subject to various lease types and stipulations. The provisions of ROPs 1, 2, 4, 11, 15, 34, and 40 all would confer protection and mitigation measures on polar bears equally, because they are identical for all the action alternatives.

Because the entire program area is available to lease for oil and gas activity, Alternative B presents the greatest difference from Alternative A by enabling program activities and facilities in nearly all potential terrestrial maternal denning habitat for polar bears in the program area. Despite the lack of specific protection of denning habitat under this alternative, however, Lease Stipulation 1 would protect some maternal denning habitat by prohibiting permanent facilities within 0.5 to 1 mile of the 10 rivers and streams listed under that stipulation. The NSO area under Lease Stipulation 1 includes 48 percent of the known historical polar bear dens (**Table 3-25**) and 29 percent of the potential maternal denning habitat mapped in the program area (**Table 3-26**).

Except for those river buffers, all program activities and facilities would be allowed throughout the areas of greatest proportional occurrence of dens (high and medium HCP zones), relying on adherence to mitigation measures required by ITRs (**Appendix J**), including pre-activity surveys to detect occupied dens before beginning winter activities. Under Alternative B, Lease Stipulations 2, 3, 4, and 5 contain no specific requirements relevant to polar bears or their habitat (other than compliance with the ESA and MMPA, as well as coordinating with local subsistence users). This would result in greater potential long-term disturbance effects than under Alternative A. Alternative B has the greatest potential area affected by development and production among the action alternatives because of the large area that would be open to development.

The coastline survey required under Lease Stipulation 9 for this alternative would provide some specific information for planning purposes but would not specifically restrict activities that could disturb polar bears using coastal habitats. This exclusion would leave the regulatory requirements of the future ITRs as the sole mitigation measures in effect in the coastal area. It would reduce disturbance of bears moving along and denning near the sea coast, including the barrier islands unit of designated critical habitat and its associated 1-mile no-disturbance zone.

Mitigation, monitoring, and reporting requirements of the current Beaufort Sea ITRs (81 FR 52318 18.128) have been incorporated into the ROPs. Adhering to ROPs 1 and 2 and to future ITR requirements would reduce the potential for polar bears to be attracted to improperly handled garbage and other rotting waste. This would greatly diminish the safety risks that could result from habituation and food-conditioning of polar bears. ROP 4 would reduce safety risks for both humans and bears by ensuring that measures are in place to address the risks of, and solutions for, bear-related problems and to follow accepted practices for deterring bears around facilities, when necessary through a polar bear interaction plan.

The highest number of documented historical polar bear dens and the greatest area of potential maternal denning habitat occur in the high- and medium-potential hydrocarbon zones, where the least restrictive development activities would be most likely to occur. Because of this, the potential impacts of waste handling and human/bear interactions under this alternative would be the most different from Alternative A and would be greater than those under the other action alternatives.

Table 3-25
Number and Percentage of Documented Polar Bear Dens by Alternative, Hydrocarbon Potential, and Lease Type

Lease Type*	Alternative B				Alternative C				Alternative D1				Alternative D2			
Hydrocarbon Potential	**High**	**Med.**	**Low**	**Total**	**High**	**Med.**	**Low**	**Total**	**High**	**Med.**	**Low**	**Total**	**High**	**Med.**	**Low**	**Total**
Not offered for lease sale	-	-	-	-	-	-	-	-	-	2	2	4	-	9	2	11
	-	-	-	-	-	-	-	-	-	11%	100%	9%	-	47%	100%	24%
Subject to NSO	17	4	1	22	18	9	2	29	23	15	-	38	23	9	-	32
	68%	21%	50%	48%	72%	47%	100%	63%	92%	79%	-	83%	92%	47%	-	70%
Subject to CSU	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-
	-	-	-	-	-	-	-	-	-	5%	-	2%	-	-	-	-
Subject to only standard terms and conditions	8	15	1	24	7	10	-	17	2	1	-	3	2	1	-	3
	32%	79%	50%	52%	28%	53%	-	37%	8%	5%	-	7%	8%	5%	-	7%
Total	**25**	**19**	**2**	**46**	**25**	**19**	**2**	**46**	**25**	**19**	**2**	**46**	**25**	**19**	**2**	**46**

Source: BLM GIS 2018; known dens were documented by Durner et al. (2010).
* The lease type "subject to TLs" was omitted from this table because those timing limitations pertain to caribou during summer.
- = not applicable

Table 3-26
Estimated Acreage and Percentage of Potential Maternal Denning Habitat by Alternative, Hydrocarbon Potential, and Lease Type

Lease Type*	Alternative B				Alternative C				Alternative D1				Alternative D2			
Hydrocarbon Potential	**High**	**Med.**	**Low**	**Total**	**High**	**Med.**	**Low**	**Total**	**High**	**Med.**	**Low**	**Total**	**High**	**Med.**	**Low**	**Total**
Not offered for lease sale	-	-	-	-	-	-	-	-	27	327	918	1,273	27	853	1,133	2,012
	-	-	-	-	-	-	-	-	2%	16%	81%	28%	2%	42%	100%	44%
Subject to NSO	422	567	330	1,319	587	1,080	949	2,617	814	1,397	182	2,393	814	922	-	1,736
	31%	28%	29%	29%	43%	53%	84%	58%	60%	68%	16%	53%	60%	45%	-	38%
Subject to CSU	-	-	-	-	-	-	-	-	127	176	33	336	127	150	-	277
	-	-	-	-	-	-	-	-	9%	9%	3%	7%	9%	7%	-	6%
Subject to only standard terms and conditions	928	1,480	802	3,211	763	967	183	1,913	382	146	-	529	382	123	-	505
	69%	72%	71%	71%	57%	47%	16%	42%	28%	7%	-	12%	28%	6%	-	11%
Total	**1,350**	**2,047**	**1,133**	**4,530**	**1,350**	**2,047**	**1,132**	**4,530**	**1,350**	**2,047**	**1,133**	**4,530**	**1,350**	**2,047**	**1,133**	**4,530**

Source: BLM GIS 2018; bank-habitat segments were mapped by USGS (Durner et al. 2006); see **Map 3-37** in **Appendix A.**
Acreage estimates assume an average width of 21 feet per mapped segment of bank habitat (Durner et al. 2001).
* The lease type “subject to timing limitations” was omitted from this table because those limitations pertain to caribou during summer.
- = not applicable

Under Lease Stipulation 5 and ROP 10, the pre-activity surveys required to locate dens, plus the 0.5-mile and 1-mile buffers for seismic and heavy equipment operation around occupied dens of grizzly and polar bears, respectively, would help to reduce the impacts of behavioral disturbance on denning bears (as well as birth lairs of ringed seals on land-fast ice along the coast) throughout the entire program area. Even so, complete detection of occupied bear dens is unlikely to be achieved; the 50 to 83 percent rate of detectability of occupied dens using airborne FLIR means that 4 to 10 undetected maternal dens may be exposed to disturbance during 3D seismic exploration of the entire program area. Two to five dens in each of the two winters would be exposed during initial, areawide exploration. Given the potential for airborne FLIR detection rates to approach 90 percent, (Amstrup et al. 2004b), two to ten dens may go undetected, or one to five each year over a two-year period.

Fewer dens would be disturbed during the development and production phases because the areas affected would be smaller than the intensive 3D seismic grid surveyed over the entire program area. Under the current ITR/LOA process to the west, the USFWS implements protective measures around a maternal polar bear den once it is discovered. This includes applying a 1-mile no-disturbance buffer around the den site and 24-hour monitoring of the den site until the bears leave the den.

The requirement to obtain permits before installing fences to capture snow under ROP 15 (identical under all action alternatives) could alleviate potential conflicts with denning bears. Pregnant polar bears could be attracted early in the denning season to drifts in the lee of snow fences, which could create suitable denning habitat if the topography allows drifts to become deep enough.

Alternative C

Most of the historical dens that have been documented in the program area occur in the zones of high and medium HCP, which would be open to development subject to only standard terms and conditions or under NSO stipulations. The NSO area under Lease Stipulations 1 and 9 would include 63 percent of the known maternal dens and 58 percent of maternal denning habitat (**Table 3-25** and **Table 3-26**). The expanded NSO setback (2 miles rather than 1 mile) around the Canning, Hulahula, and Okpilak Rivers under Lease Stipulation 1 would provide additional protection of potential denning habitat along those drainages.

The NSO buffer within 1 mile of the coastline, barrier islands, and lagoons under Lease Stipulation 9 would reduce potential disturbance of polar bears moving through those habitats during all seasons and denning there in winter; thus, it would be consistent with the 1-mile no-disturbance zone that is required around the barrier islands unit of critical habitat designated for the species. Lease Stipulations 2, 3, 4, and 5 contain no specific requirements relevant to polar bears or their habitat (other than legal compliance with the ESA and MMPA, implying future ITRs and related mitigation measures). This would result in greater long-term disturbance effects on the species than under Alternative A and effects similar to those under Alternative B in the areas covered by those lease stipulations.

The area subject to TLs under Alternative C are intended primarily as mitigation for caribou post-calving habitat during summer and thus would not benefit maternal polar bears during winter; hence, the areas subject to those TLs are included in the areas subject to standard terms and conditions in **Table 3-25** and **Table 3-26** (37 percent of known dens and 42 percent of maternal denning habitat, respectively); therefore, potential long-term disturbance impacts likely would be greater than those under Alternative A and slightly smaller than those under Alternative B.

The requirements of ROPs 1, 2, and 4 under this alternative would be identical to those under Alternative B; however, the potential impacts would be lower under this alternative because the NSO area would be larger and the STC area would be smaller than under Alternative B. The requirement of ROP 10 would be identical to Alternative B, so the potential effect would be similar between the two alternatives.

Alternative D

The Alternative D1 and D2 variants would be similar with regard to polar bears, so they are discussed and compared together. By affording the highest degree of protective measures for polar bears, these alternative variants would be the most similar to Alternative A than would the other two action alternatives. Under Alternative D1, the areas not offered for lease and the NSO areas—0.5- to 4-mile buffers around 17 rivers and streams, the Canning River delta and lakes, and three springs—would encompass 92 percent of known dens and 81 percent of maternal denning habitat (**Table 3-25** and **Table 3-26**). In comparison, Alternative D2 would encompass 94 percent of dens and 82 percent of denning habitat, affording the highest level of protection for denning polar bears among the action alternatives.

The 34 percent of the program area not available for leasing under Alternative D1 contains 28 percent of the maternal denning habitat but only 9 percent of the known dens (**Table 3-25** and **Table 3-26**). In contrast, the various NSO areas contain 54 percent of the denning habitat and 83 percent of the dens. Under Alternative D2, the 49 percent of the program area not available for leasing contains 44 percent of the maternal denning habitat and 24 percent of the known dens (**Table 3-25** and **Table 3-26**). The NSO areas contain 38 percent of the denning habitat and 70 percent of the dens; hence, both variants reduce the potential for impacts from program-related habitat loss and disturbance to the lowest degree among the action alternatives. The difference between the two variants is that Alternative D2 would protect more maternal denning habitat and known dens, primarily due to the difference in den distribution between the no-leasing and NSO lease types in the medium HCP zone. Seismic surveys are unlikely to be conducted in areas closed to leasing, thereby likely reducing or eliminating impacts to polar bears in those areas under Alternatives D1 and D2.

Under Lease Stipulation 5, the coastal polar bear denning river habitat zone (see **Map 2-6** and **Map 2-8** in **Appendix A**) subject to NSO and associated TLs totals 105,400 acres under Alternative D1 and 90,600 acres under Alternative D2.[40] Under Alternative D1, this zone constitutes 6.7 percent of the program area and 8.8 percent of the terrestrial denning unit of designated critical habitat in the program area; under Alternative D2, it constitutes 5.8 percent of the program area and 7.6 percent of the terrestrial denning unit of designated critical habitat. Despite being such small percentages of that unit of critical habitat, the stipulated areas within 5 miles of the coast and 1 mile of the Sadlerochit, Niguanak, and Katakturuk Rivers and Marsh and Carter Creeks encompass 37 percent (17 of 46) of the maternal dens documented in the program area under both variants of Alternative D.

In addition to the specific protection of maternal denning habitat in the 5-mile coastal denning zone designated under Lease Stipulation 5, Lease Stipulations 1 and 2 under both Alternative D variants would protect more denning habitat. This would be the result of prohibiting permanent facilities in NSO buffers within 0.5 to 4 miles of the 17 rivers and streams and 0.5 miles of the other water bodies listed under those two stipulations. Lease Stipulation 3 would protect additional denning habitat by excluding leasing and instituting 3- to 4-mile NSO buffers around Sadlerochit Spring, Fish Hole 1 on the Hulahula River, Tamayariak Spring, Okerokavik Spring, and along the east bank of the Canning River.

The various stipulations restricting facilities and activities in coastal habitats would reduce potential behavioral disturbance of polar bears moving along the coastline throughout most of the year. In the NSO area under Lease Stipulation 5, TLs would reduce disturbance of polar bears by prohibiting all program-related

[40]The difference in acreage is because 14,800 acres would be unavailable for leasing under Alternative D2.

activities, including seismic exploration, within 1 mile of mapped denning habitat up to 5 miles inland between October 30 and April 15; therefore, they would confer more protection than does the NSO designation, which applies only to permanent infrastructure.

In addition, the TLs under Lease Stipulations 4 and 9 would reduce disturbance between May 15 and November 1, or whenever sea ice is 10 miles or more from shore, whichever occurs later. They would do this by restricting program-related activities within a 2-mile coastal buffer, extending protections 1 mile farther inland than under Alternative C.

As with the other two action alternatives, ROPs 1 and 2 would reduce the potential for attraction to waste and would greatly diminish the safety risks that could result from habituation and food-conditioning of polar bears, and ROP 4 would further reduce the safety risks for both humans and bears. ROP 10 would reduce the impacts of behavioral disturbance on denning bears (and birth lairs of ringed seals on landfast ice) to the greatest degree among the action alternatives, most similar to Alternative A.

Transboundary Impacts

Polar Bear

Polar bears of the SBS stock range throughout much of the Beaufort Sea, routinely crossing the Alaska/Yukon border; thus, they are a shared resource subject to international agreements between the US and Canada and with other Arctic nations. Post-leasing activities and related impacts affecting bears in the program area have the potential to affect Canadian users of this resource, specifically First Nations hunters, in the Inuvialuit Settlement Region of northern Yukon and the Northwest Territories.

As described earlier, the subsistence harvest of this stock of bears is managed under the Inuvialuit-Iñupiat Agreement established between indigenous hunters in Alaska and Canada. That harvest is subject to a quota[41] that is based on current assessments of the size, trend, and health of the bear population and is reviewed periodically; therefore, any additional mortality that affects the SBS stocks could have repercussions for the harvest quota and the hunters in both nations who are party to the agreement. Cub mortality could be from oil spills in the marine environment or from females prematurely abandoning undetected dens during 3D seismic exploration.

The regulation of oil and gas activities under the ITR/LOA process in the US requires that the effects of unintentional incidental take do not have unmitigable adverse effects on Alaska Native subsistence hunters. This underscores the importance of developing and instituting new ITRs for the program area that avoid or minimize adverse impacts on polar bears. Such mitigation that avoids or minimizes impacts on Alaskan subsistence hunters would have ancillary effects on hunters in Canada as well.

Whales and Seals

All species of whales and seals in the program area also occur in Canadian waters to the east and in Russian waters to the west of the marine transportation route. Bowhead and beluga whales represent the strongest connectivity among the Pacific Arctic nations. This is because the migrating Beaufort stocks of both species transit the American Beaufort Sea to summer in the Canadian Beaufort Sea, returning westward in the fall. Bowhead whales cross the Chukchi Sea and transit through Russian waters during their fall migration. Ringed, spotted, and bearded seals also use habitat throughout the Pacific Arctic, regardless of international boundaries.

[41]Currently 56 bears total: 35 in Alaska and 21 in Canada (Miller et al. 2018)

The proposed action alternatives are not anticipated to have population-level impacts on whales or seals in the program area or along the marine transportation route. The International Whaling Commission counts the US, Canada, and Russia among its 88 member countries. It regulates whaling and addresses conservation issues, including bycatch and entanglement, ocean noise, pollution and debris, collision between whales and ships, and sustainable whale watching. There is no similar global commission for pinnipeds; instead they are protected by national laws and bilateral working groups, such as the US-Russia Marine Mammal Working Group.

Cumulative Impacts

Overall, the impacts of oil and gas exploration and development on marine mammals in the central Beaufort Sea have been short term, with no population-level impacts. *Climate Change*, above, describes the numerous changes being experienced by the SBS stock of polar bears due to the loss of sea ice habitats in recent decades from climate warming. The rapid rate and magnitude of changes in the sea ice habitats that polar bears rely on primarily poses the greatest cumulative threat to the population. They are caused by global factors that are not controllable without sustained international efforts to reduce GHG emissions. The effects of climate change on sea ice habitat are resulting in cascading changes in weather and habitat conditions across the Arctic, with attendant consequences for polar bears; however, the situation is especially concerning for the SBS stock, one of three judged to have the highest vulnerability to the effects of climate change.

To summarize the effects and consequences of climate change described above, the earlier retreat of sea ice in spring and the later advance in fall is resulting in a longer open-water season and decreases in sea ice concentration, thickness, and length of the ice-cover season. In response, polar bears have shown increases in movements, including swimming, time spent active, and time spent in marginal habitats, thus increasing energy expenditure. Models predict decreased survival of polar bears in the SBS population with reduced sea ice coverage, including reductions in breeding rates, cub survival, and recruitment of young bears into the breeding population.

More bears are coming ashore and spending more time on land, arriving earlier and departing later. On shore they have more difficulty catching prey, spend longer periods fasting, and have increased chances of encountering humans, thereby increasing the risk of being killed in defense of human life. Pregnant females are making increased use of terrestrial habitats for maternal denning, while warming temperatures, increased precipitation, and longer growing seasons have negative implications for the stable conditions required for maternal denning.

The decreased availability of energy-rich, high-fat foods and long fasting periods increase the probability of nutritional stress. While whale-bone piles provide important supplemental food sources locally, the availability of whale remains from subsistence harvests is not likely to provide a sufficient food source to replace ice seals in polar bear diets, as sea ice continues to decline. Also, the congregation of polar bears on shore around Kaktovik poses increased risks of susceptibility to oil spills and disease transmission.

These impacts of climate change are occurring now and are predicted to continue until global action reduces the GHG emissions that are driving the changes. While it is challenging to project the incremental effects of burning the oil and gas that may be extracted from the program area, it is certain that doing so would contribute incremental impacts on climate change (see **Section 3.2.1**). As explained earlier, however, managing climate change is beyond the ability of the agencies responsible for managing oil and gas activities in the program area; thus, those agencies must focus instead on avoiding and otherwise mitigating other cumulative incremental effects on the polar bear population.

New ITRs to the program area, if promulgated, would be the principal mechanism to address those potential impacts, such as possible mortality or injury from 3D seismic exploration, marine oil spills, and lethal takes around program facilities and activities. That would be in addition to the lesser effects on polar bear movements, energy budgets, and denning behavior from the increased presence of human infrastructure and activities in coastal habitats currently not subject to industrial activities.

The principal activities in Arctic Alaska contributing to cumulative effects on polar bears and other marine mammals are subsistence harvesting and changes in the activities of local communities, existing oil and gas development, commercial transportation, and management and research actions by federal and state agencies. The USFWS (2016, 2017) has recognized effective management of these activities as being especially important. This is because of the agency's inability to unilaterally control GHG emissions and the concomitant effects on climate warming.

Thus far, analyses of the risks posed by these activities at existing levels have shown them to be far less of a threat to polar bear populations than those posed by climate warming through sea ice loss and altered prey availability (Atwood et al. 2016a; USFWS 2016). The greatest component of human-caused removal for the SBS stock is harvesting by indigenous hunters, which is important because of its high subsistence and cultural values. Under the Inuvialuit–Iñupiat Agreement, harvest quotas have been reduced in the past as the SBS population has declined. Human-caused removal is an important factor affecting polar bear demography and sustainability (Regehr et al. 2015).

Under the ITR/LOA process for industrial activities, avoiding or minimizing disturbance and lethal take to the maximum extent possible and avoiding adverse effects on subsistence harvest are the most important factors for mitigating the effects of activities allowed under the ITRs. Tourism is growing in Kaktovik, with a growing number of commercial enterprises offering viewing opportunities of polar bears and recreational travel in the Arctic Refuge; however, impact assessments of those activities were not available to review for this analysis.

Most industrial development in the established oil fields along the Beaufort Sea coast has occurred in terrestrial habitats, which, except for a narrow coastal band, typically are used much less by polar bears throughout the year than are marine habitats offshore. Industry reporting under the ITR/LOA process in those fields have demonstrated that required mitigation has been effective at keeping both incidental and intentional take at negligible levels. Recent expansions from the Prudhoe Bay, Kuparuk, and Alpine oil fields into NPR-A to the west and Point Thomson to the east have had only negligible impacts. Those established developments and projected future expansions in the NPR-A, such as the proposed Willow project, have occurred in areas of habitat that are used less by SBS polar bears, especially for maternal denning.

The greater width of the terrestrial denning unit of critical habitat (20 miles, rather than 5 miles) east of the Shaviovik and Kavik Rivers, including the program area, reflects higher probability of use, and thus potentially greater impacts, than has been experienced to date farther west. The greater use of the program area by polar bears underscores the importance of developing effective new ITRs that would be required for post-leasing activities in the program area.

Over time, development has expanded into the marine environment, starting with the construction of West Dock in the Prudhoe Bay field. It was followed by the Endicott Project, which was the first offshore production facility in the region, the Northstar Project, located on artificial islands offshore from Prudhoe Bay, the Ooguruk and Nikaitchuq islands northwest of the Kuparuk field, and the planned Liberty Project, located offshore east of Endicott. Offshore production facilities (Endicott, Northstar, Ooguruk, and Nikaitchuq islands) have recorded the highest incidences of polar bear sightings and nonlethal hazing incidents in the established oil fields in recent years, accounting for 47 percent of polar bear observations (182 of 390 sightings) from 2005 to 2008, the most recent period for which such statistics are available (76 FR 47010; 81 FR 52276).

Those analyzing the cumulative effects of oil and gas leasing, exploration, development, and production by the National Research Council (NRC 2003: p. 105) concluded that "industrial activity in the marine waters of the Beaufort Sea has been limited and sporadic and likely has not caused serious cumulative effects on ringed seals or polar bears." Nevertheless, continued expansion of oil and gas development along the Arctic coast on both land and sea may reach a level at which such effects become problematic for polar bears in the future (Amstrup 2003a; USFWS 2009).

Offshore projects linked to shore facilities by subsea pipelines, such as Northstar or the new Liberty Project, pose a risk of a large marine oil spill. Although the risk is very low, the magnitude could be major, potentially affecting maximum numbers of 23–75 polar bears during September and October if no cleanup or other mitigation could be accomplished (81 FR 52302). The probability of oiling five or more bears was calculated as 0.3–7.4 percent, decreasing further to 0.1–2.3 percent for 10 or more bears, and 0.1–0.8 percent for 20 or more bears (81 FR 52303).

Marine mammals are exposed to potentially toxic chemical compounds in the water and the food web that have been transported to the Arctic from around the world through the atmosphere, water currents, and migrating animals (AMAP 2010). As a top predator, polar bears tend to have higher levels of potentially toxic compounds that bioaccumulate in the food chain, such as organochlorines and mercury (Braune et al. 2005; AMAP 2010). At the time of listing under the ESA, however, contaminant levels in Alaska polar bears were considered relatively low compared to other stocks (USFWS 2017a). Alaska stocks, including the SBS stock, continue to have some of the lowest concentrations of polychlorinated biphenyls, chlorinated pesticides, and flame retardants among all polar bear stocks (McKinney et al. 2011).

Onshore oil and gas production, such as that proposed in the program area, typically requires large sea lifts using barges to transport facility modules, equipment, and material from southern ports to docks on the Beaufort Sea coast. Onshore infrastructure also can affect marine mammals through the need for ice roads that cross ringed seal habitat in landfast ice, and ice and gravel infrastructure can affect polar bear habitat and maternal polar bear denning, as described above. These impacts of onshore production would likely affect polar bears through disturbance in coastal barrier-island and denning habitats, especially during construction, but would be mitigated through future ITRs.

Past responses of ringed seals to oil and gas activities have consisted primarily of minor behavioral reactions, with a few exceptions related to tracked vehicle activity in nearshore areas. In 1998, a vehicle crushed a lair, killing one seal pup and injuring the female. In 2018, two separate events involving vehicles exposed seal lairs, causing the inhabitants to flee. BLM requirements for buffers around lairs and LOAs issued by NMFS would ensure that the impacts of onshore infrastructure development in the RFD (**Appendix B**) would not add to the past, ongoing, or future impacts.

The combined effects of likely future actions, particularly those located in the arctic marine environment, may contribute to adverse effects on polar bear, seal, and whale populations in the future, primarily through expansion of coastal and offshore development and the increased risk of a major marine oil spill. Impacts on marine mammals would mostly be short term, with the potential for a small number of deaths. Considering the incremental contribution of the action alternatives to cumulative oil spills, the added oil spill impacts of past, present, and future spills would continue to have short-term, localized effects on marine mammals, with limited potential for a few deaths.

Considering all past, present, and reasonably foreseeable future actions, by far the most significant factor affecting Arctic marine mammals is ongoing climate change from GHG emissions and the resulting loss of sea ice habitat. The effects of climate change would primarily influence the degree and rate of cumulative impacts on polar bears and other marine mammals; however, the impacts of climate change are not readily manageable or amenable to mitigation without sustained global action, which is beyond the ability of resource management agencies.

Under the current management structure, the outcomes of human/bear interactions and associated disturbance from human activities, including post-leasing oil and gas activities, have the next greatest potential impact on polar bears. Those impacts can be avoided or reduced through effective implementation of a future ITR/LOA process and its attendant mitigation. Considering the effects of post-leasing oil and gas activities in conjunction with other human/bear interactions, the post-leasing effects of oil and gas activities in the program area would have incremental cumulative effects on the SBS stock of polar bears. The significance of those effects would depend on the successful implementation of effective mitigation and the action alternative selected. The relative magnitude of the increments added, in descending order, would be Alternatives B (least protective), C, D1, and D2, (most protective).

3.4 Social Systems

3.4.1 Landownership and Use

Affected Environment

The affected environment for landownership and use is similar to Section 4.1.2, Land Status, in the Arctic Refuge CCP (USFWS 2015a); however, because the Coastal Plain program area does not include the entire Arctic Refuge, a revised description of the program area is included here. Lands administered by the USFWS, including submerged lands, account for greater than 99.9 percent (1,562,600 acres) of the 1,563,500-acre program area. The remaining 900 acres of lands are Alaska Native Allotments. Patented and allotment lands are mostly located along the Beaufort Sea between the Hulahula and Jago Rivers. There also are smaller, isolated allotments along the coast. Descriptions of Alaska Native Lands and Allotments are incorporated here by reference from the USFWS CCP (USFWS 2015a).

There are no BLM-administered surface lands in the program area; however, the BLM manages all of the subsurface mineral estate there (see **Sections 3.2.5** and **3.2.6**). Although none currently exist, the BLM would manage federal oil and gas leases, permits, and ROWs associated with fluid mineral development. The BLM would verify subsurface mineral estate ownership at a site-specific level prior to a lease sale.

With the exception of Barter Island, there are no roads, power lines, pipelines, or other permanent facilities or structures in the program area. On Barter Island is a single runway airport and the city of Kaktovik, a community of approximately 250 people.

Direct and Indirect Impacts

Issuance of oil and gas leases under the directives of Section 20001(c)(1) of PL 115-97 would have no direct impacts on the environment because by itself a lease does not authorize any on the ground oil and gas activities; however, a lease does grant the lessee certain rights to drill for and extract oil and gas subject to further environmental review and reasonable regulation, including applicable laws, terms, conditions, and stipulations of the lease. The impacts of such future exploration and development activities that may occur because of the issuance of leases are considered potential indirect impacts of leasing. The reasonably foreseeable development scenario (**Appendix B**) identifies five phases associated with the hypothetical scenario: leasing, exploration, development, production, and abandonment and reclamation; therefore, the analysis considers potential impacts on landownership and use from on-the-ground post-lease activities. See **Appendix B** for the estimated time frames of analyzed phases and associated projected activities.

Potential impacts on landownership and uses are the result of decisions that change landownership or from lease stipulations that allow or restrict certain land uses. Landownership decisions, such as conveyance or transfers, can increase or decrease the amount of federal land and the type of management available for those lands. Use restrictions, such as those intended to protect resources or to reduce conflicts with other uses, can preclude the placement of new infrastructure or require special conditions for development. In areas subject to NSO, new land uses would be precluded. Any new uses would be required to locate in areas outside of the NSO area. Depending on the use, developing the use outside of the NSO area may not be physically or commercially viable. In areas subject to CSU or TLs, additional requirements, such as long-term monitoring, special design features, and special siting requirements, could restrict a future project's location or viability of projects.

Alternative A

Under Alternative A, there would be no federal minerals offered for future oil and gas lease sales in the program area and therefore no direct or indirect impacts on uses. There would be no change in landownership.

Impacts Common to All Action Alternatives

Under all action alternatives, areas would be made available for lease sales consistent with PL 115-97. Impacts are analyzed through five phases of development—leasing, exploration, development, production, and abandonment and reclamation—and they are driven by demand for petroleum. This would result in the subsequent development of oil and gas exploration and production well pads, CPFs, roads, pipelines, barge dock, a STP, and other ancillary uses to support oil and gas development. The BLM would grant rights-of-way (ROWs) or easements across the Coastal Plain for access and construction of facilities, including in unleased areas. Impacts from the five phases of development on land uses would vary under the action alternatives, as discussed below, the size, type, and amount would be nearly the same.

The five phases of oil and gas development, as described in **Appendix B**, in the program area would indirectly affect land uses in and surrounding the community of Kaktovik. As a point of arrival and departure for air travel to the program area, new or expanded residential, commercial, industrial, and civic land uses would be expected, especially over the long term. Areas south of Kaktovik's current development footprint more likely to experience the most notable growth (NSB 2015a).

Potential impacts from the five phases of development on the program area may affect Native allotments and ANCSA corporation uses there. Native allotments cover approximately 900 acres of the Coastal Plain, primarily concentrated near rivers, and these allotments support subsistence activities and uses. Construction of infrastructure near the Native allotments may reduce the desirability of using a specific area or allotment, primarily from exposure to dust, air pollution, noise, helicopters, and road traffic from development; however, Lease Stipulation 11 would prevent the development of oil and gas-related infrastructure on Native allotments, unless the owner gives written consent. See **Table 3-27**, below, for the acreage of Native allotments that may be affected by oil and gas development in the Coastal Plain.

Under all action alternatives, ANCSA corporation mineral interests may be affected throughout the five phases of development. The ASRC owns subsurface acreage in the Coastal Plain, while the KIC owns surface

Table 3-27
Lease Stipulations Near Native Allotments by Alternative

Lease Availability/Stipulations within 3 miles of Native Allotments (acres)	B	C	D1	D2
Not offered for lease sale	0	0	52,280	102,900
Available for lease sale: subject to NSO	63,030	143,650	134,190	86,350
Available for lease sale: subject to CSU	0	0	1,210	1,210
Available for lease sale: subject to TL	57,380	17,710	0	1,340
Available for lease sale: subject to standard terms and conditions	71,390	30,440	4,120	0

Source: BLM Geographic Information Systems (GIS) 2018
Note: Acreages are rounded up or down to nearest 10.

acreage. Lease stipulations and ROPs from the leasing program may affect ANCSA corporation mineral interests by restricting access to mineral opportunities or enforcing NSOs next to ANCSA corporation lands. Site-specific impacts on Native allotments and corporations would vary under all action alternatives. For a description of subsistence use impacts that may occur near Native allotments, **see Section 3.4.3**; for a description of mineral interest impacts on ANCSA corporations, see **Sections 3.2.5** and **3.2.6**.

There would be no change in landownership under any of the action alternatives. The USFWS would continue to manage all federal lands in the Coastal Plain, including both leased and unleased areas. Under all action alternatives, the BLM would be responsible for managing all aspects of the oil and gas program. The Tax Act assigned the BLM the responsibility of making oil and gas program decisions; however, the BLM intends to coordinate with the USFWS before making decisions. The CCP will be revised to reflect all purposes of the Arctic Refuge in the Coastal Plain, as amended by PL 115-97.

Alternative B (Preferred Alternative)

The nature and types of impacts on land uses under Alternative B would be the same as those described under *Impacts Common to All Action Alternatives*. Making the entire program area available for lease sale and applying NSO stipulations to only 23 percent of the lands available for leasing would allow land to be developed in most areas for oil and gas projects. Although Alternative B NSO stipulations would generally preclude surface-disturbing activities along rivers and streams (Stipulation 1) and nearshore marine, lagoon, and barrier islands (Stipulation 4), essential pipelines androad crossings would be permitted through the setback areas in accordance with PL 115-97. Gravel mines could also be permitted in setback areas.

Alternative C

Under Alternative C, the nature and types of impacts on land uses would be as described under *Impacts Common to All Action Alternatives*. Making 932,500 acres subject to NSO (Lease Stipulations 1, 4, 7, and 9) would limit the locations where new uses could be developed to 631,000 acres (40 percent) of the program area. These areas would be subject to TLs. Lease Stipulation 7 would influence the future design, location, and extent of seasonal use associated with the use in the PCH post-calving habitat area.

Impacts on ANCSA corporations and allotments would be the same as those described under Alternative B, but to a greater degree, as more lands would be subject to NSO or TL. Approximately 30,440 acres in the program area would be open to lease sale, subject to standard terms and conditions, within 3 miles of a Native allotment.

Alternative D

Under Alternatives D1 and D2, the nature and types of impacts on land uses would be the same as those described under *Impacts Common to All Action Alternatives* and would be similar to Alternative C. Alternative

D1 would make 526,300 acres unavailable for lease sales and an additional 708,600 acres subject to NSO (Lease Stipulations 1, 2, 4, 5, 7, 9, and 10). This would limit the locations where new uses could be developed to the remaining 328,600 acres (21 percent) of the program area. Impacts on ANCSA corporations would be as described under *Impacts Common to All Action Alternatives* and would be greatest under Alternative D1; however, Lease Stipulations and acres unavailable for lease sale under Alternative D1 would mitigate impacts on the 4,120 acres available for lease sale within 3 miles of a Native allotment in the program area.

Alternative D2 would limit more locations for development than Alternative D1 by making 763,500 acres unavailable for lease sales and an additional 505,800 acres subject to NSO. Alternative D2 would leave only 294,200 acres (19 percent) of the program area open for new uses. Impacts on ANCSA corporations would be the same as those described under Alternative D1, but to a lesser degree. This is because more land is unavailable for leasing sales and less land is subject to NSO under Lease Stipulations 1, 4, 5, 7, 9, and 10. Impacts on Native allotments would be the same as those described under *Impacts Common to All Action Alternatives*; however, Alternative D2 provides the greatest mitigation because no lands are available for lease sale within 3 miles of a Native allotment in the program area.

Transboundary Impacts

There would be no direct or indirect transboundary impacts on landownership and uses under any of the action alternatives.

Cumulative Impacts

Cumulative impacts on landownership and uses would be the result of a change in the demand for lands to be transferred out of federal ownership to support a public use or demand for land uses associated with energy or mineral development. Past, present, and reasonably foreseeable future actions, described in **Appendix F**, that would cumulatively affect landownership and uses include future oil and gas exploration and production and associated demand for infrastructure, and community expansion, particularly near Kaktovik, with associated demand for land uses and potential land tenure actions.

Under all action alternatives, new oil and gas exploration and development, such as the Alaska LNG or the Alaska Stand Alone Pipeline, would increase the number and density of uses in the program area. Applications for uses would be processed on a case-by-case basis, subject to lease stipulations and other protective measures. NSO stipulations, particularly under Alternatives C and D could result in the concentration of new uses in smaller areas. As new oil and gas uses are developed in an area, the availability of those public lands for other oil and gas infrastructure would decline. Collocation or use of shared facilities would alleviate this potential impact.

Seismic activity related to the leasing program may occur across the entirety of the program area, even if an area is unavailable to lease sales. Seismic impacts may diminish the desirability of using specific Native allotments or public lands. These impacts would primarily occur during the exploration phase of oil and gas development, as described in **Appendix B**.

Expanding interest in the program area would influence uses in nearby Kaktovik. Combined with past, present, and future actions, which include plans to expand community infrastructure and transportation facilities in the city, new oil and gas development could increase demand for new residential, commercial, civic, and industrial lands uses in the city. Because Kaktovik's urban footprint is confined by the Beaufort Sea to the north, by public lands to the east and west, and by private lands to the south, there may be future interest in conveying lands out of federal ownership to accommodate new community development; however, an act of Congress would be required to convey lands in the Coastal Plain out of federal ownership.

3.4.2 Cultural Resources

Affected Environment

This section addresses the cultural resources of the program area associated with several Alaskan and Canadian indigenous groups including Inuit (i.e., Alaskan Iñupiat and Canadian Inuvialuit) and Gwich'in Athabascans. Also addressed are the cultural resources associated with more recent, post-contact Euro-American groups.

The Kaktovikmiut (i.e., Iñupiat of Kaktovik) are the current indigenous inhabitants of the program area. This section incorporates information from the following sources: the ADNR, Office of History and Archaeology (ADNR OHA 2018) Alaska Heritage Resources Survey (AHRS);[42] NSB's Iñupiat History, Language, and Cultural (IHLC) Division's repository of Traditional Land Use Inventory (TLUI) sites (IHLC 2019); the ADNR, Division of Mining, Land and Water (ADNR MLW 2018) Revised Statute (RS) 2477 trail database (e.g., historic public ROWs; the NOAA Office of Coast Survey (NOAA OCS 2016) wrecks and obstruction database; and previous literature and EIS documents near the program area, including the Point Thomson EIS (USACE 2012) and Arctic Refuge CCP (USFWS 2015a). The BLM also reviewed scoping comments for this EIS for information on cultural resources in the program area, including comments provided by Canadian entities that addressed the cultural ties of the Canadian Inuvialuit and Gwich'in to the program area.

Section 106 of the NHPA (with its implementing regulations in 36 CFR 800) and NEPA require the BLM to evaluate the effects of the Leasing EIS on cultural resources.[43] Federal agencies are encouraged to coordinate compliance with Section 106 with any steps taken to meet the requirements of NEPA and should consider their Section 106 responsibilities as early as possible in the NEPA process (36 CFR 800.8a). Other relevant legislation or EOs that apply to the management of cultural resources include the Antiquities Act of 1906 (54 USC 320301 et seq.); the Archaeological Resources Protection Act of 1979 (ARPA; 16 USC 470aa et seq.); the Abandoned Shipwreck Act of 1987 (43 USC 2101 et seq.); the American Indian Religious Freedom Act (42 USC 1996); Section 4(f) of the DOT Act (49 USC 303); the Archaeological and Historic Preservation Act of 1974 (the Moss-Bennett Act); EO 13007 (Indian Sacred Sites); and the Native American Graves Protection and Repatriation Act (25 USC 3001-3013).

Several international laws also address cultural considerations that are relevant and should be taken into account during the decision-making process: the Migratory Birds Convention and Protocol, Inuvialuit-Iñupiat Polar Bear Management Agreement in the Southern Beaufort Sea, Ramsar Wetlands Convention 1971, and International Covenant on Civil and Political Rights.

Cultural and Historic Context

The Arctic Refuge Revised CCP (USFWS 2015a, Section 4.4.1.2) and Point Thomson EIS (USACE 2012, Sections 3.21.4 and 3.21.5) describe the cultural themes and periods of the Arctic Refuge, including the program area. **Table 3-28**, below, provides a summary of the cultural context of the Arctic Refuge as presented in the CCP (USFWS 2015a) and based on information provided in USACE (2012). **Section 3.4.4**, Sociocultural Systems, also provides a cultural overview of the Iñupiat and Gwich'in that is relevant to this section.

[42] AHRS data reviewed for this EIS in June of 2018

[43] Section 106 of the NHPA requires the BLM to evaluate effects on historic properties, which are a type of cultural resource.

Table 3-28
Cultural Themes and Periods of the Arctic Refuge Area

Theme	Period
Paleoindian	13,700 to 9,800 years ago
American Paleo-Arctic	11,800 to 8,000 years ago
Northern Archaic	8,000 to 3,000 years ago
Arctic Small Tool Tradition	5,000 to 2,400 years ago
Athabascan (including Gwich'in)	2,000 years ago, to present
Birnirk Culture	1,600 to 1,000 years ago
Thule	1,000 to 400 years ago
Iñuit (including Iñupiat and Inuvialuit)	400 years ago, to present
Euro-American exploration	1820s to 1900s
Early ethnographic research	1900s to 1920s
Trading posts and reindeer herding	1910s to 1940s
Military presence/DEW Line sites	1950s to 1980s
Land conservation	1950s to present
Oil development	1970s to present

Sources: USACE 2012; USFWS 2015a

Cultural Resources in the Program Area

Previous Archaeological and Historic Resources Surveys

In general, previous survey efforts focused on identifying archaeological and historic resources in the program area have been concentrated primarily along the coastal region, with fewer investigations along the river systems and little research in the overland areas. A review of the previous surveys module of the AHRS database (which uses section-level[44] spatial coverage for the program area) revealed 10 literature reviews, 12 reconnaissance surveys, and one intensive survey. A similar review of the document repository module of the AHRS returned 30 records for reports associated with those sections.

Past surveys were primarily concentrated in and around the village of Kaktovik, along the coast and barrier islands of the Beaufort Sea, and along several of the major rivers in the area. Of special note is one wide-area survey of the program area conducted by Edwin Hall (1982) over approximately 20 days, using aerial overflights and limited pedestrian investigation of the coastal area and select river systems. This survey represents the only attempt at systematic coverage of the program area guided by targeted surveys at high potential landforms and topographic settings. Overall, vast inland areas of the program area have received little to no systematic investigation for cultural resources; while the coastal region has been the subject of a greater number of survey efforts, dynamic coastal erosion processes are affecting those resources (Grover and Ryder 2011).

Previously Documented Sites

The USFWS (2015a, Section 4.4.1.1) identified several site types that could be found in the Arctic Refuge, and the following categories outline the types of sites that are most likely to be found in the program area:

- Coastal settlements, consisting of semi-subterranean driftwood or whalebone houses, in some cases associated with cemeteries or additional structures; post-contact and pre-contact houses are present along the coast of the Beaufort Sea
- Inland settlements, consisting of semi-subterranean driftwood or whalebone houses, also in some cases associated with cemeteries or additional structures; this is the least known type of site on the Arctic Refuge

[44]The finest resolution of the AHRS database for wide-area queries is the section level, which may result in non-program area lands being included in the search.

- Tent ring complexes, consisting of arrangements of stones used to secure skin tents to the ground, often with associated hearths in and outside the ring; these features are found along river corridors on elevated terraces and likely relate to seasonal caribou hunting; in some cases, these complexes are near or next to caribou drive lines or fences
- Lithic scatters, consisting of surface and subsurface collections of artifacts and debris resulting from the procurement, preparation, and manufacture of stone tools; in many cases, lithic typological and technological comparisons are the only way of assigning an age or cultural affiliation to a site
- Post-contact[45] structures, including sod houses and cabins, built by indigenous peoples, early explorers, and trappers that offer insights into the early contact period
- Graves and burials are another category of site types that occur in the program area.

As identified in the AHRS database, there are 89 AHRS sites recorded in the program area, including sites of both prehistoric and post-contact origin (**Appendix L**). Five are eligible for listing on the NRHP, one is not eligible, two are pending reevaluation for their eligibility, and 81 have not had formal evaluations for their NRHP eligibility.

Approximately one-third of the sites have prehistoric components, including such features as sod houses, lithic scatters, tent rings, and various artifact scatters. Due to the limited research associated with these sites, the cultural affiliation of many of them is unknown but could be associated with ancestral Iñupiat, Inuvialuit, or Gwich'in. Post-contact sites comprise the remaining two-thirds of sites and include military sites associated with the DEW Line and several Iñupiaq structures, such as sod houses, cellars, tent frames, and other buildings.

The NSB’s TLUI database documents place names, landmarks, traditional land use sites, travel routes, and important locations remembered by the Iñupiat, particularly the Kaktovikmiut and their ancestors who have occupied the Coastal Plain for thousands of years. Many of the studies that helped inform the TLUI database (e.g., Jacobson and Wentworth 1982), including ongoing TLUI updates,[46] describe in detail the strong cultural ties that the Kaktovikmiut have to the lands in and next to the Coastal Plain.

In essence, the Coastal Plain is the homeland of the Kaktovikmiut. According to the TLUI database, there are 53 recorded TLUI sites in the program area (**Appendix L**). These sites primarily consist of house ruins (both collapsed sod and cabin structures), graves, and important hunting, fishing, camping, and lookout areas. Except for five TLUI sites inland, the remaining 48 sites are located along coastal areas of the program area.

The following information, summarized from the TLUI and based on the different types of sites, demonstrates how integrally tied the Kaktovikmiut and their ancestors are to the Coastal Plain. The area has been the homeland of the Kaktovikmiut since time immemorial:

- House ruins—Many of the TLUI sites in the program area reflect widespread use by the Kaktovikmiut before centralizing in Kaktovik. Many of the ruins are associated with the names of respected elders living at these locations in the early twentieth century and who were instrumental in the establishment of the current community of Kaktovik.

[45]Refers to the period after contact with European and American people
[46]TLUI updates are ongoing, and additional work remains to document the Kaktovikmiut uses of the Coastal Plain; TLUI data in this EIS are current as of July 1, 2019.

- Graves—There are burials of past Kaktovikmiut family members also throughout the coastal locations, many near house ruins and old settlements.
- Harvesting areas—These are important places where the Kaktovikmiut could reliably find resources, such as whitefish, grayling, arctic char, Dall sheep, caribou, waterfowl, ptarmigan, and berries.
- Ice cellars—These are locations where food was stored and preserved, also often associated with nearby house ruins.
- Camps—These are places where people stayed or camped during their travels along the coast or between the coast and inland areas.
- Place names and legends—Many places have special names that translate to tell meaningful stories about the Kaktovikmiut past, including where you go to listen, primarily for whales; oil seeps; farthest north mountains; and the place where two Indian kids got swallowed by fish. The latter is also reported in TLUI as having an Indian name of Saluksa.
- Reindeer herding— These are locations used during the early twentieth century for herding reindeer.
- Trading Posts—These are post-contact stores for trading between Euro-Americans and Kaktovikmiut.

Other sources of cultural resources information are the RS 2477[47] database, and the NOAA Wrecks and Obstruction database. The RS 2477 trail database identifies three RS trails (914, 1043, and 1649) in the program area. RS 914 is the Poker (Pokok) Lagoon Southeast Trail, a 5.5-mile winter trail near Pokok Lagoon; RS 1043 is the Bullen-Staines River Trail, a 22-mile tractor trail; and RS 1649 is the Tamayariak River-Simpson Cove Trail, a 20-mile tractor trail.[48] The NOAA database identifies two shipwrecks in the program area, one just off the northeast shoreline of Barter Island and a second in Camden Bay next to the POW-DEW Line site.

BOEM (2017) states that submerged pre-contact sites dating from between 20,000 and 3,000 years before present could be in the offshore environment, depending on the regional landform variation. While the extent of disturbance to submerged landforms is unknown, past research has suggested that areas near barrier islands, such as nearshore locations in the program area, could exhibit less ice gouging and have a greater potential for intact archaeological resources (Darigo et al. 2007).

Locations of Previously Documented Sites

Due to the confidential and sensitive nature of cultural resource sites, no map is provided in this EIS; however, there are two main locations where cultural resources have been documented in the program area: on barrier islands and protected coasts of the Beaufort Sea and inland on elevated dry ground landforms, such as pingos, river terraces, and bluffs. While these are the types of landforms on which inland sites have been found, one reason for this is because these were the types of landforms focused on by Hall (1982) when he surveyed in

[47]RS 2477 is found in Section 8 of the Mining Law of 1866 and states, "The ROW for the construction of highways over public lands, not reserved for public uses, is hereby granted." This statute granted states and territories ROWs over federal lands that had no existing reservations or private entries. In Alaska, this law effectively ended in 1969, but due to the time frame in which these ROWs were established (1866–1969), these highways, trails, and other ROWs are considered historical resources and are taken into consideration in this EIS (ADNR MLW 2013).

[48]The RS 2477 trails have been identified and asserted by the State of Alaska, but the validity of all RS 2477 trails must be determined either via a determination of perfection prior to the Federal Land Policy and Management Act or through appropriate judicial proceedings

the interior. Sites of greatest antiquity are found inland, as these landforms appear to have long periods of relative stability.

Documented coastal sites are mainly post-contact, as the dynamic coastal environment appears to cause rapid displacement of sediments and soils through erosion, underlying permafrost thawing, elevated sea levels, and the likely destroying ancient shoreline sites (CCRS and NLUR 2010). These areas correspond to locations having the highest potential for human activity and where previous surveys have focused. Other undocumented sites are likely present in unsurveyed portions of the program area.

Many of the sites in the program area were documented before the use of global positioning systems, so the reported sites may not be accurate.

Ethnographic Cultural Resources

Cultural aspects of the environment are not limited only to discrete locations where physical remains of past human activities are preserved, but they may also include culturally valued places, cultural use of the biophysical environment, such as religious and subsistence uses, and sociocultural attributes, such as social cohesion, social institutions, lifeways, religious practices, and other cultural institutions (National Preservation Institute 2018). These ethnographic resources are cultural or natural features of a region, where traditionally associated cultures have formed significant connections. They are closely linked with their own sense of purpose, existence as a community, development as ethnically distinctive peoples, and survival of their lifeways.

Ethnographic resources are held as traditionally meaningful and may be sites, landscapes, structures, objects, or natural resources, such plants, animals, minerals, and bodies of water, that are assigned traditional legendary, religious, subsistence, or other significance in the cultural system of a group. The significance that cultures assigned to ethnographic resources may encompass both the tangible and the intangible aspects of these special places. These types of sites provide knowledge regarding places important to identity, spirituality, and, in the case of ethnographic landscapes, a broader more holistic way of viewing cultural resources in the natural resources that surround them.

Many terms are used by different groups to describe these ethnographic resources. Although not an exhaustive list, commonly used terms to describe the various types of ethnographic resources include the following:

- Traditional cultural properties (TCPs)
- Ethnographic landscapes
- Native American sacred sites
- Intangible cultural resources (e.g., oral traditions, indigenous knowledge, traditional skills)

Traditional knowledge provided through oral histories and scoping testimonies is one avenue of identifying ethnographic resources. Such knowledge can be derived from oral histories and public testimony and can provide traditional knowledge that is both general, such as testimony on long-standing use of the arctic environment, or very specific, such as testimony about use of a specific family subsistence camp.

Besides the NSB’s TLUI program, surveys and research to identify and document potential sacred sites, TCPs, ethnographic landscapes, or intangible resources have not been completed to date in the program area. Kaktovik commenters stressed the importance of residents being able to maintain, if not increase, their access to and management of traditional areas in the program area and broader Arctic Refuge.

During the scoping process, commenters, particularly the Gwich'in in Arctic Village and Venetie, expressed the importance of investigating TCPs in the program area. They commented that there should be an emphasis on consultation with local tribal governments and organizations, nongovernmental agencies, and other interested parties. Broadly speaking, it is evident that the program area is held as sacred by many of the Gwich'in, particularly for those residing in Arctic Village and Venetie. They identify the Coastal Plain as *Iizhik Gwats'an Gwandaii Goodlit*, "The Sacred Place Where Life Begins" (Gwich'in Steering Committee 2004). They hold it sacred because it is where life begins, particularly for its association with caribou calving and bird nesting grounds. It encompasses all aspects of the environment and is integral to the Gwich'in and their sense of self (see **Section 3.4.4**, Sociocultural Systems).

During the Draft EIS public comment period, the Native Village of Venetie Tribal Government, a cooperating agency on this EIS, identified the following preliminary landscape characteristics they believe are associated with the *Iizhik Gwats'an Gwandaii Goodlit:*

- Cultural traditions—Gwich'in cultural practices have influenced the development of the *Iizhik Gwats'an Gwandaii Goodlit* in terms of land use, patterns of land division, stylistic preferences, and the use of materials, as follows:
  - The cultural identity of the Gwich'in as the "Caribou People," which is intertwined with the PCH calving areas
  - Ancestral and historic trade with Iñupiat at places along the coast
  - Occasional battles and peaceful conflict resolution with Iñupiat
  - Ancestral and historic camping, hunting, and traveling
  - Avoidance of the area in modern times to reduce the chances of disrupting caribou calving and waterfowl nesting and to ensure future successful harvesting and preservation of the Gwich'in culture
- Circulation—Ancestral Gwich'in followed rivers to facilitate travel in the *Iizhik Gwats'an Gwandaii Goodlit* and to connect the landscape with the larger region. They used some of these travel routes for trade.
- Archaeological sites—Ancestors of the Gwich'in and Iñupiat created these sites as a result of their shared use of the program area. Many of the documented sites are along rivers that ancestral Gwich'in followed to access the program area. The ancestral Gwich'in-derived sites contribute to the significance of the *Iizhik Gwats'an Gwandaii Goodlit.*

Further efforts to describe the process for consulting, identifying, and documenting these types of ethnographic cultural resources that the Iñupiat and Gwich'in hold as culturally important would be addressed in accordance with the Section 106 process.

Transboundary Cultural Ties

In addition to the cultural ties of the Iñupiat and Gwich'in in Alaska to the program area, traditional knowledge and other forms of documentation have identified the cultural connections and ties of the Inuvialuit and Gwich'in in Canada to the program area. Long before the creation of an arbitrary US/Canada border, the ancestors of the Inuvialuit used the Arctic Coastal Plain. Many continue to maintain connections with, and have family ties to, the Iñupiat in Alaska. While the focus of the reports was on cultural uses in Canada, Milton Freeman Research Limited (1976) and the Wildlife Management Advisory Council (North Slope) and Aklavik Hunters and Trappers Committee (2018) are just two examples of researchers who describe cultural and contemporary ties between the Inuvialuit and Iñupiat traveling along the coast between the two countries.

In Alaska, SRB&A (2010) also documented these ties during their subsistence mapping project in Kaktovik. The Vuntut Gwich'in in Canada also recognize the ethnographic resource of the *Iizhik Gwats'an Gwandaii Goodlit* as being an important sacred resource for their people (Vuntut Gwich'in Government 2017). Additional details related to sociocultural and subsistence values and connections to the *Iizhik Gwats'an Gwandaii Goodlit* by the Gwich'in are identified in **Section 3.4.3** and **Section 3.4.4**.

Climate Change

As identified in the GMT2 Final SEIS (BLM 2018a) and 2012 NPR-A Final IAP/EIS (BLM 2012), cultural resources on the North Slope are susceptible to climate change effects of erosion, mass wasting, melting permafrost, and cryoturbation.[49] These effects result in increased thawing and lack of preservation of frozen artifacts. They can also cause a loss of spatial relationships between cultural levels, leading to disturbances in site integrity and context. Erosion (particularly along the coast) and melting permafrost can worsen the effects of wind erosion, cryoturbation,[50] and solifluction[51]; however, impacts from climate change are not universal across Arctic Alaska, and in some places, cultural resources may not be as affected (e.g., coastal accretion instead of erosion) or experience noticeable changes. A USACE survey of coastal sites that included locations in the program area (Grover and Ryder 2011) found that while coastal erosion is widespread, it is not uniform. Rather it depends on the geomorphological characteristics of the site location and the coastal dynamics at play.

Direct and Indirect Impacts

Issuance of oil and gas leases under the directives of Section 20001(c)(1) of PL 115-97 would have no direct impacts on the environment because by itself a lease does not authorize any on the ground oil and gas activities; however, a lease does grant the lessee certain rights to drill for and extract oil and gas subject to further environmental review and reasonable regulation, including applicable laws, terms, conditions, and stipulations of the lease. The impacts of such future exploration and development activities that may occur because of the issuance of leases are considered potential indirect impacts of leasing. Such post-lease activities could include seismic and drilling exploration, development, and transportation of oil and gas in and from the Coastal Plain; therefore, the analysis considers potential impacts on cultural resources from on-the-ground post-lease activities. The effects of climate change described under *Affected Environment* above, could influence the rate or degree of the potential direct and indirect impacts.

Alternative A

Alternative A would not result in potential direct or indirect impacts on cultural resources because no leasing activity that could affect cultural resources would occur in the program area. Existing activities that could affect cultural resources would include people using Arctic Refuge lands and waters that could lead to purposeful or inadvertent damage to cultural resources. Additionally, natural processes, such as erosion, would continue to affect cultural resource sites under this alternative.

Impacts Common to All Action Alternatives

Potential impacts associated with the development of a lease could include physical destruction of or damage to all or part of a cultural resource, removal of the resource from its original location, change in the character of the resource's use, dating potential, or change of the physical features in the resource's setting (e.g.,

[49]Refers to the mixing of materials from various horizons of the soil down to the bedrock due to freezing and thawing. Occurs to varying degrees in permafrost soils.
[50] The mixing of materials from different soil horizons due to periodic freezing and thawing, namely those of active layer sediments that overlie permafrost
[51]The downslope movement of soil as it thaws

vibration, noise, visual, or olfactory) that contribute to the resource's importance and potential eligibility for the NRHP, or change in access to traditional use sites by traditional users.

In areas where avoidance does not occur, examples of ground-disturbing activities that could potentially cause direct impacts include excavation of material sites; construction and maintenance of gravel roads, pads, airstrips, bridges and culverts; construction of ice roads and pads; construction of VSMs for power lines and pipelines; and any other disturbance of the ground surface in the proximity of development project components. Lease Stipulation 4, which imposes NSO conditions in coastal waters, lagoons, and barrier islands, would reduce the potential for ground-disturbing activities to harm submerged archaeological sites; however, the authorizations for certain infrastructure under Lease Stipulation 4, such as pipelines, docks, and barge landings, could affect these types of sites.

Other activities and events that could potentially cause direct impacts on cultural resources include seismic and other exploratory activities, damage caused by equipment during the exploration, development, production, and abandonment and reclamation phases of development projects, and unanticipated accidents, such as blowouts, spills, or fires, and subsequent cleanup activities (see **Appendix B** for description of the reasonably foreseeable development scenario). Certain future impacts, such as oil spills, can contaminate site artifacts and organic materials to make them undatable. Section 4.3.12.2 in BLM 2012 provides additional discussion of potential direct impacts on cultural resources associated with oil and gas exploration and development.

Potential indirect impacts on cultural resources could also occur at distances greater than the development project footprints. Indirect impacts on cultural resources could occur throughout the five phases of a development project and during closure and reclamation. Examples of indirect impacts on cultural resources could include increased access and potential unauthorized removal, trampling, or dislocation of cultural resources and culturally sensitive areas by personnel and visitors; complete or partial destruction of a site from erosion, thawing permafrost, and thermokarsting; the loss of traditional meaning, identity, association, or importance of a resource; effects on beliefs and traditional religious practices; or neglect of a resource that causes its deterioration.

While potential impacts on specific cultural resource sites would differ by alternative (see discussion below), broader cultural impacts on belief systems/religious practices would be common across all alternatives. Particularly for the Gwich'in, who hold the program area as sacred ground to their culture and as *Iizhik Gwats'an Gwandaii Goodlit* (Gwich'in Steering Committee 2004), the presence of development in the program area would constitute a cultural impact on the Gwich'in. This is because they believe that development in the program area would harm the caribou and other migratory resources (such as waterfowl) that migrate to the Coastal Plain to give birth.

This sacred pattern of migration and birth maintains the value of, and gives essence to, the Coastal Plain as the place where life began. This sacred belief is based on the intergenerational traditional knowledge of the Gwich'in that is built on millennia of residence in the region (see Irving 1958 and Kofinas et al. 2002 for examples of this knowledge). Similar to the cultural value that Iñupiat place on bowhead whales in their culture, caribou are held in the highest regard by the Gwich'in and are the backbone of their cultural identity (Slobodin 1981). Any potential impacts on the resource would constitute a cultural effect. These effects, including those on belief systems, are also discussed in **Section 3.4.4**.

Both the Iñupiat and the Gwich'in have cultural and ethnographic ties to the program area, as evidenced by cultural sites, traditional and contemporary uses, oral histories, and current beliefs and values. When these are viewed as a whole, these ties to land and place are often documented and identified in the cultural resource regulatory framework as TCPs or cultural landscapes.

These types of cultural resources have not been documented to date in the program area under the existing regulatory frameworks, although the wide array of individual TLUI and AHRS sites in the program area demonstrate the potential for these ethnographic resources, such as TCPs, cultural landscapes, and sacred sites, to be documented. While the available data (see *Affected Environment*, above) have not documented these types of cultural resources for Iñupiat or the Gwich'in in the program area, the absence of these cultural resources can be attributed to the lack of past research to document these types of resources rather than the fact that they do not exist.

The Gwich'in in Arctic Village have stated that documented and undocumented TCPs do exist for them that they believe could be affected by oil and gas leasing in the program area and that the Section 106 consultation process needs to fully consider these cultural resources. Other scoping testimony identified the Coastal Plain of the Arctic Refuge as a cultural landscape that provides for indigenous communities and that the area should be explicitly analyzed as a traditional cultural landscape of the Gwich'in Nation.

In summary, given the information currently available and the undetermined location and nature of development in the program area, potential impacts on traditional belief systems/religious practices and other ethnographic cultural resources, such as TCPs and cultural landscapes, particularly for the Gwich'in, would be adverse, regional, and long term. Continued consultation with the tribes during the NEPA and Section 106 processes will continue to explore options for minimization and mitigation measures related to ethnographic cultural resources. For cultural resource sites in the program area where direct effects could not be avoided or that would experience indirect effects, the impacts would be adverse, local, and long term.

No potential adverse effects on documented specific cultural resource sites would be expected in areas where adequate investigation, such as surveys, consultation, and interviews, has occurred prior to development and where appropriate avoidance, minimization, or mitigation measures are implemented. The Section 106 process for addressing effects on historic properties is occurring concurrently with the NEPA process and will include the development of a programmatic agreement to address the process for identifying historic properties and resolving potential adverse effects through avoidance, minimization, or mitigation.

Lease Stipulations 1, 2, 3, and 4 include provisions to buffer various oil and gas activity areas where cultural resource sites have a higher potential of occurring, such as along certain rivers and streams, springs/aufeis, and coastal locations. Required operating procedures already proposed include conducting cultural surveys before ground-disturbing activities begin (ROP 29) and cultural awareness training and orientation (ROP 40).

Alternative B (Preferred Alternative)

Under Alternative B, the types of potential impacts on cultural resources would be the same as those described above (*Impacts Common to All Action Alternatives*). Alternative B would make available the largest number of acres for potential leasing and development; therefore, in terms of direct and indirect impacts on cultural resource sites (e.g., TLUI, AHRS, RS 2477 trails), Alternative B could affect the greatest number of documented sites (**Table 3-29**). Thirty-six AHRS and 28 TLUI sites are in areas that are open with standard terms and conditions or TLs and could experience ground-disturbing activities. RS 2477 trails #1649 and #914 also occur in these areas. An additional 57 AHRS and 25 TLUI sites are in areas of NSO and would have less potential to be affected, due to the reduced levels of ground-disturbing activities in the NSO areas. RS 2477 trails #1649, #1043, and #914 and the two shipwrecks occur in the NSO area.

Table 3-29
Cultural Resource Sites by Action Alternative

Alternative	STC/TL	CSU	NSO	Not Offered for Lease Sale
B	36 AHRS 28 TLUI 2 RS 2477	n/a	57 AHRS 25 TLUI 3 RS 2477 2 shipwrecks	n/a
C	6 AHRS 3 TLUI 1 RS 2477	n/a	85 AHRS 50 TLUI 3 RS 2477 2 shipwrecks	n/a
D1	1 AHRS 1 TLUI	0	74 AHRS 47 TLUI 3 RS 2477 2 shipwrecks	15 AHRS 5 TLUI
D2	1 AHRS 1 TLUI	0	56 AHRS 34 TLUI 4 RS 2477 2 shipwrecks	33 AHRS 18 TLUI 1 RS 2477

Source: BLM GIS 2018
Notes: Some larger sites may overlap multiple lease areas. This table does not include ethnographic resources, which are addressed under *Impacts Common to All Action Alternatives*.
STC = Subject only to standard terms and conditions
TL = Timing limitations
CSU = Controlled surface use
NSO = No surface occupancy

Because Alternative B has the smallest setbacks from areas of highest potential for containing undocumented cultural resources, such as rivers and coastline, this alternative would have the highest likelihood for affecting undocumented resources. Potential impacts on cultural resource sites under Alternative B would be adverse, local (up to 2,000 acres of development and general vicinity), and long term for sites that could not be avoided or would experience indirect effects.

Alternative C

Alternative C would have the same number of acres available for potential leasing and development compared to Alternative B, but a larger number of acres would be subject to NSO stipulations, which have less potential to impact cultural resource sites; therefore, in terms of direct and indirect impacts on documented cultural resource sites (e.g., TLUI, AHRS, RS 2477 trails), Alternative C would have fewer sites affected in areas subject only to standard terms and conditions or TL stipulations than Alternative B.

Six AHRS and three TLUI sites are in standard terms and conditions/TL areas that are open to leasing and could experience ground-disturbing activities (**Table 3-29**). RS 2477 trail #1649 occurs in these areas. An additional 85 AHRS and 50 TLUI sites are in the NSO area and would have less potential to be affected due to the reduced levels of ground-disturbing activities. RS 2477 trails #914, #1043, and #1649 occur in the NSO area as do the two shipwrecks.

Because Alternative C has a 1-mile pad and CPF exclusion area near the coast, it has a slightly lower likelihood than Alternative B for affecting undocumented cultural resources. Potential impacts on cultural resource sites under Alternative C would be of lower intensity than Alternative B and would be adverse, local (up to 2,000 acres of development and general vicinity), and long term for sites that could not be avoided or would experience indirect effects.

Alternative D

Alternative D1 and D2 would make available the fewest number of acres for potential leasing and development and therefore, in terms of potential direct and indirect impacts on documented cultural resource sites (e.g., TLUI, AHRS, and RS 2477 trails), Alternative D2 would affect the fewest number of sites. Only one AHRS and one TLUI site are in the areas subject to only standard terms and conditions or TLs that are open to leasing and could experience ground-disturbing activities (**Table 3-29**). An additional 74 AHRS and 47 TLUI sites are in the NSO area under Alternative D1 and 56 AHRS and 34 TLUI under Alternative D2. These sites would have less potential to be affected, due to the reduced levels of ground-disturbing activities.

Three RS 2477 trails occur in the NSO area under Alternative D1 and four under Alternative D2; the two shipwrecks are also in the NSO area.

Lastly, 15 AHRS sites and 5 TLUI sites are in areas not offered for lease sale under Alternative D1. An even greater number (33 AHRS, 18 TLUI, and 1 RS 2477) are not offered for lease sale under Alternative D2 and would not experience impacts.

Because Alternatives D1 and D2 have the largest setbacks from areas of highest potential for containing undocumented cultural resources, such as rivers and coastline, these alternatives would have the lowest likelihood for affecting undocumented resources. Potential impacts on cultural resource sites under Alternative D1 or D2 would be of lower intensity than under Alternative B and would be adverse, local (up to 2,000 acres of development and general vicinity), and long term for sites that could not be avoided or would experience indirect effects. Of the action alternatives, Alternative D2 would have the fewest impacts on cultural resources, due to it having the largest area not offered for lease sale.

Transboundary Impacts

Transboundary impacts would be similar to those described above under *Impacts Common to All Action Alternatives*. For the Inuvialuit, oral histories and traditional knowledge attest to coastal uses that they encountered while traveling between the Iñupiat and Inuvialuit areas. Documented and undocumented cultural sites associated with this past use in coastal locations could experience direct and indirect impacts from development associated with exploration, development, production, and abandonment and reclamation.

Furthermore, certain subsistence species, such as the PCH, polar bears, Arctic cisco, seals, whales, and grizzly bears, which move or migrate through the program area into Inuvialuit territory, have strong cultural significance. For example, the Inuvialuit portray the polar bear as a prominent cultural icon in their mythology, spirituality, storytelling, art, song, and other forms of cultural expression (Joint Secretariat 2015). Impacts on these subsistence resources would therefore have corresponding indirect cultural impacts on Inuvialuit (see **Sections 3.3.4**., **3.3.5**, and **3.4.3**).

The Canadian Gwich'in could also experience cultural impacts in relation to effects on the ethnographic resource of *Iizhik Gwats'an Gwandaii Goodlit* (see *Impacts Common to All Action Alternatives*). In terms of action alternatives and associated impacts, Alternative D would have the fewest impacts on cultural resource due to the lower likelihood for affecting undocumented cultural resource sites. The lower likelihood is because of the larger setbacks and also the more restrictive stipulations and ROPs, which would lead to fewer impacts on biological resources that have cultural importance to the Inuvialuit and Gwich'in.

Cumulative Impacts

Past, present, and reasonably foreseeable future activities, in combination with oil and gas development in the program area, would increase the potential for cultural resource impacts, both directly on specific cultural resource sites and other ethnographic resources such as TCPs and cultural landscapes. Past and present actions that have affected cultural resources are oil and gas exploration, development, and production; onshore and offshore transportation and infrastructure projects; increased recreation and tourism; scientific research; community development; and climate change. The types of effects include destruction or possible disturbance of undocumented cultural resources, added noise and visual effects on cultural resources and traditional use areas, and fragmentation of culturally important areas by reducing access and by changes in local resource availability.

Because of the potential of many undocumented cultural resources on the North Slope, it is difficult to quantify the extent to which they have been affected by past and present activities. Generally speaking, early oil and gas exploration and seismic, military construction, community infrastructure projects on the North Slope had greater potential to affect cultural resources. This was due to the less stringent regulations and identification requirements than what are in place today. In the program area, for example, military construction of the DEW relay station south of Nuvagapak Point along Beaufort Lagoon occurred in an area of previous Iñupiat use; subsequent formerly used defense site cleanup disturbed human remains.

Proposed and current activities that could affect cultural resources are the additional or continued development of onshore and offshore oil and gas resources. Reasonably foreseeable activities include theSAExploration 3D seismic proposal.

Other reasonably foreseeable activities that introduce impacts are from additional infrastructure projects, such as scientific research, recreation and tourism in the region, and new permanent and seasonal roads, airport improvements, and community infrastructure improvements through the ASTAR program.

Today, local, state, and federal regulations provide for stricter identification requirements that diminish the chances for direct impacts on cultural resources from projects like those mentioned above. In most instances, avoidance policies are implemented around documented cultural resource sites, particularly those that are eligible for listing on the NRHP; however, the potential for impacts, particularly for undocumented cultural resource sites, increases with oil and gas exploration, development, and production, with onshore and offshore transportation and infrastructure projects, increased recreation and tourism, scientific research, and community development.

Indirect impacts can occur, are less easy to avoid or mitigate, and could have substantial consequences to cultural resources. Such potential impacts are as follows:

- Decreased or increased access
- Potential removal, trampling, or dislocation of cultural resources and culturally sensitive areas by personnel and visitors
- Complete or partial destruction of a site from erosion, thawing permafrost, and thermokarsting
- Loss of traditional meaning, identity, association, or importance of a resource
- Effects on beliefs and traditional religious practices
- Neglect of a resource that causes its deterioration

The updated Nuiqsut Paisaŋich (SRB&A 2018a) documented an example of indirect effects on traditionally used fish camps near Nuiqsut. Although the site is physically intact, Nuiqsut families, since the early 2000s, have not used the fish camps at the traditional *Nanuq* site. Reasons for the abandonment are development of the Alpine oil fields, resulting changes in caribou migration, and an increase in dust from development that prohibits fish drying, due to dust settling on the fish racks (SRB&A 2018a).

Others attribute the abandonment to decreasing water levels that led to reduced fishing success, possibly an indicator of climate change-induced effects. The effects of climate change, described under *Affected Environment* above, introduce cumulative impacts that could influence the rate or degree of the potential cumulative impacts. In general, the effects of climate change, while not uniform across the North Slope, are adverse, in that they hasten the disturbance or eventual destruction of cultural resource sites through erosion or thawing permafrost leading to decreased preservation or by exacerbating the effects of thermokarsting, cryoturbation, and solifluction.

Other examples of indirect effects, such as unauthorized artifact collection, have been recently identified as potential causes for the lack of formal and culturally diagnostic artifacts near the Toolik Lake Research Natural Area on the North Slope. Here there has been an increase in research activities, hunters, and recreationists since the 1970s (SRB&A 2019). Infrastructure projects, such as those implemented through ASTAR, could result in greater public access to cultural resources in the program area, thus resulting in even greater potential for unauthorized collection or inadvertent disturbance of sites.

Cumulative impacts would have the greatest effect on ethnographic resources, such as TCPs and cultural landscapes. Compared to specific sites, impacts there are not as easy to avoid and mitigate because their significance is tied to historic and present cultural identity. These could be affected by the presence of development. This cultural identity relates to the cultural importance of the land and its surrounding natural resources, such as the Gwich'in and *Iizhik Gwats'an Gwandaii Goodlit*.

For these reasons, the action alternatives, in combination with other oil and gas exploration and other proposed development or recreation activities on the North Slope, have the potential to create cumulative effects on cultural resources. Alternatives that allow the greatest amount of land to be developed are likely to have the greatest cumulative effect on cultural resources. This is because they could affect a greater number of documented and undocumented cultural resources; thus, Alternative B would have the largest contribution to cumulative effects on cultural resources, while of the action alternatives, Alternative D2 would have the smallest contribution to cumulative effects on cultural resources.

3.4.3 Subsistence Uses and Resources

Affected Environment

This section summarizes the relevant subsistence activities of communities that use the program area or the resources that migrate through the program area and are harvested elsewhere. For the purposes of this analysis, there are four primary subsistence study communities: Kaktovik, Nuiqsut, Arctic Village, and Venetie. They are the closest to the program area and have subsistence uses in or near the program area or rely heavily on resources that use the program area. In addition, because of the importance of the program area to caribou—particularly the PCH and CAH—this section also includes relevant data on subsistence uses of caribou by 22 Alaskan communities, including the four subsistence study communities listed below, in GMU subunits in the PCH and CAH herd ranges, which have Federal Subsistence Board customary and traditional[52] use

[52]Customary and traditional use, based on federal definitions (36 CFR 242.4), means a long-established, consistent pattern of use, incorporating beliefs and customs that have been transmitted from generation to generation. This use plays an important role in the economy of the community. Where the Federal Subsistence Board has made a customary and traditional use determination regarding subsistence use of a specific fish stock or wildlife population (36 CFR 242.24), only those Alaskans who are residents of rural areas or communities designated by the board are eligible for taking of that population or stock on public lands for subsistence uses.

determinations for caribou (**Map 3-41**, Coastal Plain EIS Subsistence Study Communities, in **Appendix A**). In this EIS, these communities are referred to as the caribou study communities. Many of these communities, such as Fort Yukon, Chalkyitsik, Wiseman, Beaver, Circle, Birch Creek, and Stevens Village, have reported geographic, historic/prehistoric, or cultural ties to the Arctic Refuge as a whole (USFWS 2015a).

Additionally, Gwich'in, Inuvialuit, and other user groups in Canada have cultural, historical, and subsistence ties to the Arctic Refuge or the PCH or both. According to the Agreement Between the Government of Canada and the Government of the United States of America on the Conservation of the Porcupine Caribou Herd, "when evaluating the environmental consequences of a proposed activity, the Parties will consider and analyze potential impacts, including cumulative impacts, to the Porcupine Caribou Herd, its habitat and affected users of Porcupine Caribou" (Section 3(g)). Canadian uses of the PCH and other subsistence resources relevant to the program area are addressed under the section below, *Transboundary Subsistence Uses*.

Additional associated information relevant to subsistence is in **Section 3.4.4**, which addresses cultural history, social and political organization, mixed cash/subsistence economy, and belief systems; **Section 3.4.2**, Cultural Resources, addresses prehistory/history, archaeological sites, and traditional land use sites.

Subsistence Definition and Relevant Legislation

Subsistence is a central aspect of rural life and culture and is the cornerstone of the traditional relationship of the indigenous people with their environment. Residents of the study communities rely on subsistence harvests of plant and animal resources both for nutrition and for their cultural, economic, and social well-being. Activities associated with subsistence—processing, sharing, redistribution networks, cooperative and individual hunting, fishing, and gathering, and ceremonial activities—strengthen community and family social ties, reinforce community and individual cultural identity, and provide a link between contemporary Natives and their ancestors. These activities are guided by traditional knowledge, based on a long-standing relationship with the environment. More than just food, subsistence includes economic, social, cultural/traditional, and nutritional elements.

The program area is almost entirely on federal lands managed by the USFWS; Alaska Native allotments comprise about 900 surface acres. In Alaska, subsistence hunting and fishing are regulated under a dual management system by the State of Alaska and the federal government. Subsistence activities on all lands in Alaska, including private lands, are subject to state or federal subsistence regulations. Fish and wildlife harvesting on corporation-owned land being managed by the State. See USFWS (2015a) for a more in-depth discussion of subsistence management in the Arctic Refuge.

Overview of Subsistence Uses

The following sections provide a brief overview of subsistence uses for the four study communities, in addition to *Subsistence Uses of the PCH and CAH*, below. Additional subsistence data tables are provided in **Appendix M**, and maps are provided in **Appendix A**. Other sources provide additional descriptions of subsistence or contain data that are relevant to subsistence but are not directly comparable to the information in this section, such as reported versus estimated harvests and Native households versus all households. These sources include the USFWS (2015a, Section 4.4.4), which provides a detailed description of subsistence uses in the Arctic Refuge, and the NSB census reports and community plans (e.g., NSB 2015a, 2015b), which includes subsistence data that focus on Native households and selected resources.

Kaktovik

Kaktovik residents are the primary subsistence users of the program area, which crossed much of the community's traditional and contemporary area of subsistence use (**Map 3-42**, Kaktovik Subsistence Use

Areas, in **Appendix A**). Kaktovik use areas from the two previous comprehensive all resources mapping studies show overlap with the program area; for the most recent period (1996 to 2006), the data show the greatest amount of overlapping use areas in the program area occurring along the coast, between Beaufort Lagoon and Brownlow Point, and inland around the Sadlerochit, Hulahula, and Jago Rivers. In addition, high levels of overlapping subsistence use areas occur offshore from the program area in the Beaufort Sea. All respondents (38 active harvesters) (SRB&A 2010) reported 1996 to 2006 subsistence uses in the program area.

Kaktovik use areas overlap with the program area for the following resources: terrestrial mammals (including caribou, moose, grizzly bear, and Dall sheep), furbearers and small land mammals, fish, birds (including geese and eiders), vegetation, and marine mammals (including bowhead whale, beluga whale, seal, walrus, and polar bear) (**Map 3-43**, Kaktovik Caribou Subsistence Use Areas in Coastal Plain, through **Map 3-53**, Kaktovik Polar Bear Subsistence Use Areas in Coastal Plain, in **Appendix A**). The primary inland subsistence uses for Kaktovik in the program area are caribou, furbearer, and grizzly bear hunting, in addition to limited moose hunting, vegetation gathering, and fishing in select locations along rivers. The primary coastal subsistence uses that overlap the program area are fishing, harvesting vegetation, and hunting for caribou, geese, eider, and bearded and ringed seals in nearshore areas. Offshore areas are used primarily for hunting bowhead whales, with more limited walrus hunting.

The timing of subsistence activities in Kaktovik is depicted in **Table M-4** in **Appendix M**. Subsistence activity, in terms of the number of resources targeted, is highest during the late summer/fall, when residents hunt bowhead whales in addition to targeting caribou, moose, fish, waterfowl, and plants and berries. April is another busy time, when geese arrive in the area and are harvested along the coast and inland. The fewest resources are targeted from December through February, although some residents pursue inland resources, such as furbearers, moose, caribou, and freshwater fish during this time.

Kaktovik residents access much of their subsistence use along the coast using boats, while inland travel is limited exclusively to four-wheel vehicles along coastal locations in the summer/fall and large overland areas by snowmachine in the winter (**Table M-5** in **Appendix M;** SRB&A 2010). Inland travel during the snow-free months is limited due to restrictions on motorized access in the Arctic Refuge. Residents also walk or use vehicles to access subsistence use areas on Barter Island. The program area, which includes coastal, nearshore, and inland subsistence use areas, is accessed using boats and snowmachines, with some inland travel from the coast by four-wheel vehicles.

As shown in **Table 3-30**, based on years with available data, Kaktovik residents harvest an annual average of 588 pounds of subsistence resources per capita. Marine mammals are the primary resource harvested in terms of edible weight, contributing over 60 percent toward the community’s subsistence diet. Large land mammals are the second-most harvested resource by edible weight, followed by fish other than salmon and migratory birds. During most years, the primary subsistence species harvested by Kaktovik residents (**Table M-3** in **Appendix M**) is bowhead whale, caribou, Dolly Varden, Arctic cisco, beluga whale (during some years), bearded and ringed seal, Dall sheep, and moose.

Over 90 percent of Kaktovik households participate in one or more subsistence resource harvesting activities, with over two-thirds of households participating in marine mammal hunting, fishing, and large land mammal hunting. Sharing is a central aspect of Kaktovik subsistence. A recent BOEM-funded study on sharing networks documented Kaktovik households giving an average of 3.1 and receiving 4.5 core species (identified by Kofinas et al. [2016] as being harvested in the greatest quantity, having the most cultural importance, and

Table 3-30
Selected Kaktovik Harvest and Participation Data, Average Across Available Study Years

Resource Category	Estimated Pounds Per Capita	Percent of Total Harvest	Percentage of Households			
			Using	Attempting to Harvest	Giving	Receiving
All resources	588	100.0	99	92	83	98
Salmon	1	<1	16	5	6	12
Non-salmon fish	57	10.1	87	70	53	72
Large land mammals	176	24.7	97	68	60	93
Small land mammals	1	<1	45	41	21	22
Marine mammals	318	62.7	93	72	61	91
Marine invertebrates	<1	<1	1	1	0	1
Migratory birds	12	1.9	80	63	45	65
Upland game birds	3	<1	80	60	42	47
Bird eggs	<1	<1	9	6	5	6
Vegetation	1	<1	49	38	15	36

Sources: 1985, 1986 (ADFG 2018c); 1992 (Fuller and George 1999); 1992 (Pedersen 1995a); 1994-95 (Brower et al. 2000); 2000-01, 2001-02 (Pedersen and Linn 2005); 2002-03 Bacon et al. 2009); 2007-2012 (Harcharek et al. 2018); 2010-11 (Kofinas et al. 2016)
Note: See **Tables M-1, M-2,** and **M-3** in **Appendix M** for data by study year.

being representative of a range of resources). The study found that during a single year, 176,577 pounds of subsistence foods flowed between Kaktovik households. In addition to food, sharing was in the form of labor, money/equipment, and other contributions. Sharing networks extend across nearly all regions of Alaska and to other states (Kofinas et al. 2016). Sharing not only serves to distribute food throughout a community, but "social relations in the form of cooperation and sharing persist and may act as sources of resilience for community households" (Kofinas et al. 2016); thus, sharing is a crucial part of social structure, social ties, and resiliency in Alaska Native communities.

An analysis of resource importance, based on material (percentage of total harvest) and cultural (percentage of households harvesting and percentage of households receiving), is provided in **Table M-6** in **Appendix M** (see USACE [2012] for a description of the method used). Based on this analysis, resources of major importance in Kaktovik are bearded seal, Bering cisco, bowhead whale, caribou, Dall sheep, Dolly Varden/Arctic char, ptarmigan, and wood.

Nuiqsut

Nuiqsut is west of the program area, where there are limited subsistence uses; however, Nuiqsut residents harvest resources that migrate through the area (**Map 3-54**, Nuiqsut Subsistence Use Areas, in **Appendix A**). For the most part, Nuiqsut subsistence users utilize lands west of the Prudhoe Bay area, although many of the lands in the area were traditionally used by Nuiqsut people. In addition, the community's whaling grounds are based out of Cross Island and whaling sometimes extends offshore of the program area. As shown in **Map 3-55**, Nuiqsut Whales Subsistence Use Areas in Coastal Plain, **Map 3-56**, Nuiqsut Seal Subsistence Use Areas in Coastal Plain, and **Map 3-57**, Nuiqsut Wolf and Wolverine Subsistence Use Areas in Coastal Plain, in **Appendix A**, Nuiqsut use areas overlap the program area for marine mammals (bowhead whale and ringed/bearded seal; three mapping studies) and furbearers (wolf and wolverine; one mapping study).

For the most recent period for which information is available (1995 to 2006), bowhead whale and seal use areas overlap the program area in nearshore areas east of Flaxman Island. Cross Island whaling crews travel this far east during certain years, depending on ice conditions and resource availability. During certain years, whaling crews have reported disturbances in their hunting area from vessel traffic and seismic activity. A wolf and wolverine hunting area, likely reported by a single hunter, was documented extending overland from

Nuiqsut's core hunting area and crossing the Sadlerochit, Hulahula, and Jago Rivers. Use areas overlapping the program area were reported by four Nuiqsut respondents (12 percent; SRB&A 2010). Nuiqsut residents harvest caribou primarily from the Teshekpuk Herd and the CAH, which sometimes passes through the program area before heading west toward the Colville River delta.

Data on the timing of Nuiqsut subsistence activities are depicted in **Table M-9** in **Appendix M**. August and September are the peak of hunting and harvesting in Nuiqsut, when residents station whaling crews at Cross Island, hunt moose and caribou, and harvest fish. October/November is a crucial time for subsistence in the community, when residents set nets for Arctic cisco (*qaaktak*) as they run upriver. These *qaaktak* are the same that originate in the Mackenzie River delta and migrate west along the coast, passing by the program area, before arriving at their destination in the Colville River delta.

Winter activities are limited primarily to furbearer and caribou hunting, with some fishing through the ice. Residents travel by snowmachine and boat during the spring to hunt waterfowl and then travel offshore and inland during the summer by boat to hunt seals and caribou, set nets for broad whitefish, fish for grayling and Dolly Varden, and harvest berries. Boats are the most commonly used method of transportation for Nuiqsut subsistence activities, although snowmachines are necessary for inland pursuits, such as wolf and wolverine hunting and geese hunting (**Table M-10** in **Appendix M**). In recent years, all-terrain vehicles and trucks have become more commonly used during the summer and fall, when residents hunt caribou to the west of the community (SRB&A 2017b).

As shown in **Table 3-31**, based on years with available data, Nuiqsut residents harvest an annual average of 679 pounds of subsistence resources per capita. Marine mammals, large land mammals, and fish other than salmon contribute nearly equal amounts toward the subsistence harvest, although bowhead whaling success often determines the relative contribution of other resources (**Table 3-31**, and **Table M-7** in **Appendix M**). During most years, the primary subsistence species harvested by Nuiqsut residents (**Table M-8** in **Appendix M**) are bowhead whale, caribou, Arctic cisco, broad whitefish, bearded and ringed seal, white-fronted geese, and moose.

Table 3-31
Selected Nuiqsut Harvest and Participation Data, Average Across Available Study Years

Resource Category	Estimated Pounds per Capita	Percent of Total Harvest	Percentage of Households			
			Using	Attempting to Harvest	Giving	Receiving
All resources	679	100.0	100	95	93	98
Salmon	5	<1	65	43	31	35
Fish other than salmon	209	30.6	97	81	81	79
Large land mammals	224	32.6	96	77	77	78
Small land mammals	<1	<1	45	41	17	12
Marine mammals	226	33.8	97	54	60	97
Migratory birds	13	2.3	85	78	58	52
Upland game birds	2	<1	54	48	36	15
Bird eggs	<1	<1	24	16	8	11
Vegetation	1	<1	61	52	19	33

Sources: 1985 (ADFG 2018c); 1992 (Fuller and George 1999); 1993 (Pedersen 1995b); 1994-95 (Brower and Hepa 1998); 1995-96, 2000-01 (Bacon et al. 2009); 2014 (Brown et al. 2016)
Note: See **Tables M-7** and **M-8** in **Appendix M** for data by study year.

One hundred percent of Nuiqsut households report using subsistence resources, and 95 percent participate in one or more subsistence resource harvesting activities, with over two-thirds of households participating in harvests of fish other than salmon, large land mammals, and migratory birds. Household participation in bowhead whale hunting is relatively limited, due to the substantial distance of the whaling site (Cross Island) from the community and the required absence from the community. Nuiqsut residents consider sharing to be central to their identity; the bowhead whale hunt, in particular, centers on sharing, as evidenced by the 97 percent of households who receive bowhead whale meat annually.

An analysis of resource importance, based on indices of harvest (percentage of total harvest), harvest effort (percentage of households attempting harvests), and sharing (percentage of households receiving), is provided in **Table M-11** in **Appendix M**. Based on this analysis, resources of major importance in Nuiqsut are Arctic cisco, Arctic grayling, bearded seal, bowhead whale, broad whitefish, burbot, caribou, cloudberry, white-fronted geese, and drift wood.

Arctic Village

Arctic Village is south of the program area, on the south side of the Brooks Range, along the East Fork Chandalar River. As shown in **Map 3-58**, Arctic Village and Venetie Subsistence Use Areas, in **Appendix A**, Arctic Village subsistence use areas do not overlap the program area; however, Arctic Village is on the Arctic Refuge boundary, so most subsistence activities do extend into the refuge. Resource uses farthest north toward the program area are sheep and caribou hunting and furbearer harvesting.

Caribou is the most important food source for Arctic Village and other northern Gwich'in and they refer to themselves as the caribou people (see **Section 3.4.4**). Caribou from the PCH calve in the program area, and for this reason, it is considered sacred ground to the Gwich'in (USFWS 2015a). Subsistence harvesting by Arctic Village residents generally occurs on their lands or in the Arctic Refuge south of the program area. Key harvesting locations are Old John Lake, the Chandalar, Sheenjek, Junjik, and Wind rivers, and Red Sheep Creek (USFWS 2015a).

Data on the timing of Arctic Village subsistence activities are depicted in **Table M-14** in **Appendix M**. In terms of the number of resources targeted, the fall and winter are the most active times for subsistence harvesters in Arctic Village. From August through October, residents target a variety of large land mammals, including caribou, moose, and Dall sheep, in addition to fishing and harvesting wood for the upcoming winter. The fall is particularly important for caribou hunting, as residents wait for caribou from the PCH to migrate through their traditional hunting grounds after the PCH has spent the spring and summer on the North Slope, including in the program area (USFWS 2015a). Caribou hunting continues through the winter as caribou are available, and residents also set traps during this time. The spring and summer are primarily dedicated to the harvest of waterfowl and fish.

Harvest data estimated for the community of Arctic Village are somewhat limited. Residents shared that this is associated with a general distrust by Arctic Village residents of outsiders and state and government officials. This is rooted in historic injustices against the Gwich'in and a lack of respect by resource managers (Alliance for a Just Society and Council of Athabascan Tribal Governments, no date).

While no systematic household surveys were conducted, Caulfield (1983) reports that during the 1981-82 period, Arctic Village residents reported harvesting between 300 and 400 caribou, substantially higher than reported estimates for other nearby communities, such as Venetie and Kaktovik. Based on data collected by the Council of Athabascan Governments (2003), 98.4 percent of Arctic Village households report receiving and using moose or bear meat, and the same percentage of households report attempting to harvest these resources;[53] thus, participation in large land mammal hunting among Arctic Village households is high.

Forty-four moose were reported harvested by Arctic Village households in 2003. These CATG data (e.g., Council of Athabascan Tribal Governments 2002, 2003, 2005) are not estimated for the entire community or have low response rates. Because of this, they are not comparable to the more comprehensive surveys, which report estimated harvests for the community as a whole; however, the reported percentages demonstrate that moose and caribou are highly important to the subsistence harvest of Arctic Village. The USFWS (2015a) states that, based on reported harvests alone and not community-wide estimates, moose and caribou comprised more than 90 percent of the harvest by weight during harvest years in the 1990s and early 2000s.

Data that estimate harvests for the entire community are limited to less complex studies documenting harvests of migratory birds and fish. As shown in **Table 3-32**, based on 3 years of limited data, Arctic Village residents harvested an average of 51 pounds of non-salmon fish per capita, and 6 pounds of migratory birds per capita. Scoters were the most commonly harvested migratory bird, followed by scaup, long-tailed ducks, mallards, and white-fronted geese. Whitefish, particularly humpback whitefish and broad whitefish, contributed the greatest amount to the non-salmon fish harvest, with Arctic grayling and northern pike also contributing substantial amounts (**Table M-13** in **Appendix M**).

Table 3-32
Selected Arctic Village Harvest and Participation Data, Average Across Available Study Years

Resource Category	Estimated Pounds Per Capita	Percent of Total Harvest	Percentage of Households			
			Using	Attempting to Harvest	Giving	Receiving
Non-salmon fish	51	—	71	—	23	35
Migratory birds	6	—	—	—	—	—

Sources: 2000 (Andersen and Jennings 2001); 2001, 2002 (ADFG 2018c)
Note: See **Tables M-12 and M-13 in Appendix M** for data by study year.

An average of 70 percent of households use non-salmon fish (**Table 3-32**), and half of Arctic Village households report harvesting fish other than salmon. Forty-six percent reported harvesting migratory birds during the 2000 study year and 87 percent used migratory birds (**Table M-12** in **Appendix M**).

While data on sharing subsistence resources are limited to fish, the strong sharing relationship between Arctic Village and its sister village of Venetie, with whom it shares ownership of tribal lands, has been documented (Kofinas et al. 2016). This relationship is particularly important because of the more limited availability of certain resources, such as moose in the Arctic Village area, in addition to the relatively limited availability of caribou in the Venetie area.

Data to calculate resources of importance for Arctic Village are not available, as there have been no comprehensive household harvest surveys in that community; however, based on existing literature reviews and statements from community members during public scoping and elsewhere, the assumption is that caribou are a resource of primary subsistence, economic, cultural, and spiritual importance for the community of Arctic Village (see **Appendix C** and **Appendix R**).

[53]Caulfield did not address caribou hunting in the study.

Venetie

Venetie is south of Arctic Village on the Chandalar River. As shown on **Map 3-58** in **Appendix A**, Venetie subsistence use areas do not overlap the program area. As with Arctic Village and other Gwich'in, Venetie residents consider caribou to be a primary food source and central to their cultural identity (see **Section 3.4.4**). Subsistence harvesting by Venetie residents generally occurs on tribal lands surrounding their community and surrounding the Chandalar (including the East and Middle Forks), Yukon, Christian, and Hadweenzic Rivers (Caulfield 1983; Van Lanen et al. 2012). Caribou are primarily available to Venetie and Arctic Village residents along the upper Chandalar River drainage and the foothills of the Brooks Range (Van Lanen et al. 2012).

Data on the timing of Venetie subsistence activities are listed in **Table M-18** in **Appendix M**. In terms of the number of resources targeted, the spring and fall are the most active times for subsistence harvesters in Venetie. Fishing and hunting of waterfowl, black and brown bears, and small land mammals (muskrats and ground squirrels) are common activities during April and May; these activities continue through the summer and into the fall. Berries are harvested also during summer and early fall. As with Arctic Village, caribou hunting begins in the fall (generally August), when caribou from the PCH begin their annual migration through Gwich'in hunting grounds in the north. Residents also hunt moose during the fall and continue to hunt both moose and caribou through the winter, along with trapping furbearers.

Data on subsistence harvests for Venetie are provided in **Tables M-15** through **M-17** in **Appendix M** and in **Table 3-33**, below. Venetie data are limited to one comprehensive study of all subsistence resources for the 2009 study year, in addition to several years of data for migratory birds and land mammals. As shown in **Table 3-33**, based on years with available data, Venetie residents harvest an annual average of 274 pounds of subsistence resources per capita. Large land mammals constitute approximately half of the subsistence harvest in terms of edible pounds. Also important are harvests of salmon, fish other than salmon, and migratory birds (Kofinas et al. 2016).

Table 3-33
Selected Venetie Harvest and Participation Data, Average Across Available Study Years

Resource Category	Estimated Pounds Per Capita	Percent of Total Harvest	Percentage of Households			
			Using	Attempting to Harvest	Giving	Receiving
All Resources	274	100.0	99	86	—	—
Salmon	76	27.8	76	37	—	—
Non-Salmon Fish	25	9.0	81	67	—	—
Large Land Mammals	95	49.6	94	63	—	—
Small Land Mammals	12	4.2	56	44	—	—
Marine Mammals	0	0.0	18	0	—	—
Migratory Birds	27	7.4	79	57	—	—
Upland Game Birds	<1	<1	20	31	—	—
Bird Eggs	—	—	—	—	—	—
Vegetation	5	1.8	67	46	—	—

Sources: 2000 (Andersen and Jennings 2001); 2009 (Kofinas et al. 2016); 2008-09, 2009-10 (Van Lanen et al. 2012), 2010-11 (Stevens and Maracle, no date)
Note: See **Tables M-15**, **M-16, M-17** in **Appendix M** for data by study year.

The primary subsistence species for Venetie residents are moose, caribou, chum and chinook salmon, grayling, geese, and whitefish. Ninety-nine percent of Venetie households report using subsistence resources, and 86 percent participate in subsistence activities. Over half of the households participate in harvests of large land mammals, fish other than salmon, and migratory birds. A recent BOEM-funded study documented Venetie sharing networks extending throughout the state, but with a focus on nearby interior communities, such as Arctic Village, Fort Yukon, Eagle, Chalkyitsik, Stevens Village, Beaver, and Birch Creek. Venetie residents also have sharing networks with multiple North Slope communities, including Utqiaġvik, Nuiqsut, and Anaktuvuk Pass (Kofinas et al. 2016). The study notes the importance of the close kinship ties between Venetie and Arctic Village as a source of resiliency, as caribou harvested in Arctic Village are often shared with Venetie, sometimes in exchange for resources, such as salmon, which are less available in Arctic Village (Kofinas et al. 2016). The importance of caribou in Venetie sharing networks is evidenced by the 22,445 pounds of caribou that flowed between households (nearly half of all subsistence food flows).

An analysis of resource importance, based on harvest (percentage of total harvest), harvest effort (percentage of households attempting harvests), and sharing (percentage of households receiving), is provided in **Table M-19** in **Appendix M**. Based on this analysis, resources of major importance in Venetie are Arctic grayling, caribou, chinook salmon, chum salmon, and moose.

Alaskan Subsistence Uses of the PCH and CAH

Harvest and sharing patterns of 22 Alaskan communities and seven Canadian user groups are relevant if post-lease oil and gas activities changes caribou resource availability or abundance for those users. **Map 3-41** in **Appendix A** shows the location of the 22 caribou study communities and communities associated with the seven Canadian user groups. Canadian uses of the PCH are discussed below in *Transboundary Subsistence Uses*.

Table M-20 in **Appendix M** provides caribou use and harvest data for all of the 22 Alaskan caribou study communities, along with data averages for each study community across all available study years. The 22 Alaskan communities have documented customary and traditional uses for caribou in GMU subunits that are in the ranges of the CAH and PCH. Ten of the 22 communities are in GMU subunits that overlap the range of the PCH. They are Arctic Village, Kaktovik, Beaver, Birch Creek, Chalkyitsik, Circle, Eagle, Fort Yukon, Stevens Village, and Venetie. All but two of the 22 study communities (Eagle and Stevens Village) are in GMU subunits overlapping the range of the CAH; thus, for many communities, harvests reflected in **Table M-20** (in **Appendix M**) include some combination of PCH and CAH caribou.

With few exceptions, use of caribou among the 22 Alaskan study communities is high; over 50 percent of households in Bettles, Eagle, Evansville, Allakaket, Venetie, Coldfoot, Wiseman, Alatna, Utqiaġvik. Anaktuvuk Pass, Point Lay, Kaktovik, Atqasuk, Nuiqsut, and Wainwright use caribou. Less than 5 percent of households in Stevens Village, Beaver, and Chalkyitsik have reported using caribou during years when data are available. The contribution of caribou toward the total subsistence harvest is highest in the communities of Anaktuvuk Pass (84 percent) and Coldfoot (85.3 percent) and lowest in the communities of Fort Yukon (2.5 percent) and Evansville (4.9 percent). Four communities reported zero harvests of caribou during available study years: Birch Creek, Stevens Village, Beaver, and Chalkyitsik. Caribou sharing ranges widely, with 0 percent receiving caribou in Beaver and Chalkyitsik during reported study years; between 8 and 28 percent of households receiving caribou in Stevens Village, Wiseman, Birch Creek, and Fort Yukon; and at least 30 percent of households receiving caribou in the remaining study communities.

Transboundary Subsistence Uses

Table M-21 in **Appendix M** provides caribou harvest data for the following seven Canadian user groups of the PCH: Inuvialuit (Aklavik, Inuvik, and Tuktoyaktuk), Northwest Territory (NWT) Gwich'in (Aklavik, Inuvik, Fort McPherson [*Tetlit Zheh*], and Tsiigehtchic), Vuntut Gwich'in (Old Crow), Tr'ondek Hwech'in (Dawson City), Nacho Nyak Dun (Mayo), and other residents living in the Yukon Territory and the NWT.

Other transboundary subsistence uses are the Inuvialuit harvests of polar bears and other marine mammals and Inuvialuit and Gwich'in uses of waterfowl and fish, which may pass through the program area and be harvested elsewhere. The Inuvialuit-Iñupiat Polar Bear Management Agreement reflects the particular cultural importance of this resource to the Iñupiat and Inuvialuit of the Beaufort Sea, and there are efforts to co-manage this resource similar to caribou; however, due to particular sensitivity toward impacts on caribou, and the high reliance of Canadian communities on caribou as opposed to other resources, this section focuses on transboundary subsistence uses of caribou.

According to recent data on PCH harvests by Canadian user groups (**Table M-21** in **Appendix M**), the NWT Gwich'in , the Vuntut Gwich'in , and the Inuvialuit are the primary users of the PCH in terms of number of caribou harvested. These data primarily represent a minimum count of actual harvest (whereas the data for Alaska communities are estimated for the community as a whole). Furthermore, variability in herd distribution affects the harvest, and harvests in the 2010s have not been as high as they were in the 2000s due to migratory variability.[54] Available data show the NWT Gwich'in (Aklavik, Inuvik, Fort McPherson, and Tsiigehtchic) harvested an estimated 7,696 PCH caribou between 2010 and 2016; the Vuntut Gwich'in (Old Crow) harvested an estimated 1,914 PCH caribou during this same period, and the Inuvialuit of the Northwest Territories (Aklavik, Inuvik, and Tuktoyaktuk) harvested an estimated 1,427 PCH caribou (**Table M-21** in **Appendix M)**. These data generally represent minimum counts and therefore are likely lower than the actual harvests. In terms of individual community averages, Old Crow shows the highest harvest from the PCH.

The most recent data that compare PCH harvests between the US and Canada from 1992 to 1994 (the last time that harvest data were compiled for PCH user groups in Alaska and Canada) indicate that Canadian users accounted for 85 percent of the harvest, and Alaska users were 15 percent of the harvest (**Figure 3-6**, Average Portion of Harvest of Porcupine Caribou Herd Between the US and Canada (1992-1994), in **Appendix A**). The NWT Gwich'in accounted for 45 percent of all PCH harvests, followed by Inuvialuit (20 percent), Yukon Territory First Nations (13 percent), Alaska Native (12 percent), and the remaining 10 percent split among Yukon Territory and Alaska residents/non-residents (**Figure 3-6** in **Appendix A**); thus, most of the PCH harvest occurs in Canada (Porcupine Caribou Management Board 2010). Information on the timing and location of caribou hunting for Fort McPherson residents indicate that most hunting takes place in areas next to or accessible via the Dempster Highway. It extends from the fall through the spring, when the PCH is available in the area, and PCH hunting peaks in September. Similarly, residents of Aklavik hunt primarily from fall to spring; while some hunting may occur in summer (June/July), residents generally avoid hunting during this time due to the calving season and the relatively poor condition of bulls (Wildlife Management Advisory Council [North Slope] and Aklavik Hunter and Trappers Committee 2009).

Canadian Gwich'in and Inuvialuit consider the PCH to be central to their cultural identity, spirituality, and social and community well-being, and PCH are a key source of nutrition (Wildlife Management Advisory Council [North Slope] and Aklavik Hunter and Trappers Committee 2009, Wildlife Management Advisory Council [North Slope] 1996). Among the Gwich'in, caribou play a particularly important role in traditional belief systems and spirituality (Kritsch et al. 2000).

Both the Gwich'in and Inuvialuit consider protecting the Arctic Coastal Plain—which extends from the North Slope of Alaska into the North Slope of Canada—to be central to the survival of the PCH. The particular importance of this habitat to the PCH, in addition to such resources as upland birds, waterfowl, moose, grizzly bear, polar bear, and muskoxen, has been described in numerous traditional knowledge studies among the

[54]Suitor, Mike. Personal communication. Email from Mike Suitor, Regional Biologist, Environment Yukon to Paul Lawrence, SRB&A on September 27, 2018 regarding Porcupine Caribou Herd harvests in Canada.

Gwich'in and Inuvialuit (Wildlife Management Advisory Council [North Slope] and Aklavik Hunters and Trappers Committee 2018a).

As noted in **Section 3.4.4** (Sociocultural Systems), Canada's Ivvavik National Park, which is on the coastal plain next to the US border, was established under the Inuvialuit Final Agreement. Its primary purpose is protecting the Canadian calving grounds of the PCH; thus, the Inuvialuit likely view the coastal plain west of the US border with similar concern (Wildlife Management Advisory Council [North Slope] and Aklavik Hunters and Trappers Committee 2018b). The Gwich'in and Inuvialuit of Canada also report transboundary subsistence uses, sharing, and kinship ties.

Climate Change

Climate change has the potential to affect subsistence uses by affecting the availability of subsistence resources, access to hunting and harvesting areas, and harvester safety. The success of subsistence activities in the Arctic relies on the predictability of weather conditions, such as the timing of freeze-up and breakup, precipitation amounts, storms and prevailing winds, ice conditions, and temperatures, as well as the presence of an adequate number of healthy subsistence resources in traditional subsistence use areas at the expected time of year. North Slope hunters have already reported experiencing the effects of climate change on subsistence, including changes in species productivity and distribution, reduced habitat for marine mammals associated with decreased sea ice, changes in the timing of subsistence activities due to later freeze-up or earlier breakup, changes in lakes, rivers, and wetlands, and increased risks to hunters associated with changes in ice thickness, ice movements, and currents (SRB&A 2009a). Subsistence users may experience greater risks to safety when travel conditions are not ideal.

Shrinking sea ice, thawing permafrost, and warmer temperatures could change the migration, distribution, health, and abundance of subsistence resources, thus affecting their availability to subsistence users who rely on them being in their expected locations at certain times of the year. For example, in recent years, North Slope hunters have observed that the ice pack has retreated more quickly than it used to and is farther from shore. This has resulted in hunters having to travel farther from shore, with increased risks to safety, in order to locate and harvest marine mammals, which tend to follow the ice pack (SRB&A 2009a; Callaway 1998).

Climate change is expected to change the survival rates and distribution of terrestrial mammals (including caribou and muskoxen), marine mammals (including bowhead whales, seals, beluga whales, and polar bears), birds (including white-fronted geese, brants, and eiders), and fish ACIA 2004). The effects on subsistence uses of these resources would depend on the nature of the changes and the degree to which they occur. Changes in resource abundance or distribution from climate change can also affect the availability of those resources to subsistence users or may cause subsistence users to travel farther and spend more time and effort on subsistence activities (Brinkman et al. 2016).

Further, the warming temperatures in the Arctic and their potential impact on soils and permafrost could affect subsistence users' ability to store food gathered by subsistence activities. Many subsistence users have underground cellars that use the frozen ground to keep perishables frozen. The failure of ice cellars due to warming may cause subsistence food to spoil, and users may need to increase their harvest to offset loss due to spoilage or increase their reliance on electric or gas refrigeration.

Direct and Indirect Impacts

This section identifies potential subsistence impacts on Iñupiat and Alaska Gwich'in subsistence uses and resources; Inuvialuit and Canadian Gwich'in subsistence impacts are discussed under *Transboundary Impacts* at the end of this section.

Issuance of oil and gas leases under the directives of Section 20001(c)(1) of PL 115-97 would have no direct impacts on the environment because by itself a lease does not authorize any on the ground oil and gas activities; however, a lease does grant the lessee certain rights to drill for and extract oil and gas subject to further environmental review and reasonable regulation, including applicable laws, terms, conditions, and stipulations of the lease. The impacts of such future exploration and development activities that may occur because of the issuance of leases are considered potential indirect impacts of leasing. Such post-lease activities could include seismic and drilling exploration, development, and transportation of oil and gas in and from the Coastal Plain; therefore, the analysis considers potential impacts on subsistence uses and resources from on-the-ground post-lease activities.

Included in the discussion below are potential impacts on user access (resulting from legal or physical barriers), resource availability (resulting from resource migration, distribution, or health), and resource abundance (resulting from overall population changes), which, following BLM Alaska guidance (Instruction Memorandum No. AK-2011-008), are the three impact categories that must be addressed to inform the ANILCA Section 810 preliminary evaluation (see **Appendix E**). Common types of direct and indirect effects associated with oil and gas development in the program area include changes in subsistence use areas, harvest success, harvest amounts, participation, costs and time, competition, culture, and access (both physical and legal barriers and user avoidance). The hypothetical development scenario is used to inform the analysis of impacts for each alternative, but future analyses would occur with site-specific proposals. The effects of climate change, described under *Affected Environment* above, could influence the rate or degree of the potential direct and indirect impacts.

Alternative A

Under Alternative A, no oil and gas leasing would take place in the program area, so subsistence uses among the Iñupiat and Gwich'in would be unaffected by oil and gas development in the Coastal Plain. Existing impacts on subsistence would continue, including oil and gas development to the west of the program area, increased vessel traffic in the Beaufort Sea, infrastructure and transportation projects, environmental and biological changes affecting subsistence resources, changes in land status, and hunting and fishing regulations.

Impacts Common to All Action Alternatives

This section discusses potential impacts on the subsistence uses and resources from the post-lease activities of exploration, development, production, and abandonment and reclamation that are common to all alternatives (see **Appendix B**). The primary factors that may result in impacts on subsistence resources and uses are as follows:

- Noise, traffic, and human activity
- Infrastructure, including physical barriers
- Contamination
- Legal or regulatory barriers
- Increased employment or income/revenue
- General development and associated cultural impacts

These factors could affect resource availability, resource abundance, and user access for residents of the study communities. Short term, or lasting less than 5 years, does not necessarily reflect the level of impact on subsistence uses; an impact lasting 4 years, for example, could have a large effect on subsistence uses.

In all cases, future development would affect subsistence uses of resources of major importance for the subsistence study communities (see **Tables M-6, M-11,** and **M-19** in **Appendix M**). As described in *Affected Environment* above, Kaktovik is the primary user of the program area and would therefore be most likely to experience direct impacts associated with development. Nuiqsut could experience potential direct and indirect impacts on harvesting marine mammals, such as bowhead whale, and indirect impacts associated with the harvests of caribou, waterfowl, and fish, all of which are resources of major importance to the community (**Table M-11**). Arctic Village, Venetie, and other communities that use the PCH and CAH herds, have the potential to experience indirect impacts associated with caribou and, to a lesser extent, waterfowl. Caribou and geese both are resources of major importance to Venetie. Data to calculate resources of importance for Arctic Village are not available (see **Appendix M**).

In the case of the 22 Alaskan caribou study communities and seven Canadian user groups (**Table M-20** and **M-21** in **Appendix M**), those with a greater reliance on caribou would be more likely to experience potential indirect impacts related to caribou abundance or availability. Alaskan communities with the greatest reliance, that is those where caribou accounts for greater than 10 percent of the annual subsistence harvest, on average, and over 50 percent of households use the resource, are Alatna, Anaktuvuk Pass, Utqiaġvik, Bettles, Coldfoot, Eagle, Kaktovik, Nuiqsut, Point Lay, Venetie, Wainwright, and Wiseman. In Allakaket, Atqasuk, and Evansville, caribou accounts for less than 10 percent (or data are not available), but over 50 percent of households use caribou (**Table M-20** in **Appendix M**). In addition, as noted under *Subsistence Uses of the CAH and PCH*, above, approximately 85 percent of the PCH harvest occurs in Canada; the NWT Gwich'in, Vuntut Gwich'in, and Inuvialuit are the primary Canadian users in terms of number harvested (**Figure 3-6** in **Appendix A)**.

Potential impacts, particularly those relating to changes in calving distribution and calf survival, are expected to be more intense for the PCH because of their lack of previous exposure to oil field development (see **Section 3.3.4**). Among Alaskan communities, Kaktovik, Venetie, and Eagle are in GMU subunits overlapping the PCH herd and have a high reliance on caribou; however, a portion of Eagle harvests likely come from the Fortymile Caribou Herd; therefore, caribou study communities most likely to experience impacts from the leasing program include the communities of Kaktovik and Venetie (ADFG 2018b).

In addition, Arctic Village, although lacking harvest data, would also be most likely to experience impacts due to their proximity and reported reliance on the PCH. Compared with these three Alaskan communities, uses of PCH caribou (in terms of number harvested) by the NWT Gwich'in, Vuntut Gwich'in, and Inuvialuit user groups are comparable or higher, and communities associated with these user groups—Old Crow, Aklavik, and Fort McPherson—are in the PCH range (**Map 3-41** in **Appendix A**); thus, these Canadian communities would be among the most likely to experience potential indirect impacts due to their proximity to and reliance on the PCH.

The following sections identify potential subsistence impacts on Iñupiat and Alaska Gwich'in subsistence uses and resources; Inuvialuit and Canadian Gwich'in subsistence impacts are discussed under a separate heading *Transboundary Impacts* at the end of this section.

Noise, Traffic, and Human Activity

Noise, traffic, and human activity associated with post-leasing oil and gas activities would result from construction, gravel mining, air, vessel, and ground traffic, seismic activity, drilling, and human presence. Noise, traffic (both ground and air), and human activity can cause both direct and indirect impacts on subsistence users.

In general, activity levels and associated noise and traffic would be greatest during the development phases of projects and would be at lower levels during the exploration, production, and abandonment and reclamation phases. Certain types of impact sources, such as construction and seismic noise, would be most likely to occur during the exploration and development phases.

Regardless of the availability of lands for leasing, seismic activities could occur across the entire program area. Noise, traffic, and human activity would be local and long term. Impacts related to noise and traffic have been a primary concern reported by subsistence harvesters on the North Slope and elsewhere. Noise and traffic associated with the leasing program could potentially affect the availability of resources, such as caribou, marine mammals, furbearers, and small land mammals, fish, and migratory birds. While most impacts related to noise and traffic would be local, occurring in areas where Kaktovik subsistence use areas overlap with action areas, certain impacts, particularly those related to caribou migration, could extend outside the program area and would be regional. Even small changes in resource migration or distribution, from a biological perspective, can have larger impacts on subsistence users if resources are not in traditional use areas at expected times of the year.

According to traditional knowledge of North Slope Iñupiat, furbearers, caribou, and marine mammals are particularly sensitive to noise and human activity (SRB&A 2017b, 2009a). Potential impacts on caribou availability include displacement of caribou from areas of heavy oil and gas activity, diversion of caribou from their usual migratory routes, and skittish behavior, which results in reduced harvest opportunities (SRB&A 2017b).

Air traffic—particularly helicopter traffic—has been the most commonly reported impact on caribou hunting by Nuiqsut harvesters since the Nuiqsut Caribou Subsistence Monitoring Project began in 2009. Residents note that air traffic can cause skittish behavior in caribou, either causing them to stay inland from riversides or diverting them from their usual migration and crossing routes (see **Section 3.3.4**); such potential impacts could occur for Kaktovik harvesters as they travel along the coast by boat or inland by snowmachine looking for caribou. Ground traffic has also been observed diverting or delaying caribou movement across roads, and biological research have shown caribou, especially cows with calves, avoiding roads and other areas of human activity (see **Section 3.3.4**).

These impacts would be most likely during the peak of the caribou hunting season for Kaktovik, in July and August (SRB&A 2010). PCH use of the program area during July and August varies annually; while most PCH had left the Coastal Plain by the end of June from 2000 to 2014, PCH stayed in the program area later in the summer between 2015 and 2018. The CAH routinely moves through the program area during the July and August insect season; therefore, impacts on resource availability for Kaktovik hunters may be more likely for that herd in some years (**Section 3.3.4**).

These responses may be more likely for PCH caribou, as they have had less exposure to development than the CAH. If development causes large-scale displacement from PCH calving grounds, then the herd could experience a decline in calf survival and stagnant herd growth. In addition to large land mammals, furbearers, such as wolf and wolverine, may avoid areas of heavy traffic, drilling noise, seismic testing, and other activity. Lease Stipulation 9 and ROPs 36, 37, 39, and 41 associated with subsistence consultation for permitted activities, would require consultation with potentially affected communities regarding the timing, siting, and methods of development, including seismic activities.

Few caribou use the program area during winter, so impacts on PCH from seismic activities would be minimal; however, those caribou that are present during that time are an important resource to Kaktovik hunters. ROP 34 places restrictions on the timing, location, and altitude of aircraft, in addition to requiring consultation with subsistence users, which would help reduce air traffic-related impacts.

Impacts on marine mammals from noise and traffic have also been reported by whaling crews and marine mammal hunters in Kaktovik and Nuiqsut (SRB&A 2009a); biological science also shows that marine mammals are sensitive to such disturbance. As noted in the *Affected Environment* discussion, Kaktovik whaling crews and seal hunters hunt offshore from the program area, and Nuiqsut whaling crews hunt to the west of the program area from Cross Island, sometimes hunting in areas offshore from the program area. In addition, Kaktovik residents hunt ringed and bearded seals along the coast and offshore from the entirety of the program area, with peak hunting July to September.

Whaling crews have reported skittish behavior in bowhead whales and other marine mammals during times of heavy air and vessel traffic and seismic exploration. Such activity can divert bowhead whales farther from shore or cause unpredictable behaviors, resulting in greater risks to hunter safety (SRB&A 2009a; Galginaitis 2014). If Conflict Avoidance Agreements (CAAs) between industry and the Alaska Eskimo Whaling Commission continue in relation to the proposed oil and gas leasing program and barging activities, then impacts on whaling from the leasing program are unlikely; however, not all vessel traffic, such as that from barging not associated with oil and gas development, is subject to CAAs, so impacts from shipping and other activity could occur even with a CAA in place.

CAAs are generally considered an effective measure by whaling crews, industry, and agencies (SRB&A 2013). They would apply to the whaling season and would not occur for the entirety of the marine mammal hunting season, which, in Kaktovik, is primarily from July through September; thus program-related barge and vessel traffic may disrupt seal hunting outside the primary whaling season due to skittish behavior in the vicinity of vessels.

Lease Stipulation 4 and ROP 46 provides a number of requirements and restrictions to marine vessel traffic and associated activities when in the vicinity of whales, walruses, polar bears, and seals in addition to restrictions near important habitat areas. It also would help reduce potential conflicts with subsistence users, resources, and offshore activities. ROP 4 is directed at minimizing potential conflicts related to polar bears, including several requirements and standards aimed at protecting subsistence uses of polar bears.

While most marine mammals are hunted in the summer, seismic exploration could affect March and April seal hunting along the coast. If STPs occur in areas of high use and overlap seal hunting, then residents may experience reduced success in those areas. This is because associated noise and activity may result in more widespread displacement during STP operation.

Overall, because most development would be land based and because of the existence of CAAs to reduce potential impacts associated with barging, impacts on resource availability may occur in isolated instances for individual hunters; however, they are not expected to occur for the community as a whole.

Noise and traffic associated with future oil and gas development would also potentially disturb subsistence resources, such as birds and fish, and could cause temporary reductions in harvesting success for Kaktovik harvesters; however, most displacement would be temporary and would not change the overall population levels (**Section 3.3.2** and **Section 3.3.3**).

Noise and exploration vehicle traffic associated with seismic surveys could alter flows, thus blocking fish passage. In addition, underwater shock waves could disturb, injure, or kill fish in winter (**Section 3.3.2**). During winter, Kaktovik residents fish through the ice at inland locations, including First, Second, and Third

Fish Holes on the Hulahula River, in addition to locations on the Kongakut, Sagavanirktok, and Shaviovik Rivers and Schrader Lake. Depending on the location of seismic surveys, these individuals could experience decreased fishing success from seismic activities, as has been reported in other communities (SRB&A 2009b).

Spring geese hunting could be affected if ice road or seismic activity continues into May. Summer eider hunting could be affected by barge traffic, although disturbances to eiders from vessel traffic would likely be temporary and local. Disturbances to birds and fish have been reported by Nuiqsut harvesters as a result of the Alpine Satellite Development Plan and other developments; however, such disturbances have not resulted in overall reductions in harvests of these resources over time (SRB&A 2009a) (see **Section M.2** in **Appendix M**). ROPs 14 and 16 would address some disturbances to fish habitat from seismic activity and exploratory drilling.

The above impacts on resource availability may be considered localized from a biological standpoint; however, small localized changes can have larger impacts on subsistence harvesters when resources are not present in traditional hunting areas at the expected times and in adequate abundance. Residents may experience reduced harvest success, increased costs and time, and increased safety risks if resources are less available.

While potential impacts on resource availability related to noise and traffic are most likely to be local in extent, such as for Kaktovik or Nuiqsut residents who use the program area, more widespread changes in migration or abundance resulting from noise and traffic and infrastructure (see discussion below) could cause regional impacts extending outside the program area to other communities, such as the Gwich'in communities of Arctic Village and Venetie and the Gwich'in and Inuvialuit user groups in Canada. Residents of these communities harvest primarily from the PCH (see **Table M-20** in **Appendix M**).

Activities during the summer that may affect caribou distribution or migration are helicopter and plane flights and ground traffic along gravel roads. Combined with impacts of infrastructure (see below), this could affect the timing or location of PCH caribou arrival into Gwich'in hunting areas to the south of the Arctic Refuge during the peak fall hunting season (August to October). The Nuiqsut, Kaktovik, and Anaktuvuk Pass harvesters of the CAH could also be affected by disruptions to this herd, although the project affects a smaller portion of the herd's overall range and the CAH is more habituated to development.

Reduced harvests of caribou by residents from Kaktovik, Nuiqsut, Arctic Village, or Venetie could disrupt existing sharing networks to other communities and regions if residents are unable to share as widely or frequently as they are accustomed to.

In addition to affecting resource availability, future noise, traffic, and human activity may also affect user access by deterring subsistence users from their usual harvesting areas. Avoidance of subsistence use areas due to development has been documented in Nuiqsut (SRB&A 2017a) and would likely occur for some Kaktovik harvesters if development occurs in their harvesting area. Residents may experience discomfort hunting in the presence of outsiders; may avoid hunting near areas of high air or ground traffic because of a perceived or actual reduction in the availability of subsistence resources; may avoid hunting near human activity due to safety concerns; or may consider noise pollution and increased human activity to degrade the subsistence experience.

Infrastructure

Infrastructure associated with exploration, development, and production could include future gravel and ice roads, pipelines, gravel pads, bridges, gravel mines, and runways. While most potential impacts related to infrastructure would be site-specific or local, occurring in and around action areas, certain impacts—particularly those related to caribou migration and abundance—could extend outside the program area and would be regional. Infrastructure impacts would be long term.

Infrastructure could cause loss of subsistence use areas due to direct overlap (**Map 3-59**, Kaktovik Subsistence Use Areas and Areas of Hydrocarbon Potential, in **Appendix A**). Much of the coastline in the area of high HCP shows high overlapping use by the community of Kaktovik for subsistence purposes, particularly for caribou, fish, and waterfowl (**Map 3-43**, **Map 3-47**, Kaktovik Fish Subsistence Use Areas in Coastal Plain, and **Map 3-48**, Kaktovik Bird Subsistence Use Areas in Coastal Plain, in **Appendix A**).

While actual infrastructure would be limited to a smaller proportion of the overall development area, areas excluded from subsistence use would likely be greater than the actual footprint, either due to avoidance or security and firearm restrictions. In Nuiqsut, 48 percent of harvesters have avoided development activities or infrastructure at one time or another between 2013 and 2017 (SRB&A forthcoming). During individual study years, the number of respondents avoiding areas for development reasons has ranged from 31 to 46 percent. Avoidance of road areas may be less likely for Kaktovik, as roads may open access to hunting areas that are not currently accessible.

If future development extends into areas of medium and low potential for oil and gas development, as is expected, associated infrastructure could extend throughout areas of high overlapping use for the community of Kaktovik and could present a barrier (either perceived or actual) between the community and more highly used inland hunting areas for caribou, wolf/wolverine, moose, Dall sheep, and fish (**Map 3-43** through **Map 3-47** in **Appendix A**).

Infrastructure would pose physical obstructions to subsistence users if roads and pipelines are not designed to account for overland hunter travel, or if bridges and causeways obstruct travel along rivers or coastlines. Some residents in Nuiqsut have reported difficulty safely crossing certain gravel roads with snowmachines or four-wheel vehicles due to the steep side slopes (SRB&A 2017a).

Kaktovik hunters frequently travel by boat to the west and east of the community, searching for caribou as they congregate along the coast during the insect relief season. Pipelines in coastal areas could cause physical obstructions for these individuals; residents may be unable to shoot inland or may have to expend extra effort accessing suitable use areas if pipelines are situated too close to the coast. As noted in USACE 2012, such impacts would be particularly likely if pipelines are within 1 or 2 miles of the coast. Increased use of roads or changes in travel routes due to the presence of infrastructure could increase the likelihood of injuries and accidents for Kaktovik harvesters (see **Section 3.4.11**, Public Health). ROPs 18, 20, 21 and 23 would minimize potential direct obstructions to subsistence uses from infrastructure; however, impacts on access may still occur due to some harvesters avoiding industry.

If Kaktovik residents have easy access to roads associated with the oil and gas leasing program, it is likely that some would use the roads to access subsistence harvesting areas, when overland snowmachine travel is difficult and for residents who do not have access to overland modes of travel, such as snowmachines and four-wheel vehicles. Use of these roads would be less likely or frequent if the roads are not connected to the community of Kaktovik or are connected only seasonally via ice roads.

The use of future program roads for subsistence activities can introduce benefits to subsistence users; examples are facilitating access to areas at times when access is difficult, providing access for community residents who do not own snowmachines, four-wheelers, or boats, and allowing residents to access resources when they are unavailable closer to the community. Because Kaktovik residents have limited access in the program area, road access would open areas that are generally not accessible to them.

If roads, such as the Dalton Highway, connect to the road system and facilitate access by non-local hunters, then residents could experience increased competition from outsiders hunting in traditional subsistence use areas. ROP 38 would prohibit hunting, trapping, and fishing by lessees, operators, and contractors when persons are on work status; however, this would not apply once workers' shifts end and they return to a public airport or community, such as Kaktovik or Deadhorse.

Similar to noise, traffic, and human activity, infrastructure could also affect the availability of certain resources through changes in resource abundance, migration/distribution, and behavior. Infrastructure would be most likely to affect migratory terrestrial resources, particularly caribou, but could also affect furbearers, waterfowl, and fish. Infrastructure could divert or impede caribou movement, displace waterfowl from nesting and other habitat, and displace fish from nearshore or riverine habitats, at least temporarily.

Studies on the North Slope show that caribou distribution, especially cows with calves, changes around transportation corridors, and that a percentage of caribou (approximately 30 percent) are influenced in their movement by the presence of roads (NRC 2003; Wilson et al. 2016). Approximately 2.49 miles has been observed to be displaced at North Slope oil fields, and similar displacement levels would be expected in the program area; however, the potential for hunting along road corridors and the relatively lower habituation of the PCH may result in greater displacement distances (**Section 3.3.4**).

Future development in the areas of high, medium, and low oil and gas potential could present obstacles to caribou migrating from inland areas to the coast, where Kaktovik residents have traditionally hunted them during the summer (SRB&A 2010). It has been noted that in recent years caribou have been remaining inland and not venturing to the coast; the lack of caribou along the coast, in combination with restricted access for Kaktovik residents into the Arctic Refuge, has resulted in caribou not being available to residents (see **Appendix S**). While infrastructure is not expected to divert caribou migration altogether, linear features occurring perpendicular to migratory routes could slow caribou movement through the area, further reducing their availability to hunters along the coast (NRC 2003; Wilson et al. 2016) (see **Section 3.3.4**). Road avoidance is particularly likely during times of high human activity, including ground vehicle use.

In addition, pipelines have been shown to influence caribou movements when they are parallel to mosquito relief movements, which could affect caribou crossing toward the coast and hunter success. The PCH has had much less exposure to development and infrastructure than the CAH; however, the herd has shown some indication of habituation to infrastructure during winter and may encounter the Dempster Highway and other development in the Yukon (**Section 3.3.4**). Despite the possible increased habituation, areas of avoidance were still larger than those reported for the CAH (**Section 3.3.4**). The Dempster Highway is in the PCH range in Canada and residents use it to access hunting areas.

Future oil and gas infrastructure in the program area is expected to result in long-term loss and alteration of bird habitat; however, these changes are not expected to cause overall changes in bird populations (**Section 3.3.3**). Infrastructure could affect fish habitat by causing habitat loss, increased turbidity from dust and gravel spray, reduced fish passage, and reduced water quantity (**Section 3.3.2**).

According to **Section 3.3.4**, future oil and gas infrastructure in the program area, particularly in the PCH calving grounds, could cause a shift in calving distribution during some years, which would likely reduce calf survival and halt herd growth. To the extent that calving grounds are disturbed by oil and gas development, PCH calf survival and herd numbers could be reduced. One analysis estimated that the decline in calf survival from development of the program area would be 10 percent (**Section 3.3.4**). An overall reduction in the PCH could also affect harvest success among Iñupiat, the Gwich'in, and Inuvialuit caribou hunters.

According to the Gwich'in's knowledge, any development in the program area would have devastating effects on the population of the PCH and other resources, such as migratory birds, that have key habitat in the coastal plain. In addition, there are those among the Iñupiat who report similar knowledge regarding the effects of ACP development (BLM 2018c, 2018d, 2018e, 2018f). These concerns are based on Alaska Native observations of the sensitivity of resources to development and change, in addition to traditional knowledge that has been passed on through generations. See **Appendix C** for additional information.

Contamination

Real or perceived contamination, including contamination from oil spills, fugitive dust, transport of waste and hazardous materials, erosion, and air pollution, could affect resource availability and user access. If an oil spill causes reduced abundance or reduced health of certain resources, then they could become less available to the subsistence users. Contamination could occur during the exploration, development, production, and abandonment and reclamation phases. Depending on the nature of the contamination, it would be site-specific or local and either short or long term. If migratory resources are affected, contamination impacts could extend to a regional level.

Dust deposition from gravel infrastructure, ground traffic, and construction could affect fish habitat in the long term (**Section 3.3.2**), thus affecting the availability of fish in certain traditional harvesting areas, such as along the Hulahula River, for Kaktovik harvesters. In addition, depending on the location of STPs, discharging brine into coastal waters could affect salinity, thus affecting the availability of fish for Kaktovik harvesters in certain coastal locations (**Section 3.3.2**). Vegetation harvests may be affected by dust deposition along roads, and caribou may also ingest contaminated vegetation in the event of small-scale spills along roadways (**Section 3.3.1** and **Section 3.3.4**).Potential impacts on resources from oil spills would occur for marine and riverine resources such as fish, seals, and bowhead whales, in addition to bird and terrestrial resources that frequent riverine and marine areas. Small spills in the program area or air contamination (either real or perceived) could also cause subsistence users to avoid harvesting certain resources, particularly near development areas. This could have potential indirect effects on human health through reduced consumption of nutritional foods (**Section 3.4.11**).

Impacts on fish availability would not likely extend beyond Kaktovik harvesting areas unless there is large-scale contamination. In this event, it is possible that the availability of Arctic cisco, which migrate past the program area on their way to the Colville River delta, could be affected for Nuiqsut harvesters. While unlikely, large spills on land could affect waterfowl nesting areas, destroy large numbers of birds (**Section 3.3.3**), and affect their availability to harvesters in other regions, such as those to the south of the program area.

In addition, vegetation harvesting areas would be affected, particularly if spills occur in coastal areas where Kaktovik harvesters have the most access during the summer. Finally, large-scale oil spills in open water, particularly during the summer, could have adverse effects on large numbers of marine mammals, thus affecting the availability of these resources to Kaktovik and Nuiqsut residents; however, the likelihood of this occurring is negligible (see **Section 3.3.5**). Potential impacts from contamination are most likely to occur for Kaktovik residents and would be local; however, in the event of a large-scale oil spill in the marine or riverine environment or other contamination event, subsistence users who harvest resources that use or pass through the development area—such as those from Nuiqsut, Arctic Village, and Venetie—may also experience reduced resource availability. This would be due to physical contamination or avoidance of resources from the perception that resources are contaminated; thus, impacts related to contamination would be of local to regional context. Monitoring air quality and contaminants in subsistence foods (ROPs 6 and 7) and comprehensive waste management plans (ROP 2) would help address subsistence user concerns related to contaminants and would help to identify potential human health issues.

While a large-scale oil spill associated with oil and gas development in the program area is considered unlikely, smaller contamination events may contribute over time to the perception that species in the program area are contaminated or unsafe to eat. This may cause residents who use the program area to avoid them (Kaktovik and Nuiqsut). Subsistence users also might avoid consuming caribou, marine mammals, and waterfowl that migrate through the program area and are harvested elsewhere. Examples are the residents of Arctic Village, Venetie, and other Gwich'in and other Canadian Inuvialuit communities.

Avoiding subsistence foods due to contamination concerns is well documented. In a recent study on the North Slope, around half of community households in Nuiqsut and Kaktovik reported having avoided eating certain subsistence foods during the previous year, due to concerns that they were contaminated (SRB&A 2017b)

Legal or Regulatory Barriers

There would be legal or regulatory barriers, including restrictions on access and firearm discharge near oil and gas facilities, during the exploration, development, and production phases that reduce user access and resource availability in traditional use areas. Associated impacts would be site-specific or local and long term or short term, depending on the nature of the barrier, for example a pipeline or road versus temporary construction activity. Hunters would likely be subject to certain restrictions regarding discharging firearms near pipelines, roads, and other facilities. Depending on the parameters of such restrictions, such as the distance at which a firearm can be discharged, subsistence users may potentially have difficulty hunting in certain areas, particularly where pipelines or roads parallel the coast.

Miscommunication surrounding rules and restrictions around future oil and gas facilities, as has been documented in the case of Nuiqsut (SRB&A 2017a), may dissuade residents from accessing development areas. Impacts related to legal or regulatory barriers are most likely to occur for Kaktovik and would be of local extent; however, whaling crews from Nuiqsut could experience impacts when hunting offshore of the program area. Lease Stipulation 11 would require consultation with the community of Kaktovik to develop a subsistence access plan.

Employment and Revenue

Increased employment and revenue related to future oil and gas development could have potential beneficial and adverse impacts on subsistence uses in affected communities during the exploration, development, and production phases. Employment and revenue impacts could be a regional and long term. Increased income from employment and corporation dividends would likely be put to use in supporting subsistence activities through the purchase of faster and more efficient equipment and technologies and through supporting super-harvester households[55] in the community. Data on Kaktovik and Venetie show that community engagement in subsistence activities has remained strong, alongside significant social and economic changes over the past several decades, such as higher household incomes (Kofinas et al. 2016).

Despite the relative persistence of subsistence harvesting, data also show a relatively high percentage of households that report low food security (40 percent in Kaktovik and 34 percent in Venetie), which showed

[55]Households with an abundance of able-bodied labor who are able to become the centers of subsistence production and distribution for a community.

no correlation with household income or harvest levels. In terms of harvest and income levels, there is a great diversity among village households, from high income/high harvest to low income/low harvest. These households show different levels of social connections, such as sharing ties, depending on harvest and income levels; thus, certain households may be less able to adapt to changing conditions and may be more vulnerable than others (Kofinas et al. 2016). Social connections are an important mitigation in the absence of household assets, such as income and harvest equipment, through sharing and cooperation; disruption of social connections could thus increase vulnerability in communities.

A potential increase in employment could cause a shift in subsistence roles in the community, as employed individuals may have less time to engage in subsistence activities (see **Section 3.4.4**). These potential impacts would be most likely to occur for Kaktovik (see **Section 3.4.10**, Economy), which is most likely among North Slope villages to see an increase in employment and income from the proposed oil and gas leasing program; however, increased income resulting from ANCSA corporation dividends could extend throughout the North Slope and would therefore be of regional context.

General Development and Culture

Overall, future development in the program area could have lasting effects on cultural practices, values, and beliefs through its impacts on subsistence. The potential impacts of development could result in reduced harvests, changes in uses of traditional lands, and decreased community participation in subsistence harvesting, processing, sharing, and associated rituals and feasts. Because of this, communities could experience a loss of cultural and individual identity associated with subsistence, a loss of traditional knowledge about the land, damaged social and kinship ties, and effects on spirituality associated with degradation of the Alaska coastal plain. These are key concerns that were reported by the Iñupiat and Gwich'in during public scoping meetings associated with the oil and gas leasing program (BLM 2018c, 2018d, 2018e, 2018f). While most general development and cultural impacts would be long term and program area wide, certain impacts affecting migratory resources could extend regionally.

Kofinas et al. (2016) analyzed different scenarios of change, including loss or shortfalls of harvestable resources, altered resource distribution/harvester access, increased costs associated with hunting, and employment, and the potential ramifications to village social and sharing networks. The study notes that households and communities are resilient to change, in large part because of the complex sharing networks that allow for some flexibility in household roles and annual harvests; however, larger disruptions to subsistence, such as a community-wide harvest shortfalls, could “have disproportionately negative community-wide effects on distribution as high harvesters redistribute more food on aggregate” (Kofinas et al. 2016).

Such effects could extend outside communities as well, particularly between communities with strong sharing ties, such as Arctic Village and Venetie. On a household level, Kofinas et al. (2016) suggest that certain households, such as those with fewer social connections and less income, are more vulnerable to changes in subsistence. This is because they have less adaptive capacity with which to weather reduced resource availability or reduced income.

The various impacts on subsistence from development can weaken social cohesion over time through reduced participation in subsistence activities, including hunting, processing, and sharing. See **Section 3.4.4** for a discussion of potential effects related to social cohesion, and **Section 3.4.11** for a discussion potential effects related to food insecurity. ROP 40 would require cultural training for oil and gas personnel on environmental, social, traditional, and cultural concerns. Proper education may reduce the potential for conflicts between subsistence users and visiting workers.

Alternative B (Preferred Alternative)

Under Alternative B, the types of potential impacts on subsistence uses and resources would be the same as those described under *Impacts Common to All Action Alternatives*, above. The duration of all types of impacts would be long term, although certain specific impacts, such as those from seismic activity and construction noise, would occur only during the exploration and construction phases of individual development plans.

Potential direct impacts on resource availability, resource abundance, and user access from noise, traffic, and human activity, infrastructure, contamination, and legal or regulatory barriers would occur primarily for Kaktovik residents who use the program area. Potential indirect impacts on resource availability and resource abundance resulting from noise, traffic, and human activity, infrastructure, and contamination could extend outside the program area to other communities, such as Nuiqsut, Arctic Village, Venetie, and other Alaskan and Canadian communities that harvest from the PCH and CAH (**Table M-20** in **Appendix M**).

Changes in user access related to an increase in employment rates or income, including decreased time to engage in subsistence activities and increased income with which to support subsistence activities, are most likely for the community of Kaktovik, particularly Arctic Slope Regional Corporation (ASRC) and Kaktovik Iñupiat Corporation (KIC) shareholders; however, these changes could extend to other communities on the North Slope. Not all residents would experience the benefits of increased employment and income associated with development of the program area.

Because of its proximity to the program area and the high potential for development in areas of high overlapping use, the community of Kaktovik would experience the greatest intensity of potential effects associated with the proposed oil and gas leasing program. Impacts on subsistence resources and uses may also occur for other communities if oil and gas development in the program area results in changes to resource abundance or availability, particularly caribou, which is a resource of major importance to the communities of Kaktovik, Nuiqsut, Arctic Village, and Venetie (see **Tables M-6**, **M-11**, **and M-19** in **Appendix M**).

Under Alternative B, 721,200 acres of calving habitat would be available for leasing, which would result in the greatest potential impact on calf survival and overall herd numbers. In addition, Alternative B would include 0.5- to 1-mile setbacks, with no permanent oil and gas infrastructure, including roads and pipelines, allowed, for 10 major rivers, as well as several springs/aufeis (Lease Stipulations 1 and 3). Many of these rivers, such as the Hulahula, Okpilak, and Jago, are key drainages used for subsistence activities. Furthermore, residents of Kaktovik provided input during the public and government-to-government meetings for this EIS on subsistence areas and routes. The BLM incorporated this input when developing Lease Stipulation 1 (see **Appendix Q**).

Alternative B may include roadless developments for some of the CPFs and construction of associated airstrips, which would likely result in higher levels of air traffic, compared with roaded developments. Some timing and other restrictions on oil and gas activity (see Lease Stipulation 7 and 8 and ROP 23 and 34) would be in place for calving and post-calving habitats of the PCH, which could reduce impacts on resource abundance and availability. Coastal waters, lagoons, and barrier islands would be subject to NSO, which would minimize potential impacts on coastal hunters.

While mitigation measures can help reduce impacts on subsistence users, they cannot eliminate them. In some cases, well-intended measures meant to mitigate impacts may create new, unforeseen impacts. For example, the Alpine development is roadless in order to reduce its footprint and impacts on hunters and wildlife; however, lack of year-round road access necessitated high levels of plane and helicopter traffic, which became a primary source of impacts on caribou hunters. Mitigation measures may be less effective if not adequately enforced, communicated to local residents, or developed in consultation with local subsistence users.

Alternative C

The types of potential impacts under Alternative C would be the same as those described under Alternative B but of lower intensity. Under Alternative C, fewer acres overlapping PCH calving grounds would be available for lease, most (606,200) acres of PCH primary calving habitat would be subject to NSO, 985,500 acres of post-calving habitat would be subject to TLs restricting road traffic, and pads and CPFs would not be allowed within 1 mile of the coast, although essential pipelines and roads may still occur. Alternative C would include greater setbacks (2 miles) along the Canning, Hulahula, and Okpilak Rivers. In addition, Alternative C would impose greater TLs on human activity in the PCH post-calving habitat area than Alternative B. Demographics impacts on the PCH would be less likely than Alternative B; therefore, the intensity of potential subsistence impacts under Alternative C would be less than under Alternative B.

Alternative D

The types of potential impacts under Alternative D1 and D2 would be the same as those described under Alternative B; however, the intensity of subsistence impacts would be substantially less under Alternative D. Less than half of the calving ground acres offered for sale under Alternative B would be offered for sale under Alternative D, and more lands would be subject to NSO lease stipulations or not made available for lease. As a result, Alternative D would be the least likely to affect calf survival and overall herd numbers of all action alternatives.

Alternative D also includes greater setbacks from key subsistence drainages, compared with Alternative B, including 4 miles for the Hulahula River and 3 miles for the Okpilak River, which would greatly reduce impacts on subsistence in those areas, particularly during the winter. Under Alternative D, no pads or CPFs would be allowed within 2 miles of the coast, reducing potential impacts on coastal subsistence hunters and fishers. Any development in coastal areas would be subject to NSO and various TLs and consultation requirements (Lease Stipulation 4).

Alternative D would limit the density of development in areas closed to lease sales or with NSO restrictions, which would retain the ability of caribou to navigate through those areas. In addition, reclamation of infrastructure would be on ongoing process for each development area, thus lessening the duration of impacts for individual developments related to infrastructure.

Alternative D would require additional design features meant to address impacts on subsistence resources and users. Alternative D2 would be less likely to affect subsistence uses and resources, when compared with Alternative D1. This is because of the additional 201,200 acres that would not be offered for lease sale and the remaining acres all subject to NSO, CSU, or TL stipulations under Alternative D2.

Alternative D2 would have the least impact of all the alternatives because the larger area not offered for lease sale would limit the potential for direct impacts on subsistence users, resources, and habitat to the smallest area. Furthermore, the NSO, CSU, and TL stipulations on the remaining acres would provide added protection in areas that are subject only to the standard terms and conditions in the other alternatives.

Transboundary Impacts

Impacts on subsistence may extend outside the US to the Inuvialuit, Gwich'in, and other user groups of Canada. Transboundary impacts would primarily affect subsistence harvests of PCH caribou; however, Canadian groups also harvest other migratory resources, such as fish, particularly Arctic cisco. Such fish pass by the program area when migrating between the Colville River delta and Mackenzie River delta, where they are harvested by Aklavik and Inuvik residents. Other harvested resources are marine mammals, including polar bear, seals, and whales, and waterfowl, which pass through or by the program area on their way to traditional harvesting areas in Canada.

A large-scale spill associated with oil and gas development in the program area could affect the availability of these resources to Canadian user groups; however, the likelihood of impacts on marine mammals, fish, and waterfowl extending outside the program area is low (see **Sections 3.3.2**, **3.3.3**, and **3.3.5**); therefore, this analysis focuses primarily on potential impacts on the availability and abundance of PCH caribou to Inuvialuit, Gwich'in, and other Canadian user groups.

The importance of the PCH and their particular vulnerability to activities in the US or Canada is evident through the establishment of certain agreements. One example is the Porcupine Management Agreement Between the Government of Canada and the Government of the United States of America on the Conservation of the Porcupine Caribou Herd. Other indications of the importance of the PCH is establishment of the Porcupine Caribou Management Board and International Porcupine Caribou Board. Moreover, wildlife refuges and parks, such as Ivavvik National Park, are dedicated to conserving the herd (Porcupine Caribou Management Board 2019; Wildlife Management Advisory Council [North Slope] 2006).

Inuvialuit and Canadian Gwich'in traditional hunting methods reflect observations and beliefs regarding caribou behavior. In particular, the movement of caribou into traditional harvesting areas can be affected by disruption of the leaders of a caribou herd. According to traditional knowledge, these herd leaders have special knowledge of migration routes and therefore establish routes for the rest of the herd to follow; thus, residents wait and let caribou start passing through an area before they start hunting them.

Actions and infrastructure that may affect the movement of caribou are of primary concern to Gwich'in, Inuvialuit, and other Canadian users of the PCH (Padilla and Kofinas 2010; Padilla 2010). Traditional knowledge also includes the critical importance of calving and post-calving habitat on the Coastal Plain to the overall health and abundance of the PCH. As noted in **Section 3.4.4**, Canadian Inuvialuit and Gwich'in have spiritual and cultural ties to the program area and to the PCH as a whole; thus, any degradation of the Coastal Plain could have adverse effects on the social, spiritual, and cultural well-being of these Canadian users of the PCH.

As noted under "Transboundary Subsistence Uses," most PCH caribou harvests are by Canadian Gwich'in and Inuvialuit, with the Vuntut Gwich'in community of Old Crow perhaps the most heavily reliant on caribou in terms of harvest amounts. Indirect impacts on resource availability described under *Noise, Traffic, and Human Activity*, *Infrastructure*, and *Contamination*, could also apply to Canadian harvesters of the PCH if the impacts are widespread. Development noise, traffic, and activity, in addition to the existence of such infrastructure as roads and pipelines, could delay caribou movement. This could affect their availability in traditional harvest areas at the expected times of year.

Perceived or real contamination of the coastal plain or the PCH could also result in residents avoiding harvests of PCH due to health concerns. If exploration, development, production, and abandonment and reclamation of the program area results in a decline in the abundance of the PCH due to reduced calving success or large-scale changes in PCH migration or distribution, then Canadian Gwich'in and Inuvialuit residents could experience decreased harvests of PCH. There could be resulting impacts on subsistence hunting and associated processing, consumption, and sharing of caribou.

Over time, decreased opportunities to harvest PCH could result in decreased opportunities to participate in other culturally importance activities, such as sharing, and a loss of connection to traditionally important places. There could also be reduced opportunities to pass on traditional knowledge and cultural values to younger hunters, which could result in a loss of knowledge and values over time. A decline in subsistence harvests could also affect consumption of wild foods which could have an adverse effect on the physical health of Inuvialuit and Gwich'in of Canada.

While the likelihood of large-scale changes in caribou abundance, migration, or distribution are low (see **Section 3.3.4**), Alternative B would allow for the greatest amount of development in the calving areas of the PCH; therefore, it has the greatest potential to affect PCH abundance and calf survival. On the other hand, of all the action alternatives, Alternative D2 would make available the fewest acres for leasing, would provide the strictest protections for key caribou habitat, and would have the least potential to cause transboundary impacts.

Cumulative Impacts

Past and present actions that have affected subsistence uses and resources are as follows:

- The degradation of traditional lands by development
- Restrictions on traditional uses resulting from the creation of wildlife refuges and national parks
- Government hunting and harvesting regulations
- Recreation and sport hunting and fishing
- Scientific research and associated activities, including those associated with oil and gas development
- Transportation corridors, including the Dalton Highway and marine highway systems
- Climate change

Today, oil and gas development on the North Slope is a primary source of impacts on subsistence for the Iñupiat, especially for the community of Nuiqsut, which is now connected to the Alpine development via a year-round road. The Gwich'in of Arctic Village and Venetie live in an area relatively undisturbed by development; however, construction of the TAPS and Dalton Highway have affected subsistence access and resource availability for Gwich'in communities. Many residents believe that the highway and pipeline have changed caribou migration across the region.

In all regions, increased sport hunting and fishing and associated air traffic have increased competition for local subsistence users and have disturbed and displaced subsistence resources, such as caribou.

In Canada, subsistence users face similar impacts, including construction of the Dempster Highway and associated traffic, increased plane and boat traffic, oil and gas exploration and development (including in the Beaufort Sea and to the west in Alaska), sport hunting and recreation, and contamination from DEW Line sites (Wildlife Management Advisory Council [North Slope] 2006; Wildlife Management Advisory Council [North Slope] and Aklavik Hunter and Trappers Committee 2009).

Impacts of climate change on Alaskan and Canadian hunters and harvesters include changes in the predictability of weather conditions, such as the timing of freeze-up and breakup, snowfall levels, storm and wind conditions, and ice conditions, such as ice thickness on rivers and lakes. All of these affect individuals' abilities to travel to subsistence use areas when resources are there. In addition, subsistence users may experience greater risks to safety when travel conditions are not ideal.

Changes in resource abundance or distribution resulting from climate change can also affect the availability of those resources to subsistence users or may cause subsistence users to travel farther and spend more time and effort on subsistence activities (Brinkman et al. 2016).

For further discussion of the impacts of climate change, see *Climate Change*, above. The effects of climate change described under *Affected Environment* above could influence the rate or degree of the potential cumulative impacts.

Development of the program area would likely change resource abundance, resource availability, and user access for Kaktovik. It could also change resource abundance and availability for Nuiqsut, Arctic Village, Venetie, and other Alaskan and Canadian communities who use resources that migrate through the program area, such as users of the PCH and CAH. The project would introduce large-scale oil and gas development into an area that was previously undeveloped and used primarily for subsistence and recreation.

Under any of the alternatives, Nuiqsut and Kaktovik have direct uses of the program area, and additional communities have traditional uses there or rely heavily on the PCH, which calve in and use the program area. Most communities that have traditional uses of the program area or use resources that migrate through it are rural, low-income, and are not connected by roads. Residents there rely on subsistence to support their mixed economy.

Development of the program area would introduce impacts on resource availability for key resources, such as caribou, fish, marine mammals, and waterfowl. Roads associated with development may benefit increased access for Kaktovik residents into areas previously inaccessible during certain times of year. Kaktovik may also benefit from reduced costs associated with shipping and supplies.

Impacts on resource availability may be most pronounced for communities that do not experience increased income associated with the oil and gas development, such as jobs or dividends, or that do not experience project-related lower costs of subsistence supplies and equipment, food, or other goods. These communities would have less opportunity to purchase or invest in fuel and equipment to adjust to changes in access and resource availability.

Proposed and current activities affecting the subsistence study communities include additional or continued development of oil and gas resources in the onshore and offshore development. Reasonably foreseeable activities that could impact subsistence uses and resources include the following:

- SAExploration 3D seismic proposal
- CD5, GMT2, Willow, and Nanushuk developments in the Colville River region
- Continued development of Kuparuk and Prudhoe Bay
- Liberty Development in the Beaufort Sea; Beaufort Sea OCS lease sales
- Development of a natural gas pipeline from the North Slope to Canada, Valdez, or Cook Inlet (Alaska Stand Alone Gas Pipeline or Alaska LNG pipeline)

Other reasonably foreseeable activities are additional infrastructure projects, including new permanent and seasonal roads, and airport and community infrastructure improvements through the ASTAR program and the continued and increased marine vessel traffic and air traffic associated with shipping, scientific research, and recreation and tourism and business in the region.

Future development of the program area would lead to further expansion of the developed area on the North Slope, which would contribute to impacts on subsistence resource abundance, resource availability, and user access for subsistence users across the region. Oil and gas and other development would result in the physical removal of traditional subsistence hunting and harvesting areas in addition to decreased access to certain areas through security and access restrictions and through user avoidance of development areas.

Increased infrastructure and activity in and around the program area and in offshore areas could contribute to a feeling of being boxed in by development, particularly for Kaktovik. Concerns to this effect have been reported as early as the 1980s, when some Kaktovik hunters indicated they no longer approach or cross the Canning River because of oil and gas activity to the west of it (Impact Assessment Inc. 1990a). The overall area available for subsistence use would likely shrink over time due to the increasing presence of infrastructure and human activity in traditional use areas. While Kaktovik hunters would adapt, to varying extents, to the changes occurring around them and may continue to harvest resources at adequate levels, their connection to certain traditional areas may decrease over time.

Increased development around Nuiqsut, including development in the program area, could also contribute to existing concerns about being surrounded by development and losing connections to traditional harvesting areas (SRB&A 2017b, 2009a). The shifting of subsistence use areas away from oil and gas development would likely continue and result in long-term changes in subsistence use patterns. In addition, the increased existence of road corridors in traditional use areas could shift how residents access subsistence harvesting areas, such as via roads, but could also affect resource availability, particularly for those who choose not to use roads. Such changes, including increased use of roads combined with changes in harvesting patterns and resource availability, have been documented elsewhere in Alaska (SRB&A 2007, 2009b, 2018); however, in Kaktovik, where overland travel in the program area has been heavily restricted, residents may be more likely to use roads for hunting, particularly in light of recent comments that caribou availability along the coast has declined.

This increased use of roads in the program area could represent a countervailing beneficial impact on other potential adverse impacts discussed in this section. Over time, development and infrastructure projects would increase the area accessible by outsiders, including non-local hunters, who could increase competition for locals, and resulting in higher levels of oil and gas activity; examples are vessel, ground, and air traffic, seismic activity, gravel mining and blasting, and drilling.

Other similar activities, including shipping activity not subject to CAAs and research-related air traffic, would also continue and be additive to oil and gas related disturbances. Harvesters may adapt to such changes by increasing the amount of effort and time spent on the land, investing in more efficient means of travel, and shifting to new subsistence areas in an effort to increase harvest success rates. Increased income, primarily expected to occur for Iñupiaq residents, could help offset some of these impacts by providing cash with which to purchase fuel, equipment, and supplies for subsistence pursuits. Certain individuals, such as those who are low income, those with limited time or modes of travel, or those who choose to avoid development (including roads) may be less able to adapt to changes in resource availability and harvester access. Construction of additional roads and infrastructure in the future would contribute to fragmentation of habitat for such resources as caribou, moose, and waterfowl. Infrastructure that would remove usable habitat for these resources and in the case of caribou could cause substantial changes in range distribution. Impacts on migrating caribou increase with density of roads and infrastructure (see **Section 3.3.4**).

An analysis of potential impacts on the PCH resulting from development of the program area resulted in the conclusion that changes in caribou behavior, such as increased time running and less foraging, would lead to changes in body condition and thus affect pregnancy and calf survival rates. The models predicted a population decline of between 6 percent (Alternative D2) and 17 percent (Alternative B). The models are based on various assumptions, some of which are not supported in the literature; thus, the conclusions may overestimate the effects on the PCH. Still, a decline in herd size as estimated above could have substantial impacts on communities that rely on the PCH, particularly for those with a less diverse resource base, such as Arctic Village and Old Crow.

If the program area eventually becomes open to public access, the potential for impacts on local communities from increased competition and overall human activity would be much higher. Furthermore, infrastructure projects, including those cumulative impacts from implementing such projects as ASTAR, could result in greater public access to traditional hunting areas in the program area, particularly on the North Slope. If road, ROWs, or reclaimed ROWs increase access into the program area, state and federal regulators may respond by introducing stricter hunting and harvesting regulations as well. This would affect the availability of resources to local communities. Increased competition and decreased resource availability may result in residents having to travel farther and spend more time, money, and effort to harvest such resources as moose and caribou.

The availability of certain subsistence resources, such as caribou, sheep, moose, small land mammals, fish, waterfowl, or vegetation, would likely be reduced. The causes would be development of the program area, in combination with future oil and gas development in surrounding onshore and offshore areas, increased marine, ground, and air traffic, and construction of new infrastructure projects. If these projects reduce resource availability for subsistence study communities or if they decrease access to traditional use areas, then residents may have to spend greater amounts of time, effort, and money in order to locate and procure these resources.

Residents may also have to travel farther to less familiar areas to find resources, with greater risks to their health and safety. This could be compounded by similar impacts related to climate change. While some hunters respond to changes in resource availability by taking more trips and increasing costs in order to harvest what they need, others may choose to take fewer trips because of lack of funds or reduced success.

Nuiqsut residents have shown adaptability to the changes around them and continue to harvest subsistence resources at rates similar to before; however, despite continued harvests, residents stress that the frequent disturbances to subsistence activities, loss of connection to traditional use areas resulting from oil and gas infrastructure, and increased time and effort spent by harvesters continue to affect their overall subsistence way of life (SRB&A 2017b).

As development continues to grow around the community, it remains to be seen if, or for how long, the community of Nuiqsut would be able to continue adapting to the changes. If changes in resource availability occur on a larger scale as a result of the leasing program, such as changes in migration or overall abundance of the PCH, then communities farther away, particularly those with a high reliance on the PCH that would not experience increased economic activity and revenues from the increased development. Examples are Arctic Village and Venetie and such Canadian user groups as the Inuvialuit and Gwich'in. They all could experience greater net impacts on subsistence.

As noted in Kofinas et al. (2016) a total loss of caribou harvests would represent a 31 percent decline in subsistence foods for Venetie and a 32 percent decline for Kaktovik. While harvest data are not available to provide a similar estimate for Arctic Village, impacts would likely be even higher, as residents from that community rely less on other subsistence resources. In addition, Canadian communities harvest most of the PCH and could therefore experience a greater proportion of impacts should there be a large-scale decline in

PCH abundance. Such a scenario would cause a severe disruption in social ties and cohesion for Alaskan and Canadian study communities.

Ultimately, cumulative impacts on subsistence could alter subsistence use areas, user access, and resource availability for Iñupiat, Gwich'in, and Inuvialuit subsistence users. When subsistence users' opportunities to engage in subsistence activities are limited, then their opportunities to transmit knowledge about those activities, which are learned through participation, are also limited. If residents stop using portions of the program area for subsistence purposes, either to avoid development activities or reduced availability of subsistence resources, the opportunity to transmit traditional knowledge to younger generations about those traditional use areas would be diminished. Communities would likely maintain a cultural connection to and knowledge of these areas as part of their traditional land use area; nevertheless, the loss of direct use of the land could lead to reduced knowledge among the younger generation of place names, stories, and traditional ecological knowledge associated with those areas.

There would also be fewer opportunities for residents to participate in the distribution and consumption of subsistence resources, ultimately affecting the social cohesion of the community. Any changes to residents' ability to participate in subsistence activities, to harvest subsistence resources in traditional places at the appropriate times, and to consume subsistence foods could have long-term or permanent effects on the spiritual, cultural, and physical well-being of the study communities. This would be due to the diminishing social ties that are strengthened through harvesting, processing, and distributing subsistence resources and by weakening overall community well-being.

For additional discussion of potential cumulative impacts on sociocultural systems, including culture and belief systems, see **Section 3.4.4**.

Thus far, communities on the North Slope have adapted to the changes occurring around them and maintained a strong subsistence identity; however, this is not to say they have not experienced impacts on subsistence hunting, loss of subsistence use areas, and social effects. There could be a tipping point where residents are longer be able to adapt to such changes (see **Section 3.4.4**). The continued maintenance of subsistence traditions would depend on the continued availability of subsistence resources and the continued ability of subsistence users to access resources, particularly if there are changes in resource abundance, distribution, or migration.

Alternatives that allow the greatest amount of land to be developed and which have fewer timing and other restrictions would provide the greatest potential contribution to cumulative effects on subsistence uses and resources. This is because they would have a greater effect on resource availability, resource abundance, and user access; thus, Alternative B would have the largest potential contribution to cumulative effects on subsistence uses and resources, followed by Alternative C and Alternative D1, while Alternative D2 would have the smallest potential contribution to cumulative effects on subsistence uses and resources.

3.4.4 Sociocultural Systems

Affected Environment

This section describes the affected environment for sociocultural systems potentially affected by the leasing program. In particular, the program could affect sociocultural systems among the Iñupiat, Inuvialuit, and Gwich'in who use the program area, who have cultural ties to the program area, who use resources that cross through the program area, or who could experience social or economic changes associated with the leasing program.

This section provides a brief overview of sociocultural systems among the Iñupiat, Inuvialuit and Gwich'in (in both Alaska and Canada), including history, social/political organization, the mixed cash/subsistence economy, and belief systems. There is an emphasis on the communities closest to the program area: Kaktovik, Nuiqsut, Arctic Village, and Venetie. The 2012 Point Thomson EIS (USACE 2012, Sections 3.21 and 3.22) and 2012 NPR-A IAP/EIS (BLM 2012, Sections 3.4.2, 3.4.3, and 3.4.4) are incorporated here by reference. They contain additional relevant details regarding Iñupiat subsistence values, their relationship to the environment, and the history of Kaktovik.

The Iñupiat of Kaktovik (Kaktovikmiut) are the primary users of the program area. They have strong cultural and subsistence ties and consider themselves the stewards of the program area (Native Village of Kaktovik 2019). Because of this, the Iñupiat are most likely to experience sociocultural impacts associated with development of the program area. Because of the potential for indirect and cumulative impacts on subsistence for the Inuvialuit and Gwich'in and because of their concerns about development of the Coastal Plain, Inuvialuit and Gwich'in sociocultural systems are also addressed in this affected environment section. Differences in how these sociocultural systems may be affected by development of the program area are described below under *Direct and Indirect Impacts*. Additional associated information relevant to sociocultural systems is given in **Sections 3.4.2**, **3.4.3**, **3.4.10**, and **3.4.11**.

History

Iñupiaq

Prehistory and history associated with the program area is described in more detail in USFWS (2015a). Kaktovik and Nuiqsut are the two Iñupiaq communities closest to the program area. The Iñupiat are an Alaska Native people whose territory ranges throughout Northwest and Northern Alaska. Archaeological research indicates that humans have occupied northern Alaska for roughly 14,000 years (Kunz and Reanier 1996). The earliest people entering the North American Arctic were the bearers of the Paleoindian and Paleoarctic traditions. Over thousands of years different cultures came to occupy Arctic Alaska and various parts of the program area, subsisting on resources available to them and developing various tools for survival. The Thule people, whose culture emerged about 1,000 years ago, are the direct ancestors of the Iñupiat living on the North Slope today and are the forebearers of modern whaling technologies and culture.

At the time of Euro-American contact, the North Slope was inhabited by kinship-based groups of Iñupiat who lived in either coastal or inland areas and traveled as needed, depending on food supplies and other factors (Spencer 1984). The coastal settlement pattern was characterized by permanent villages along the coast with outlying minor permanent and temporary settlements (Spencer 1959). One reason for the coastal villages' permanence was due to the marine mammal resource base—particularly bowhead whales—on which community members subsisted. On the North Slope, there is evidence for coastal Iñupiaq settlements from Point Hope (Tikigaq) in the west to as far as Demarcation Point near Canada in the east. The Nuiqsut and Kaktovik areas were known as places where Iñupiat and Athabascan people gathered to trade and fish, maintaining connections between the inland areas and the coast (Maguire 1988; Brown 1979; Impact Assessment Inc. 1990b).

Initial contact between the Iñupiat of the North Slope and Euro-Americans occurred in the early nineteenth century with the arrival of explorers. Exploration of the North Slope began in 1825 with the first Franklin expedition, which included stays by Sir John Franklin and his crew at Herschel and Barter islands. Commercial whaling along the North Slope durin the second half of the nineteenth century brought the first major outside influence on Iñupiaq settlement patterns, affecting both coastal and inland settlements.

Employment in the whaling industry and access to trade goods served to concentrate people along the coast, reducing interior populations.

Commercial whaling also introduced diseases for which the Iñupiat had no immunity, thereby further affecting demographics on the North Slope. It has been estimated that between 1854 and 1897, over 50 percent of the Native population in North Alaska died due to disease and famine (Burch 1979). Euro-American contact also introduced Native residents to alcohol, resulting in adverse social effects.

Following a decline in populations of caribou and marine mammals, caused in part by demand for these resources to support whalers during the commercial bowhead whaling period (SRB&A and ISER 1993), many Iñupiat had moved to Utqiaġvik (formerly Barrow) or Herschel Island (in Canada) where food and medical care were available. By the early to mid-1900s, many residents who had lived along the Arctic Coast had relocated to Utqiaġvik. The collapse of the commercial whaling industry in the early 1900s, because of a lack of demand for baleen and marine mammal oil from the increase in petroleum development, was followed by an increase in demand for furs. Also, reindeer herding was introduced as a means to supplement the declining caribou populations. Both the fur trade and reindeer herding filled some of the economic gap left by the decline in commercial whaling in the early 1900s.

Sheldon Jackson, a Presbyterian missionary, introduced reindeer herding to Alaska Natives, and the Iñupiat maintained herds in the vicinity of Wainwright, Barrow, and Nuiqsut and elsewhere on the North Slope (Jackson 1906). The area between Brownlow Point and Demarcation Bay was divided into separate reindeer herding areas. Several families maintained herds at Camden Bay, Barter Island, and Demarcation Bay. Reindeer herding ended in the region in 1938 (Chance 1990).

Local mission schools and trading posts, established during the late 1800s and early 1900s, also had a profound effect on Iñupiaq settlement patterns through centralization of Iñupiat into permanent communities. Compulsory education in local coastal settlements forced many (though not all) of the interior people to abandon their more semi-nomadic lifestyle and relocate to coast communities. Trading posts were often established near missions and schools, and these areas became focal points for the Native population, thus affecting settlement patterns during the early 1900s.

Because of the centralization of goods and services, the smaller coastal settlements that had once typified the Iñupiat of the North Slope are also no longer as prevalent. Seasonal coastal settlements enabled the semi-nomadic indigenous population to maximize the use of the environment and to harvest resources that were migratory or may have been available only in particular locations.

The Iñupiat today continue to rely on these subsistence resources, despite not all resources being available near their communities; thus, even though the modern North Slope settlement pattern revolves around permanent communities, in order to continue to access subsistence resources, the modern Iñupiat have established a network of camps and cabins across the North Slope to maintain their access to subsistence resources. These mirror the camps and temporary settlements used in the past. SRB&A and ISER (1993) observed that the location of cabins in productive habitat was "a strong tradition stemming from the predominant lifestyle prior to the establishment of the town of Barrow, and continued to provide an important opportunity for children to learn and begin using subsistence skills."

Oral histories say the Kaktovikmiut (suffix "miut" means "people of") lived within and used the Kaktovik area many generations and over thousands of years (Arctic Slope Community Foundation 2012). Archaeologists have identified sites on Barter Island with artifacts representative of the Thule period (Grover

2004). Both before and after Euro-American contact, Kaktovik has always been “a seasonal home for the nomadic ancestors of present-day Kaktovik residents, who traveled the area in pursuit of caribou, sheep, sea mammals, fish, and fowl” (Jacobson and Wentworth 1982). Archaeological evidence indicates that Kaktovik was a place where people used and possibly hunted whales; in addition, the name Kaktovik means “the seining place.” Barter Island, where the village of Kaktovik is located, had been the site of a large prehistoric Iñupiaq village and was an important trading center between various Iñupiat, Athabascan, and Canadian Inuit groups for centuries. Many Kaktovik residents maintain family and social ties with the Canadian communities of Inuvik and Aklavik (SRB&A 2010; USFWS 2015a).

Later, the village was a key seasonal subsistence harvesting location and a stopover point for commercial whalers. In 1923, Tom Gordon established a trading post on Barter Island (Wentworth 1979). During this time, Iñupiat who lived along the coast would congregate on Barter Island for subsistence activities and to sell their furs, and some settled there more permanently; however, until the 1950s, most people in Kaktovik lived a more nomadic lifestyle, living seasonally in such places as Camden Bay, Hulahula River, Griffin Point, Demarcation Bay, Herschel Island, and other places 75 miles east and west of the island (Jacobson and Wentworth 1982); thus, the people of Kaktovik have a longstanding history and relationship with the program area that is based on the seasonal harvests of subsistence resources.

The trading post was closed in 1942 and caused the disbursement of many local families to Barrow and Herschel Island (Jacobson and Wentworth 1982); however, the population of Kaktovik, which had grown throughout the 1930s, grew again in the mid-1940s, when Iñupiat were drawn back for construction of the DEW Line site at Barter Island (Wentworth 1979). Development of the island by the Air Force resulted in the destruction of and relocation of two village sites in the 1950s (Wentworth 1979; Impact Assessment Inc. 1990a; Mikow 2010; Kofinas et al. 2016). The current village site was not established until the 1960s (Wentworth 1979).

In 1968, the largest oil discovery in North America was made by Arco at Prudhoe Bay, resulting in a rush to develop the physical and legal infrastructure of Alaska so that production could begin (Coates 1991). Oil development and production at Prudhoe Bay became the nucleus for expanding networks of oil and gas production wells at neighboring fields (Impact Assessment Inc. 1990a, b).

The discovery of oil prompted passage of ANCSA in 1971 and the formation of the NSB in 1972. Formation of the NSB allowed residents to benefit economically through taxation of the oil and gas industry and provided for infrastructure development and jobs (USACE 2012). In 1973, after the 1971 passage of the ANCSA, 27 families from Utqiaġvik permanently resettled in Nuiqsut to live in a more traditional manner (Brown 1979). Many of those who moved there had family connections to the area (Impact Assessment Inc. 1990b). The families selected the present location of Nuiqsut for its centrality to subsistence resources and ease of access to inland, riverine, delta, and marine harvest locations (Brown 1979).

Inuvialuit

The Inuvialuit, meaning “real people,” are a First Nations people whose homelands are the Mackenzie River delta and the coastal areas of the Yukon North Slope, next to the Western Arctic Beaufort Sea (Wildlife Management Advisory Council [North Slope] 1996). Inuvialuit, along with other Inuit groups, including their Iñupiaq neighbors in Alaska, are descendants of the Thule people, whose culture emerged about 1,000 years ago (Wildlife Management Advisory Council [North Slope] and Aklavik Hunters and Trappers Committee 2018a). Archaeological research indicates that the Thule people relied heavily on sea mammals, using skin boats and harpoons with bladder floats to hunt seals and whales. Adapting to cooling temperatures and an increase in sea ice (which began approximately 800 years ago), the Thule people eventually expanded their use of land-based resources, spreading into the Mackenzie River delta by around AD 1300 (Wildlife Management Advisory Council [North Slope] 1996; Inuvialuit Regional Corporation 2011).

At the time of contact with Europeans, the Inuvialuit were divided into approximately eight territorial groups, living along the Arctic coastal plain, from Barter Island in Alaska to Franklin Bay in the Inuvialuit Settlement Region of the Northwest Territories (Lyons 2009). The estimated Inuvialuit population at the time was between 2,000 and 2,500 (Wildlife Management Advisory Council [North Slope] and Aklavik Hunters and Trappers Committee 2018a). Each of the eight territorial groups resided in a primary winter village for a portion of the year, then dispersed into smaller harvesting camps during the rest of the year (Wildlife Management Advisory Council North Slope]and Aklavik Hunters and Trappers Committee 2018a). The territorial groups established active trade networks with other Inuit, including the Iñupiat, and Gwich'in. Regular trade routes covered north Alaska and the central Arctic and stretched across the ACP to Point Barrow and Barter Island (Wildlife Management Advisory Council [North Slope] 1996).

Although contact with the West began as early as the late 1700s with European expeditions to search for a Northwest Passage, the Inuvialuit generally maintained a traditional way of life throughout much of the 1800s (Inuvialuit Regional Corporation 2011). A trading post was established south of the Inuvialuit settlement region, at the current location of Fort McPherson in the mid-1800s. This increased trade across the regions (Lyons 2009).

Direct, sustained contact with Western culture for the Inuvialuit began at the end of the nineteenth century, when crews from American whaling ships began overwintering at Herschel Island. This was a time of profound and rapid change for Inuvialuit people. Within a few decades, Western residential schools and hospitals and Anglican and Roman Catholic missions were established in Inuvialuit homelands. With the advent of the Western education system, it also became common for Inuvialuit children to be sent away to more distant residential schools for a large portion of the year. This directly affected a family’s ability to teach Inuvialuiktun languages and Inuvialuit traditional cultural values and practices to the younger generations (Wildlife Management Advisory Council [North Slope] and Aklavik Hunters and Trappers Committee 2018).

Today, there are approximately 5,000 Inuvialuit people residing in six main communities: Aklavik, Inuvik, Tuktoyaktuk, Paulatuk, Ulukhaktok, and Sachs Harbour (Joint Secretariat 2015). Aklavik, which is the Inuvialuit community closest to the program area, became a center of commerce and administration during the 1930s (Wildlife Management Advisory Council [North Slope and Aklavik Hunters and Trappers Committee 2018a). While Inuvik has since replaced Aklavik as the center of commerce and administration in the region, Aklavik still has a population of approximately 600 (Government of Northwest Territories, no date). Residents of both Inuvik and Aklavik have family and social ties with residents of the Iñupiaq community of Kaktovik in Alaska. Many Inuvialuit still feel culturally connected to the North Slope of Alaska, including the Coastal Plain, due to their ancestral ties there.

Gwich'in (Alaska)

Prehistory and history associated with the program area is described in USFWS (2015a). The Gwich’in are an Athabascan cultural group who traditionally occupied a massive territory that incorporated long sections of the Yukon, Porcupine, Peel, Chandalar, Itkillik, and Sagavanirktok Rivers and into present-day Canada to the Mackenzie Flats and River Delta (Burch 1998; Raboff 2001, 1999; Slobodin 1981). Archaeological data suggest a Paleoarctic human occupation in the Yukon River region, which includes the contemporary Gwich'in communities of Arctic Village and Venetie, beginning at least 12,000 years ago (Griffin and Chesmore 1988). Ancestral to the Gwich'in Athabascans, the Kavik culture occupied areas of the North Slope and Brooks Range as early as 600 years ago and as late as the early to mid-nineteenth century.

In the north, interactions between the Gwich'in or Koyukon and the Kukpigmiut Iñupiat of the Colville River were marked by territorial tensions and hostility, culminating in a series of violent incidents that forced the Athabascans south of the mountains (Raboff 2001). Continuing battles with the Iñupiat and other Athabascans in the 1840s pushed the Gwich'in from the Koyukuk River east to Chandalar Lake and beyond. The Gwich'in were among the most nomadic of the Athabascan groups in their settlement patterns and continued to travel north to trade with the Iñupiat at Barter Island into the 1920s (Jacobson and Wentworth 1982). Similar to the Nunamiut farther north, the Gwich'in relied heavily on the harvest of large land mammals—particularly caribou, but also moose and Dall sheep—for their livelihood.

Some of the first contact with the Gwich'in by Europeans likely took place with the Hudson’s Bay Company trading post at Fort Yukon in 1847, some of the latest in terms of first contact in Alaska. It continued with little contact through the end of the nineteenth century (Hadleigh-West 1963). Still, the indirect contact that occurred with other groups trading with the Gwich'in in the 1850s resulted in an epidemic that devastated their population, especially in the western extent of their territory near the Kanuti River. By 1870, most Gwich'in groups had moved into the Yukon Flats or east of Chandalar River. This constitutes the known modern territorial range of the Gwich'in today (Burch and Mishler 1995).

Continuous Euro-American presence in Gwich'in territory came later than for some other indigenous groups in Alaska. As such, the traditional subsistence lifestyle, including a continued reliance on hunting and fishing as a primary source of food and as a primary basis for Gwich'in belief systems, was substantially maintained until World War II (Caulfield 1983).

A severe decline in caribou populations in the Yukon Flats area in the late 1930s and 1940s may have precipitated the need for the Gwich'in to adapt to a more cash-based economy (Caulfield 1983). The US established several Native reservations in Alaska following the inclusion of Alaska in the Indian Reorganization Act of 1936. The Venetie Indian Reservation included the Gwich'in of Arctic Village, Venetie, Christian Village, and Robert’s Fish Camp. It was during this period that the Gwich'in made a final transition to permanent settlements (Inoue 2004). The early 1960s saw the creation of the Arctic Refuge, which included lands traditionally used by the Gwich'in.

Gwich'in (Canada)

Despite being separated by the border between the US and Canada, the Canadian Gwich'in and the Alaskan Gwich'in share the same Athabascan heritage and history. Archaeological evidence suggests that the area of Northwest Canada has been inhabited for tens of thousands of years (Wolfe et al. 2011). Before European contact, the Gwich'in were organized into nine regional groups (bands) and occupied a large area extending from the Alaskan interior to the Mackenzie River Valley.

The Canadian Gwich'in reside in the Northern Yukon and Mackenzie River Valley in the Northwest Territories (Western Arctic Handbook Committee 2002; Fafard and Kritsch 2003). They continue to have kinship ties to Gwich'in in Alaska and maintain sharing and social networks. Similar to other Gwich'in groups, the Gwich'in of Northwest Canada, known as the Tsii'deii, lived a semi-nomadic lifestyle based on the seasonal availability of wild resources (Western Arctic Handbook Committee 2002).

Today, the primary Canadian Gwich'in groups are the Vuntut Gwich'in (Old Crow), Teetlit Gwich'in (Fort McPherson), Ehdiitat Gwich'in (Aklavik), Nihtat Gwich'in (Inuvik), and Gwichya Gwich'in (Tsiigehtchic) (Western Arctic Handbook Committee 2002). The Vuntut Gwich'in of Old Crow have a territory and dialect that is distinct from the Gwich'in of the Northwest Territories (Fort McPherson, Aklavik, Inuvik, and Tsiigehtchic) (Fafard and Kritsch 2003).

The first Euro-Canadian contact occurred in the late 1700s, when the Gwich'in briefly encountered Alexander Mackenzie on what is now the Mackenzie River (Western Arctic Handbook Committee 2002). Contact with Europeans picked up in the early 1800s when John Franklin travelled down the Mackenzie River in search of the Northwest Passage (Kritsch et al. 2000). The Hudson’s Bay Company subsequently established a trading post on the Peel River, which was relocated 4 miles downriver in 1850 and is known today as Fort McPherson (Kritsch et al. 2000). Trade was slow at firs but grew over time, and soon the Teetlik Gwich'in made yearly trips there for meat and fur trading and food celebrations (Kritsch et al. 2000).

The establishment of Roman Catholic and Anglican missions in the mid-1800s and schools in the early 1900s further encouraged the centralization of the Gwich'in into permanent communities. Many children were sent away to schools during this time, often returning home with little knowledge of Gwich'in language or culture (Western Arctic Handbook Committee 2002).

The Klondike Gold Rush of the late 1800s and early 1900s brought further change to the Gwich'in with the influx in outsiders, establishment of police posts, and increase in economic opportunity. Gwich'in participated in the fur trade and also acted as hunters and guides for the mounted police (Kritsch et al. 2000; Western Arctic Handbook Committee 2002).

The Gwich'in continued to live a primarily subsistence-based lifestyle throughout the early 1900s, which was supplemented by the fur trade; however, in the 1950s the fur trade had collapsed, and the government began to establish more infrastructure and services within the region. In the 1970s the Dempster Highway was constructed and connected most Gwich'in communities to the road system (Old Crow is still accessible only by aircraft). After many years of negotiations, in 1992 the Gwich'in and the Canadian government signed the Gwich'in Comprehensive Land Claim Agreement in Fort McPherson. It provided for a cash settlement, surface and subsurface rights to a large settlement area, establishment of co-management boards, and a self-government agreement.

Today, there are approximately 4,000 Gwich'in living in the Northwest Territories and Old Crow (Vuntut Gwitchin First Nation 2019; Gwich'in Tribal Council, no date). Despite modernization and centralization into such communities as Fort McPherson and Old Crow, the Gwich'in continue to keep their traditional ties to the land and culture through subsistence hunting, trapping, and fishing on their lands (Kritsch et al. 2000).

Social and Political Organization

Iñupiaq

Iñupiaq social organization traditionally revolved around the family and extended kin, in addition to trading partnerships and friendships (Hall 1984). The social and political organization of Iñupiaq societies revolved around the family; however, one person in particular—the *umialik*—exerted the most political influence. In coastal communities, an umialik would be responsible for organizing cooperative hunting activities, such as the bowhead whale hunt. The *umialik* and his wife managed a crew that assisted year-round in preparing for the hunt, hunting, and processing and distributing a whale once it had been harvested (Chance 1990; Burch 1980).

Following Euro-American contact in the second half of the nineteenth century, the social and political organization of the Iñupiat changed. These changes were a result of various factors, including compulsory education. This led to the following (Chance 1990):

- Centralization of people into permanent villages
- Introduction of modern technologies, which altered residents' methods for harvesting and processing subsistence foods
- Introduction of a cash economy
- Introduction of Christianity
- Incorporation of the Iñupiat into new systems of laws and governing systems

Alaska Natives began forming village councils, which were reorganized under the IRA. The ANCSA was passed in 1971 and resulted in the formation of regional and village corporations; the NSB formed in 1972.

Despite the changes in social and political organization over time, the core of Iñupiaq social organization is similar on the North Slope today, in that it encompasses not only households and families, but also wider networks of kinship and friends and individual family groups that depend on the extended family for support. The sharing and exchange of subsistence resources strengthen these kinship ties. The Iñupiat continue to uphold certain traditional social roles, such as those of the whaling captains, whaling crew members, and whaling captains' wives. Similar to the traditional role of the umialiks, today's whaling captains play a key role in Iñupiaq society and political life. Six North Slope communities, including Kaktovik and Nuiqsut, are members of the Alaska Eskimo Whaling Commission and have local whaling captains' associations.

Political organizations, while exhibiting the structure of Western organizations, have traditional leadership patterns (Case 1984). Village council decisions, based on precedent from previous group decisions, reflect continuity with the past, and all decisions emphasize the desire to maintain peace and order in the community (Case 1984). The many Native political organizations that have come about as a result of the political change over the past century have successfully adapted Western structure to achieve Native goals. Specific examples of these organizations on the North Slope are the NSB, Native Village of Barrow, Arctic Slope Telephone Cooperative Association, ASRC, Arctic Slope Native Association, and Alaska Eskimo Whaling Commission.

On the village level, traditional leadership by the *umialik* on the North Slope was replaced by a system that included elected officials serving in a village council presided over by a president or chief. Despite changes over the past two centuries, political positions with Native roots are still present and are being adapted into Western political leadership roles. Across the North Slope coastal whaling communities, the position of the *umialik* or whaling captain is still recognized, and many of the traditional roles are practiced, including generosity, providing a boat and supplies for the crew, and maintaining egalitarian principles. Galginaitis (et al. 1984) observed that the people in Nuiqsut regard the office of mayor as an "*umialik*-position," and many of the mayors are recognized *umialiks*.

The program area is in the NSB, which has permit authority relevant to the leasing program. Other federal and state agencies, including the USFWS, which is the land manager for all nonnative land in the program area, also have permit authority related to the program (see **Appendix D**). Many residents of the eight permanent North Slope communities are members of the regional federally recognized Iñupiat Community of the Arctic Slope and are shareholders in the ASRC.

The NSB and ASRC not only provide employment but also revenue and economic opportunities throughout the region. The NSB has taxing authority on all lands throughout the North Slope, while the ASRC and other village corporations generate revenue through leasing their lands and providing oil field services. As oil and gas development has moved closer to Nuiqsut, the community's Kuukpik Corporation has generated revenue, provided employment opportunities, and become a key player in advocating for environmentally and socially responsible development on the North Slope; thus, North Slope communities have shared in the financial gains associated with petroleum development since the 1970s.

Community institutions in Kaktovik include the City of Kaktovik, the Native Village of Kaktovik (a federally recognized tribe), and the KIC. Community institutions in Nuiqsut are the City of Nuiqsut, the Native Village of Nuiqsut (a federally recognized tribe), and the Kuukpik Corporation. In addition, the Kuukpik Subsistence Oversight Panel, Inc., was established in Nuiqsut in 1996 in response to development of the Alpine oil field.

Inuvialuit

Similar to the Iñupiat of Alaska, Inuvialuit social structure revolved mainly around families. Families lived together in groups that had an *umialiq*. *Umialiqs* were rich and powerful men who took on positions of political and social authority (Morrison, no date).

Sustained Euro-American contact began at the end of the nineteenth century, as Herschel Island became a whaling center and winter headquarters for whaling captains and crews. Euro-American and Iñupiaq whalers became mainstays in the area, as did such groups as the Gwich'in, who came to Herschel Island to trade terrestrial game meat, which was preferred by the western whaling crews. Intermarriage between the Inuvialuit and their southern Gwich'in neighbors became more common during this period, which over time contributed to the diminishment of traditional disputes between these groups (Lyons 2009). The influx of other cultures, particularly the colonial Western culture, brought with it many changes to the Inuvialuit way of life, including the following (Lyons 2009):

- Centralization of people into larger, permanent village sites
- Introduction of a cash economy
- Semi-compulsory Western education
- Incorporation of Inuvialuit into Western government structures and laws
- Some loss of language due to enforced English policies at residential and day schools
- Impacts on the traditional annual cycle of hunting
- Introduction of disease and high mortality rates

Changes continued to occur with the discovery of oil and gas deposits in Alaska, triggering a series of exploration projects and proposed development projects in Canada (Wildlife Management Advisory Council [North Slope] 1996). Reacting to the adverse impacts of some of these changes, two indigenous women—Nellie Cournoyea (Inuvialuit) and Agnes Semmler (Gwich'in Métis)—founded the Committee for Original Peoples' Entitlement (COPE) in the late 1960s. COPE worked toward greater aboriginal sovereignty and autonomy. Shortly after the founding of COPE, the Inuvialuit began work on the first comprehensive land agreement between Inuvialuit and the Government of Canada (Lyons 2009). In 1984, after nine years of work and negotiation, the agreement, called the Inuvialuit Final Agreement (IFA), was signed.

The IFA bound the Inuvialuit, the government of Canada, and the governments of Yukon and Northwest Territories to protect the land and to preserve Inuvialuit identity and cultural values (Wildlife Management Advisory Council [North Slope] 1996). It prevented a single group from making unilateral decisions about land use on the Yukon North slope and mandated that public comment and Inuvialuit recommendations be considered during decision-making.

To facilitate cohesive management between Inuvialuit communities and other governments, the IFA established the Wildlife Management Advisory Council (North Slope) and the Fisheries Joint Management

Committee. The IFA also mandated that developers must have permission to occupy or remove resources from the land. As a result of the IFA, the Canadian government withdrew a large amount of land for conservation, which would later become Ivvavik National Park, Herschel Island Qikiqtaruk Territorial Park, and other conservation areas. Ivvavik National Park was established with the primary purpose of protecting the Canadian calving grounds of the PCH, illustrating the importance of this herd to the Inuvialuit (Wildlife Management Advisory Council [North Slope] 1996).

Gwich'in (Alaska)

The Gwich'in are one of several Athabascan cultural groups in Alaska and Canada. Traditional social and political organization of the Gwich'in involved people who lived in small autonomous bands composed of closely related kinsmen. Kinship affiliations were extensive, reaching beyond the immediate group or band and providing people with a network of relationships from which to seek assistance in time of need.

The Gwich'in had a kinship system based on matrilineal[56] clans organized into moieties[57] (McKennan 1959; Guédon 1974; Haynes and Simeone 2007). Political organization was decentralized and informal, with most decisions affecting the group reached by consensus. In some cases, a leader attained a particular status that enabled him to attract a following (De Laguna and McClellan 1981; Clark 1981). Today, Gwich'in continue to recognize certain highly respected individuals with the title of chief.

Beginning in the mid- to late 1800s, the fur trade, mineral development, church, and government all worked to undermine traditional kinship patterns by emphasizing the individual over the group. Europeans and Americans also brought new social values, laws, and economic models that undermined and even banned the traditional practices that supported the existing social structure and hierarchy. The Episcopal Church, for example, attempted to stop the ceremonial potlatch,[58] because missionaries believed it was wasteful (Dinero 2016, 2005; Simeone 1992). In doing so, the church failed to understand the importance of Gwich'in reciprocity by sharing wealth and maintaining physical and social well-being. The church's attempted ban threatened Gwich'in social and political organization and their survival. Despite the impacts of the Episcopal Church on social and political organization, the Gwich'in in many ways embraced the religion and viewed it as a positive force in their lives, while maintaining a connection to traditional belief systems that emphasized a spiritual connection between the human and animal worlds (Dinero 2016).

Despite the various changes to social and political organization over time, much of the traditional Gwich'in social and political structure remains intact. Subsistence remains central to their identity. The people of Arctic Village and Venetie are primarily descendants of the Neets'aii band of the Gwich'in and, along with other Gwich'in, identify as the "caribou people" in reference to their main source of food and cultural and spiritual identity (Kofinas 1998). They view their primary cultural tradition as living with the caribou, with an emphasis on the reciprocal nature of their relationship with this important resource.

Many traditional roles and practices related to hunting, fishing, and gathering remain in place today, and residents still observe traditional rituals and feasts, including the potlatch. Similar to the Iñupiat, sharing is central to maintaining social and kinship ties among the Gwich'in. Modern Gwich'in leadership also mirrors traditional leadership models, with village councils providing both moral and legal guidance to tribal members

[56]Ancestral lineage traced through female relatives
[57]Social organization divided into two parts
[58]A ceremonial feast, where participants part with or destroy possessions in a display of wealth or prestige

(Dinero 2005). The Gwich'in highly value traditional knowledge of the land and its resources; also, the passing on of traditional knowledge to younger generations is of utmost importance.

In the early 1940s, as a result of the combined efforts of the residents of the area, the US Department of the Interior established the Venetie Indian Reservation, which was meant to protect the lands for subsistence uses. After passage of ANCSA, residents of Arctic Village and Venetie, opted for title to the 1.8 million acres of reserve land, which they now own jointly through the Native Village of Venetie Tribal Government (Venetie Village Council 2013; Inoue 2004).

Unlike many Alaska Native communities, Arctic Village and Venetie are not shareholders in a regional ANCSA corporation and do not have ANSCA village corporations. As such, those communities do not receive any increased economic activity associated with resource development or shares therein by ANCSA corporations.

Since interest in developing the Arctic Refuge began in the 1980s, the Gwich'in—particularly the Gwich'in of Arctic Village and Venetie—have taken various legal and political actions to prevent such development. Based primarily on concerns about impacts on caribou who calve in the Coastal Plain and subsequent impacts on Gwich'in cultural survival, their opposition has led to many residents advocating for caribou and the Gwich'in way of life. Many of their people wish to protect their traditional lifestyle centered on the PCH. However, in 1984, the Native Village of Venetie Tribal Government, proposed to offer their approximately 1.8 million acres of land for competitive oil and gas leasing (Senator Murkowski 2000)

In 1988, the first of many Gwich'in gatherings was held in Arctic Village to discuss the potential for development in the Arctic Refuge. Out of this meeting the Gwich'in Steering Committee was established, whose stated goal was to “establish Gwich'in cultural survival as a major issue in the debate over oil development in the Arctic Refuge” (Inoue 2004). Meeting attendees included over 500 Gwich'in from both Alaska and Canada.

Community institutions in Arctic Village include the Arctic Village Council; community institutions in Venetie include the Venetie Village Council. Both Arctic Village and Venetie are members of the Native Village of Venetie Tribal Government, the Council of Athabascan Tribal Governments, and the Tanana Chiefs Conference (ADCCED 2018c).

Gwich'in (Canada)

Traditional Canadian Gwich'in social structure is similar to that described for the Alaska Gwich'in (above); however, as residents of separate nations, their more recent social and political organizations involve the Canadian Government, the Gwich'in Tribal Council (GTC) and associated communities, and the Vuntut Gwich'in First Nation. All of these entities work together to co-manage Gwich'in land and wildlife (Gwich'in Tribal Council 2018).

There have been numerous studies conducted or funded by various Gwich'in organizations, such as *At the Heart of the Teetlit Gwich'in Cultural Landscape*, funded by the Teetlit Gwich'in First Nation. Such studies demonstrate a lasting commitment to preserving their land and resources.

The PCH is of high importance to the Canadian Gwich'in and has been a driver in the formation of agreements and legislation, such as the International Porcupine Caribou Agreement. It was established in 1987 and was signed by both the Canadian and US governments and was intended to help protect the PCH, which migrates between northeastern Alaska and northwestern Canada (Vuntut Gwich'in Government 2017). Caribou Leadership: A Study of Traditional Knowledge, Animal, Behavior, and Policy is another example of co-management of the land and wildlife that was conducted in coordination with Trondëk Hwëch'in First Nation, the Teetli't Gwich'in Renewable Resource Council of Gwich'in First Nation, and the Vuntut Gwitch'in First Nation (Padilla 2010).

The Gwich'in Tribal Council represents the Gwich'in of the Northwest Territories, while the Vuntut Gwich'in First Nation represents the Gwich'in of the Yukon (Old Crow). The Gwich'in Tribal Council formed in 1992 (Gwich'in Tribal Council, no date) and consists of a system of coordination with their federal partners to help support their vision (Gwich'in Tribal Council 2018). The Gwich'in Tribal Council vision strives to be a "culturally vibrant and independent nation that is environmentally responsible and socially, economically, and politically self-reliant" (Gwich'in Tribal Council 2018). Other Gwich'in organizations are the Gwich'in Development Corporation, the Vuntut Gwich'in Limited Partnership, and the Gwich'in Steering Committee, which includes membership by Alaskan and Canadian Gwich'in.

Mixed Cash/Subsistence Economy

Iñupiaq

The Iñupiat traditionally participated in an economy that relied on subsistence resources and used trade to acquire goods not readily available in their immediate area. The concept of wealth was based on the number or amount of accumulated foods and goods; those with the most material possessions were the wealthiest. Among the Iñupiat, the umialik was often held by the wealthiest person, who needed to have a surplus of food and property to outfit a whaling crew.

Iñupiat participated in extended trade networks that included both formalized and less formal modes of trading (Spencer 1959). Their trade was not limited to other Iñupiat, and they also traded with Athabascan peoples farther south, in addition to Inuit people to the east and Siberian people to the west. Trading often occurred through established trade fairs, such as those at Nigliq, on Barter Island and as far as Sheshalik in Kotzebue Sound (Burch 1981, Gubser 1965).

The economy of the North Slope underwent major changes beginning in the mid-nineteenth century. This is when commercial whaling introduced a new type of economy to the Iñupiat, followed by other economic developments, such as reindeer herding and fur trapping. The development of petroleum reserves began in the 1940s and is still the driving force of the economy on the North Slope.

Today, the Iñupiat of the North Slope continue to rely on subsistence resources, while participating in the cash economy. Like other communities on the North Slope, Kaktovik and Nuiqsut have a mixed, subsistence-market economy (Walker and Wolfe 1987), where families invest money into small-scale, efficient technologies to harvest wild foods. Subsistence harvests are important in providing food to local households, and these foods are preferred by Natives, especially elders, over store-bought foods.

Cash from wage labor is also important in today's economy, as it enables residents to purchase gas, rifles, ammunition, transportation, and other tools and technologies they need in order to harvest subsistence resources. ANCSA corporation dividends rely heavily on oil and gas development, and many residents use their dividends as investments into their subsistence way of life. These investments can include gill nets, motorized skiffs, and snowmachines used to conduct subsistence activities. They are not oriented toward sales or profits but are focused on meeting the self-limiting needs of families and small communities.

For many Iñupiat, traditional hunting and harvesting patterns, which revolved around procuring subsistence foods when they were most available, now must be balanced with a need for income; thus, for individuals with full time jobs, resource harvesting is more likely to occur on weekends. In other cases, the wage provider of the household may not always be able to accompany other household members during certain subsistence activities but provides the cash for purchasing supplies and fuel. These arrangements, in which one person provides the money for other people to engage in subsistence activities, have become common in today's mixed subsistence-market economy.

The trade networks that characterized the traditional subsistence economy between coastal and inland Iñupiat continue today, exchanging subsistence marine mammal products for terrestrial resource products. In fact, sharing subsistence foods with other communities and regions is a major component of the mixed economy, and it has been facilitated by advancements in rural transportation and technology. During a single year of sharing by Kaktovik households for key species, Kofinas et al. (2016) documented sharing ties between Kaktovik and 131 households spread across 22 other Alaskan communities, two Canadian villages, and 11 locations outside of Alaska. Further discussion of subsistence uses of the program area by residents of Kaktovik and Nuiqsut are provided in **Section 3.4.3**.

Inuvialuit

Just as their ancestors did, Inuvialuit people maintain a strong connection to the land and its resources. Many Inuvialuit continue to live a subsistence lifestyle, hunting caribou, seal, fish, and whales, and using other wild resources of the North Slope and Beaufort Sea (Wildlife Management Advisory Council [North Slope] 1996).

Since ancient times, Inuvialuit have traded with neighboring groups, including the Iñupiat to the west and the Gwich'in to the south and southwest. As Euro-American whalers began settling in the area, trade expanded to include western trade goods, such as firearms. The Euro-American whalers also introduced a cash economy. In addition to trading with the Western whalers, Inuvialuit also became involved in the commercial whaling and commercial trapping industries, which reached their peak after World War I (Wildlife Management Advisory Council [North Slope] 1996).

As described in Usher (2002), the cash-based economy and reliance on wage employment became more widespread as development projects in the area increased. The bowhead whale industry collapsed around 1910 and, in its wake, decimated populations of caribou and marine mammal populations. The fur trade took over as the main economy of the region, and several fur trade posts were established. By the late 1960s, most Inuvialuit were adjusting to a way of life that included a mixture of wage employment and reliance on hunting, trapping, and fishing. As oil and gas exploration boomed in the 1970s and 1980s, Inuvialuit income and employment patterns changed even more.

Another factor that contributed to the development of a mixed cash and subsistence economy was the opening of day schools in Inuvialuit communities, which made a settlement-based way of life nearly unavoidable. The first federal day school was opened in Aklavik in 1951. Because attendance was mandatory in order for families to receive allowance benefits, families needed to stay in the vicinity of Aklavik during the school year. This schedule, in addition to the introduction of wage labor and economic pursuits, conflicted with the timing of many traditional subsistence activities (Wildlife Management Advisory Council [North Slope] and Aklavik Hunters and Trappers Committee 2018; Lyons 2009).

Despite the introduction of a cash economy, new technologies, imported goods, and a shift to a settlement-based way of life, Inuvialuit have worked to preserve their identity and their ties to the land. Part of protecting the Inuvialuit identity has been maintaining a subsistence-based economy, which persists today (Usher 2002). One method of maintaining Inuvialuit identity was through the Inuvialuit land claims and resulting IFA. The creation of the IFA was centered around maintaining Inuvialuit identity, including those cultural values that are intimately tied to a subsistence way of life. Today, the Inuvialuit people rely on both marine and terrestrial resources, including the PCH, which is a primary resource of cultural importance (Wildlife Management Advisory Council [North Slope] 1996).

Gwich'in (Alaska)

Before Euro-American contact, the Gwich'in were seminomadic hunters and gatherers who moved seasonally throughout the year in reasonably well-defined territories to harvest fish, wildlife, and a variety of plants. The pre-contact Gwich'in economy revolved around subsistence resources, and they traded to acquire goods not readily available in their immediate area. The subsistence economy was focused primarily on harvesting not only caribou but also fish, such as whitefish, and other resources.

First contact between Europeans and the Neets'aii Gwich'in occurred somewhere between 1847, upon establishment of Hudson's Bay Company at Fort Yukon, and the 1860s, with missionary efforts in the region (Dinero 2016). Up until the discovery of gold in the Gwich'in territories in the 1890s (1893 at Birch Creek), the subsistence economy was largely intact, and Native people remained independent and essential to the Euro-American fur trading economy (Mishler and Simeone 2004). The Gwich'in increasingly participated in the cash economy, while maintaining a strong subsistence lifestyle. This increasing reliance on a mixed cash/subsistence economy, in combination with the establishment of schools and requirement that all children attend them, prompted a shift to a more stable village life, which opened the door for further changes to the traditional economy (Dinero 2016; Stern 2018).

Beginning with the gold rush and especially by the start of World War II, the Gwich'in were presented with alternative ways of living, which were not oriented toward a life wholly dependent on the land. A living based on hunting, fishing, and trapping became only one of several choices; subsistence became a component of a "mixed, subsistence-market economy" (Walker and Wolfe 1987), rather than supplying the entire economy as it once did.

The Gwich'in of Arctic Village and Venetie have a deep relationship with the land they occupy and the resources they use. In contrast to the Iñupiaq villages farther north, there is little economic development in the Gwich'in area and few opportunities for local employment (Kofinas et al. 2016). In most cases, seasonal employment rather than full-time or permanent employment directly supports the subsistence activities of individuals. They, in turn, share the harvest with residents, as well as those who live in villages and regional centers, including Fairbanks and Anchorage (Caulfield 1983). The relative lack of cash to support subsistence activities would make these communities more vulnerable to changes in the availability of resources, such as caribou. This is because residents have less capacity to travel great distances in search of subsistence resources or to purchase alternative foods that are less desirable.

Gwich'in (Canada)

Like the Alaskan Gwich'in, before European contact the Canadian Gwich'in led semi-nomadic lives, subsisting off the land on a seasonal basis. They hunted wild game, such as caribou, moose, mountain sheep, black bear, beaver, porcupine, and birds, and fished along the rivers (Kritsch et al. 2000). They also gathered plants for food and had yearly celebrations at the end of every long winter, where they traded goods with one another (Fafard and Kritsch 2003). These celebrations would occur during harvest season when the caribou herds were migrating through the region. As with the Gwich'in of Alaska, the PCH remains central to the livelihood of the Canadian Gwich'in. In particular this is the case among the Vuntut Gwich'in of Old Crow due to their location and the availability of caribou relative to other resources (Benson 2012).

The fur trade began with the arrival of the Europeans in the early 1800s and the establishment of trading posts, followed by a gradual growth of the wage economy (Wray 2011). The increase in settlers to the region created a need for hunters and trappers to provide fur and food. Gwich'in men began working for the new settlers, often providing manual labor, such as chopping wood and repairing boats (Wray 2011).

As schools opened and furthered the centralization of the Gwich'in, many Gwich'in women settled into homes and began making clothing and doing laundry for the newcomers (Wray 2011). With the influence of Western culture came significant changes to the traditional Gwich'in economy. Introductions to new hunting technology, such as snow machines and guns, made subsistence hunting easier, but the cost of gas and equipment encouraged participation in the cash economy to pay for these supplies.

As discussed above under *History* and *Social and Political Organization*, a number of other factors played into the transition from a subsistence-based to a mixed subsistence-cash economy: the Klondike Gold Rush, construction of the Dempster Highway, and reduced wildlife populations (Fafard and Kritsch 2003). Land claims by the Gwich'in were in many ways prompted by increased competition for wild resources and efforts to develop traditional Gwich'in lands. Such claims were meant to provide for Gwich'in management of their lands, wildlife, and natural resources, in addition to allowing for the responsible development of their own lands (Wein and Freeman 1995; Western Arctic Handbook Committee 2002). Although there has been a significant amount of change to the Gwich'in land and culture, the Canadian Gwich'in have continued to keep their culture alive through subsistence hunting and continued care for the land and its animals, while participating in the wage economy.

Belief Systems

Iñupiaq

Traditional Iñupiaq belief systems consisted of two religious elements: hunting ritual and shamanism. These elements were similar to belief systems held by other Eskimo populations (Spencer 1984). Iñupiaq beliefs originally revolved around a system oriented to the environment and its animals.

Following proper hunting rituals was necessary to ensure a successful harvest. These rituals included actions taken before the hunt to avoid offending the animals and rituals taken after an animal was taken. Examples of this are offering freshwater to sea mammals, giving gifts to trapped land animals, and cutting the throat or opening the brain pan to free the soul (Spencer 1984). The more important the resource was to the community, the more elaborate and extensive the rituals and ceremonies associated with it. One of the most important ceremonies on the coast, which remains important today, was the whale feast (Nalukataq); its inland counterpart was the caribou festival (Spencer 1959). The messenger feast (Kivgiq), which has seen a revival on the North Slope in recent years, was an opportunity for Iñupiat from across the region to come together for trading and sharing.

Shamanism was a second key component to Iñupiaq belief systems. Shamans played specific roles relating to illness, predicting weather, finding lost items, foretelling the future, and speaking to the dead (Spencer 1984; Hall 1984). Despite the existence of shamans in traditional Iñupiaq society, the traditional belief system was largely fatalistic (Chance 1990); in other words, Iñupiat believed that powers beyond their control governed their environment. Their rituals and shamans, while having some influence, might prove ineffective despite their efforts.

Belief systems among the Iñupiat of the North Slope were largely unchanged before 1890, even though the region had experienced several changes from the whaling industry and various exploratory expeditions. After 1890, a number of Christian missions were established in the region, and rapid changes to Iñupiaq belief systems began.

The introduction of Christianity also introduced a rippling effect of changes that altered some Iñupiaq cultural values and traditions, particularly those surrounding housing, morality, subsistence, and social organization; however, despite these changes, the Iñupiat of the North Slope today retain a strong cultural identity associated with traditional subsistence hunting and harvesting patterns, and many traditional belief systems are strongly held and celebrated.

Iñupiat adhere to a set of core beliefs and values that are rooted in their culture. These contemporary Iñupiaq values strongly mirror traditional ones and include knowledge of the family tree, humility, avoidance of conflict, hunting traditions, family and kinship, respect for nature, sharing, and spirituality (NSB 2018a). Many Inupiaq values are directly reflected in subsistence activities and practices; others reflect the importance of cultural continuity and social and family ties within and among communities. Examples of this are language, family and kinship, humor, compassion, love and respect for elders, humility, avoidance of conflict, and spirituality (USACE 2012).

Language retention rates are relatively high among the Iñupiaq of the North Slope, with 71 percent of household heads indicating that use of the Inupiaq language was very important in 2016 (SRB&A 2017b). This could be evidence of the North Slope residents to promote knowledge of traditional values, such as through the establishment of the NSB IHLC Division, reintroducing the Iñupiaq language into schools, publishing elder conference proceedings, working with archaeologists to continue building their cultural history, and replacing English place names with Iñupiaq ones (Chance 1990).

Both Christian and traditional values and beliefs continue among the Iñupiat. While many traditional beliefs are no longer ascribed to, Christianity and the traditional belief system have become fused and often exist simultaneously in a single system (John 1996). Although there is primarily a Christian belief system in place, Alaska Native reverence for their environment and the traditional concepts of respect for the animals and each other is still in place and practiced. This is clearly seen in the values listed above, which emphasize respect for nature and hunter success. The Alaska Natives’ respect for their environment and the fish and animals is thus an integral part of their belief system.

Coastal North Slope communities, such as Kaktovik and Nuiqsut, maintain a strong maritime culture that centers on the bowhead whale hunt and emphasizes cooperation, participation in hunting traditions, and sharing. Whaling captains continue to have central roles as leaders in their communities and across the region. To the Iñupiat, protecting the land and water is essential to maintaining a culture that relies on the harvest of wild resources. This includes maintaining lands that are untouched by industry and where residents can conduct subsistence activities in relative solitude.

For the program area and greater territory of the Kaktovikmiut, this belief in the duty of the Iñupiat to protect their homeland and to serve as stewards of the land and sea is described in the City of Kaktovik’s document “In This Place” and is succinctly expressed in the opening general statement as follows: “We the Kaktovikmiut, the people of Kaktovik, are principally Iñupiat Eskimo, Native people of the Arctic Slope, the country that drains northward from the Brooks Range to the Arctic Ocean. We use and occupy this country, its associated waters, and the sea; and have claimed it since time immemorial by virtue both of aboriginal rights and our continued and undisplaced use and occupance [sic]” (City of Kaktovik and Karl E. Francis & Associates 1991, page 1)

Inuvialuit

According to an ancient story, Inuvialuit people are descendants of a hunter, his wife, his son, and an orphan girl who all survived a great flood by building a raft (Wildlife Management Advisory Council [North Slope] and Aklavik Hunters and Trappers Committee 2018a). Other passed-down stories and legends tell about *ingilraani*, or “a long time ago.” These stories, which are still told, provide a link to times far beyond living memory and serve to perpetuate cultural values (Inuvialuit Regional Corporation 2011).

Traditional Inuvialuit spiritual beliefs revolved around the belief that all things in nature have spirits. They could be helpful or harmful to people, depending on whether they were properly respected. Within this belief system, shamans (*angatkut*) had the power to intervene and communicate with spirits. People could seek the help of a shaman if they were sick, unsuccessful in hunting, or otherwise afflicted. The shaman could help to ward off or appease harmful spirits and even had the power to control the weather. *Aanruarutit* (amulets or charms) could also be worn to ward off harmful spirits (Inuvialuit Regional Corporation 2011). Many rules and taboos dictated proper behavior. Following the rules was a way to show respect for the spirits, while breaking rules could show the opposite and result in misfortune (Inuvialuit Regional Corporation 2011).

As Euro-American whalers moved into Inuvialuit homelands they brought with them Christianity, new belief systems, and new religious values and rules. The Inuvialuit resisted initial Christian conversions, illustrated by the fact that Anglican minister Isaac Stringer was said not to have a single convert during his time among the Inuvialuit. It was only after missionaries began incorporating elements of traditional Inuvialuit culture that Inuvialuit people began converting to Christianity (Lyons 2009). Christianity and many western systems and rules were eventually incorporated into Inuvialuit culture; however, Inuvialuit people today continue to have a distinct value system, including a strong sense of stewardship of the land and resources and a traditional knowledge base that dictates how to protect those resources (Wildlife Management Advisory Council [North Slope] 1996).

Gwich'in (Alaska)

The Gwich'in have a spiritual relationship with their environment that is integral to their cultural system. Before the gradual incorporation of Christian beliefs and Western values into their existing traditional belief system beginning in the mid-nineteenth century, the Gwich'in followed a loosely organized, animistic religion. It centered on a reciprocal relationship between humans and the rest of the natural world (Slobodin 1981; VanStone 1974).

Gwich'in belief systems have a holistic view of nature, in that no distinction existed between humans and animals, and everything in nature was considered sentient or to have a spiritual essence. Plants and animals are not objects governed by instinct but social beings with a spiritual potency controlled by powerful spirits or guardians. According to testimony by Johnny Frank of Arctic Village, traditional spiritual beliefs hold that humans and animals were once the same, and they all shared the same language. Caribou hold a particularly special relevance to Gwich'in spirituality and were believed to share a physical and spiritual connection with humans (Dinero 2016).

According to Gwich'in elders, before humans and animals separated, they reached an agreement in which they acknowledged each other’s hardships and came to agreement regarding human-animal relations. As part of the agreement, humans were given some of the wisdom of the caribou, while the caribou were given the ability to run fast. Caribou were still allowed to retain some of the wisdom that was imparted to humans and, hence, humans and caribou share a special bond (Kofinas 1998). In fact, the Gwich'in believe that a piece of caribou heart is in every human, and vice versa (Gwich'in Steering Committee 2004). The key cosmological figures among the Gwich'in were Raven, the cultural hero Attachookaii, and the trickster Vasaagijik (Slobodin 1981).

Christian missionaries of various denominations had considerable effect on the traditional Gwich'in belief system and used an intense five-fold strategy of building, speaking, teaching, healing, and traveling to undercut traditional ways of life and to provide what were perceived as appropriate Christian alternatives (Fienup-Riordan 1992). Early in the twentieth century the Episcopal Church attempted to abolish the potlatch, but was rebuffed, and today the potlatch is stronger than ever and remains a significant part of Native identity. Others fused Christianity and traditional beliefs into a single belief system as some of the Dena'ina had done with the Russian Orthodoxy and the Iñupiat had done with the Anglicans and Presbyterians. Lastly, some individual Athabascans saw the presence of missionaries as a good thing, saving individuals from alcoholism, while others saw a bias against Native people and their traditional ways (Reckord 1979).

The proper relationship between humans and animals is a central tenet of the traditional belief system. Animals were not only a source of food but powerful spiritual beings that must be treated with respect. Animals and humans shared an essence of personhood; both were sentient and volitional. They acted on their own values and choices and shared a fundamental organization in that each had a soul, a language, a family, and similar emotional characteristics, including anger and a desire for vengeance.

Animals and humans existed in a reciprocal relationship in which humans needed to kill animals to survive and animals desired to give themselves as food, but only on the condition that humans treated them with respect. The importance of reciprocity extends to humans as well—failure to share resources with others is not only frowned on socially but is considered a violation of a kind of social contract with game animals, threatening the success of future harvests (Caulfield 1983).

The importance of reciprocity in human and animal relationships is evident in contemporary Gwich'in culture through their continued identification as the caribou people, their continued observance of certain customary laws, the continued practice of traditional rituals, such as the potlatch, and the strong belief in the sacredness of places like the Coastal Plain, due to its integral connection to caribou calving and migratory bird nesting grounds.

Gwich'in (Canada)

Traditional Canadian Gwich'in belief systems are similar to those described for the Alaskan Gwich'in above. The strong connection between the Gwich'in, their homeland, and the animals that inhabit their homeland is illustrated by a traditional story of a meeting between animals and humans in the spirit world to discuss how to hunt and treat animals in the future (Wray 2011). The Gwich'in today still uphold this respect for animals, which is reflected in their stories and hunting methods and rules.

Similar to the Gwich'in of Alaska, Canadian Gwich'in belief systems focused on the spiritual connection between them and caribou. Canadian Gwich'in also believe that humans carry a piece of caribou heart in them and vice versa. The Gwich'in believe that they once lived in peaceful intimacy with caribou. Once the animal and human worlds separated, humans began hunting caribou, but a mutual respect was maintained; humans were allowed to use animals for food but agreed to treat their prey with respect and to take only what they needed (Wray 2011).

The establishment of Roman Catholic and Anglican missions in the mid-1800s had a dramatic effect on Gwich'in belief systems. Conversion to Christianity resulted in changes to the seasonal round, as residents were encouraged to come to town during religious holidays, such as Christmas and Easter (Western Arctic Handbook Committee 2002). Despite the adoption of Christian beliefs, many Gwich'in consider their relationship with the land and its resources to be a core spiritual value. In particular, they rely heavily on the PCH, more heavily than some in coastal communities, who have a wider resource base; therefore, the herd is considered central to the spiritual and cultural survival of the Gwich'in (Inoue 2004).

Direct and Indirect Impacts

This section identifies potential sociocultural impacts on Iñupiaq and Alaska Gwich'in sociocultural systems; Inuvialuit and Canadian Gwich'in sociocultural impacts are discussed under a separate heading *Transboundary Impacts* at the end of this section.

Issuance of oil and gas leases under the directives of Section 20001(c)(1) of PL 115-97 would have no direct impacts on the environment because by itself a lease does not authorize any on the ground oil and gas activities; however, a lease does grant the lessee certain rights to drill for and extract oil and gas subject to further environmental review and reasonable regulation, including applicable laws, terms, conditions, and stipulations of the lease. The impacts of such future exploration and development activities that may occur because of the issuance of leases are considered potential indirect impacts of leasing. Such post-lease activities could include seismic and drilling exploration, development, and transportation of oil and gas in and from the Coastal Plain.

Regardless of the availability of lands for leasing, seismic activities could occur across the entire program area; however, seismic surveys are unlikely to occur in areas closed to leasing due to lack of demand for seismic data in those areas. The analysis considers potential impacts on sociocultural systems from on-the-ground post-lease activities. As described in the previous section, Iñupiaq and Gwich'in sociocultural systems are based on social and kinship ties, subsistence harvesting, and a deep connection to the land and its resources. Oil and gas development in the program area would likely affect sociocultural systems by introducing changes to traditional subsistence lands and resources, the social, health, and cultural environment, and local and regional economies.

Alternative A

Under Alternative A, no oil and gas leasing program would take place in the program area. Sociocultural systems among the Iñupiat and Gwich'in would remain unaffected by additional oil and gas development and the associated economic, biological, and social changes. Iñupiaq and Gwich'in sociocultural systems would likely continue to evolve as a result of existing forces of change, such as increased modernization and technology, development and associated activities (such as oil and gas development and research) outside the Coastal Plain, infrastructure and transportation projects, changes to land status, environmental changes, and increased outsiders in traditional use areas.

Impacts Common to All Action Alternatives

This section discusses potential impacts on sociocultural systems from post-lease activities, including those common to all alternatives, such as exploration, development, production, and abandonment and reclamation (see **Appendix B**) While impacts on sociocultural systems do not vary greatly in terms of types of impacts, the intensity of impacts may vary by phase; these differences are identified where applicable.

The primary factors that may result in impacts on sociocultural systems are as follows:

- Changes in income and employment levels
- Changes in available technologies
- Disruptions to subsistence activities and uses
- Influx of outside temporary workers associated with post-lease oil and gas activities
- Influx of outsiders coming into the subsistence study communities

Many of the lease stipulations and ROPs designed to reduce potential impacts on subsistence uses and resources (see **Section 3.4.3**) would also help reduce sociocultural impacts. ROP 40 and the required orientation program would also help address sociocultural impacts. The goal would be to increase sensitivity and understanding of personnel to community values, customs, and lifestyles and to training designed to ensure strict compliance with local and corporate drug and alcohol policies.

Additional ROPs and lease stipulations directly address subsistence uses and activities; these are ROPs 2, 4, 6, 7, 18, 20, 21, 23, 34, 36-39, 41, 46 and Lease Stipulation 9. While most sociocultural effects (both beneficial and adverse) would affect the community of Kaktovik in program-area wide context, a number of sociocultural effects could extend beyond Kaktovik to other North Slope communities or, in some instances, to the Inuvialuit or Alaska and Canadian Gwich'in, in a regional context. The specific communities and regions that could be affected are discussed below for the various types of effects. The sociocultural effects would last longer than 5 years.

Changes in Income and Employment Levels

Increased income and employment levels—most likely to occur among the Iñupiat of the North Slope—could affect sociocultural systems by changing the socioeconomic status of certain community members, reducing the time spent by certain individuals on harvesting subsistence resources and thus affecting social ties in the community, and increasing the amount of cash available to engage in subsistence activities and support subsistence-related equipment and infrastructure. An influx of cash into a small, rural community can have both beneficial and adverse impacts on sociocultural systems. Traditional Iñupiaq and Gwich'in societies are based on social and kinship ties, which are established and strengthened through the procurement, processing, consumption, and sharing of subsistence resources (see *Affected Environment* above).

Certain households or individuals play a particularly important role in the harvesting of subsistence resources and distribution of those resources to households and individuals who are unable to hunt or harvest for themselves. These super-harvester households have been identified through previous ADFG research, which found that 30 percent of households generally harvest 70 percent of the total community harvest (Wolfe 2004). An increase in employment opportunities may result in some of these households shifting from their role as super-harvesters to high-earning households, as they lack the time to engage in subsistence activities as frequently as they once did. This could result in weakening or shifting of certain social ties in the community, and these changes could persist in the long term.

While this could cause social stresses in a community, Kofinas et al. 2016 notes that the role of super-harvester households often changes over time and that communities are in fact quite resilient to these changes. In addition, the roles of super-harvester households and high-earning households are not mutually exclusive; in fact, Kofinas et al. (2016) found that super-harvester households also tend to have high income.

In Kaktovik, 14.3 percent of all households were high-harvest high-income households; of all high-harvesting households, 43 percent were high-income, compared with 24 percent of medium-harvest households and 30 percent of low-harvest households (Kofinas et al. 2016); thus, an increase in income and employment may increase opportunities for subsistence harvesting. That said, a sudden and substantial increase in employment and income may cause a more dramatic shift in the role of super-harvester households in the community, and it may take longer for the community to adjust to the changes.

During the initial period of post-lease development, there may be a lack of super-harvester households as new roles are established. As a result, distribution of subsistence foods throughout the community could temporarily decline. If communities experience a dramatic change in the availability of such subsistence resources as caribou, there would likely be a tipping point where residents would no longer be able to adjust to such changes.

It is not possible, based on available data, to predict when or how such a tipping point may occur; however, recent data comparing road-connected communities to those not connected by roads have shown that road-connected communities have substantially lower subsistence harvests than those not connected (Guettabi, et al. 2016). In the analysis, road-connected communities are in more densely populated areas and on publicly accessible roads. Roads associated with development of the program area are not expected to be publicly accessible; however, if they are eventually opened to the public or if they substantially increase access to visiting hunters, the project could have greater impacts on sociocultural systems for local communities, particularly Kaktovik. The potential sociocultural impacts of such an occurrence would likely be adverse and long term (Chapin et al. 2009).

In addition to super-harvester households, high earning households also play an important role in the subsistence economy. This is because they often provide financial support to subsistence harvesters in the community as well as in their own households. As noted above, super-harvester households also tend to be high-earning households. An increase in employment and income resulting from the proposed oil and gas leasing program could therefore have potential positive effects on social ties once community roles are established; however, increased income opportunities in a community can also cause greater potential income disparities between households, especially if certain households are not shareholders in the ANCSA corporations. Such disparities can affect social relations and leadership roles in a community.

In general, an increase in employment opportunities could strengthen residents' resolve to remain in their home communities rather than moving in search of employment. Subsistence activities have been shown to persist despite increased income and wage employment, which demonstrates that the importance of subsistence is not limited to its nutritional benefits alone (Kruse 1991).

Changes in income and employment associated with post-lease activities would have the most potential direct impact on the Iñupiaq community of Kaktovik and may also extend to other Iñupiaq communities, although direct participation in oil and gas activities by North Slope residents would be relatively limited (**Section 3.4.10**). Kaktovik is closest to the program area, and therefore, when compared with other North Slope communities, Kaktovik residents are most likely to obtain employment associated with development and support activities in the program area.

Jobs and job-related income associated with development of the program area would likely be highest during the production phase. Jobs during exploration and development phases would be seasonal, temporary, and fewer (**Section 3.4.10**). Levels of local employment would depend largely on the implementation of adequate local hiring policies and opportunities for NSB-based businesses and corporations.

In addition, residents of Kaktovik would likely see greater economic revenues associated with the oil and gas leasing program as shareholders of KIC. Revenue would be minimal during the leasing stage but would increase during development or construction through property taxes. It would increase again during the production phase through royalties and other taxes (**Section 3.4.10**).

The City of Kaktovik may also receive bed tax revenues associated with increased visitors to the community, particularly during the initial years of development and construction. An increase in tax revenue could support sociocultural systems by contributing to community improvements (**Section 3.4.10**).

On a regional scale, Iñupiat communities across the North Slope may see increased economic activity resulting from post-lease activities as shareholders of the ARSC and through NSB revenues, and they may also be exposed to a greater number of employment opportunities. By contrast, Gwich'in residents would likely see only modest economic activity and revenues associated with profit sharing from ASRC to their regional corporation (Doyon, Inc.). The Gwich'in communities closest to the program area—Arctic Village and Venetie—do not belong to Doyon and do not have ANCSA corporations holding land in the program area; therefore, they would see limited economic activity and revenues associated with the proposed oil and gas leasing program (See **Section 3.4.10**).

The comparative lack of economic activity for the Gwich'in, especially the communities of Arctic Village and Venetie, could make those communities more vulnerable to social impacts, particularly those associated with disruption of subsistence activities. If communities experience reduced harvests, their increased reliance on store-bought foods could introduce financial hardships for certain households. Without the increased economic activity associated with development, communities are more vulnerable to its impacts and less able to adapt to environmental and social changes resulting from the development.

Changes in Available Technologies

Increased income and employment resulting from future oil and gas exploration, development, and production could also increase access to technologies, such as subsistence equipment and fuel. Access to such technologies could aid subsistence users in accessing subsistence harvesting areas, particularly if development results in subsistence users having to travel farther or spend longer to find and harvest subsistence resources.

Communities close to oil and gas development areas may also eventually have greater access to high-speed Internet and strong cell phone reception. In recent years, greater use of and access to cell phones and social media has shifted how residents in and between communities communicate with one another. In some ways, it has expanded social ties by facilitating connections across regions of Alaska and encouraged the establishment of trading relationships. Greater access to transportation and shipping options can also have a positive impact on sharing networks and the ability to bring goods directly into the community.

Finally, road corridors resulting from development of the program area could open up access for local hunters to subsistence areas not easily accessible or restricted during certain times of the year (see **Section 3.4.3**, Subsistence). In Nuiqsut, construction of road corridors associated with development of CD5 and GMT-1 has increased the use of those corridors by residents for subsistence hunting. In particular, residents who benefit from the presence of roads are those who do not have access to boats or overland modes of travel, such as four-wheel-drive vehicles and snowmachines and those who have limited time due to jobs and other commitments (SRB&A 2017a).

Some individuals have increased their participation in subsistence activities due to the increased access to hunting areas. In contrast, other hunters have decreased their use of areas surrounding roads so as to avoid industry and because of their personal preferences against road hunting. Data also show a possible shift away from traditional use areas to areas west of the community, where the road systems have increased access (SRB&A forthcoming). Because of this, access to roads may increase subsistence opportunities for many hunters and possibly increase overall participation in hunting; however, road access may also change traditional harvesting patterns and avoidance by certain individuals. Such changes would be most likely to occur for Kaktovik because of its proximity to the program area.

Disruptions to Subsistence Activities and Uses

Disruptions to subsistence activities associated with future oil and gas activities could potentially indirectly affect social cohesion. As noted above, increased income and employment levels could change social ties and organization by causing certain individuals and households to shift to new roles that are less focused on subsistence production. Such impacts would be highest during the production phase, when the number of available, permanent jobs would be highest. In addition to the extent that development in the program area disrupts subsistence or reduces the availability of certain resources to subsistence harvesters, residents may either experience reduced harvests of subsistence foods, or they may spend greater time, effort, and expense in pursuit of subsistence resources (see **Section 3.4.3**).

Potential impacts on subsistence resource availability would likely occur throughout the life of post-leasing activities in the Coastal Plain. They are most likely to affect terrestrial and riverine resources, such as caribou, fish, and waterfowl, with minimal impacts expected for other key resources, such as bowhead whales. Impacts would be minimal during the leasing phase and would increase during the exploration and construction phases. During the production phase, disruptions to subsistence activities in the way of noise and traffic would be lower; however, impacts related to infrastructure would be higher.

Nuiqsut residents have reported impacts on resource availability associated with nearby developments but continue to harvest resources at levels similar to before; however, continued harvests do not imply an absence of impacts. Residents report adapting to changes in resource availability by shifting to new hunting areas, spending more effort and time on the land, or changing hunting methods, such as hunting caribou along newly introduced road corridors.

Kaktovik residents are most likely to experience decreased availability of subsistence resources in the vicinity of development; however, larger changes to caribou migration and distribution could extend to additional communities, such as Nuiqsut (for the CAH), Venetie, Arctic Village, and Canadian user groups (for the PCH). Such changes in caribou migration and distribution could result in residents spending more time and effort hunting for caribou and traveling farther with greater risk to their safety (see **Section 3.4.3**).

An inability to harvest adequate subsistence resources can have adverse social consequences for a community. Decreased harvests of subsistence resources—particularly key resources, such as bowhead whales (for the Iñupiat) and caribou (for the Iñupiat and Gwich'in)—results in decreased opportunities for participation in such activities as processing, consuming, and sharing subsistence foods and participating in culturally important feasts and festivals. These are all important in maintaining and strengthening social and cultural ties in the community.

While impacts on resource availability of bowhead whales are unlikely, there may be impacts on caribou availability, particularly for the community of Kaktovik (see **Section 3.4.3**, Subsistence). Larger impacts on resource availability could have community- and region-wide effects on sharing networks, which could affect social ties if harvest shortfalls persist (see **Section 3.4.3**, Subsistence).

The inability of subsistence harvesters to provide for their community can also have adverse social and health/nutritional consequences (**Section 3.4.11**). Residents have reported that during times of reduced harvest success, they have witnessed increased social problems, such as drug and alcohol use, particularly among younger subsistence hunters (SRB&A 2009b). Introduction of new infrastructure and industrial traffic in traditional use areas, and associated changes in subsistence travel routes and harvesting patterns could increase the risk of injuries and accidents during subsistence activities, causing adverse social effects; however, these impacts would likely lessen over time, as residents become accustomed to security policies and traveling within developed areas (**Section 3.4.11**).

Finally, decreased use of certain traditional areas, due to changes in resource availability, user access, or the degradation of one's experience on the land resulting from noise and human activity, can result in fewer opportunities for residents to pass on traditional knowledge about those places, weakening the cultural associations residents have with the land. These impacts could extend to future generations.

Potential impacts on subsistence would occur to varying extents for different communities. Direct impacts from future oil and gas exploration, development, and production on subsistence activities would likely be greatest for Kaktovik; however, potential indirect impacts on the availability of resources, such as caribou, could occur for Nuiqsut, Arctic Village, Venetie, and other communities that rely on the PCH and CAH (see **Section 3.4.3**).

Even in the absence of physical disruptions to the distribution or migration of PCH caribou, real or perceived contamination or degradation of the Coastal Plain or the PCH could have adverse social and psychological effects on Iñupiaq and Gwich'in community members; examples are sense of self, community, and efficacy and psycho-social well-being. This would be due to the importance of the area to Iñupiaq and Gwich'in cultural and spiritual identity. See **Section 3.4.3** for a more detailed discussion of potential impacts on subsistence by community.

Influx of Non-Resident Temporary Workers and Outsiders

Another potential source of potential impacts on sociocultural systems is an influx of non-resident temporary workers associated with future oil and gas activities into local communities and traditional use areas and a general influx of outsiders into local communities associated with increased development in the region. While interactions with non-locals has become increasingly common in rural Alaskan communities, most Iñupiaq and Gwich'in communities continue to be relatively remote and primarily Alaska Native.

Interactions with non-locals can sometimes cause discomfort for residents when non-locals do not respect or understand local traditional values and customs. Residents have expressed discomfort conducting subsistence activities when non-locals are around for fear that their traditions are misinterpreted, misunderstood, or exploited for political purposes. Such concerns have become particularly prevalent in today's climate of social media posts, viral videos, and negative online backlash (Oliver 2017).

Witnessing non-locals mistreating or disrespecting the land and its resources can also have adverse cultural and spiritual impacts on locals, especially if the area holds particular importance to a community. In the case of the Coastal Plain, the area is in Kaktovik's core subsistence harvesting area and is considered sacred ground to many Gwich'in because of its importance to the health and survival of the PCH.

The presence of temporary workers who are associated with future post-lease development in traditional hunting areas could result in negative interactions between subsistence users and workers due to a lack of cultural understanding and respect on the part of the workers, or miscommunication of policies and procedures surrounding use of the land by local residents for hunting purposes. The number of workers would be highest during the production phase of development (**Section 3.4.10**).

If future oil and gas activities facilitate or promote access of outsiders into Kaktovik for reasons associated with development or otherwise, potential impacts could include increased social problems (e.g., outsiders bringing in drugs and alcohol), lack of infrastructure to accommodate the increase in visitors (e.g., lodging and transportation), and conflicts resulting from lack of knowledge or respect of traditional values. Native women and girls experience substantially higher rates of domestic and other violence. Oil and gas development in or near Native communities in the United States may raise the already high risk of violence to Native women and girls (Walker 2015).

An increase in population associated with post-lease activities is not expected for Kaktovik; workers are expected to stay in work camps and return to other areas of Alaska or outside Alaska (**Section 3.4.10**); however, while an increase in permanent residency is not likely, it is possible that Kaktovik would experience an increase in visitors associated with oil and gas industry, as has happened in Nuiqsut.

Alternative B (Preferred Alternative)

Under Alternative B, the types of potential impacts on sociocultural systems associated with future exploration, development, and production activities would be the same as those described under *Impacts Common to All Action Alternatives*, above. The duration of impacts would be long term for all types of impacts, although certain types of impacts, such as interactions with temporary workers, may be more frequent or intense during the exploration and construction phases of development. Potential impacts related to an increase in visitors to and an influx of nonresident temporary workers associated with future development would occur in the general vicinity of the action area or in the community of Kaktovik. Increases in income and employment levels may extend beyond the program area to other communities on the North Slope and possibly outside the North Slope. Changes related to disruption of subsistence activities and uses could extend outside the North Slope region to other communities that rely on the PCH and CAH herds.

Because the community of Kaktovik is the primary subsistence user of the program area, the people of this community would experience the greatest intensity of effects associated with future oil and gas activities in the Coastal Plain. Potential impacts on sociocultural systems may also occur for other communities if future oil and gas exploration, development, and production in the program area results in changes to resource abundance or availability, particularly caribou, which is a resource of major importance to the closest communities of Kaktovik, Nuiqsut, Arctic Village, and Venetie.

Because of the spiritual and cultural importance of the coastal plain and PCH calving grounds to the people of Kaktovik, Arctic Village, and Venetie, any disruption to that herd or perceived contamination or degradation of calving grounds in the program area would have sociocultural impacts on Iñupiat and Gwich'in, in terms of their belief systems, cultural identity, and the impact of development in the sacred calving grounds of the PCH.

While most impacts would occur on the PCH, development of the program area may also contribute to existing impacts of oil and gas development on the CAH. For residents of Nuiqsut, who rely on the regular movement of the CAH toward the Colville River delta during the summer, disruptions to CAH movement and distribution could also reduce the availability of caribou, thus affecting sociocultural systems in that community as well.

Alternative C

The types of potential impacts under Alternative C would be the same as those described under Alternative B. Because fewer acres of calving grounds would be available for surface occupancy, and ROP 34 (minimizing the effects of low-flying aircraft) would apply to a larger area, the intensity of potential impacts on the PCH and therefore the intensity of sociocultural impacts related to caribou availability under Alternative C would be less than under Alternative B (see **Sections 3.4.3**, Subsistence, and **3.3.4**, Terrestrial Mammals). While the intensity of impacts related to caribou availability would be lessened, other sociocultural impacts associated with changes in income and employment, changes in available technologies, influx of temporary workers and outsiders, and perceived or real degradation of traditional harvesting areas would likely be similar under any alternative.

Alternative D

The types of potential impacts under Alternative D1 and D2 would be the same as those described under Alternative B. Because fewer acres of caribou calving grounds would be available for leasing, and because more lands would be subject to development restrictions, the intensity of potential impacts on the PCH and therefore the intensity of sociocultural impacts under Alternative D would be less than under Alternative B (see **Sections 3.4.3**, Subsistence, and **3.3.4**, Terrestrial Mammals). In particular, Alternative D2 would be somewhat less likely to affect sociocultural systems, when compared with Alternative D1. This is because of the greater restrictions under Alternative D2 on development in caribou summer habitat and overall fewest acres opened for potential leasing and development.

While the intensity of impacts related to caribou availability would be lessened under Alternatives D1 and D2, other sociocultural impacts associated with changes in income and employment would likely be similar under any alternative. Examples are changes in availability technologies, influx of temporary workers and outsiders, and perceived or real degradation of traditional harvesting areas.

Transboundary Impacts

Impacts on sociocultural systems could extend to communities outside the US, particularly in the context of disruptions to subsistence activities. The project would likely not change income and employment, available technologies, or an influx in temporary workers and outsiders for the Inuvialuit, Canadian Gwich'in, and other PCH user groups in Canada; nevertheless, it may affect the availability of subsistence resources, thus affecting sociocultural systems. As noted above, Canadian Gwich'in and Inuvialuit, the primary Canadian users of the PCH, rely heavily on harvests of PCH caribou and have a spiritual connection both to the PCH and to the lands that the PCH depend on. The Inuvialuit and Gwich'in also have traditional uses of. kinship with, and sharing ties to the Coastal Plain.

Inuvialuit and Gwich'in land claims were centered on their ability to manage First Nations lands and resources to protect them from degradation by outsiders. Specifically, the Ivvavik National Park was established by the Inuvialuit to protect the Canadian calving grounds of the PCH. Any disruption to PCH habitat—particularly calving habitat—could result in social stress and loss of cultural connection to traditional lands.

As discussed in **Section 3.4.3** (Subsistence Uses and Resources), Canadian user groups represent 85 percent of overall harvests of the PCH; as such, they would experience the most impacts if the PCH population declines substantially or if herd migration or distribution changes to the extent that Canadian hunters experience reduced resource availability (see **Section 3.4.3**, Subsistence Uses and Resources). Should PCH availability or abundance decline, Canadian hunters may experience reduced harvests. A substantial reduction in caribou availability would reduce the opportunities to participate in traditional hunting, harvesting, processing, consumption, and sharing practices. That would erode key social and cultural values and activities over time.

As discussed under **Section 3.4.3**, the proposed leasing program is not expected to cause large population declines in the PCH, although a greater degree of development in calving grounds could increase the likelihood of decreased calf survival rates and declines in herd abundance. Because Alternative B would allow the most development in PCH calving grounds, it would be most likely to cause sociocultural impacts on the Canadian Gwich'in, Inuvialuit, and other Canadian user groups.

Cumulative Impacts

Past, present, and reasonably foreseeable future activities, in combination with oil and gas development in the program area, would increase the potential for sociocultural impacts, including changes in income and employment levels, changes in available technologies, disruptions to subsistence activities and uses, and increased interactions with outsiders. Past and present actions that have affected sociocultural systems among the Iñupiat, Inuvialuit, and Gwich'in include oil and gas development, onshore and offshore transportation and infrastructure projects, scientific research, increased recreation and tourism, demographic changes, changes in land status, government regulations, modernization, and climate change.

North Slope Iñupiat, Inuvialuit, and Gwich'in have experienced the impacts of development on their social organization since their initial contact with European explorers in the nineteenth century. The traditional social structure, which was based around extended kinship ties, trading partnerships, and friendships, underwent numerous changes throughout the nineteenth and twentieth centuries. These changes include the centralization of residents into permanent communities through mandatory education, the introduction of modern technology and changes to the traditional subsistence-based economy through the introduction of a cash economy, and the incorporation of Native peoples into new systems of laws and governing systems.

More recent changes are the following

- Degradation of traditional lands from development
- Creation of wildlife refuges and national parks and resulting restrictions on traditional uses
- Government hunting and harvesting regulations
- Recreation and sport hunting and fishing
- Scientific research and associated activities, including research associated with oil and gas development
- Transportation corridors, including the Dalton Highway and marine highway systems
- Climate change

Today, oil and gas development on the North Slope is a primary source of impacts on social organization among the Iñupiat, especially for the community of Nuiqsut, which is now connected to the Alpine development via a year-round road. Economic impacts associated with oil and gas development are another major driver of change on the North Slope. While it has brought increased revenue, which has contributed to infrastructure development and social services on the North Slope, increased income opportunities and disparities have also introduced tensions on communities. One example is the lack of shareholder status for certain community members.

Although the Gwich'in of Arctic Village and Venetie live in an area relatively undisturbed by development, construction of the TAPS and Dalton Highway have affected subsistence access and resource availability. Many residents believe that the highway and pipeline have change caribou migration across the region.

In all regions, increased sport hunting and fishing and associated air traffic have increased competition for local subsistence users and have disturbed and displaced subsistence resources, such as caribou. In Canada, the primary sources of impacts on sociocultural systems are oil and gas development, construction of the Dempster Highway, and increased sport hunting and recreation in the region.

Impacts of climate change are from changes in the predictability of weather conditions, such as the timing of freeze-up and breakup, snowfall levels, storm and wind conditions, and ice conditions, such as ice thickness on rivers and lakes. All of these factors affect individuals' abilities to travel to subsistence use areas when resources are there. In addition, subsistence users may experience greater risks to safety when travel conditions are not ideal. Changes in resource abundance or distribution from climate change can also affect the availability of those resources to subsistence users or may cause them to travel farther and spend more time and effort on subsistence activities (Brinkman et al. 2016).

Proposed and current activities affecting the study communities include additional or continued development of oil and gas resources in the onshore and offshore development. Reasonably foreseeable activities that could impact sociocultural systems include the following:

- SAExploration 3D seismic proposal
- CD5, GMT2, Willow, and Nanushuk developments in the Colville River region
- Continued development of Kuparuk and Prudhoe Bay
- Liberty Development in the Beaufort Sea; Beaufort Sea OCS lease sales
- Development of a natural gas pipeline from the North Slope to Canada, Valdez, or Cook Inlet (Alaska Stand Alone Gas Pipeline or Alaska LNG pipeline)

Other reasonably foreseeable activities are additional infrastructure projects, such as new permanent and seasonal roads, airport and community infrastructure improvements through the Arctic Strategic Transportation and Resources (ASTAR) program, the increased marine vessel traffic and air traffic associated with shipping, scientific research, and recreation and tourism activities and business in the region. The proposed oil and gas leasing program could also lead to or facilitate additional oil and gas development outside the program area and other development and infrastructure projects.

All of these activities, in combination with development or oil and gas resources in the program area, would increase the potential for interactions between local residents and visiting workers, as well as the potential for conflicts in communities regarding their support for or opposition to these projects. Tensions between communities relating to differences in opportunities for increased economic activity, such as increased employment, and potential adverse sociocultural impacts, such as disruptions to subsistence levels, could strain social ties and reduce social cohesion. Income disparities or political differences in and between communities could also contribute to social tensions between residents and community institutions.

Development also could increase tensions between different community institutions from disagreements about land jurisdiction and management and differing priorities and agendas, resulting in additional strains on social cohesion. Such changes could worsen political differences between Iñupiat and Gwich'in communities, potentially weakening social ties. If employment opportunities were to increase to the extent that fewer community residents have the time to engage in subsistence activities, then overall community harvests and participation could decrease, weakening the community's identity and association with the subsistence lifestyle (see **Section 3.4.3**) and causing reduced social cohesion and increased social problems. A countervailing impact of increased income through employment or dividends could encourage residents to remain in their home communities and provide financial support for subsistence activities in communities, thus strengthening the mixed subsistence cash economy.

The cumulative impacts of the past, present, and reasonably foreseeable activities on economic organization are tied closely to cumulative impacts on subsistence. The study communities participate in a mixed subsistence-market economy. The increasing presence of development in and around study communities may disrupt the economic organization of the community through changes in subsistence activities and participation in the cash economy. If subsistence activities or resources are disrupted to the extent that overall harvests of subsistence resources decline, then residents may begin to rely more heavily on wage employment and participate less in traditional subsistence activities.

Alternatively, increased income in the community, either through ANCSA corporation dividends or wage employment, may introduce a countervailing impact and provide more people with opportunities to participate in subsistence activities. This could affect residents who previously could not participate in subsistence activities due to a lack of equipment or money for fuel.

Infrastructure projects, including those cumulative impacts from the implementation of projects such as ASTAR, could result in greater public access to traditional hunting areas in the program area, particularly on the North Slope. This could result in even greater potential for interactions with non-Native individuals who may not share the same cultural values and respect for the land. Development of roads and other infrastructure may, however, introduce a countervailing impact of reduced costs of goods and services for local communities, thus encouraging residents to remain in their home communities.

Cumulatively, strong local economies could have positive social impacts as long as communities are able to adapt to such changes, while maintaining cultural traditions and values, such as subsistence, humility, respect for elders, family and kinship, and avoidance of conflict; however, while research has documented the resilience of subsistence-based economies, it has also made clear the vulnerability of rural communities to large-scale changes in subsistence resource availability, harvester access, employment levels, income, and road access.

The cumulative impacts of past, current, and reasonably foreseeable actions on subsistence activities are discussed above, in **Section 3.4.3**. Subsistence activities are key to maintaining social ties within indigenous communities, so any disruption to the hunting, harvesting, processing, distribution, and consumption of subsistence resources would also have impacts on social organization in the community. The incremental construction of development-related infrastructure throughout traditional Iñupiaq hunting and harvesting areas and in areas of cultural and traditional importance to the Gwich'in and Inuvialuit may erode their identity or cultural connection with those lands. This impact has already occurred in traditional use areas or camps in the Prudhoe Bay and Alpine areas, which are no longer accessible or usable by local residents.

Development of the program area would likely change subsistence and social systems, particularly for Kaktovik. If development of the program area reduces calving success for the PCH and causes the availability of caribou from that herd or the CAH to decline overall, then cumulative impacts on sociocultural systems could extend to Nuiqsut, Venetie, Arctic Village, and other Alaskan and Canadian users of the PCH and CAH (see **Section 3.4.3**). This would come about through direct changes in harvest success or reduced flows in sharing networks.

Future development of large-scale oil and gas development project would contribute to impacts on caribou including the PCH, CAH, and TCH. It also could increase the likelihood of disrupting subsistence harvesting of caribou and other migratory resources, such as waterfowl. This could be the case under such developments as Alaska LNG or ASAP.

There also could be a gradual increase in developed areas on the North Slope through further development of the Prudhoe Bay/Kuparuk oil fields and the Alpine, GMT-1 and GMT-2, Nanushuk, and Willow developments to the west. If this occurs in communities not experiencing increases in income or employment levels, such as Arctic Village and Venetie and Canadian groups, they could be more vulnerable to changes in subsistence harvests.

Development of offshore oil and gas resources in the Beaufort Sea would result in greater disruption to marine harvesting for the communities of Kaktovik and Nuiqsut, thus adding to the cumulative effects on subsistence.

Climate change will likely further contribute to impacts on subsistence activities and social systems. It would result in the following:

- Affect the availability of subsistence resources at traditional times and places
- Reduce access to traditional lands
- Degrade traditional hunting and camping areas from erosion of coastlines and riverbanks
- Cause greater risks to hunter safety and increased costs due to residents having to go farther to access resources or to travel in unsafe conditions

Alternatives that allow the most land to be developed in the program area and that have fewer timing and other restrictions are likely to have the greatest potential contribution to cumulative effects on subsistence resource availability and therefore the greatest contribution to cumulative effects on sociocultural systems. This is because future post-lease activities would have a greater effect on subsistence uses and resources and the greatest likelihood of interactions with outsiders, while increasing regional or local economic activity; thus, Alternative B would have the largest contribution to cumulative effects on sociocultural systems, followed by Alternative C and Alternative D1, while Alternative D2 would have the smallest contribution to cumulative effects on sociocultural systems.

3.4.5 Environmental Justice

Affected Environment

Environmental justice is defined in EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations. It requires that proposed projects be evaluated for "disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations."

In 2016, the DOI released the updated Environmental Justice Strategic Plan that establishes goals, objectives, and detailed guidance for federal agencies to ensure that no racial, ethnic, cultural, or socioeconomic group disproportionately bears the negative environmental consequences of governmental programs, policies, or activities (DOI 2016).

Guidelines for evaluating the potential environmental justice effects of projects require specific identification of minority populations, when either the minority population of the affected area exceeds 50 percent, or the minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis.

These guidelines also stipulate that low-income populations in an affected area should be identified using annual statistical poverty thresholds (CEQ 1997). The State of Alaska socioeconomic characteristics were selected as the reasonable general reference population for both minority populations and low-income populations.

Guidelines on environmental justice also suggest that where an agency action may affect fish, vegetation, or wildlife, it may also affect subsistence patterns of consumption and indicate the potential for disproportionately high and adverse human health or environmental effects on low-income populations, minority populations, and Indian/Alaska Native Tribes.

It is relevant to identify differential patterns of consumption of natural resources among minority populations and low-income populations, where the term means differences in rates or patterns of fish, water, vegetation, or wildlife consumption among minority populations, low-income populations, or Indian/Alaska Native Tribes, compared with the general population (CEQ 1997). Subsistence patterns in the affected environment are covered in detail in **Section 3.4.3**; if subsequent analysis of the action alternatives finds high and adverse impacts on subsistence, these would be of environmental justice concern as well.

Kaktovik is the closest community to be potentially affected by the leasing program. Based on their identified use of subsistence resources (see **Section 3.4.3**), the communities of Nuiqsut, Arctic Village, and Venetie are also relevant to the environmental justice analysis.

According to 2010 Census data, American Indian/Alaska Native residents of Kaktovik, Nuiqsut, Arctic Village, and Venetie—specifically Iñupiat in Kaktovik and Nuiqsut and Gwich'in in Arctic Village and Venetie—account for between 87.1 and 91.6 percent of the total population of each community. The total minority[59] populations of these communities range from 90.0 to 98.2 percent of the total community population. The statewide population is 14.4 percent American Indian/Alaska Native and 35.9 percent minority overall.

The minority composition of Kaktovik, Nuiqsut, Arctic Village, and Venetie, compared with Alaska, is shown in **Table N-2** in **Appendix N**. Based on 2010 census data, the minority population in all four communities is well above the 50 percent threshold and meaningfully greater than the general reference population, as specified in the CEQ guidelines (US Census Bureau 2010). Based on minority population criteria, these communities should be considered for potential environmental justice issues when evaluating the effects of the action.

Additionally, as shown in **Table N-1** in **Appendix N**, while the proportion of low-income residents in Kaktovik and Nuiqsut is well below that seen in the general population of Alaska, the low-income population components of Arctic Village and Venetie are meaningfully greater, at about 4.6 and 5.3 times higher, respectively, with roughly half the residents in both communities living below the poverty level (US Census Bureau 2016). Finally, each of these four communities is predominantly Alaska Native, with associated tribal entities. As a result, each community meets more than one criterion for potential impacts of the action to be of environmental justice concern.

As noted in **Section 3.4.10**, residents of the NSB would experience a range of direct or indirect economic impacts from the action, such as increased economic activity and revenues. As shown in **Tables N-1** and **N-2** (**Appendix N**), while the low-income proportion of the NSB's overall population is roughly equivalent to that of Alaska, the minority proportion of the NSB's population is meaningfully greater than that of the state. The result is that there is the potential for impacts from future projects to disproportionately accrue to a population that is otherwise of environmental justice concern.

The CEQ guidance on environmental justice under NEPA (CEQ 1997) directs federal agencies to apply CEQ guidance with flexibility. It says to consider them as a point of departure, rather than conclusive direction in

[59]For the purposes of environmental justice analysis, a minority population includes all persons other than those who self-identify in the census as both White and non-Hispanic or Latino.

applying the terms of the EO 12898. Following this guidance, analyses of potential impacts should be highly sensitive to the history or circumstances of a given community or population.

As noted in the Sociocultural Systems and Economy affected environment discussions (**Section 3.4.4** and **3.4.10**, respectively), the different histories and circumstances of the relevant Iñupiat and Gwich'in , such as outcomes under the ANCSA and the formation of the NSB, are likely to not only result in a differential distribution of potential impacts from the action but also to affect the vulnerability and resilience relative to potential adverse impacts.

As noted in **Section 3.4.4**, social and cultural values related to subsistence resources and activities represent another key area for the exploration of environmental justice. For example, primary concerns of the Gwich'in expressed during public scoping were the sacredness of the caribou calving and bird nesting grounds in the program area. This is in addition to more direct potential impacts on the reliability of the PCH and waterfowl annual migrations through Gwich'in territory. In other words, potential environmental justice impacts related to potential adverse impacts on subsistence resources extend well beyond the immediate program area, and they encompass the social and cultural value of subsistence resources (and their uses), as described in ANILCA, as well as the value of direct reliance on these resources for physical sustenance.

Climate Change

As noted in BLM (2018a) climate change can be understood as an environmental justice issue. The Iñupiat of the North Slope are disproportionately affected by it, both by the fact that climate change effects are more pronounced in the western Arctic and by the fact that Iñupiaq subsistence activities are particularly dependent on ice, wind, and permafrost conditions.

Climate change is changing the environment of the North Slope and affecting subsistence users' ability to access subsistence resources at appropriate times (Brinkman et al. 2016). The reduction of sea ice has worsened coastal erosion, the weather has become less predictable, the shore ice in spring is less stable for whaling, fall travel for caribou is hampered by a late and unreliable freeze up, spring hunting for geese is hampered by an early breakup, and ice cellars provide less reliable food storage. All of these issues create significant concerns for many Iñupiat because they are factors that cannot be controlled and that are threatening their way of life. Similar issues are also faced by those who are not on the North Slope but nevertheless depend on its subsistence resources, such as the Gwich'in communities of Arctic Village and Venetie.

Direct and Indirect Impacts

Issuance of oil and gas leases under the directives of Section 20001(c)(1) of PL 115-97 would have no direct impacts on the environment because by itself a lease does not authorize any on the ground oil and gas activities; however, a lease does grant the lessee certain rights to drill for and extract oil and gas subject to further environmental review and reasonable regulation, including applicable laws, terms, conditions, and stipulations of the lease. The impacts of such future exploration and development activities that may occur because of the issuance of leases are considered potential indirect impacts of leasing. Such post-lease activities could include seismic and drilling exploration, development, and transportation of oil and gas in and from the Coastal Plain; therefore, the analysis considers potential impacts on environmental justice from on-the-ground post-lease activities.

This analysis of impacts related to environmental justice considers if implementation of the proposed alternatives would result in disproportionately high and adverse environmental or human health effects on the communities of Kaktovik, Nuiqsut, Arctic Village, or Venetie. These communities meet the demographic characteristics to be qualified as minority populations (and the latter two as low-income populations) and require evaluation for disproportionate impacts under environmental justice.

EO 12898 directs federal agencies, to the greatest extent practicable and permitted by law, to achieve environmental justice by identifying and addressing disproportionately high and adverse human health or environmental effects of proposed federal actions on minority and low-income populations. The NEPA analysis of environmental justice is also informed by CEQ guidance, as follows:

> Under NEPA, the identification of a disproportionately high and adverse human health or environmental effect on a low-income population, minority population, or Indian [or Alaska Native] tribe does not preclude a proposed agency action from going forward, nor does it necessarily compel a conclusion that a proposed action is environmentally unsatisfactory. Rather, the identification of such an effect should heighten agency attention to alternatives (including alternative sites), mitigation strategies, monitoring needs, and preferences expressed by the affected community or population (CEQ 1997).

Federal agencies also are required to give affected communities opportunities to provide input into the environmental review process, including the identification of mitigation measures. The BLM has assured meaningful community representation in the process by holding public meetings in the communities of Kaktovik, Arctic Village, and Venetie, among others; coordinating directly with federally recognized tribal governments in compliance with EO 13175 and BLM's Tribal Consultation policy, which has resulted in government-to-government meetings with relevant entities in Kaktovik, Arctic Village, and Venetie, among others, and ANCSA corporation consultation meetings with the KIC and the ASRC, among others; and having several tribal governments sign on for participation as cooperating agencies, including the Native Village of Kaktovik, Arctic Village Council, Venetie Village Council, and the Native Village of Venetie Tribal Government.

Following CEQ (1997) guidance on evaluating environmental justice under NEPA, the analysis should recognize if the question of whether agency action raises environmental justice issues is highly sensitive to the history or circumstances of a particular community or population. The historical context in which environmental justice issues are considered is presented in the sociocultural systems analysis (**Section 3.4.4**). The BLM recognizes the interrelated cultural, social, occupational, historical, or economic factors that are likely to amplify the natural and physical environmental effects of post-lease oil and gas activities.

CEQ guidance also directs the BLM to consider any multiple or cumulative effects on human health and the environment, even if certain effects are not in the control or subject to the discretion of the agency (CEQ 1997); therefore, the BLM determined whether the potential environmental effects of post-lease oil and gas activities would be disproportionately high and adverse. It based this on whether there is or would be an impact on the natural environment that significantly and adversely affects Alaska Native residents of Kaktovik, Nuiqsut, Arctic Village, or Venetie. Such effects may include subsistence, sociocultural, economic, or public health and safety impacts on residents when those impacts are interrelated to impacts on the natural and physical environment.

Potential impacts for these resources are discussed in **Sections 3.4.3**, **3.4.4**, **3.4.10**, and **3.4.11**, and are not recapitulated in this section beyond brief summaries. This environmental justice analysis also considers that some Inupiaq entities and Iñupiat individuals, as shareholders in ANCSA corporations, would see increased economic activity and revenues from post-lease oil and gas activities.

Alternative A

No potential environmental justice impacts are evident in the analysis of Alternative A. Specifically, subsistence uses, sociocultural systems, and public health and safety among the Iñupiat and Gwich'in would be unaffected by oil and gas development in the program area. Iñupiat and Gwich'in sociocultural systems would likely continue to evolve due to existing forces of change. The economic conditions and the local, regional, and state level are expected to continue along current trends.

Impacts Common to All Action Alternatives

For all action alternatives, potential environmental justice impacts would derive from disproportionately high and adverse human health or environmental effects identified in other resource area analyses that would accrue to minority populations, low-income populations, or Alaska Native tribal entities. Impacts identified as subsistence, sociocultural, and public health and safety are largely, if not exclusively, also of importance to environmental justice.

In the case of subsistence and sociocultural analyses, identified potential adverse effects are concentrated in communities with largely Alaska Native populations, namely Kaktovik, Nuiqsut, Arctic Village, and Venetie. All of these have affiliated tribal entities and, in the case of the North Slope communities, affiliated Alaska Native regional and local corporations, with substantial resident shareholder populations.

In the case of potential public health and safety impacts, nearly all of the identified potential adverse effects are concentrated in Kaktovik as the community closest to likely future development. In the case of economic impacts, with the exception of subsistence-related impacts that, in turn, have an economic dimension, few potential adverse impacts are identified, but potential localized economic impacts are noted as most likely to accrue to residents of Kaktovik and other NSB communities, both in terms of governmental revenues and in terms of returns to resident ANCSA corporation shareholders.

As noted above, the potential indirect impacts of post-leasing activities, namely exploration, development, production, and reclamation and abandonment (see **Appendix B**), on the resource areas and sociocultural systems that affect environmental justice issues are discussed in their respective sections. Provided below are brief summaries of these potential effects.

Subsistence Uses and Resources

The primary factors that may result in potential impacts on subsistence resources and uses are noise, traffic, and human activity; infrastructure, including physical barriers; contamination; legal or regulatory barriers; and increased employment or income/revenue. These factors would affect resource availability, resource abundance, and user access for residents of the study communities, which in turn would result in adverse economic impacts for those whose cost of living would rise as a result of needing to purchase alternative foodstuffs.

In all cases, development could potentially affect subsistence uses of resources of major importance for the subsistence study communities. Kaktovik residents are the primary users of the program area and would therefore be most likely to experience potential direct impacts associated with development. Nuiqsut residents could experience potential direct and indirect impacts associated with harvests of marine mammals, such as the harvests of bowhead whale by Nuiqsut whalers near Cross Island, and indirect impacts associated with harvests of caribou, waterfowl, and fish. Arctic Village, Venetie, and other communities whose residents subsist in part on the PCH and CAH, could experience indirect impacts associated with caribou and, to a lesser extent, waterfowl. Impacts related to an increase in employment rates or income are most likely for the community of Kaktovik but would extend to other communities on the North Slope. Overall, future development in the program area would have potential lasting adverse effects on cultural practices, values, and beliefs through its impacts on subsistence.

Sociocultural Systems

The primary factors that may result in potential impacts on sociocultural systems include: 1) changes in income and employment levels, 2) changes in available technologies, 3) disruptions to subsistence activities and uses, 4) influx of non-resident temporary workers associated with the oil and gas leasing program, and 5) influx of outsiders coming into the study communities. An influx of cash into a small, rural community can have both beneficial and adverse impacts on sociocultural systems.

Economy

As noted in **Section 3.4.10**, historically, very few North Slope residents participate in direct oil and gas activities in the North Slope; however, North Slope residents who live near existing oil developments have participated in oil and gas jobs, such as ice road monitors, camp security and facilities operators, and subsistence representatives.

As further noted in **Section 3.4.10**, in 2016, while 55 oil and gas jobs were held by NSB residents, or less that 0.5 percent of the total oil and gas jobs based on the North Slope, it is also possible that, with more education and training, the future composition of the oil and gas workforce would be different. Training programs geared toward developing special skills required in oil field services are expected to create more employment opportunities for residents of Kaktovik in particular, given their proximity to the region where oil and gas activities are likely to occur. Petroleum development in the region is expected to generate revenues to the NSB government, the State, and the federal government from royalties, income taxes, production taxes, and property taxes, as shown in **Table 3-40**.

The City of Kaktovik would likely receive increased bed tax revenues with higher hotel occupancy, especially during initial development years (mobilization) and stakeholder engagement and industry community outreach; however, the change in the level of hotel occupancy is difficult to quantify at this point, because the timing and amount of local consultations and mobilization is uncertain and may vary. No changes to population growth rate or increase in population are expected in Kaktovik, because industry workers are expected to commute on a rotational basis, rather than relocating to Kaktovik or other North Slope communities.

Given that future oil field workers would be housed in work camps at the CPFs and drill pads, no increase in demand for local services and other public infrastructure is anticipated in Kaktovik. As noted in **Section 3.4.10**, however, local businesses in Kaktovik, including the KIC and its subsidiaries, could increase their economic activity from participation in oil and gas activities occurring during the exploration, development, and production of petroleum resources in the Coastal Plain; however, the level of increased economic activity cannot be quantified with existing data.

Public Health

All action alternatives are likely to be below applicable air quality standards for all phases of a future development project. Water would be contaminated in the event of an accidental discharge; however, the likelihood of any such discharge occurring with the resultant human exposure is low, given the lease stipulations and ROPs around waste prevention, handling, disposal, spills, and public safety. If exposure were to occur, it would be likely short term and intermittent and unlikely to lead to significant health effects.

There is a low likelihood of contamination of subsistence food sources, with the possible exception of contamination through an oil spill or through contaminants mobilized through erosion or permafrost degradation. The history of oil and gas operations on the North Slope suggests a number of other potential oil and gas-related sources of contamination of subsistence foods (NRC 2003); however, the perception of contamination may result in stress and anxiety about the safety of subsistence foods and avoidance of subsistence food sources, with potential changes in nutrition-related diseases as a result. These health impacts (perceived or real) arise regardless of whether there is any contamination at levels of toxicological significance; the impacts are linked to the perception of contamination, not to measured levels.

Noise level increases from construction or operation of oil and gas facilities would result in potential effects, ranging from minor irritation and annoyance to more severe health outcomes. Given the likely location of development away from Kaktovik, individuals at cabins or camps near developments would be most affected. Until site-specific development activities are proposed, the extent of this effect is not possible to determine.

Increased income for Kaktovik residents and families could improve health through increases in the standard of living, reductions in stress, and opportunities for personal growth and social relationships; however, experience with other oil and gas development in the NSB suggests that there is also the potential for an increase in social disruption (BLM 2012).

Future oil and gas development in the program area could increase the risk of injuries and accidents during subsistence activities. Increasing use of roadways increases the risk of motor vehicle accidents and injuries; however, the likelihood of accidents on ice roads or in-field roads is low, given the lease stipulations and ROPs that address vehicle and roadway use.

Alternative B (Preferred Alternative)

Subsistence Uses and Resources

Alternative B would result in the greatest potential impact on caribou calf survival and overall herd numbers, due to the amount of lands available for oil and gas leasing. Alternative B would include 0.5- to 1-mile setbacks (with no permanent oil and gas infrastructure, including roads and pipelines, allowed) for eight major rivers, many of which, such as the Hulahula, Okpilak, and Jago Rivers, are key drainages used for subsistence activities. Some TLs on human activity would be in place for calving and post-calving habitats of the PCH, which would reduce impacts on resource abundance and availability.

Sociocultural Systems

Because of its proximity to the program area, the community of Kaktovik would experience the greatest intensity of potential effects associated with the proposed oil and gas leasing program. Potential impacts on sociocultural systems may also occur for other communities if oil and gas development in the program area results in changes to resource abundance or availability, particularly of caribou, which is a resource of major importance to the closest communities of Kaktovik, Nuiqsut, Arctic Village, and Venetie.

Because of the particular spiritual and cultural importance of the Coastal Plain and PCH calving grounds to the people of Arctic Village and Venetie, any disruption to that herd or contamination or degradation of calving grounds in the program area would have potential sociocultural impact on the Gwich'in, in terms of their belief systems and cultural identity.

Economy

Potential economic effects would be similar to those discussed above in *Impacts Common to All Action Alternatives*. There would be unquantifiable differences in economic effects due to the ROPs associated with the various lease stipulations under Alternative B. Some of these actions would likely also result in delays in exploration, development, and production; therefore, this would also delay potential employment and income effects, as well as revenues that would otherwise accrue to the local, State, and federal governments.

Public Health

Potential threats to subsistence activities and harvest patterns are a primary source of ongoing stress in North Slope communities. Avoidance of productive subsistence areas may reduce harvests and worsen dietary and nutritional outcomes, independent of any potential direct impact on the animals themselves. Reductions in the success of subsistence harvests for Kaktovik residents could cause a shift from subsistence resources to store-bought foods, worsening nutritional outcomes and food insecurity.

Alternative C

Subsistence Uses and Resources

Under Alternative C, Lease Stipulations 6 and 7 would provide additional protections for caribou, and pads and CPFs would not be allowed within 1 mile inland of the coast under Lease Stipulation 9, although essential pipelines and roads may still occur. In addition, Lease Stipulation 8 would impose greater TLs on human activity in the PCH post-calving habitat area than Alternative B. Potential demographic impacts on the PCH would be less likely than under Alternative B, so the intensity of subsistence impacts under Alternative C would be less than Alternative B.

Sociocultural Systems

Of the lease stipulations noted above, the intensity of potential sociocultural impacts related to caribou under Alternative C would be less than Alternative B.

Economics

The potential economic effects under Alternative C would be similar in magnitude to the economic effects discussed above in *Impacts Common to All Action Alternatives*. Similar to Alternative B, there would be differences in economic effects resulting from areas available to lease in the program area, but these economic effects would be difficult to quantify at this leasing phase.

Public Health

Through additional protection for caribou, Alternative C would likely decrease the potential for impacts on Kaktovik residents' subsistence harvest and the likelihood and severity of health impacts from reduced subsistence harvests, increased reliance on store-bought food, and food insecurity.

Alternative D

Subsistence Uses and Resources

Under Alternatives D1 and D2, lease sales on calving grounds would be most limited of all action alternatives, and more lands would be subject to future development and TL; therefore, would be the least likely to affect calf survival and overall herd numbers of all action alternatives. Alternatives D1 and D2 also include larger setbacks from key subsistence drainages than other action alternatives, including 4 miles of the Hulahula and 3 miles of the Okpilak Rivers, which would greatly reduce potential impacts on subsistence in those areas, particularly during the winter.

Furthermore, no pads or CPFs would be allowed within 2 miles of the coast, reducing potential impacts on coastal subsistence hunters and anglers. In addition, reclamation of infrastructure would be on ongoing process for each development area, thus lessening the duration of impacts for individual developments related to infrastructure. Alternatives D1 and D2 would include additional design features meant to address impacts on subsistence resources and users (see ROP 34 for example).

Sociocultural Systems

Because of increased caribou calving grounds avoidance and because more lands would be subject to development restrictions, the intensity of potential sociocultural impacts under Alternative D1 and D2 would be less than under Alternative B.

Economy

Given the higher level of restrictions under Alternatives D1 and D2, the difference in the level of economic effects would be higher, compared with the differences in economic effects under Alternatives B and C. These increased restrictions would likely reduce the amount of oil produced and defer or reduce revenues and taxes.

Public Health

Similar to Alternative C, through additional protection for caribou, Alternatives D1 and D2 would decrease the potential for impacts on Kaktovik residents' subsistence harvest and therefore the likelihood and severity of health impacts from reduced subsistence harvests, increased reliance on store-bought food, and food insecurity.

Transboundary Impacts

While transboundary impacts are addressed in other sections of this EIS, they are not included in this environmental justice analysis section, which is based on the requirements and guidelines associated with EO 12898. That EO specifically applies to "identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of [federal agency] programs, policies, and activities on minority populations and low-income populations in the United States and its territories and possessions, the District of Columbia, the Commonwealth of Puerto Rico, and the Commonwealth of the Northern Mariana Islands."

Cumulative Impacts

While there has been no previous oil and gas development in the Coastal Plain and very little oil and gas exploration in the same area, the North Slope as a region sustained contact with outside entities and institutions. This includes the decades of oil exploration and development conducted by the federal government and industry. This has directly affected habitat use and behavior of subsistence species and resulted in cumulative impacts on subsistence resources, harvest patterns, and users (BLM 2018a). These effects have altered livelihoods and ways of life and account for some of the social disruptions seen in villages today.

Oil and gas development has also provided the underpinning of a regional economy that has enabled the NSB a greater degree of local control and self-determination in addressing socioeconomic and sociocultural issues, although dependence on an undiversified economy based on the extraction of natural resources has created other challenges. The leasing program and post-leasing activities would likely contribute to potential cumulative impacts in a variety of ways across the subsistence, sociocultural, economic, and public health spectrum (these are discussed in **Sections 3.4.3**, **3.4.4**, **3.4.10**, and **3.4.11**).

Subsistence Uses and Resources

Cumulative impacts on subsistence would alter subsistence use areas, user access, and resource availability for Iñupiat and Gwich'in subsistence users. Over time, changes in how residents access and use the land and reduced opportunities for participation in subsistence harvesting, processing, distribution, and celebrations from decreased harvests would have adverse effects on culture by weakening social ties and knowledge of cultural traditions.

Sociocultural Systems

Increased interactions with outsiders in traditional use areas and communities has the potential to affect traditional values and belief systems over time and may also result in increased social problems, if such interactions lead to greater access to drugs and alcohol. Cumulatively, strong local economies would have positive social impacts, as long as the communities are able to adapt to such changes, while maintaining cultural traditions and values. Communities that are most likely to experience adverse sociocultural impacts would be those that experience impacts on subsistence, while not having increased income or employment opportunities, such as Arctic Village and Venetie. These effects would be highest under Alternative B, less under Alternative C, and the least under Alternative D.

Economy

The oil and gas leasing program and subsequent exploration, development, and production in the program area would increase oil and natural gas production on the North Slope and increase TAPS throughput. Economic activity would increase at the local, regional, and state level due to direct industry spending on labor, materials, and services. Government revenues would increase from shared royalties, tax payments such as property taxes, corporate income taxes, severance taxes, and other local taxes, although the cumulative impact cannot be quantified with existing data (see **Table 3-40** for incremental contribution of post-lease oil and gas activities). Job opportunities would increase for Alaskans, including residents of communities in the NSB. Labor income would increase in regions where industry spending would occur and where the oil and gas workforce resides, although the cumulative impact cannot be quantified with existing data (see **Table 3-38** and **Table 3-39** and accompanying discussions for the incremental contribution of post-lease oil and gas activities).

Public Health

As noted in **Section 3.4.11**, for most past, present, and reasonably foreseeable future projects, the village of Kaktovik and its residents have been buffered by surrounding undeveloped lands. Air and water quality in and around the village remains good, and the influx of oil and gas revenue for the NSB has improved infrastructure in the village.

High rates of accidents and injury are primarily due to subsistence activities, and food security for Kaktovik households remains a concern (see *Food, Nutrition, and Subsistence Activity* in **Section 3.4.11**). Future development offshore in the Beaufort Sea could likely increase the risk of accident and injury by changing the harvest patterns and requiring more time on the water to harvest animals. The onshore leasing alternatives would have similar contributions to the cumulative effects on public health for Kaktovik residents with the pathways described above.

Current levels of contamination of traditional food and water supplies in the region are low and, in the absence of major spills or accidents, are unlikely to significantly change under any alternative. Oil and gas development, particularly in areas of traditional use and subsistence harvest, would disrupt subsistence harvest patterns. Conflicts between uses of the land would lead to an increased risk of injury in hunters.

All action alternatives would increase the potential likelihood of injury due to industrial use of land previously used only for subsistence activity. Continuing economic development and increasing revenues to the local governments under all action alternatives would support maintenance of Kaktovik infrastructure and systems. The potential direct and indirect employment resulting from oil and gas exploration and development, combined with the government and ANCSA corporation revenues, are all major contributors to the positive health changes in the NSB over the last few decades. The future oil and gas activities under all action alternatives would contribute to these ongoing changes, with greater levels of employment generally being more likely to be associated with good health.

3.4.6 Recreation

Affected Environment

Recreation opportunities and settings in the program area are largely as described in the Arctic Refuge CCP (USFWS 2015a), which is incorporated here by reference; a summary is provided below.

The primary recreation opportunities in the program area are wildlife viewing, camping, backpacking, hiking, photographing, hunting, fishing, and boating (Christensen and Christensen 2009). These activities include hunting and fishing for non-federally qualified subsistence users, permitted commercial activities, such as guided float trips and hunting, and individual visitors engaged in dispersed recreation, such as backpacking and photographing. Polar bear viewing and ski touring are also popular (USFWS 2018).

The recreation setting of the program area is remote; in many cases, visitors do not encounter other people during their visit. Many people visit the program area in the summer, when near constant daylight provides unique multiday recreation opportunities. Increasingly, visitors are coming to the program area later in the fall, experiencing rapid decreases in average daily daylight and increased opportunity to view the Northern Lights. Weather, surface water and land surface conditions, and near continual darkness limit or prevent access to many parts of the program area during the winter and spring.

There is limited overland motorized access to or in the program area. Motorized recreation opportunities and use of motor vehicles to access other forms of recreation consist mainly of snowmachines, which are legal during periods of adequate snow cover. Most snowmachine use is associated with subsistence activities. The only roads in the program area are near the community of Kaktovik. Local residents typically access inland areas by aircraft, skiing, or by foot.

Visitors to the inland portions of the program area arrive by chartered aircraft or by hiking, skiing, or floating from the Arctic Village and other access points. Air operators providing transportation services to visitors are regulated through a special use permit system, which identifies the specifications for their operations. There is a relative absence of water bodies sizable enough to support float landings, so the vast majority of landings are made on land where surface conditions permit it. Visitors enter the program area directly via chartered aircraft, from the south of Brooks Range via Arctic Village, Fort Yukon, or Coldfoot, or to a lesser extent, from the Dalton Highway and then fly from Happy Valley.

In 2017, four commercial air service operators provided air taxi service for 1,400 visitors; another seven operators chartered polar bear viewing excursions for 1,600 visitors. Air taxi service supported recreation for 850 river floaters, 300 backpackers, 40 base campers, and 100 hunters (BLM 2018g).

Visitor use in the program area has increased in recent years with the emergence of polar bear viewing on waters immediately surrounding Kaktovik. Before the season for polar bear viewing, more than 90 percent of visitors access the program area via airplane, with more than 80 percent of all visitors arriving via chartered planes (Christensen and Christensen 2009). Other visitors accessed recreation opportunities in the program area via boat or on foot.

During the summer and fall, the Canning and Hulahula Rivers support most water-based access to the interior areas in the program area. The Canning, Huluhula, Okpilik, Lago, and Aichilik Rivers each provide recreation opportunities for paddlers choosing to paddle out of the mountains and across the Arctic Plain. Smaller rivers, such as the Tamayariak, Katakturuk, Marsh Creek, and Sadlerochit, also flow across the coastal plain and provide routes for backpackers. Most recreation occurs along these river corridors, and visitors typically travel by plane to their headwaters in the southern portion of the program area.

In 2017, guided polar bear viewing accounted for approximately 54 percent of all reported guided recreation activities in the program area. Polar bears are viewed on waters next to Kaktovik.

Of the remaining 46 percent of visitors to the program area, use was more dispersed, and river floaters accounted for 60 percent of visitors, while backpackers, base campers, and hunters made up 40 percent of the activity types. Visitors for each of these four recreation types depend predominantly on use of river corridors during all or a portion of their visits (BLM 2018g).

As described in the Arctic Refuge CCP (USFWS 2015a), caribou viewing and hunting are popular recreation activities among program area visitors in the late spring and early summer, with hunting occurring in August. Caribou are the primary game species hunted in the program area, which is entirely in GMU 26C. There is also subsistence hunting of caribou and marine mammals that takes place in the program area (see **Section 3.4.3**). In 2017, approximately 4 percent of all reported guided recreation in the program area was hunting. Of the visitors to the program area whose use was focused on river corridors and not polar bear viewing, approximately 8 percent were hunters (BLM 2018g).

Polar bear viewing is an increasingly popular activity in the program area. In 2013, it represented approximately one quarter of all recreation visits; in 2016 and 2017, it accounted for more than half (BLM 2018g). There are viewing opportunities near Kaktovik, including through guided viewing tours. Expanded infrastructure at Kaktovik supports international visitors seeking the unique opportunity of viewing polar bears outside of captivity.

Climate Change

The unique character of landscapes in the program area would continue to change in response to climate change. Increasing temperatures would directly affect recreation by reducing opportunities to participate in over-snow activities, such as ski touring. Warmer temperatures associated with climate change would increase the potential for direct and indirect impacts on recreation from the earlier thawing of permafrost and variable stream flows, which are altering or diminishing the quality of recreation and the ability of visitors to access them.

Direct and Indirect Impacts

The reasonably foreseeable development scenario (**Appendix B**) identifies five phases associated with the hypothetical baseline scenario: leasing, exploration, development, production, and abandonment and reclamation. In the leasing phase under the directives of Section 20001(c)(1) of PL 115-97, there would be no direct impacts on the environment. This is because, by itself, a lease does not authorize any on the ground oil and gas activities; however, a lease does grant the lessee certain rights to drill for and extract oil and gas subject to further environmental review and reasonable regulation, including applicable laws, terms, conditions, and stipulations of the lease. As such, oil and gas development, particularly exploration, development, and production, may affect recreation through seismic and drilling exploration, development, and transportation of oil and gas in and from the Coastal Plain; therefore, the analysis considers potential impacts on recreation from on-the-ground post-lease activities.

Potential impacts on recreation would result from management that enhances or diminishes the quality of the recreation setting, limits access or physically displaces visitors or non-federally qualified subsistence users because of new surface disturbance or development, increases or decreases conflicts between recreation uses, such as in high use areas, increases or decreases the ability of commercial operators to carry out specially permitted activities, or enhances or diminishes subsistence opportunities. The effects of climate change described under *Affected Environment* above, could influence the rate or degree of the potential direct and indirect impacts.

Alternative A

Under Alternative A, no oil and gas leasing program would take place in the program area; there would be no potential direct or indirect impacts on recreation from post-lease oil and gas activities in the program area.

Impacts Common to All Action Alternatives

The magnitude, spatial extent, and duration of potential impacts on recreation would vary, based on season, type of recreation, location in the program area, and phase of the development. In general, the potential for impacts on recreation would be greatest during the summer and fall, when weather and daylight conditions allow for the greatest number and type of recreation uses. Similarly, the potential for impacts would be greatest along river corridors, the Beaufort Sea coastline, and other areas where the number of recreation users is highest. Because visitors to the program area generally expect a physical setting consisting of little to no human disturbance and a social setting with little to no interaction with other visitors or human activity, small changes to the physical and social setting can have disproportionately large impacts on user experiences.

The five phases of development would vary the magnitude, area extent, and duration of impacts. Under the leasing phase, there would be no impacts because a lease itself does not authorize any on the ground oil and gas activities. Under the exploration phase, impacts would be dispersed along lease areas. This is because activities are intended to identify potential prospects and would occur for approximately 4 years (see **Appendix B**). Only Lease Stipulation 4, prohibiting surface-disturbing activities along nearshore marine, lagoon, and barrier islands, would apply under the exploration phase of the hypothetical baseline scenario.

Under the development phase, impacts would be concentrated along areas identified as viable prospects for development and are expected to last for approximately a year. While impacts may be more concentrated, activities to support construction, such as creating roadway infrastructure, may extend from the prospected location; however, under the development phase, NSO lease stipulations attach and vary by alternative.

Under all action alternatives, Lease Stipulation 1 would not allow surface disturbance along rivers and streams. Under the production phase, the dispersion of impacts would likely be reduced, as activities would be operational. Infrastructure constructed during development would affect the visual landscape, would prevent recreation in some areas, and could diminish the quality of recreation. Finally, under the abandonment and reclamation phase, approximately 85 years after initial lease sale, impacts would result from removing retired equipment and plugging wells that are no longer economically viable.

Protective measures intended to limit ground disturbance and associated impacts on resources would impact recreation less by limiting or prohibiting surface-disturbing activities that could diminish the quality of recreation experiences, conflict with recreation opportunities, or displace visitors and non-federally qualified subsistence users. The magnitude of potential impacts on recreation would be directly related to the type and extent of proposed lease stipulations or ROPs under each alternative.

While, during the exploration phase, surface development would not be allowed along nearshore marine, lagoon, and barrier island habitats only, other protective measures would prevent the construction of infrastructure on acres identified with NSO stipulations. Production infrastructure, expected to last at least 85 years, would be built only on areas open to lease sales that are subject to standard terms and conditions. In general, maintaining or improving resource conditions increases the quality of recreation (Dorwart et al. 2009).

The program area offers recreationists primitive recreation experiences, such as recreational rafting, pack rafting, expedition-length float hunts, and polar bear viewing, that are unique on a global scale and that depend largely on the physical setting. Visual quality contributes to the physical setting and directly influences recreationists' desire and satisfaction with recreation in the program area. Undisturbed landscapes contribute to higher-quality recreation opportunities, and disturbed landscapes may affect the desirability of recreation in the program area and displace recreation to areas outside the Coastal Plain, such as the Kongakut River. Protective measures attached to leases beginning in the development phase of the hypothetical baseline scenario, such as NSOs, which prevent surface disturbance and the placement of aboveground infrastructure, would eliminate the potential for changes to visual quality and associated physical setting. Where aboveground development is allowed, lease stipulations that minimize the visual contrast of new development, such as by requiring design elements that complement the predominant natural features of the characteristic landscape, would reduce the intensity of visual impacts and associated change to the recreation setting.

Night sky conditions are a component of visual quality that also contribute to the recreation setting and user experiences. The addition of artificial lighting at facilities in the future and from vehicles would diminish the quality of night sky conditions, especially in the winter and spring, when daylight hours are shortest. Diminished night sky conditions during the winter and spring would affect fewer visitors, compared with daytime visual impacts. This is because there are fewer visitors to the program area during that time of year; however, any new artificial light would result in a potential impact on those visitor experiences because there are very few artificial light sources in the program area.

Similarly, future artificial lighting during the limited nighttime hours in the summer and fall would result in a short but intense impact, which could diminish the overall quality of visitor experiences. There would also be potential indirect impact on the experience where artificial light reduces visitors' ability to observe the Northern Lights.

Under the exploration and development phases, artificial lighting would likely be dispersed along the program area during supporting activities, such as the construction of exploration wells or site infrastructure. During the production phase, impacts would be more concentrated along established infrastructure to support production operations; however, during the production phase, there is also the potential from artificial lighting impacts from gas flaring. Such impacts could disrupt the visual quality of the program area and would be greatest during night sky conditions. See **Section 3.4.8** Visual Resources, for a description of visual impacts on the program area.

Protective measures that prevent the placement of aboveground infrastructure or that specify the use of downcast lighting or other light trespass mitigation measures would minimize impacts on the quality of nighttime recreation.

The magnitude of potential impacts on the recreation setting from visual quality, including night skies, would decrease, relative to users' increasing distance from the source of any visual impact or artificial light; however, the relatively flat topographic characteristics of the program area would result in new mineral development infrastructure being visible from far distances. Also, because there is no development currently, any new development that would be visible to recreation users would modify the recreation setting and visitor experiences.

The exploration, development, production, and abandonment and reclamation phases of oil and gas development would be particularly noticeable from elevated vantage points. Even with protective measures to minimize potential visual impacts, surface disturbance and infrastructure development would modify the existing character of the landscape, diminish visual quality, and directly affect the quality of the recreation setting and associated experiences. The intensity and duration of the impact would depend on the phase, type, and location of the development, relative to recreation opportunities.

Noise from mineral development following a lease sale would modify the recreation setting and could potentially diminish visitor experiences. Noise would likely increase during the exploration and development phases of oil and gas activities, as impacts would be dispersed through the leased areas from supporting activities related to exploration and construction. During the production phase, noise would be specific to the prospected location; however, noise impacts would last approximately 85 years.

Noise impacts would likely increase during the abandonment and reclamation phase, as vehicles and supporting activities would be accessing the area. The magnitude of impacts depends on the distance between the observer and the noise source, the duration and frequency of the noise, the time at which the noise occurs, the presence of topographical features or vegetation that decreases noise, and the lease stipulations or mitigation strategies that reduce noise levels. The use of compression technology would increase the noise levels associated with mineral production. More frequent aircraft and ground-based vehicle trips could also increase the occurrence of noise impacts from those sources. Potential noise impacts on recreation would diminish farther from the source, because noise diminishes with distance.

Lease sales resulting in future mineral exploration and production and associated pipelines, private roads, mineral material sites, and other infrastructure can physically displace recreation opportunities and prevent access to areas for recreation.

In the exploration phase, some recreation opportunities could be displaced from exploratory well and supporting activities. During the development phase, displacement would result from the location where production is expected to occur and surrounding construction activities. During the production phase, displacement would be reduced because recreationists would be affected primarily by the infrastructure related to production. Impacts from the abandonment and reclamation phase would be the same as those during the development phase.

The magnitude and type of potential impacts would depend on the location of the development and recreation activity affected. The potential for impacts would be greatest during the summer and fall when visitation is highest and near river corridors and other areas where visitors concentrate; however, permanent infrastructure would displace all types of visitors year-round and over the long term. Currently, recreationists are allowed to access most areas of the coastal plains; the development of mineral-related infrastructure may preclude those opportunities. Development of new roads would be available only for private industry and subsistence use.

Overland heavy equipment vehicle use for future seismic work could displace winter users when the equipment is in use, and seismic exploration could occur across the entire program area, even if an area is not available for lease. Vehicle operation would also produce noise and artificial light, which could detract from the primitive recreation experience. Over snow heavy vehicles used for seismic work can leave grid lines on the landscape visible by aircraft passengers following snow melt. This is the result of compacted snow melting slower than surrounding areas, creating darker vegetation patterns matching the gridlines used for the seismic work. In the summer and fall, for visitors arriving by air, or where the grid lines are visible from elevated areas, this modification would influence visitor perceptions of the program area's setting. Once they are on the ground or in equal elevation to the grid lines, there would be potential impacts on visitor experiences.

Recreationists in the program area rely heavily on commercial operators for access to desired recreation opportunities and experiences. Changes in resource conditions, including physical resources, such as visual quality, and biological conditions, such as wildlife, would directly influence the quality of recreation experiences obtained through commercial operators. For example, mineral development in leased areas that relocates or decreases polar bear or caribou populations would diminish the ability of operators to provide clients with desired recreation experiences. This could lessen the viability of certain operations, resulting in fewer permitted operators, which would indirectly affect recreation by potentially reducing access to the program area via specially permitted means. Another potential indirect impact of reduced access to the program area is recreationist being displaced to areas outside of the program area.

Alternative B (Preferred Alternative)

Under Alternative B, 1,563,500 acres are available for lease sales, 77 percent of which (1,204,000 acres) would be available for surface use. This would result in potential direct and indirect impacts on recreation throughout nearly the entire program area. The types of impacts described under *Impacts Common to All Action Alternatives* would result from lease sales that would be followed by the construction and operation of drill pads, CPFs, gravel roads, pipelines, STP, and gravel pits to support mineral development.

Over time as exploration, well pad development, road construction, and extraction occur, there would be a steady decline in the recreation setting from changes to the visual quality and night sky, compared with Alternative A. Noise from construction, production, aircraft, and vehicles would also diminish the quality of the recreation setting (see **Section 3.2.3**, Acoustic Environment). With the intensification of development through the construction and production phases, there would be a steady increase in surface disturbance, which would increase the potential for visitor displacement and restrictions on access for visitors and non-federally qualified subsistence users. New roads would create up to 208 miles of dispersed, linear barriers. Year-round vehicle traffic on the roads would contribute to noise, visual, and light-related impacts on the primitive recreation uses that occur in the program area.

One-mile setbacks from the Canning, Hulahula, and Jago Rivers, and narrow setbacks for other rivers that serve as primary recreation use areas, would potentially directly impact the recreation setting and visitor experiences as described above. The narrow setback would provide little opportunity for vegetation or topography to provide consistent screening of new facilities or vehicle traffic from view of users in the river corridors; most vegetation along rivers in the program area are short, scrubby brush. The intensity of the impact would depend on structure height, topography, and vegetation that influence a user's line of sight from the river corridor. Drill pads, roads, and pipelines near these river corridors would also physically displace visitors from areas outside the setbacks. Concentrating recreation uses in narrow river corridors would increase the density of activity in those corridors, compared with Alternative A, which would increase the number of interactions among visitors. This would directly affect the social setting and could increase the potential for conflicts among different types of recreation users.

There would be no specific protection measures to minimize disturbance in polar bear denning critical habitat, which could result in potential species displacement or decline. Over time, fewer species would result in fewer viewing opportunities, which would lessen the viability of commercial operators providing guided polar bear viewing experiences. This could reduce the number of specially permitted operators and indirectly limit future opportunities for visitors to experience polar bears outside of captivity.

Minimal protection measures for development in caribou summer, calving, and post-calving habitat areas could lead to displacement and possible decline in caribou populations, which would decrease hunting and viewing opportunities. Potential impacts on caribou populations would also indirectly affect the viability of commercial recreation uses that provide guided hunting and viewing opportunities. Fewer operators would result in an overall decline in opportunities to access the program area for recreation.

The long-term, permanent degradation of the program area's primitive recreation setting could result from not requiring final abandonment to meet minimal standards for WSR designation, not restoring general wilderness characteristics of the area, and allowing exceptions to abandonment conditions.

Alternative C

Compared with Alternative A, new oil and gas development following lease sales on up to 1,563,500 acres would potentially diminish the quality of the recreation setting and visitor experiences, displace visitors and non-federally qualified subsistence users, and increase conflicts between users. Following the lease sales, the types of impacts described under *Impacts Common to All Action Alternatives* would result from the construction and operation of an anticipated 18 drill pads and construction of CPFs, gravel roads, pipelines, STP, and gravel pits to support mineral development. The intensity of impacts would be similar to those described under Alternative B; however, Lease Stipulations 7 and 8, and a larger NSO area from Lease Stipulations 1, 4, 7, and 9, under Alternative C would result in potential impacts being experienced over a smaller area than under Alternative B.

Two-mile NSO setbacks from rivers, such as the Canning and Hulahula Rivers, would better maintain recreation opportunities and avoid the displacement of visitors in those popular recreation corridors. This would come about by providing greater opportunity for vegetation or topography to consistently screen new facilities or vehicle traffic from view of users in the river corridors; however, vegetation along rivers in the program area are short, scrubby brush. The intensity of the impact would depend on structure height, topography, and vegetation that influence a user's line of sight from the river corridor. It is likely the potential impacts from mineral activity development may still exist despite being viewed from a long distance.

The potential for user conflicts in river corridors would be nearly the same as Alternative A but to a lesser degree. This is because the wide corridor setbacks would support visitor dispersion in the corridor without being constrained by development.

Where unobstructed by topography or vegetation, infrastructure and vehicle traffic would be visible from the rivers. This would alter the recreation setting and could contribute to diminished user experiences. Where vegetation and topography provide screening, impacts would be nearly the same as under Alternative A. The exception would be at nighttime, when artificial lighting skyward of any new facilities would be visible, which would affect recreation, as described under *Impacts Common to All Action Alternatives*, above. A narrower 1-mile setback along the Jago River would result in the same impacts as Alternative B. Outside the river corridor setbacks, the potential for displacing visitors and limiting access would be the same as Alternative B and as described under *Impacts Common to All Action Alternatives*, above.

Protection measures limiting activity in polar bear denning habitat and caribou summer, calving, and post-calving habitat would minimize the potential for species dispersion, or decline, which would indirectly maintain the quality of hunting and wildlife viewing experiences. This would also minimize impacts on the viability of specially permitted commercial operators.

In the long term, requiring final abandonment to meet minimal standards for WSR designation and intent to restore general wilderness characteristics of the area would allow the program area to return to a primitive recreation setting. The removal of facilities and restoration of disturbed areas would eliminate displacement and access impacts associated with those features.

Alternative D

Potential impacts on recreation under Alternative D1 and Alternative D2 would be similar to those described under Alternative C. -The exception would be that, under Alternative D1, making 1,037,200 acres available for leasing, of which 708,600 acres (45 percent) would be NSO, would largely concentrate the *Impacts Common to All Action Alternatives* described above into a smaller portion of the program area. Compared with Alternative A, the greatest potential for impacts would be in the 328,600 acres (21 percent of the program area) available for leasing with surface use; however, some impacts associated with an anticipated 21 well pads and associated infrastructure would occur inside of the NSO areas.

Alternative D2 would concentrate *Impacts Common to All Action Alternatives* to a smaller portion of the program area by reducing the lands available for leasing to 800,000 acres, 505,800 acres (32 percent) of which would be NSO. The greatest potential for impacts would be in the 294,200 acres (19 percent of the program area) open for leasing with surface use.

Both Alternatives D1 and D2 would include changes to the recreation setting from artificial lighting and alteration of the recreation setting and visitor experiences from the visual presence of infrastructure and vehicles.

Transboundary Impacts

Transboundary impacts on recreation are likely to occur as a result of the leasing program in the Coastal Plain. The program area offers primitive recreation experiences that depend on the physical setting. Visual quality, remoteness, and uniqueness directly influence the desire to recreate in the program area and the satisfaction obtained from recreation. Disturbing the landscape of the Coastal Plain through the five phases of oil and gas development may affect the desirability of recreation in the program area. Development may displace recreation to areas outside of the Coastal Plain, such as the Kongakut River, other remote regions of Alaska, or Canada.

Cumulative Impacts

Potential cumulative impacts on recreation would be the result of actions or circumstances, both in or outside the ability of BLM to manage, that would enhance or diminish the quality of the recreation setting, limit access or displace visitors or non-federally qualified subsistence users, increase or decrease conflicts between recreationists, increase or decrease the ability of commercial operators to carry out specially permitted activities, or enhance or diminish subsistence opportunities. Past, present, and reasonably foreseeable future actions described in **Appendix F** that would cumulatively impact recreation include increasing recreation use in the program area, and energy and infrastructure development.

Under all alternatives, there would be an increased demand for recreation use in the program area driven by desirability of recreation in the program area and population growth. While demand for recreation is expected to increase in the program area, the values that contribute to positive recreational outcomes may change due to future leasing and development that may reduce demand. This would be the case particularly on lands that are easily accessed from nearby communities or waterways. With this increased demand, the social recreational setting would continue changing, resulting in the potential for more frequent and intense user interactions.

Under all action alternatives, with increasing demand, the displacement of visitors near leasing areas would increase recreation use in other locations in the program area, particularly at the Kongakut River. The direct impacts on the program area may indirectly move recreation to places outside the program area, such as the Kongakut River, and may increase the potential for user conflicts in those areas. Over time, more rules and regulations to control access and use may be needed. These potential changes would cumulatively impact the quantity and quality of recreation opportunities that can be offered and the recreation experience and opportunities that can be provided.

Under all action alternatives, oil and gas development from projects such as the Alaska LNG and the Alaska Stand Alone Pipeline would increase the presence of well pads, pipelines, roads, and other infrastructure. This could displace recreation in the program area. Increase use along the Dalton Highway to access oil and gas projects may adversely affect the ability of recreationists to access the program area.

Combined with increased visitation and other reasonably foreseeable future actions, new infrastructure development would diminish the quality of the recreation setting and associated recreation experience. These potential impacts would last until the infrastructure is removed and the areas reclaimed. New roads associated with private industry development would be available for private industry access and subsistence use only. The intensity of impacts on visitor experiences and recreation setting would be greatest in areas where infrastructure is visible, and operations are audible. Visitors displaced from certain areas because of oil and gas activity could choose alternate locations in the program area to recreate, which could lead to more frequent conflicts among recreationists in those areas.

Potential impacts from seismic exploration could occur across the entire program area, even if an area is unavailable for lease sale. Seismic exploration may adversely affect recreation in the program area by disrupting the visual landscape with camp trailers and seismic equipment. Such projects as the proposed SAExploration 3D Survey would increase the potential for impacts throughout the Coastal Plain. Noise generated from seismic activity could affect the recreational quality of remote activities, such as hiking, sightseeing, and taking photographs. Disrupting the visual landscape and reducing the recreational quality has the potential to diminish the desirability of recreating in or near the program area.

The effects of climate change described under *Affected Environment* above, could influence the rate or degree of the potential cumulative impacts.

3.4.7 Special Designations

Affected Environment

Arctic National Wildlife Refuge Purposes

The Arctic National Wildlife Range was established in 1960 by Public Land Order 2214 “For the purpose of preserving unique wildlife, wilderness and recreational values.…” In 1980, ANILCA redesignated the range as part of the larger Arctic Refuge. It also designated much of the original range as wilderness under the 1964 Wilderness Act and provided four purposes that guide management of the entire refuge. Section 20001 of PL 115-97 Act amended Section 303(2)(B) of ANILCA to add a fifth purpose related to the oil and gas program in the Coastal Plain. **Table 3-34** identifies the section of this EIS where impacts of oil and gas leasing associated with specific Arctic Refuge purposes can be found.

Table 3-34
Section of EIS Describing Impacts Associated with Arctic Refuge Purposes

Purpose	EIS Section Describing Impacts on Arctic Refuge Purpose
(i) to conserve fish and wildlife populations and habitats in their natural diversity	3.2.2 Air Quality 3.2.8 Soil Resources 3.2.10 Water Resources 3.3.1 Vegetation and Wetlands 3.3.2 Fish and Aquatic Species 3.3.3 Birds 3.3.4 Terrestrial Mammals 3.3.5 Marine Mammals
(ii) to fulfill the international fish and wildlife treaty obligations of the US	3.3.4 Terrestrial Mammals
(iii) to provide the opportunity for continued subsistence uses by local residents	3.4.3 Subsistence Uses and Resources
(iv) to ensure water quality and necessary water quantity in the refuge	3.2.10 Water Resources
(v) to provide for an oil and gas program in the Coastal Plain	3.2.5 Geology and Minerals 3.2.6 Petroleum Resources 3.4.10 Economy

Marine Protected Areas

The USFWS (2015a, Section 4.1.3.3, Marine Protected Area) described marine protected areas (MPAs). The discussion below tiers to and incorporates by reference relevant information, while placing emphasis on the program area.

MPAs come in a variety of forms and are established to protect ecosystems, preserve cultural resources, such as shipwrecks and archaeological sites, or sustain fisheries production. MPAs are defined as "…any area of the marine environment that has been reserved by Federal, State, territorial, tribal, or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein" (EO 13158, May 26, 2000).

The DOI nominated the Arctic Refuge in 2005 and it was accepted for inclusion in the national system of MPAs. There are no special conditions for managing the Arctic Refuge MPA, but designation provides its managers with an opportunity to prioritize using existing management authorities and to better understand the ecological quality and function of its coastal areas.

All marine waters in the Arctic Refuge boundaries and marine waters and lagoons off the northern coast of the program area (1,631,500 acres; BLM GIS 2018) are listed as part of the National MPA System.[60] Shifting shorelines and marine-freshwater boundaries at river mouths create some variability in the acreage estimate for the refuge's contribution to the National MPA System, on the order of plus or minus several hundred acres (USFWS 2015a).

Wild and Scenic Rivers

The USFWS conducted a WSR review as part of their Revised CCP (USFWS 2015b, Appendix I Wild and Scenic River Review). The discussion below tiers to and incorporates by reference relevant information, while placing emphasis on rivers in the program area.

[60]See the viewer of the NOAA National MPAs here: https://marineprotectedareas.noaa.gov/dataanalysis/mpainventory/mpaviewer/.

WSRs are rivers or segments of rivers designated by Congress under the authority of the Wild and Scenic Rivers Act of 1968 (PL 90-542, as amended; 16 USC 1271–1287). The purposes of the law are preserving the river or river section in its free-flowing condition, preserving water quality, and protecting its outstandingly remarkable values (ORVs). They are identified on a segment-specific basis and may include scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values.

The Wild and Scenic Rivers Act mandates protections for rivers that are designated rivers of the National Wild and Scenic River System. Federal managers are obligated to use existing management authorities to protect the characteristics of rivers for the conditions under which they were found eligible and suitable (USFWS 2015b). A river's preliminary classification (either wild, scenic, or recreational, based on level of development), free-flowing condition, water quality, and ORVs must be maintained. The WSR study for Arctic Refuge (USFWS 2015b) was an agency-directed study, not a congressionally authorized study; however, where practicable and where it does not conflict with the purposes of PL 115-97, stipulations would be applied to protect WSR characteristics on rivers determined to be suitable and recommended to Congress to be included in the system.

The Marsh Fork-Canning, Hulahula, and Kongakut Rivers are north-flowing waterways found to be eligible and suitable for inclusion in the National Wild and Scenic River System (USFWS 2015b). The recommendation for this was carried forward to Congress in 2015. In the program area, the entire segment of the Hulahula River was found to be eligible and suitable, and the Canning, Jago, and Okpilak Rivers were found to be eligible in the Wild and Scenic River Review (USFWS 2015b; see **Map 3-60**, Special Designations in **Appendix A**).

The Marsh Fork-Canning River (recreational ORV) and Kongakut River (recreational, scenic, and geologic ORVs) are not in the program area, but stipulations and ROPs would be applied to protect their WSR characteristics; for example, the scenic ORV for the Kongakut River may necessitate modeling and additional setbacks in the program area to ensure infrastructure is not visible from any point in the Kongakut River corridor, or the sport fishing opportunities described as part of the Marsh Fork-Canning River recreational ORV may be preserved by stipulating program actions in the downstream segments of the program area (USFWS 2015b, Appendix I [Wild and Scenic River Review], Section 5.7.2).

The extent in river miles and the ORVs and preliminary classification of each eligible and suitable river in the program area are presented in **Table 3-35**, below.

Table 3-35
Eligible and Suitable Rivers within the Program Area

River	Preliminary Determination	River Miles of USFWS-Administered Land	Preliminary Classification	Outstandingly Remarkable Values
Canning	Eligible	41	Wild	Cultural, wildlife, fish, recreational
Hulahula	Eligible and Suitable	26	Wild	Recreational and cultural
Jago	Eligible	36	Wild	Wildlife
Okpilak	Eligible	33	Wild	Scenic and geologic

Sources: USFWS GIS 2015

Evidence of climate change is apparent in Alaska. Temperature increases and precipitation changes have changed regional hydrology. Continuation of these trends may lead to changes in the hydrologic cycle (SNAP and TWS 2009, page 1). These changes could affect soils and the vegetation along the eligible and suitable streams, most noticeably by taller shrub intrusion and thawing permafrost. This would affect the scenic quality of areas viewable from the stream by limiting vistas. It is possible that melting permafrost could increase sedimentation and turbidity in these streams, reducing water quality.

Wilderness Characteristics, Qualities, and Values

The USFWS (2015a, Section 4.1.3.5) described the wilderness characteristics in the Arctic Refuge. This section tiers to and incorporates by reference relevant information, while placing emphasis on the program area location. There have been no new data on the wilderness values associated with the program area since the completion of the Arctic Refuge CCP (USFWS 2015a).

The 1964 Wilderness Act established a national system of lands to preserve the natural and wild condition for the benefit of future generations. Public Land Order 2214 (1960) established the original Arctic Range for the purpose of preserving unique wildlife, wilderness, and recreation values. ANILCA Section 101(b) outlines the intent "to preserve in their natural state extensive unaltered arctic tundra...ecosystems; and to preserve wilderness resource values and related recreational opportunities including but not limited to hiking, canoeing, fishing, and sport hunting, in large arctic and subarctic wildlands and on free-flowing rivers…." ANILCA Section 707 directs agencies to manage Congressionally designated wilderness in accordance with the Wilderness Act, except as provided in ANILCA. Further, ANILCA 304(g)(2)(B) requires the Secretary of the Interior to identify and describe "the special values of the refuge, as well as...wilderness value of the refuge" when developing plans. In the Arctic Refuge CCP (USFWS 2015a) the USFWS recommended the lands in the program area for wilderness designation; however, Congress did not act on these wilderness recommendations, and subsequently, the minimal management standard for the Coastal Plain must now be adjusted to account for the oil and gas leasing program required by the PL 115-97.

While executive or administrative enabling actions for existing units of the Arctic Refuge system are still in effect, in the event of a conflict, pursuant to Section 305 of ANILCA, the provisions of ANILCA and ANCSA would prevail.

The Wilderness Act describes four primary qualities of wilderness, as follows:

- Generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable
- Has outstanding opportunities for solitude or a primitive and unconfined type of recreation
- Has at least 5,000 acres or is of sufficient size as to make practicable its preservation and use in an unimpaired condition
- May also contain ecological, geological, or other features of scientific, educational, scenic, or historic value

These qualities are found throughout the program area, except for certain tracts in the vicinity of Kaktovik.

Direct and Indirect Impacts

Issuance of oil and gas leases under the directives of Section 20001(c)(1) of PL 115-97 would have no direct impacts on the environment because by itself a lease does not authorize any on the ground oil and gas activities; however, a lease does grant the lessee certain rights to drill for and extract oil and gas subject to further environmental review and reasonable regulation, including applicable laws, terms, conditions, and stipulations of the lease. The impacts of such future exploration and development activities that may occur because of the issuance of leases are considered potential indirect impacts of leasing. Such post-lease activities could include seismic and drilling exploration, development, and transportation of oil and gas in and from the

Coastal Plain; therefore, the analysis considers potential impacts on special designations from on-the-ground post-lease activities.

Marine Protected Areas

The Arctic Refuge MPA was accepted for inclusion in the national system of MPAs in 2005. MPAs have legally established goals, conservation objectives, and intended purposes, such as to conserve biodiversity in support of research and education, to protect benthic habitat in order to recover over-fished stocks, and to protect and interpret shipwrecks for maritime education. These descriptors of an MPA are reflected in the site's conservation focus, which represents the characteristics of the area that the MPA was established to conserve (NOAA 2017).

Alternative A

Under Alternative A, no federal minerals in the program area would be offered for future oil and gas lease sales. Current management actions for the MPA would be maintained and resource trends would continue, as described in the Arctic Refuge CCP (USFWS 2015a). Alternative A would not meet the purpose of this EIS to inform the BLM's implementation of PL 115-97, including the requirement to hold multiple lease sales and to permit associated post-lease activities. There would be no potential direct or indirect impacts on MPAs from post-lease oil and gas activities under this alternative.

Impacts Common to All Action Alternatives

Under all action alternatives, the natural heritage conservation focus of the MPA could be affected by activities or development that cause a loss of sea ice, changes in freshwater input, increased rates of coastal erosion or accretion, increased shipping activity, offshore development, oil spills, or an introduction of invasive species associated with marine shipping.

Alternative B (Preferred Alternative)

Under Alternative B, potential impacts from exploration and development could affect the MPAs' natural biodiversity (see **Section 3.3.2** and **Section 3.3.5**). Marine and coastal ecosystem impacts would likely occur in the northwestern portion of the program area. This is because exploration wells would be focused in this high potential zone for oil and gas development. During the exploration phase, seismic exploration could cause erosion, especially along stream banks (NRC 2003, page 5). Impacts from coastal erosion are discussed further under *Geologic Hazards* in **Section 3.2.5**, Geology and Minerals.

As summarized in **Appendix B**, most equipment used for construction during the development phase would be transported from a barge landing. Barge landings and staging areas used to transport materials and supplies for facilities could have potential indirect long-term impacts on the MPA by increasing rates of coastal erosion. Gibbs and Richmond (2017) examined shoreline change along Alaska's arctic coast between 1947 and 2012. They found significant modification to coasts and beaches have occurred where production sites sit right on the coast. A more site-specific analysis would occur during the Application for Permit to Drill (APD) phase of development.

Lease Stipulation 9 would require lessees, operators, and contractors to conduct a coastline survey in the coastal area between the northern boundary of the Arctic Refuge and the mainland, and inland areas within 2 miles of the coast. The lessees, operators, and contractors would then be required to develop and implement an impact and conflict avoidance and monitoring plan to assess, minimize, and mitigate the effects of the infrastructure and its use on these coastal area habitats and their use by wildlife and people. This analysis would help reduce potential long-term impacts on the Arctic Refuge MPA natural heritage conservation focus that activities under this alternative could present.

Alternative B includes 1,563,500 acres available for oil and gas leasing and the fewest restrictions on potential disturbances to marine and coastal environments through NSO requirements (359,400 acres) of all the action alternatives. Impacts on the Arctic Refuge MPA would be greatest under Alternative B, compared with the action alternatives, as there would likely be more transportation of materials and supplies for oil and gas development in the coastal areas. A more site-specific analysis would occur during the APD phase of development.

Alternative C

Under Alternative C, potential impacts would be similar to those described under Alternative B, but more constraints would apply, thereby reducing the intensity of impacts on the Arctic Refuge MPA.

Similar to Alternative B, the lessees, operators, and contractors would be required to develop and implement an impact and conflict avoidance and monitoring plan to assess, minimize, and mitigate the effects of the infrastructure and its use on these coastal area habitats and their use by wildlife and people. Under Alternative C, the Lease Stipulation 9 would also require NSOs, which would not permit exploratory well drill pads, production well drill pads, or CPFs for oil and gas development within 1 mile inland of the coast. The BLM Authorized Officer may approve infrastructure necessary for oil and gas activities in coastal habitats, such as barge landing, docks, spill response staging and storage areas, or pipelines, but approval would be on a case-by-case basis, in consultation with the USFWS or NMFS or both, as appropriate.

Alternative C presents the same number of acres available for oil and gas leasing as Alternative B, but more acres would be subject to restrictions on disturbances to marine and coastal environments (145,100 acres). Potential impacts on the Arctic Refuge MPA would be greater than under Alternative A due to the increase in transportation of materials and supplies for oil and gas development in the coastal areas than is likely to occur under current management. A more detailed, site-specific analysis would occur during the APD phase of development.

Alternative D

Under Alternatives D1 and D2, 526,300 acres and 763,500 acres, respectively, would not be offered for lease sale. Impacts would be similar to those as described under Alternative B, but more constraints would apply, thereby reducing the intensity of potential impacts on the Arctic Refuge MPA. Lease Stipulation 9 would require NSO 2 miles inland of the coast for exploratory well drill pads, production well drill pads, or CPFs for oil and gas development.

Alternatives D1 and D2 present the fewest acres available for oil and gas leasing of the action alternatives 1,037,200 acres and 800,000 acres, respectively. Impacts on the Arctic Refuge MPA would be more than under Alternative A due to the increase in transportation of materials and supplies for oil and gas development in the coastal areas than is likely to occur under current management. A more site-specific analysis would occur during the APD phase of development.

Transboundary Impacts

The Tarium Niryutait Marine Protected Area (TNMPA) was designated in August 2010 and is Canada's first Arctic MPA (Canada DFO 2018, page 2). The three sub-regions of the TNMPA are Niaqunnaq, Okeevik, and Kittigaryuit; they are approximately 80, 120, and 180 miles from the eastern boundary of the US-Canada border, respectively, and total approximately 432,400 acres. Key threats to the TNMPA identified in a Canadian Science Advisory Secretariat Science Advisory Report (Canada DFO 2010, page 5) are climate change, commercial fishing, contaminants and diseases, hydrocarbon development and related activity, land-based activities, noise and disturbance, recreation and tourism, shipping and vessel traffic, and subsistence harvesting. Site-specific NEPA analysis for any future oil and gas activity in the program area would further explore how development in the program area could affect the TNMPA.

Cumulative Impacts

Past actions and events contributing to cumulative effects in and near the Arctic Refuge MPA have resulted primarily from surface-disturbing activities such as oil and gas exploration, development, production, and transportation for these uses, including shipping routes for delivery of development materials. Oil and gas development near the program area is expected to continue, which would also increase associated transportation activities, such as shipping and barging materials and supplies to the program area.

The following reasonably foreseeable future onshore oil and gas projects are included in the cumulative effects analysis: SAExploration 3D seismic exploration surveys, Liberty, Point Thomson, Nanushuk, Alpine CD-5, Greater Mooses Tooth, Willow, Greater Prudhoe Bay/Kuparuk, Beaufort Sea, Alaska LNG Project, Alaska Stand Alone Gas Pipeline, and the Arctic Strategic Transportation and Resources (ASTAR); see **Appendix F** for more discussion of these reasonably foreseeable future actions.

The greatest contribution to cumulative impacts would be under Alternative B, which would include the largest area available for oil and gas leasing (1,563,500 acres) and would have the fewest protections for the Arctic Refuge MPA conservation focus.

Wild and Scenic Rivers

Alternative A

Under Alternative A (No Action Alternative), no federal minerals in the program area would be offered for future oil and gas lease sales. Current management actions for WSRs would be maintained and resource trends would continue, as described in the Arctic Refuge CCP (USFWS 2015a). The USFWS would manage the four eligible or suitable rivers identified in **Table 3-35** to maintain their preliminary classifications of wild. There would be no potential direct or indirect impacts on WSRs from post-lease oil and gas activities under Alternative A.

Impacts Common to All Action Alternatives

Under all alternatives, the BLM would maintain water quality and ensure that authorized uses comply with state water quality standards. Management actions that prohibit surface-disturbing activities, including NSO, CSU, and TLs near the eligible and suitable WSRs (**Table 3-35**) would provide varying protections for ORVs. This would also ensure that the free-flowing condition of the river remains intact. Any developing infrastructure that is installed within 0.5 mile of any eligible or suitable river, such as bridges, have the potential to downgrade a river’s eligibility and suitability of a wild river to that of a recreational river, which allows some development. General impacts resulting from oil and gas development in the program area could include potential soil erosion and habitat fragmentation, which could affect cultural, fish, geologic, recreation, scenic, and wildlife ORVs. The degree of impacts on eligible and suitable WSRs would depend on the proximity of development to the river.

Appendix B summarizes hypothetical scenarios under each alternative for the leasing, exploration, development, production, and abandonment and reclamation phases of oil and gas activities. Site-specific analysis would occur during the APD phase of development. Impacts on recreation uses are described under **Section 3.4.6**, Recreation.

Alternative B (Preferred Alternative)

Under Alternative B, Lease Stipulation 1 would require an NSO standard, which would prohibit permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, in the streambed and in the described setback distances outlined in **Table 3-36**.

Table 3-36
Eligible and Suitable River Setback Distances Under Alternative B

River	Preliminary Classification	Setback Distance
Canning	Eligible	From the western boundary of the Coastal Plain to 1 mile east of the eastern edge of the active floodplain
Hulahula	Eligible and Suitable	1 mile in all directions from the active floodplain
Jago	Eligible	1 mile from the banks' ordinary high-water mark
Okpilak	Eligible	1 mile from the banks' ordinary high-water mark

Source: USFWS 2015b

For streams entirely in the Coastal Plain (**Map 3-60** in **Appendix A**), the setback extends to the head of the stream as identified in the National Hydrography Dataset.[61] Essential pipelines and road crossings would be permitted through setback areas in accordance with PL 115-97. Gravel mines could also be permitted in setback areas. The setbacks may not be practical in river deltas. In these situations, the BLM Authorized Officer may grant an exception, if the operator can demonstrate that there are no practicable alternatives to locating facilities in these areas, the proposed actions would maintain or enhance resource functions, and permanent facilities are designed to withstand a 100-year flood.

Overall, because this alternative offers the highest number of acres available for oil and gas leasing adjacent to eligible and suitable WSRs (41,900 acres) and the fewest restrictions for disturbances to these rivers, Alternative B would have the greatest magnitude of impacts on eligible and suitable WSRs of all the alternatives. Most of the acres available for oil gas leasing (41,700 acres) would be managed as NSO, but 200 acres would be subject only to standard terms and conditions and are areas of high HCP. A more site-specific analysis would occur during the APD phase of development to further analyze impacts on the free-flowing condition of rivers when locations of proposed developments, such as bridges, pilings, or any bank modifications, would be known.

Alternative C

Under Alternative C, the requirements of the Lease Stipulation 1 are the same as those described under Alternative B; however, under Alternative C, setback distances for oil and gas development would be increased to 2 miles for the Canning, Hulahula, and Okpilak Rivers, thereby further reducing the potential for impacts on their preliminary classification, free-flowing condition, and ORVs.

Alternative D

Under Alternatives D1 and D2, potential impacts from requiring Lease Stipulation 1 would be similar as those described under Alternative B, but the setback distances would be larger for most of the eligible and suitable rivers outlined in **Table 3-37**. Alternatives D1 and D2 would have 22,400 and 21,600 fewer acres, respectively, of eligible and suitable WSR corridors in areas available for oil and gas leasing than under Alternative B, which reduces the potential for impacts on their preliminary classification, free-flowing condition, and ORVs.

[61] National Hydrography Dataset: https://nhd.usgs.gov/

Table 3-37
Eligible and Suitable River Setback Distances under Alternative D

River	Preliminary Classification	Setback Distance
Canning	Eligible	From the western boundary of the Coastal Plain to 3 miles east of the eastern edge of the active floodplain
Hulahula	Eligible and Suitable	4 miles in all directions from the active floodplain
Jago	Eligible	1 mile from the banks' ordinary high-water mark
Okpilak	Eligible	3 miles from the banks' ordinary high-water mark

Source: USFWS 2015b

Alternative D would provide further protections to the fish and recreational ORVs of the Canning and Hulahula Rivers by implementing ROPs, such as preparing a gravel mine site design and reclamation plan, which excludes this activity in areas that support populations of freshwater, anadromous, or endemic fish.

Transboundary Impacts

No transboundary impacts are expected for WSRs because river segments that have been identified as eligible or suitable for designation in the National Wild and Scenic Rivers System do not cross international boundaries. See **Section 3.2.10**, Water Resources, for potential transboundary impacts on water quality and supply.

Cumulative Impacts

Past actions and events contributing to cumulative effects in or next to rivers have resulted primarily from surface-disturbing activities, such as oil and gas exploration, development, production, and transportation for these uses. Activities of oil and gas development near the program area is expected to continue. As a result, surface-disturbing activities, such as oil and gas development, transportation, and recreation affecting rivers, would continue; however, the BLM and USFWS would maintain discretionary authority over most land uses and would permit only those actions that would not impair or conflict with river systems, reducing cumulative effects on these areas. As development and transportation increases, access and use in or next to rivers would also increase.

The following reasonably foreseeable future onshore oil and gas projects are included in the cumulative effects analysis: SAExploration 3D seismic exploration surveys, Liberty, Point Thomson, Nanushuk, Alpine CD-5, Greater Mooses Tooth, Willow, Greater Prudhoe Bay/Kuparuk, Beaufort Sea, Alaska LNG Project, Alaska Stand Alone Gas Pipeline, and the Arctic Strategic Transportation and Resources (ASTAR); see **Appendix F** for more discussion of these reasonably foreseeable future actions.

The types of reasonably foreseeable future actions that could affect eligible and suitable WSRs would be similar to past and present actions. Cumulative impacts may be reduced or avoided if future actions or decisions in the program area incorporate measures to reduce or avoid impacts on river-related values. Examples are maintaining ORVs or the free-flowing nature of eligible or suitable segments in the program area, in accordance with the Wild and Scenic Rivers Act.

Wilderness Characteristics, Qualities, and Values

In general, discussions of potential impacts on wilderness characteristics, qualities, and values tend to be more qualitative in nature, measured by the overall visual quality, naturalness, wildness, and symbolic values of an area that may be affected. Indicators of wilderness characteristics include changes to the untrammeled and naturalness of the program area opportunities for solitude or primitive and unconfined recreation or to other unique or supplemental values.

Alternative A

Under Alternative A, no federal minerals in the program area would be offered for future oil and gas lease sales. Current USFWS management focuses on no or minimal manipulation of the environment, wildness, and promoting actions that facilitate solitude, self-discovery, self-reliance, remoteness, and primitive or unconfined recreation that would have long-term effects on wilderness characteristics. There would be no potential direct or indirect impacts on wilderness characteristics from post-lease oil and gas activities under Alternative A.

Impacts Common to All Action Alternatives

Management actions associated with oil and gas activities that would affect the natural appearance of lands in the program area could include the presence or absence of roads and trails, use of motorized vehicles on those roads and trails, seismic data acquisition using vibroseis trucks, construction of facilities and infrastructure for energy development, or other actions that result in or prevent surface-disturbing activities. All of these activities affect the presence or absence of human activity and, therefore, would affect an area's naturalness and opportunities for solitude in the program area.

Due to the relatively horizontal topography of the Coastal Plain and elevation changes in the Mollie Beattie Wilderness Area next to the program area, vast distances of the Coastal Plain from the wilderness area can be seen. Viewing oil and gas development in the Coastal Plain from the wilderness would affect the wilderness experience associated with visiting an area where the imprint of human's work is unnoticeable.

Alternative B (Preferred Alternative)

Alternative B has the most acres available for oil and gas leasing and the fewest restrictions on surface disturbance. Potential impacts on wilderness characteristics under Alternative B from oil and gas development would be reduced in the areas being managed as NSO (359,400 acres) or areas with TLs (585,400 acres). Prohibiting surface-disturbing activities and new developments in certain locations through the NSO and TLs would maintain the program area's apparent naturalness and opportunities for solitude or primitive and unconfined recreation. Wilderness characteristics would be eliminated on a site-specific basis should new roads be authorized; however, the area would likely retain some of its overall wilderness character. Temporary and permanent access routes to a lease area traveled by developers would adversely impact the wilderness character of that area. The degree of potential impacts on wilderness character would depend on the intensity of development, which would be further analyzed during the site-specific APD phase of development.

Alternative C

Under Alternative C, potential impacts would be reduced in the areas being managed as NSO (932,500 acres) or areas with TLs (317,100 acres); however, wilderness characteristics could be affected by development in adjacent areas. Detrimental impacts on wilderness character would be similar to those described under Alternative B but to a lesser degree due to more areas being managed with NSO and TL requirements. Overall, Alternative C would make 1,563,500 acres available for oil and gas lease sales in the program area, which would affect wilderness characteristics more than Alternative A.

Alternative D

Under Alternatives D1 and D2, there would be no direct impacts on wilderness characteristics from oil and gas development in the areas that are not offered for lease sale (526,300 acres and 763,500 acres, respectively). Wilderness characteristics could be affected by development in adjacent areas. Potential impacts would be reduced in the areas being managed as NSO (708,600 acres under Alternative D1 and 505,800 acres under Alternative D2) or areas with TLs (189,000 acres under Alternative D2). Detrimental impacts on wilderness characteristics would be similar as those described under Alternative B, but to a lesser degree due to more areas not offered for a lease sale and being managed with NSO and TL requirements.

Alternative D1 would implement Lease Stipulation 10, which would further protect naturalness and opportunities for solitude from visual obstructions and noise in the program area and the adjacent Mollie Beattie Wilderness Area by prohibiting surface occupancy and planning to minimize aircraft operations flights below 2,000 feet and 3 miles of the southern and eastern boundaries of the Coastal Plain where they are adjacent to the Mollie Beattie Wilderness Area. Alternative D2 would also implement Lease Stipulation 10; however, areas north of the Mollie Beattie Wilderness Area would not be offered for lease, thereby providing the most protection to wilderness characteristics of all the alternatives.

Transboundary Impacts

No transboundary impacts are expected for wilderness characteristics.

Cumulative Impacts

Past actions and events contributing to cumulative effects in nearby Wilderness or lands with wilderness characteristics have resulted primarily from surface-disturbing activities, such as oil and gas exploration, development, production, and transportation on existing routes for these uses. Activities of oil and gas development near the program area is expected to continue. As a result, surface-disturbing activities affecting the indicators for wilderness characteristics would also continue.

The following reasonably foreseeable future onshore oil and gas projects are included in the cumulative effects analysis: SAExploration 3D seismic exploration surveys, Liberty, Point Thomson, Nanushuk, Alpine CD-5, Greater Mooses Tooth, Willow, Greater Prudhoe Bay/Kuparuk, Beaufort Sea, Alaska LNG Project, Alaska Stand Alone Gas Pipeline, and the Arctic Strategic Transportation and Resources (ASTAR); see **Appendix F** for more discussion of these reasonably foreseeable future actions.

The greatest contribution to cumulative impacts under the action alternatives would be under Alternative B, which would include the most areas (1,563,500 acres) being available for oil and gas leasing and have the fewest protections for wilderness characteristics from surface-disturbing activities.

3.4.8 Visual Resources

Affected Environment

Visual resources are the visible physical features on a landscape, such as land, water, vegetation, animals, structures, and other features. The BLM completed a visual resource inventory (VRI) for the Central Yukon Planning Area (BLM 2018h) to the west of the Coastal Plain, using the process in its Visual Resource Inventory Handbook (H-8410-1). The VRI was based on physiographic provinces. Although the program area is not in the BLM's Central Yukon Planning Area VRI, the VRI is used to characterize its visual resources because physiographic provinces span both areas.

It is reasonable to characterize the program area using the Central Yukon Planning Area VRI because there are negligible differences between the two areas. The three physiographic provinces that span both areas are the Arctic Coastal Plain, Arctic Foothills, and Ambler-Chandalar Ridge and Lowland (**Map 3-2** in **Appendix A**). Physiographic provinces can span large geographic areas, regardless of landownership; the transitions between physiographic provinces are generally subtle.

Scenic quality is a measure of the visual appeal of a tract of land. All public lands have scenic value, but areas with the most variety and harmonious composition have the greatest value (BLM 2018h). In the VRI, each physiographic province was evaluated to determine its scenic quality. The Arctic Foothills and the Ambler-Chandalar Ridge and Lowland divisions received the highest scenic quality rating and have a great deal of visual variety, contrast, and harmony. The Arctic Coastal Plain received the second highest scenic quality rating and has a moderate amount of visual variety, contrast, and harmony. These three physiographic provinces are described below.

The Arctic Coastal Plain physiographic province occurs in most of the program area and covers 1,341,200 acres, 90 percent of the program area (BLM GIS 2018; Wahrhaftig GIS 1965). It is characterized by a smooth, poorly drained plain rising imperceptibly from the Arctic Ocean, with scattered groups of low hills to the east and a much flatter section to the west. An abrupt scarp between 50- and 200-feet high separates the Arctic Coastal Plain physiographic province from the Arctic Foothills to the south. Pingos are sufficiently abundant to give an undulatory skyline.

All the rivers in this unit feed into the Arctic Ocean, crossing the program area in braided channels and deltas, creating contrast between the adjacent landform and vegetation and the barren soils of gravel bars and delta areas. Water is a major element of this landscape. This physiographic province has a low variation in topographic relief and a low variety of plant species found in the vegetation types of wet and moist tundra; low shrubs create some diversities in color, texture, and form between the low-growing heaths and shrubs to the tall shrubs of willow and alder.

This Arctic Foothills physiographic province is in the southern part of the program area and covers 127,600 acres, 8 percent of the program area (BLM GIS 2018; Wahrhaftig GIS 1965). It is characterized by rolling plateaus and low linear mountains. It has broad east-west trending ridges, dominated locally by mesa-like mountains in the north, while the southern area displays irregular buttes, knobs, mesas, and east-west trending ridges rising 2,500 feet above the surrounding intervening, gently undulating, tundra plains. Major rivers are swift, braided courses across broad gravel flats. There are a few small thaw lakes in the river valleys and morainal lakes closer to the program area.

The Arctic Foothills are crossed by north-flowing braided rivers from sources in the Sadlerochit and Romanzof Mountains, creating contrast between the adjacent landform and vegetation and the barren soils of gravel bars. The entire area is underlain by permafrost, with ice wedges, stone stripes, polygonal ground, and other frost features creating contrast with different vegetation types and barren ground. This physiographic province has a moderate variation in topographic relief. It has a low variety of alpine and moist tundra species, such as low mat-like herbs, grasses, and heaths. High to medium shrub thickets create some diversities in color, texture, and form between the low-growing heaths and shrubs to the tall shrubs of willow.

This Ambler-Chandalar Ridge and Lowland physiographic province occurs in the southeast corner of the program area and covers 28,000 acres, or 2 percent of the program area (BLM GIS 2018; Wahrhaftig GIS 1965). It is characterized by east-west trending lowlands with elevations of 600 feet and low passes 3 to 10 miles wide, with elevations of 4,000 feet. Rolling to rugged ridges 25 to 75 miles long and 5 to 10 miles wide rise to 4,500 feet and are characteristic of the northern portion of this unit (Romanzof Mountains). Major rivers are tributaries of the Okerokovik and Angun Rivers. Large rock-basin lakes occur in the valleys, while floodplains of major streams have thaw and oxbow lakes. The entire area is underlain by permafrost.

All the rivers in this physiographic province feed into the Arctic Ocean, crossing the program area in braided channels and deltas, creating contrast between the adjacent landform and vegetation and the barren soils of gravel bars and delta areas. This physiographic province has a moderate variation in topographic relief and has a large variety of alpine tundra of low mat-like herbs, grasses, and heaths. It also features closed white spruce and birch forests, with high to medium shrubs, and open low-growing black spruce and willow shrubs. These create some diversities in color, texture, and form between the low-growing heaths and shrubs to the tall shrubs of willow.

Vegetation is an important component in determining the visual quality of an area, represented by species, variety, extent, and color. The more variety of species a landscape has, the higher the scenic quality. Vegetation visible in the program area is alpine tundra, closed spruce forests, moist tundra, open and low-growing spruce, shrub thicket, treeless bogs, and wet tundra.

Cultural modifications are also considered in determining the visual quality of an area. Cultural modifications can blend in with or stand out from the surrounding landscape. The program area is still primarily a natural landscape, where humans have not substantially changed the scenic quality; however, some areas have been modified by the activities of humans. Human-built structures are the most likely to be seen and have most modified the natural landscape. These structures primarily exist near the community of Kaktovik.

Native allotments and isolated cabins can also be found in the program area. Most of the buildings outside a community are in relative harmony with the landscape, as they are small and made of local materials and have primarily natural colors. Other modifications are airports and airstrips. While an airport is more developed and has tall structures associated with the site, the profile of an airstrip is low, with landform changes that are introduced by brown colors in predominantly green vegetation and more regular lines than the surrounding irregular vegetation.

Artificial light sources are mainly limited to the community of Kaktovik along the coast. Dispersed cabins, overland travel, recreation, and occasional single- and twin-engine aircraft overflights can also create limited, intermittent points of artificial light.

Summer travel is primarily by watercraft; however, snowmachine trails and winter travel routes can be seen from elevated locations. Summer all-terrain vehicle travel is low to nonexistent and does not leave visible trails.

Seismic exploration, authorized by Congress, was conducted in the program area during the winters of 1984 and 1985. Exploration during winter causes less damage to tundra vegetation and soils than in summer, but damage does occur. Because of the 1984–1985 seismic exploration, known as 2-D (two-dimensional) seismic, 1,250 miles of trails made by drill, vibrator, and recording vehicles crisscrossed the Coastal Plain tundra. Additional trails were created by D-7 Caterpillar tractors that pulled ski-mounted trailer-trains between work camps. The trails were about 4 miles apart. While 90 percent of all trails recovered well during the first 10 years after exploration, 5 percent of trails had still not recovered by 2009, 25 years after the disturbance. This indicates that about 125 miles of disturbed trail remained in 2009, based on a total length of about 2,500 miles of original trails, both seismic lines and camp-move trails (USFWS 2014). These trails disrupt the visual continuity of the expansive, undeveloped landscape.

Areas identified as having public concern for the scenic quality are known travel routes (especially rivers), areas of human habitation, areas of traditional use, and areas near Native allotments. Numerous areas are noted to have potentially high visual sensitivity. This is because area residents and visitors view the natural landscape as very important and have a high level of interest and sensitivity to changes to the natural landscape. Visual resources in the program area are viewed by various users of the Arctic Refuge. Views can be affected by weather conditions and time of day or year.

Users include the following:

- Individuals participating in cultural activities (see **Section 3.4.2**)
- Individuals conducting subsistence activities (see **Section 3.4.3**)
- Individuals in the village of Kaktovik (see **Section 3.4.4**)
- Recreationists (see **Section 3.4.6** and **Section 3.4.7**)
- Individuals in route to various destinations (see **Section 3.4.9**)

In the mid-1990s, no cultural modifications in the form of oil and gas development could be seen from Nuiqsut. By 2009, oil and gas infrastructure, including the facilities at the Alpine development, pipelines, and ice roads were visible from Nuiqsut and other portions of that analysis area.

Climate Change

Changes to the presence and composition of vegetation and water sources resulting from changes to the climate would affect visual resources. Also, an increase in the active layer is expected from a warming climate, resulting in greater potential for areas of land subsidence. This would change landforms, as well as the vegetation and water sources that the land supports. In turn, the presence and behavior of animals viewed in the program area could also be affected. Changes to the physical characteristics of the environment and biological resources (i.e., resources that are visible) resulting from changes to the climate are described in more detail in the GMT2 Final SEIS (BLM 2018a).

Direct and Indirect Impacts

Issuance of oil and gas leases under the directives of Section 20001(c)(1) of PL 115-97 would have no direct impacts on the environment because by itself a lease does not authorize any on the ground oil and gas activities; however, a lease does grant the lessee certain rights to drill for and extract oil and gas subject to further environmental review and reasonable regulation, including applicable laws, terms, conditions, and stipulations of the lease. The impacts of such future exploration and development activities that may occur because of the issuance of leases are considered potential indirect impacts of leasing. Such post-lease activities could include seismic and drilling exploration, development, production, including transportation of oil and gas in and from the Coastal Plain, and abandonment and reclamation.

Appendix B identifies oil and gas actions that would likely occur; therefore, the analysis considers potential impacts on visual resources from on-the-ground post-lease activities over an 85-year time frame. Although the BLM administers the oil and gas leases, a BLM visual resource management system, VRI and contrast rating was not conducted; however, analysis that demonstrates contrast from current conditions would be conducted in subsequent NEPA analyses for oil and gas post-lease activities.

In the event of an oil spill, visual resources would be affected by the spill itself, cleanup activities, and any residual changes to the landscape. See **Section 3.2.11** for more discussion on oil spills. The effects of climate change described under *Affected Environment* above, could influence the rate or degree of the potential direct and indirect impacts.

Alternative A

Under Alternative A, no federal minerals would be offered for future oil and gas lease sales. Current management actions would be maintained, and resource trends would continue. There would be no new direct or indirect impacts on visual resources from post-lease oil and gas activities.

Impacts Common to All Action Alternatives

The BLM estimates that the entire federal Coastal Plain could be subject to a 3D seismic survey, even if an area is not available for lease. After the first sale, operators would likely conduct a smaller scale 3D survey on their own lease block, assuming that seismic information would not be already available. All seismic operations would be conducted in the winter to minimize impacts on the tundra. Seismic surveys would not count toward the 2,000-acre limit. Future site-specific NEPA analysis would be done for any proposed seismic explorations.

Seismic testing trails would be several hundred feet apart. Depending on timing and local conditions, the testing and camps could create ruts in the terrain or compress vegetation beneath equipment and snow. This could create a network of visible disturbance in the texture of the land and vegetation across the landscape.

Views of the program area would be interrupted with seismic testing vehicles, equipment, and camps. The bold colors and geometric boxy forms of vehicles and camps would not resemble the colors and forms of the surrounding terrain and vegetation. The contrast would be starker when the surrounding landscape is white with snow.

Seismic testing would involve the use vehicle lights and other lights to illuminate work sites for visibility and safety. The intensity and amount of light would vary, depending on, for example, the light source and its orientation and the time of day and year. Also, reflective surfaces on construction equipment and vehicles would create glare. This would add artificial light and glare to areas in the program area that are nearly absent of artificial light.

The impacts from the presence of seismic survey activities, equipment, and vehicles would be limited to the duration of the survey. The impacts from disturbances to the terrain or vegetation would be visible until the disturbed areas are reclaimed or recover naturally.

The impacts on visual resources described below for the action alternatives would occur in different areas according to lease stipulations in **Chapter 2** (**Map 2-2**, **Map 2-4**, **Map 2-6**, and **Map 2-8** in **Appendix A**).

Alternative B (Preferred Alternative)

Impacts on visual resources would occur from oil and gas actions, such as exploration, development, and production. The impacts on visual resources described below for the action alternatives would be similar to those experienced at Nuiqsut. **Appendix B** identifies oil and gas actions that would likely occur.

Surface disturbances would affect visual resources. Although the 2,000 acres of surface development at any given time that could occur represents 0.13 percent of the program area, it would not be clustered in a specific area but would be spread out. There would be various discrete facilities, including gravel pits, connected by a network of gravel roads. Approximately 174 miles of gravel roads would be needed to connect facilities. Under Alternative B, there could be four CPFs, two in the high potential area, one in the medium potential area south of Kaktovik, and one in the low potential area. Under this alternative, the assumption is that one or more CPFs could be on State or native lands.

Examples of types of facilities that would not count toward the 2,000-acre limit are the portion of facilities that do not touch the land, such as elevated pipelines, and facilities constructed with snow or ice, such as snow trails and ice roads and pads. Pipelines are supported by vertical members. Only the VSMs, and not the pipelines, are included in the 2,000 acres of surface development. As a result, pipelines would add to the disturbance that would affect visual resources. Approximately 200 to 240 miles of pipeline would be constructed in the Coastal Plain, depending on field design. Estimates are not available on the area that would be disturbed by facilities constructed with snow or ice. Future site-specific NEPA analysis would be done for any proposed facilities constructed with snow or ice.

The impacts from the 2,000 acres of surface development would affect visual resources. During construction, crews may be working concurrently at various locations. Views of the program area would be cluttered with construction equipment, construction materials, and temporary support infrastructure. The bold colors and geometric, boxy forms of artificial construction vehicles, materials, and equipment would not resemble the colors and forms of the surrounding terrain and vegetation. The contrast would be starker when the surrounding landscape is white with snow. Rigid vertical elements and horizontal pipelines would create various focal points on an open landscape and would not resemble other landscape elements, which is mostly short vegetation during the summer. These impacts would occur only when construction equipment, construction materials, and temporary support infrastructure are present.

Construction and operations would generate dust from vehicle movement, excavation, and wind. Fugitive dust would diminish atmospheric clarity. This impact on visual resources would persist until the dust settles or is blown elsewhere. Dust that settles on snow or ice would change the color of the surface from a light or white color to the color of the dust. This impact on visual resources would persist until the snow or ice melts and the dust is washed away.

Construction would use vehicle lights and other lights to illuminate work sites for visibility and safety. Also, reflective surfaces on construction equipment and vehicles would create glare. During operations, lights would also be used to illuminate sites for visibility and safety. Reflective surfaces on buildings and structures would also create glare. The most noticeable operations lights would be at the pads, airstrip, and barge landing and on taller structures, such as the drill rigs. The intensity and amount of light and glare would vary, depending on, for example, the light source and its orientation, the intensity and angle of sunlight, and the time of day and year.

Construction and operations would add artificial light and glare to areas in the program area that are nearly absent of artificial light. The artificial light would also increase skyglow (light that is scattered back to Earth by aerosols and clouds). Artificial light and skyglow can, in turn, affect the presence and behavior of animals viewed in the program area. Given the negligible artificial light in the program area, construction and operations lights would essentially be the only sources of artificial light that would diminish the quality of dark skies and affect animal behaviors.

The impacts from construction lights would occur only when construction equipment and vehicles are present. The impacts from operations lights would be long term. They would be more visible during nighttime and winter, when there are fewer daylight hours. Under ROP 26, all structures would be designed to direct artificial exterior lighting inward and downward, rather than upward and outward, unless otherwise required by the FAA. This would be required, however, only from August 1 to October 31. It would minimize, but not prevent, the impacts from construction and operations lights and glare.

Flaring and visible water vapor plumes would be visible at certain facilities. Flaring is the controlled burning of natural gas and a common practice in oil and gas exploration, production, and processing. A flare system consists of a flare stack and pipes that feed gas to the stack. Flare size and brightness are related to the type and amount of gas or liquids in the flare stack. Flares generate heat, noise, and light. Large flares can be quite noisy because of the volume and velocity of the gas going through the flare stack (Ohio EPA 2014). Also, visible water vapor plumes would be generated at certain facilities. The height a plume reaches would depend on a variety of factors, such as its initial velocity and ambient wind speed. Due to the relatively horizontal topography of the coastal plain, flaring and visible water vapor plumes can be visible for great distances and represent visible changes to the atmosphere that do not occur elsewhere in the coastal plain.

The ground surface would be disturbed by covering it with gravel, such as for roads and pads. The flat and simple gravel base would not resemble the uneven and complex forms of the undisturbed areas immediately beyond the surface disturbance. It would also introduce linear and angular forms to a surface devoid of discernable forms. The gravel would create a sharp edge that boldly divides disturbed areas from undisturbed areas. The gravel roads would also introduce contrasting bands that divide the expansive landscape. These would be more prominent in areas where roads do not follow the slope of the terrain or if they are on higher topography. Because of a lack of vegetation on the gravel base, the darker smooth gravel base would not resemble the rougher vegetation with muted greens and tans beyond the gravel. These changes would, in turn, affect the presence and behavior of animals viewed in the program area. These impacts would be long term.

Use of gravel pits would introduce points of disturbance on the landscape. Instead of adding gravel in the case of roads and pads, gravel would be removed from pits and relocated. Due to the number of outcrops and surface deposits in the Coastal Plain, pits would be constructed next to facilities or roads used for satellite access; additional road construction would not be needed to access gravel mines. The impacts on visual resources would be similar to the aforementioned impacts from ground disturbance for roads and pads; however, instead of having a flat form and straight lines, the pits would form sunken depressions and have curved lines. Also, the depth of the pits would allow for the collection of water, possibly creating new artificial lakes.

Similar to gravel roads, pipelines would impact visual resources. Pipelines would introduce linear and rounded forms to a landscape devoid of discernable forms. The pipelines would also introduce contrasting bands that divide the expansive landscape. These would be more prominent in areas where roads do not follow the slope of the terrain. The pipelines would stand out against the surrounding muted greens and tans. They would also stand out if they are on higher topography or do not follow the natural contours of the topography and instead, for example, cross rivers or ravines. Depending on orientation, the texture of the pipelines would be smooth or bumpy, compared with the rougher vegetation. These changes would, in turn, affect the presence and behavior of animals viewed in the program area. These impacts would be long term.

The gravel pads would be developed with drills and facilities. The bold and rigid forms of the drills and facilities would contrast with the indistinct and soft forms of the surrounding undisturbed surface. The angular lines of the drills and facilities would create various focal points on an open landscape and would not resemble other landscape elements, which is mostly short vegetation during the summer. The vertical lines of the drills and facilities would be more visible during daytime and summer, when there are more daylight hours and opportunities for silhouetting to occur. They would also be more visible if they are on higher topography. The multiple colors of the drills and facilities would stand out against the muted greens and tans beyond the gravel pads. The contrast would be starker during the winter when the surrounding landscape is white this snow. The dispersed drills and facilities would create a stippled texture across a landscape with no vertical elements. These changes would, in turn, affect the presence and behavior of animals viewed in the program area. These impacts would be long term.

An average of two barge transports per year is anticipated. This would add marine traffic to an area that is used by other marine vessels. Depending on timing, the barge could draw the attention of views if it is the only vessel on the water.

An example of what gravel roads, pads, drills, and facilities could look like is depicted in **Figures 3-7**, Visual Resources Photo 1, and **3-8**, Visual Resources Photo 2, in **Appendix A**.

Alternative B would be the first major development in the program area. The above impacts would disrupt the visual continuity of the expansive, undeveloped, and open landscape by establishing dispersed, artificial structures with lights and a network of roads and pipelines, none of which are found elsewhere in the program area. Due to the undeveloped nature of the Coastal Plain, development of oil and gas in the program area would initiate an irreversible loss of visual resource quality. The locations of impacts on visual resources are shown in **Map 2-1** in **Appendix A**. Surface occupancy prohibitions would minimize but not prevent impacts on visual resources associated with, for example, rivers.

Best Management Practices for Reducing Visual Impacts of Renewable Energy Facilities on BLM-Administered Lands (BLM 2013) presents BMPs to avoid or reduce visual impacts associated with the siting, design, construction, operation, and decommissioning of utility-scale renewable energy generation facilities, including wind, solar, and geothermal facilities. Although the publication is for renewable energy generation facilities, the BMPs are also applicable to other large-scale developments, such as oil and gas facilities. Implementing the BMPs or using them as mitigation would reduce impacts on visual resources. Mitigation measures, however, would be limited and minimal.

Minimizing unnecessary disturbances through BMPs or mitigation is important to minimizing impacts on visual resources and, likely, other resources. This is because many impacts would persist until disturbed areas are reclaimed. Typically, the acts of conducting abandonment and reclamation take from 2 to 5 years following the termination of production. This does not include returning disturbed areas to pre-disturbance conditions, which would take longer. Following the completion of reclamation, the reclaimed acreage would be regained against the 2,000-acre surface development limit at any given time. This would allow for additional development of new fields as initial development is reclaimed; however, arctic vegetation does not regenerate quickly, extending the timeline for reclaiming disturbed areas, as evidenced by the time it is taking disturbances to recover from seismic testing in 1984 and 1985. Due to the time needed for disturbed areas to return to pre-disturbance conditions, surface disturbances could be visible on more than just 2,000 acres at a given time and would last beyond 85 years.

Alternative C

The impacts on visual resources would be similar to Alternative B; however, Alternative C would also occur in different locations; see **Map 2-3** in **Appendix A**. For example, in the long term, three CPFs would be built, two in the high potential area and one in the medium potential area south of Kaktovik. Also, approximately 180 miles of gravel road would be needed to connect facilities. Surface occupancy prohibitions would minimize but not prevent impacts on visual resources associated with, for example, rivers, which is more than Alternative B.

Alternative D

The impacts on visual resources would be similar to Alternative B; however, Alternative D would also occur in different locations, compared with Alternative B; see **Map 2-5** and **Map 2-7** in **Appendix A**. For example, in the long term, two CPFs would be built, one in the high potential area and one in the medium potential area south of Kaktovik. Also, approximately 185 miles of gravel road would be needed to connect facilities. Surface occupancy prohibitions would minimize but not prevent impacts on visual resources associated with, for example, rivers and wilderness areas, which is more than Alternatives B and C.

Alternative D2 would also have a smaller total area of disturbance than Alternatives B, C, or D1, because the leasable area would be limited to 800,000 acres (see **Table 2-1**, Quantitative Summary of Lease Stipulations by Alternative).

Airstrips would be constructed under the action alternatives. To the extent practicable, aircraft operations would be planned to minimize flights below 2,000 feet when flying within 3 miles of the Mollie Beattie Wilderness Area boundary (Lease Stipulation 10). This would minimize but not prevent visual intrusions in the overall landscape created by the presence of aircraft. This lease stipulation would occur only under Alternative D.

Transboundary Impacts

As described above, construction and operations under the action alternatives would add light and glare and would increase skyglow, which would diminish the quality of dark skies and affect animal behaviors. Depending on the location of post-lease construction and operations, artificial light, glare, and skyglow could potentially extend into Canada, diminishing the quality of dark skies and affecting animal behaviors beyond the program area. The potential for impacts would increase the closer construction and operations are to the eastern boundary of the program area and would be long term. These impacts would not occur under Alternative A.

Cumulative Impacts

The program area is the geographic scope of the analysis area for cumulative impacts. Impacts on visual resources in the program area from past actions occurred from the 1984–1985 seismic exploration. About 125 miles of disturbed trail remained in 2009, based on a total length of about 2,500 miles of original trails (both seismic lines and camp-move trails) (USFWS 2014). The remaining trails created visible lines and faint variations in texture across the undeveloped landscape. Future seismic exploration could have more visible impacts on visual resources, because the trails would be several hundred feet apart, instead of 3 to 4 miles apart during the 1984–1985 testing.

Impacts on visual resources in the program area from future actions could occur. The proposed SAExploration 3D seismic exploration surveys would involve seismic exploration of the Coastal Plain and could begin in winter 2019/2020. Impacts on visual resources from seismic surveys are described above. The Liberty Project is 5 miles offshore in about 20 feet of water, inside the Beaufort Sea's barrier islands, 20 miles east of Prudhoe Bay. Development would include construction of a gravel island for production facilities, including 16 oil wells. The Beaufort Sea Outer Continental Shelf Oil and Gas Lease Sale would involve three outer continental shelf oil and gas lease sales in Alaska's Beaufort Sea, one each in 2019, 2021, and 2023. These future oil and gas actions would add activities and artificial structures to undeveloped areas, which would cause impacts similar to those described above.

Past and future actions and the action alternatives would have cumulative impacts on visual resources. Given the durations of actions and the extent of construction and operation, the cumulative impacts on visual resources from the action alternatives would overshadow all other cumulative impacts on visual resources within the Coastal Plain. The effects of climate change described under *Affected Environment* above, could influence the rate or degree of the cumulative impacts. Alternative A would not contribute to cumulative impacts on visual resources as there are no direct or indirect impacts under that alternative.

3.4.9 Transportation

Affected Environment

The affected environment for transportation in the program area is as described in the Arctic Refuge CCP (USFWS 2015a); a summary is provided below.

Except for in the village of Kaktovik, there are no designated roads in the program area; cross-country motorized travel, other than over snow, is prohibited. Year-round access to and in the program area is primarily via aircraft. There is a gravel landing strip at Kaktovik that supports air travel from outside the program area and serves as the departure point for aircraft traveling inland. Arctic Village and Venetie have gravel runways, which are owned by the Native Village of Venetie Tribal Government. Aircraft are permitted to land in the program area. Several short airstrips are used by small fixed-wing aircraft for landing on wheels to transport recreationists and researchers. Landing opportunities depend on topography, water levels, snow conditions, and weather. Kaktovik, Arctic Village, and Venetie all have regularly scheduled air service, although the frequency of service varies.

During the summer and fall, motorized and nonmotorized boats provide access along the program area's northern boundary with the Beaufort Sea. Motorized and nonmotorized rafts are used along the Hulahula Rivers to access recreation and subsistence opportunities in the central portions of the program area. Improved boat technology, such as inflatable pack rafts that have shallow hulls, support river transportation in shallower areas that were previously unreachable by boat.

In the winter and spring, as snow cover conditions permit, overland travel via snowmachines is possible, especially along frozen waterways and the edge of the Beaufort Sea. Most snowmachine travel in the program area originates and terminates at Kaktovik. Snowmachine use in the program area is primarily for subsistence use, local travel, and recreation.

Climate Change

Increasing climate temperatures and associated loss of snow cover would limit the locations and times of year when ice roads could be viable in the program area. Less snow cover and soft tundra surface conditions could result in transportation infrastructure being concentrated in smaller areas. This could intensify traffic on those roads and increase the potential for conflicts with other modes as more visitors frequent the area.

Direct and Indirect Impacts

The reasonably foreseeable development scenario (**Appendix B**) identifies five phases associated with the hypothetical baseline scenario: leasing, exploration, development, production, and abandonment and reclamation.

During the leasing phase, under the directives of Section 20001(c)(1) of PL 115-97, there would be no direct impacts on the environment because by itself a lease does not authorize any on the ground oil and gas activities; however, a lease does grant the lessee certain rights to drill for and extract oil and gas subject to further environmental review and reasonable regulation, including applicable laws, terms, conditions, and stipulations of the lease. Impacts are likely during the exploration and development phases of oil and gas activities. Roadways may be developed to access seismic and drilling exploration sites and to support construction of long-term infrastructure. During the production phase, oil and gas would be transported in and from the Coastal Plain. Some roadway expansion may occur during the production phase to support the development of new exploratory drill sites. Finally, during the abandonment and reclamation phase, developers would likely use existing roadways from the previous phases of development to reclaim the area.

Potential impacts on transportation would be from management that increases or decreases opportunities for new transportation infrastructure, management of the timing, location, and type of vehicle use, and from changes in the level of public and subsistence use access in the program area. The magnitude, duration, and spatial extent of impacts on transportation would vary, based on the location and extent of transportation infrastructure, season and snow cover conditions, and other management, such as seasonal TLs for certain uses that would modify the nature of travel via certain modes.

Protective measures that specify the type and placement of new or expanded transportation infrastructure would affect the size, design, and location of the proposed infrastructure. Lease stipulations that limit the placement of permanent transportation infrastructure, depending on season and snow cover conditions, would seasonally reduce private transportation opportunities for oil and gas development, while minimizing potential conflicts with the public and subsistence users.

Management that limits vehicle use based on location, vehicle type, or season can limit or preclude access for certain travel modes while increasing access for others. For example, seasonal or location-specific limitations on vehicles used for mineral development would minimize the potential for impacts on other travel modes used for subsistence uses or recreation.

New transportation infrastructure, such as seasonal or year-round roads, airstrips, or other facilities, would not be available for motorized public use. Accordingly, new infrastructure would have the potential to enhance nonmotorized public access only; however, program-related roads would be available only for private industry access and subsistence use only. The effects of climate change described under *Affected Environment* above, could influence the rate or degree of the direct and indirect impacts.

Alternative A

Under Alternative A, no oil and gas leasing program would take place in the program area; there would be no potential direct or indirect impacts on transportation from post-leasing oil and gas activities in the program area. Existing resource trends and impacts on transportation would continue to occur.

Impacts Common to All Action Alternatives

Under all action alternatives, there would be no direct impacts from leasing on transportation; however, lease sales would result in approximately the same number of subsequent gravel and ice roads, airstrips, fueling stations, and a barge landing area to support new oil and gas development. In areas subject to NSO, new roads, airstrips, and other transportation-related infrastructure would be precluded, unless they are essential pipelines and road crossings in accordance with PL 115-97. Gravel mines could also be authorized in setback areas (Lease Stipulation 1). Under all alternatives, there would be no gravel roads constructed during the exploratory drilling phases; potential direct and indirect impacts described above associated with gravel roads would occur only in the long term.

Under all alternatives, lease stipulations would limit the number of new roads to the amount necessary to support production activities. Protective measures would also require the free movement of caribou and subsistence users. These measures would maintain access for subsistence users; however, because transportation infrastructure would be closed to non-subsistence public users, there would be no increase in public access and no increased connectivity with developed areas. In some areas, roads may obstruct cross country, over snow travel via other modes, or nonmotorized travel, such as skiing or hiking. Compared with Alternative A, there would be no change in public access from the construction of private landing strips.

Under all action alternatives, the amount of barge traffic may increase from the leasing program. With oil and gas development, the amount of barge traffic would likely increase through the longevity of the production phase. Barges may experience congestion along traditional transportation routes from increased activity. During the abandonment and reclamation phase, barge transportation would likely reduce to traditional levels.

Alternative B (Preferred Alternative)

Under Alternative B, anticipated transportation infrastructure development and associated potential impacts following lease sales would be as described under *Impacts Common to All Actoni Alternatives*. During the exploration phase, developers would rely on ice roads to access exploratory drill sites. Making available 1,563,500 acres for lease sales, 77 percent (1,204,000 acres) of which would be available for surface use, would allow for the construction of program-related roads throughout nearly the entire program area during the development and production phases. Impacts from the construction of gravel roadways would begin the development phase and would climax in the production phase as developers expand prospected drill sites. Up to 208 miles of new gravel roadways would support private travel for oil and gas production, while ice roads would provide additional private access for exploratory drilling and would be the primary means of overland access during the winter and spring for developers.

Alternative C

The nature and types of potential impacts under Alternative C would be as described under *Impacts Common to All Action Alternatives*, above. Applying NSO to 59 percent (922,500 acres) of the area available for lease would limit the locations where new roads and other transportation infrastructure could be placed during the development and production phases. This would minimize the areas where new transportation infrastructure associated with oil and gas development would conflict with public access; however, because approximately 213 miles of gravel roads are anticipated, there would be a higher density of roads in areas available for surface use. This impact would begin in the development phase, when construction requires access to prospected location, and would peak in the production phase, when expansion drill sites are explored and constructed.

Alternative D

Under Alternative D1, not offering 526,300 acres for lease sale and applying an NSO stipulation (Lease Stipulations 1, 2, 4, 7, 9, and 10) to 68 percent (708,600 acres) of the area available for lease would limit the locations where new roads and other transportation infrastructure could be placed during the development and production phases. Compared with Alternative A, there would be no change in transportation conditions on approximately 1,251,900 acres (79 percent) of the program area that would either not be offered for lease sale or offered but managed as NSO. The nature and types of potential impacts described under *Impacts Common to All Action Alternatives* would be in the 328,600 acres (32 percent of leased areas; 21 percent of the program area) available for leasing with surface use.

Alternative D2 would further limit the area available for new roads and other transportation-related infrastructure by not offering 736,500 acres for lease sale and by applying NSO stipulations (Lease Stipulations 1, 2, 4, 7, 9, and 10) to 63 percent (505,800 acres) of the area available for leasing. Approximately 1,057,000 acres would not be offered for lease sale or offered but managed as NSO, and these areas would experience no change in transportation conditions, compared with Alternative A. There would be impacts common to all action alternatives in the 294,200 acres (36 percent of leased areas; 19 percent of the program area) available for leasing with surface use. There would be a concentration of gravel roads developed during the development and production phases of oil and gas development under this alternative.

Transboundary Impacts

There would be no transboundary impacts to transportation from the leasing program.

Cumulative Impacts

Cumulative impacts on transportation would be the result of past, present, and reasonably foreseeable future actions that would increase or decrease opportunities for new transportation infrastructure, change the types of vehicles available for use, or change the level of public and subsistence use access in the program area. Past, present, and reasonably foreseeable future actions described in **Appendix F** that would cumulatively affect recreation include increasing visitation to the program area for recreation and mineral exploration, energy and infrastructure development, and climate variability.

Impacts on transportation may increase from future oil and gas-related development near the program area. Projects such as the Alaska LNG and the Alaska Stand Alone Pipeline may affect transportation near the program area by increasing gravel roadway networks and use. Vehicle access to the program area is primarily via the Dalton Highway, and increasing oil and gas activity in Alaska may increase congestion and travel times.

Under all action alternatives, future oil and gas exploration and development, combined with increased visitation, would increase the potential for roads and other infrastructure to conflict with public access. These potential conflicts would be more likely along river corridors and the Beaufort Sea coastline, where visitor concentrations are highest. The effects of climate change described under *Affected Environment* above, could influence the rate or degree of the potential cumulative impacts.

3.4.10 Economy

Affected Environment

This section describes the existing socioeconomic conditions in areas that could be affected by exploration, development, and production in the Coastal Plain from the leasing program. All NSB communities, the NSB, and the state of Alaska are included for comparison purposes. Arctic Village and Venetie, which are communities outside the NSB, are also included in the discussion due to their reliance on subsistence resources in the program area.

This section provides baseline information on the following socioeconomic indicators: employment, income, population, and fiscal conditions (government revenues and expenditures). In addition, information on ANCSA corporations and a description of local businesses, local facilities, and public infrastructure is presented.

Population

Table O-1 in **Appendix O** shows population estimates by the Alaska Department of Labor and Workforce Development (ADOLWD) by community/area from 2010 to 2017 (ADOLWD 2018a). At the NSB and state levels, population growth from 2010 to 2017 has been modest, at 4 percent. The communities of Kaktovik and Atqasuk have seen a slight decline in population, while all other communities in the NSB have experienced varying degrees of population growth. Arctic Village, Nuiqsut, and Point Lay have seen the most growth, each with more than 20 percent growth in population over this time frame.

Local Employment and Income

Table O-2 in **Appendix O** provides employment and wage data by community (ADOLWD 2018b). The local government sector employs the highest number of workers in all communities. Private sector employment is highest in Utqiaġvik, accounting for 43 percent of total resident employment, followed by Point Hope and

Nuiqsut, where the private sector employs 39 and 38 percent of the resident workers. These communities also have the highest total wages in the region. Venetie has the highest rate of unemployment, with only 57 percent of residents employed. Articc Village and Venetie both show total community wages much lower than communities in the NSB. Employment and income at the borough and state levels are discussed in the regional economy and state economy sections, below.

Local Economy: Kaktovik

Kaktovik lies on the north shore of Barter Island on the Beaufort Sea coast, in the Arctic Refuge. It is the community closest to the program area. The following provides more details on the economy, infrastructure, and fiscal conditions of Kaktovik.

Kaktovik is the easternmost village in the NSB and is situated on approximately 1 square mile of land (630 acres) and water on the northeastern shore on the Kaktovik Lagoon. A detailed description of Kaktovik's history is provided in the Kaktovik Comprehensive Development Plan (NSB 2015a). Residents in Kaktovik are predominantly Iñupiaq (88 percent of the population). According to population estimates published by ADOLWD (2018a), 234 people lived in Kaktovik in 2017. The NSB's most recent census report indicated there were 262 residents in Kaktovik in 2015, while ADOLWD estimated 243 residents in that same year (NSB 2015b).

Economic and employment opportunities are limited in Kaktovik because of its remoteness. Sixty-seven percent of the working residents are employed by the local government sector, and 33 percent work in the private sector, primarily by ANCSA corporations and their affiliates (ADOLWD 2018c). The Borough and NSB School District provide most of the local employment, and the ANCSA corporation and city government also provide some employment opportunities. Besides the local government sector, residents are also employed in construction, finance, leisure and hospitality, and other sectors (**Table O-3** in **Appendix O**). Short-term construction or skilled labor jobs with the oil industry, private construction firms, and the ASRC and its subsidiaries and summer jobs related to tourism can also be found. Subsistence hunting, fishing, and whaling play a major role in the local economy (NSB 2018b).

There are 15 active businesses operating in Kaktovik, including the KIC, a hotel, a bed and breakfast, a store, and several tour and adventure businesses (ADCCED 2018a). The KIC runs the local store, which provides groceries, clothing, first-aid, hardware, camera film, and sporting goods. Fishing and hunting licenses, guide services, and aircraft and repair services for autos and aircrafts are locally available (NSB 2018b).

The KIC is the village corporation established pursuant to ANCSA. KIC owns approximately 92,000 acres of surface lands in and around the community. All of the corporation's land is in the Arctic Refuge boundary. Kaktovik Holdings, LLC is wholly owned by KIC and has three subsidiaries—Kaktovik Enterprises, LLC (which provides services on power generation, storage, and control), Kaktovik Environmental, LLC (which provides a variety of environmental engineering, consulting, and construction services), and Kaktovik Telecom, LLC (which provides full-service, turn-key solutions for all telecommunications and tower needs). The company's operations are in Alaska, the lower 48, and Guam (Kaktovik Holdings, LLC 2018).

The estimated per capita income in Kaktovik in 2016 was $21,925, which was lower than the $34,191 per capita income for the state (ADOLWD 2018d). The median family income was $66,250 compared to $87,365 for the state. The disparity between Alaska and Kaktovik income is important to note, given the high cost of living in Kaktovik.

The community incorporated as a second-class city in 1971.[62] For fiscal year (FY) 2018, Kaktovik adopted a $1.46 million operating budget (ADCCED 2018a) (**Table O-4** in **Appendix O**). Seventy-six percent of the City's operating revenues are generated by local funds, such as taxes, services, and enterprise revenues, which account for 57 percent of the locally generated revenues. Outside sources, including the community revenue sharing from the State and other grants contribute, 24 percent to their operating budget.

The NSB provides public electricity, piped water, sewer services, and trash pickup to the community. Kaktovik has a public safety building and a fire station equipped with fire engines and an ambulance. The Harold Kaveolook School offers education from pre-school through grade 12 and adult basic education. Communications include phones, internet, mail, public radio, and cable television. The community also has a health clinic staffed by community health aides.

Transportation to the village is provided by scheduled airlines and air taxi service from Barrow and Fairbanks. Freight arrives by cargo plane and barge (during the summer). Air travel provides the only year-round access to Kaktovik. Marine transportation provides seasonal access to Kaktovik.

Regional Economy

The program area is in the NSB jurisdiction. Its population is predominantly Iñupiaq. In 2017, the NSB was estimated to have a population of 7,248 living year-round in its eight communities. In addition to the permanent local population, 2,601 oil field workers lived in Prudhoe Bay in 2017, contributing to the total regional population of 9,848.

Oil and gas exploration and development is the primary industry in the NSB and the largest employer of the region's industrial workforce, including nonresidents. In 2016, approximately 14,000 oil and gas jobs (including oil field services companies) were reported in the NSB (McDowell Group 2017). These jobs are based in the North Slope, in self-contained work sites that are far from the NSB communities; however, few of the jobs are held by residents of the NSB. In 2016, 55 oil and gas jobs were held by NSB residents, which amounts to less than 0.5 percent of the total oil and gas jobs based in the North Slope. Total earnings from the oil and gas extraction sector, which amounted to about $864 million, accounted for 69 percent of the total wages earned for all industries in the North Slope in 2016 (ADOLWD 2018e); however, a large portion of the earnings are not spent in the local and regional economy, as most workers reside permanently outside the NSB.

The unemployment rate in the NSB in 2016 was 6.5 percent, which was roughly the same as the statewide unemployment rate of 6.6 percent (ADOLWD 2018f).

The local government sector (primarily the NSB government) is the largest employer of North Slope residents. In 2016, the local government sector employed 1,988 residents, accounting for 61 percent of the resident workers in the region. Other sectors that employ residents are educational and health services (9.8 percent), the trade, transportation, and utilities sector (9.4 percent), professional and business services sector (7 percent), construction (4.4 percent), and some employment in the financial activities, leisure and hospitality, and natural resources and mining sectors (less than 3 percent; see **Table O-5** in **Appendix O**).

[62] A type of general law municipality or city that has taxation powers but with certain limitations. Section 29.45.100 of the Alaska Statutes provides that limitations on the amount of property tax that may be collected apply only to taxes for operating expenses and not to taxes collected to pay for bonded indebtedness. A special limitation on taxation by second-class cities is that the city cannot levy property taxes exceeding 2 percent (20 mills) of the assessed value of property in the city in any one year (Office of the State Assessor 2017; ADCCED 2018a).

The NSB government was formed in 1972. It provides a wide range of public services to all of its communities, including capital projects. Its total general fund revenue for the FY 2017 to 2018 is approximately $376 million; 97 percent of the total general fund is sourced from property and sales taxes (ADCCED 2018b). Oil and gas property taxes are the primary source of revenue for the NSB government. In 2016, State-assessed oil and gas property in the NSB was valued at approximately $20.27 billion. The NSB received about $373 million in oil and gas property taxes (a tax levied on oil and gas infrastructure), accounting for 97 percent of the total property tax ($386 million) collected by the NSB that year (Office of the State Assessor 2017).

The ANCSA regional and village corporations in the North Slope are also important economic players in the region, employing residents participating in the oil and gas service industry and creating additional wealth in the region. ASRC is the regional ANCSA corporation that is owned by and represents the business interests of the North Slope Iñupiat. ASRC provides an array of oil field engineering, operations, maintenance, construction, fabrication, regulatory and permitting, and other services for oil and gas companies.

Village ANCSA corporations in the NSB also are active in the oil and gas sector. For additional details on the North Slope ANCSA corporations, see the GMT2 Final SEIS, which is incorporated here by reference (BLM 2018a).

State Economy

The petroleum industry is a major sector in the Alaska economy. Economic events related to the petroleum industry have pervasive effects across the state's economy. The drop in oil prices in late 2014 resulted in a significant decline in State government revenues. In early 2015 and in 2016, the State government lost 1,200 jobs, while the oil and gas sector lost 2,900 jobs. Other sectors were also affected; for example, the professional and business services sector lost 1,600 jobs and the construction sector lost 1,400 jobs (Wiebold 2018).

In 2016, the oil and gas extraction sector contributed 10 percent of the state's total gross domestic product ($50 billion), the highest among all industries in Alaska (Bureau of Economic Analysis 2018). This does not include the oil and gas support industries and the oil pipeline transportation sector.

In 2016, there were 11,100 direct oil and gas jobs in the state (Fried 2017). In addition to the direct jobs, there are thousands of indirect jobs in security, catering, accommodations, facilities management, transportation, engineering services, and logistics, which support the oil and gas industry but are not categorized as oil and gas jobs. The most recent estimate for total direct and indirect jobs associated with the oil and gas industry in Alaska was 45,575 jobs in 2016; these jobs contributed $3.1 billion in total annual wages in Alaska (McDowell Group 2017).

The State government is highly dependent on oil revenue; its budget is sensitive to oil price and oil production. Petroleum-related revenues include oil and gas property tax, petroleum corporate income tax, oil and gas production taxes, mineral bonuses and rents, and oil and gas royalties (State and federal). The State's Unrestricted General Fund revenue is now forecast to be $2.3 billion in FY 2018 and $2.3 billion in FY 2019. The revenue forecast is based on an annual Alaska North Slope oil price of $61 per barrel for FY 2018 and $63 for FY 2019. The State expects oil prices to stabilize in the low $60s per barrel in real terms. The revenue forecast is also driven by an expectation for North Slope oil production to average 521,800 barrels per day in FY 2018 and increasing to an average of 526,600 barrels per day in FY 2019 (ADOR 2018).

In FY 2017, the State of Alaska received $12.9 billion in revenues from all sources: petroleum[63] ($1.7 billion), non-petroleum[64] ($1.2 billion), investment ($6.8 billion), and federal revenues ($3.2 billion). The General Fund Unrestricted Revenues (GFUR), the funds that are available for general state activities and capital projects, amounted to $1.35 billion, with petroleum revenues accounting for 65 percent of the unrestricted revenue. Petroleum royalties contributed $681 million to the GFUR, while petroleum property and oil and gas production taxes contributed $120 million and $134 million (ADOR 2018).

National Economy

Development in the Coastal Plain is anticipated to contribute to the nation's economy through job creation, increase in federal revenues, and increase in energy security (or reduced reliance on imported petroleum products). The importance of the economic contributions of a leasing program in the Coastal Plain to the national economy and the importance of preserving the region for its unique wildlife, wilderness, and recreation values has been noted during the EIS process (see **Appendix S**).

The Coastal Plain, which is part of the Arctic Refuge, has nonmarket environmental values that are important to the American public (Bengston et al. 2010). The national public's interest in the Arctic Refuge is focused on protecting its wildlife and maintaining its natural, ecological processes; this is referred to as non-use or passive use values. For wilderness areas, non-use values are often characterized as existence value (knowing an area exists even if one never visits), bequest value (ensuring an area is available for future generations), and option value (maintaining the option to visit an area in the future) (Holmes et al. 2015).

Non-use values are a component of an area's total economic value. For remote areas such as the Coastal Plain, they can be a significant component. For more detailed discussion of non-use values and valuation methods, see Valuing Option, Existence, and Bequest Demands for Wilderness (Welsh et al. 1984) and National Research Council (2005). For the Arctic Refuge, the non-use value primarily comes from knowing the area exists and continues to be protected. The public's concern is that new oil and gas exploration activities may change the way people think about the area (Kotchen and Burger 2007).

A study to quantify the non-use values of the Coastal Plain is outside the scope, funding, and time constraint of this EIS; instead, described here are and cited below are other relevant, publicly available studies on non-use values.

In 1998, an economic assessment of the Bristol Bay Area National Wildlife Refuges estimated that the net economic value of its uses in 1997 was $82 million, while the non-use value was between $2.3 to $4.6 billion (Goldsmith et al. 1998). A valuation study was conducted to estimate damages from the Exxon Valdez oil spill by determining a household's willingness-to-pay (via a nationwide survey) for an oil spill prevention plan and using the number of US households to estimate the damages or lost existence value (Carson et al. 1992; Carson et al. 2003).

This study has also been used in other valuation studies for areas in Alaska (Colt 2001; Hahn & Passell 2010) as an available estimate of existence value for Alaska ecosystems. The authors of one study that was focused on the Arctic Refuge noted that Carson et al.'s (2003) estimate may be a lower bound for the Arctic Refuge's existence value; this is because it has more pristine area and therefore likely a higher existence value than Prince William Sound (Hahn and Passell 2010). A 2010 BLM memorandum points out that it is unclear

[63]Petroleum revenues include State taxes and royalties from oil production on both State and federal lands.
[64]Non-petroleum revenues include excise taxes, non-petroleum corporate income tax, fisheries tax, and other State taxes.

whether the value of preserving the Arctic Refuge as a wilderness should be estimated at the scale of the Alaska's population, the US population, or the global population. The studies mentioned here used the US population scale.

There have been other studies outside Alaska that have estimated non-use values for wilderness areas elsewhere in the US. They show a range in willingness-to-pay per household to preserve wilderness areas (Holmes et al. 2015).

In the absence of primary valuation studies for the non-use values of the Arctic Refuge, some studies have used the estimated value of oil in the area to determine how much each person in the US would be compensated for lost non-use values from oil extraction (Kotchen and Burger 2007), or how much each household would have to pay for preservation to match the value of oil extraction (NRC 2003). The idea is that if people are willing to pay more for preservation than the value of oil development and the loss of non-use values (costs) would outweigh the benefits of oil development. The 2007 study by Kotchen and Burger calculated the break even willingness to accept compensation to allow drilling in the Arctic Refuge to be a one-time payment of $1,141 per person.

Climate Change

Climate change could adversely affect the economy of the North Slope because villages are primarily located at or near sea level; any increase in mean sea level or violent storms may require relocating part or all of villages and subsistence camps. This would have an adverse economic impact on the villages, the NSB, and the State if villages had to be relocated.

Direct and Indirect Impacts

Direct impacts from issuing oil and gas leases under the directives of Section 20001(c)(1) of PL 115-97 would include the federal government receiving bonus bids and rental payments from leasing; however, these payments cannot be quantified because there is not enough specificity at this time regarding the lease terms. There would be no other direct impacts on the environment from leasing because by itself a lease does not authorize any on the ground oil and gas activities; however, a lease does grant the lessee certain rights to drill for and extract oil and gas subject to further environmental review and reasonable regulation, including applicable laws, terms, conditions, and stipulations of the lease. The impacts of such future exploration and development activities that may occur because of the issuance of leases are considered potential indirect impacts of leasing. Such post-lease activities could include seismic and drilling exploration, development, and transportation of oil and gas in and from the Coastal Plain; therefore, the analysis considers potential impacts on the economy from on-the-ground post-lease activities.

The potential economic impacts are evaluated with respect to jobs, income, and government revenues at the local, regional, and statewide level. As noted in *Affected Environment*, quantifying nonmarket values associated with the Arctic Refuge is not part of this analysis. The evaluation of potential impacts on the physical environment, biological resources, and other social systems, such as cultural resources, subsistence, recreation, visual resources, and public health, are provided in other sections of this EIS.

The temporal scope of the economic analysis covers potential impacts of leasing activities as well as the subsequent exploration, development, and production activities that could ensue following the leasing program through 2050. The potential economic effects of reclamation and abandonment are also estimated, although the time frame for these activities is expected to be beyond year 2050.

The effects of climate change described under *Affected Environment* above, could influence the rate or degree of the potential direct and indirect impacts.

Alternative A

Under Alternative A, no federal minerals in the Coastal Plain would be offered for future oil and gas lease sales. The economic conditions at the local, regional, and state level, as discussed in *Affected Environment*, are therefore expected to continue. Alternative A would not meet the purpose of this EIS to inform BLM's implementation of PL 115-97, including the requirement to hold multiple lease sales and to permit associated post-lease activities. There would be no potential direct or indirect economic impacts under this alternative from post-leasing oil and gas activities. The non-use and passive use values of the Coastal Plain and its other ecosystem service values (although not quantified in this analysis would maintain their current value and would not be diminished by oil and gas leasing and subsequent development.

Impacts Common to All Action Alternatives

The potential economic effects of the proposed leasing program are evaluated based on the hypothetical development scenario (**Appendix B**), which is a set of assumptions that reflect possible industry-wide exploration, development, and production activities. The scenario represents only a possible picture of the future. It is likely that different activities and timing would occur in the future, as each company that would participate in the leasing program would have its own unique plans about how to identify and recover oil and natural gas resources. Furthermore, market conditions change over time and can affect outcomes. It is difficult to anticipate what the actual development pattern would be, but the assumptions used in this analysis provide a reasonable basis to evaluate potential future economic effects.

PL 115-97 mandates that the first lease sale occur within the first 4 years of the implementation of the law and a second lease sale be held within 7 years. The hypothetical development scenario assumes that the first lease sale would occur within one year of the ROD and that industry would aggressively lease and explore the tracts offered in the lease sales. Several industry groups would likely independently explore and develop new fields.

The hypothetical development scenario also assumes that oil deposits of significant volumes would be discovered in the program area, resulting in the construction of up to 3 CPFs—one in the western portion of the high HCP area, one in the eastern portion of the high HCP area, and one in the medium HCP area south of Kaktovik (this CPF could be on Native lands). Development in distant and remote areas like the program area would take time; this analysis assumes that first oil production from the first CPF would occur 10 years from the first lease sale.

The exploration phase of each anchor field and associated satellite fields can occur over a span of 10 years. Exploration includes seismic surveys, well-site surveys, and drilling of exploration wells. Note that before the first lease sale, initial 3D seismic exploration surveys could also occur over the entire Coastal Plain. Following discovery, the development phase normally takes 3 to 6 years. Development includes obtaining permits, fabricating production modules, constructing roads, pipelines, and other on-site facilities, transporting materials and facilities to the site, and implementing environmental studies and monitoring.

The production phase can start after development of a CPF and would continue until the end of life of each oil field. Production activities are the continued development-well drilling, production ramp-up, operations and maintenance of processing and other on-site facilities, well-workovers, infill drilling, and other support activities, including environmental monitoring. For a more detailed discussion of the typical exploration, development, and production activities occurring in the Alaska North Slope, see the NPR-A IAP/EIS (BLM 2012), which is incorporated here by reference.

For the purposes of this analysis, the projections based on the hypothetical development scenarios on potential economic impacts are carried through 2050 only. Within this time frame, only two anchor fields would be developed, with each one having its own CPF. A third CPF could be developed but would occur after 2050. Abandonment activities would also occur after this time frame. The first anchor field is assumed to have about 400 million barrels of proven producible reserves.

Six smaller satellite fields would be developed around this first anchor field, with more modest producible reserves of about 100 million barrels each. The assumption is that the second anchor field would be discovered and developed several years after the first anchor field and would have four smaller satellite fields that would be developed by 2050 and tie into its CPF.

A future natural gas transport pipeline from the North Slope to southcentral Alaska could be expected, where the gas would be transformed into liquefied natural gas. Liquified natural gas transported to global markets from the North Slope would be expected to come from established fields with proven reserves initially. If proven gas resources are discovered in the Coastal Plain, they would be transported to the pipeline to maintain pipeline capacity as the primary fields are depleted. Companies exploring the Coastal Plain would likely focus on crude oil discoveries, which are of higher value than natural gas. Any co-occurring gas produced with oil would be reinjected to maintain reservoir pressure or used to manufacture natural gas liquids to blend and transport with the oil (**Appendix B**).

Potential indirect effects related to oil or natural gas development would include the spin-off effects of spending; these are also referred to as multiplier effects. They include additional economic effects that would result from in-state industry spending on goods and services, workers' spending of wages, and government spending of royalties and tax payments during the construction and operations phases.

Like other development projects in the North Slope, many of the materials and equipment are expected to be purchased outside Alaska and would be shipped to the specific job site. Still, a significant portion of the total future development costs, both capital and operating costs, would be paid to companies in Alaska for construction, transportation, logistics, and other oil field services.[65] Some of the contracts for construction and operations and maintenance of the facilities are expected to be awarded to Alaska owned and operated companies, including the North Slope regional and village ANCSA corporations. These payments to local businesses would in turn generate additional economic activity in the state, resulting in indirect economic effects in the form of additional business sales, employment, and labor income. Likewise, potential local spending by workers as well as government spending of revenues would also generate multiplier effects statewide.

[65]The amount of direct in-state industry spending is based on purchase coefficients contained in the Alaska IMPLAN model. These in-state purchase coefficients reflect the availability of locally produced products in the state and are calculated from the trade model for the state in IMPLAN. The extraction of natural gas and crude petroleum sector, drilling oil and gas wells sector, and support activities for oil and gas operations sector require or demand different goods and services from other sectors of the economy. All have varying percentages of in-state purchases, with the highest percentages in the services sector and the least in the manufacturing sectors. There is not one specific in-state purchase percentage applied to the total direct oil and gas industry spending; rather the purchase coefficients in the model vary by the type of goods and services purchased.

Potential impacts on subsistence activities could have impacts on cost of living for some families through the need to substitute store-bought foods for subsistence obtained foods. The potential impacts on subsistence are discussed in **Section 3.4.3**.

Potential impacts on recreational resources could have impacts on businesses that provide recreation in the area; the potential impact on recreation is discussed in **Section 3.4.6.**

The non-use and passive use values of the Coastal Plain and its other ecosystem service values (although not quantified in this analysis) would be diminished from their current value by oil and gas leasing and subsequent petroleum development.

The following are some of the major assumptions and data sources used in the economic impact analysis:

- The hypothetical unconstrained development scenario (**Appendix B**) provided the basis for modeling the potential oil and gas activities and time frames, which included assumptions of the number of CPFs, gravel roads and ice road construction, other on-shore facilities, including pipelines, and size of oil field discoveries.
- Estimates of production volumes by year were based on the size of each oil field and a production decline rate of 8 percent per year. This information was used to calculate potential royalty payments and other State and the federal government tax payments.
- Oil price projections were obtained from the Energy Information Administration's 2018 Annual Energy Outlook (EIA 2018). This information was used to quantify potential royalty payments and other fiscal effects.
- Construction costs were estimated based on costs provided in Attanasi and Freeman (2009) and cost data from other North Slope development projects. This information was used to calculate direct and indirect employment and income effects of construction spending as well as potential government revenues, including oil and gas property taxes and state corporate income taxes.
- Estimates of annual operating expenditures are based on the prevailing operating costs in the Alaska North Slope—a fixed $/well/year estimate of $450,000 and a variable operating cost component of $10 per barrel of oil. The default value for the fixed cost per well in the ADNR cash flow model was adjusted to account for the greater distance from Prudhoe Bay (ADNR 2018b). This information was used to calculate the direct and indirect employment and income effects, as well as tax revenues during the production phase.
- Tariffs and transportation costs were used to calculate netback prices which are the bases for calculating royalty payments. Data on existing tariffs and transportation costs are from the ADNR Revenue Sources Book (ADNR 2018b).

The IMPLAN model for Alaska was used to estimate the potential direct and indirect employment and income effects of the various exploration, development, and production activities (MIG, Inc. 2018). The cash flow model developed by the ADNR (modified to fit the development and production assumptions used in this analysis) was used to generate the projected royalties and government taxes.

Jobs

Future exploration, development, and production activities in the program area for the two anchor fields and their associated satellite fields are estimated to generate about 250 direct jobs per year during exploration activities, 470 direct jobs per year during the development phase, and 730 direct jobs per year during the production phase. Exploration activities are anticipated to peak on the fifth year of the exploration phase, generating an estimated 650 jobs that year. The peak year of the development phase is estimated to generate 680 jobs, and 1,150 jobs are estimated to be required during the peak production year. Jobs during the exploration and development phases are seasonal and temporary, while production phase jobs are year-round and would last through the economic limit of the life of each oil field. **Table 3-38** also provides estimates of the indirect jobs that could be generated as a result of industry spending on exploration, development, and production activities.

Table 3-38
Projected Direct and Indirect Jobs: Exploration, Development, and Production Phases

Effects	Jobs (Average Number of Part-Time and Full-Time Jobs)	Annual Average	Peak
Direct	Exploration	250	650
	Development	470	680
	Production	730	1,150
Indirect	Exploration	190	560
	Development	3,130	4,570
	Production	3,160	4,970

Source: Northern Economics, Inc 2018 estimate
Note: Jobs during the exploration and development phases are seasonal and temporary.

Abandonment and reclamation activities that would occur at the end of the economic life of each of the fields are also going to generate jobs. The total estimated direct jobs for abandonment and reclamation per anchor field is about 550 jobs and an additional 520 indirect jobs. Each satellite field on the other hand is estimated to generate 160 direct jobs and 150 indirect jobs during reclamation and abandonment. The assumed future exploration, development, and production activities are expected to generate job opportunities for workers residing in the North Slope, other areas of Alaska, and outside Alaska. The jobs shown in **Table 3-38** are total jobs that could be available for workers from any region, including outside Alaska. It is uncertain at this time how many workers from North Slope communities would participate in the direct oil and gas activities. Historically, very few North Slope residents participate in direct oil and gas activities in the North Slope. As noted in *Affected Environment*, above, less than 0.5 percent of the total oil and gas jobs in the North Slope in 2016 were held by NSB residents.

In 2016, 27.5 percent of the workers in the oil and gas extraction sector and 36.8 percent of the workers in oil field services sector were from out of state (ADOLWD 2018g). These nonresident percentages have been consistent in the last decade, and it is possible that these levels would continue; however, it is also possible that, with more education and training, the future composition of the oil and gas workforce could be different.

Oil field development projects in the North Slope typically require specialty tradesmen and construction workers with the skills and experience in ice roads, pipeline construction, facilities construction, and drilling. North Slope residents who live near existing oil developments have participated in oil and gas jobs, such as ice road monitors, camp security and facilities operators, and subsistence representatives. The ADOLWD and the oil and gas industry have training programs geared to developing special skills required in oil field services. This is expected to create more employment opportunities for residents of Kaktovik, given their proximity to the program area.

Population

No changes to population growth rates or increased population are expected in Kaktovik as a result of migration of industry workers for post-lease oil and gas activities. Workers are expected to commute to the work camps on a rotational basis and are not expected to relocate to Kaktovik or other North Slope communities.

At the state level, there could be potential increases in population, particularly in south-central Alaska, as nonresidents who would be working year-round at the oil company headquarters in Anchorage are expected to relocate to the region. Statewide population, however, would be affected by other economic and demographic factors and would be hard to predict.

Labor Income

The estimated labor income effects resulting from future exploration, development, and production of oil resources in the Coastal Plain region are presented in **Table 3-39**. The table shows projected direct and indirect annual average and peak labor income by phase.

Table 3-39
Projected Direct and Indirect Labor Income: Exploration, Development, and Production Phases

Effects	Labor Income (Millions of Dollars 2017)	Annual Average	Peak
Direct	Exploration	$29	$77
	Development	$96	$140
	Production	$125	$197
Indirect	Exploration	$10	$30
	Development	$211	$307
	Production	$212	$307

Source: Northern Economics, Inc 2018 estimate

As noted above, it is uncertain at this time how much of this total potential labor income would accrue to the local workforce, regional workforce, and Alaska workforce. Currently, about 36 percent of the total wages and salaries in the oil and gas extraction sector and 28 percent of wages and salaries in the oil field services sector go to out-of-state workers (ADOLWD 2018g). It is possible that these percentages could change over time.

Economic Sectors

Industry spending during future exploration, development, and production phases would increase the level of activity in the Alaska economy, not just in the oil and gas extraction sector but also in other economic sectors, including oil field support services; construction, engineering, environmental, and other professional technical services; air, water, ground, and pipeline transportation sectors; retail and wholesale trade sectors; rental and leasing sectors; warehousing; accommodations and food services; and communications, IT support, management, and other business support sectors.

Resource development in the program area could spur additional development in adjacent areas, including on Native-owned land. This in turn could generate revenue for landholders and businesses in the various sectors noted above. This includes the ASRC and KIC, which are engaged in the oil and gas services sector, and it would further increase job opportunities for residents.

Government Revenues

Future petroleum development in the program area is expected to generate revenues to the NSB government, the State, and the federal government from royalties, income taxes, production taxes, and property taxes. The projected annual average and total government revenues by type of revenue are presented in **Table 3-40**. The total represents the estimated revenues through 2050. Property taxes would start accruing during the development or construction phase, while royalties and other taxes would be generated during the production phase.

Table 3-40
Projected North Slope Borough, State, and Federal Government Revenues

Government Revenues (in Millions of Dollars, 2017)	Annual Average	Total
NSB Property Taxes	$50	$1,139
State Royalties	$936	$22,460
State Taxes	$2,153	$49,519
Federal Royalties	$936	$22,460
Federal Taxes	$495	$11,883

Source: Northern Economics, Inc 2018 estimate

At the local level, the City of Kaktovik could receive increased bed tax revenues with higher hotel occupancy during the initial years of development. Also, local consultations are likely going to occur and while mobilization of construction equipment would be occurring, and even during operations. The City of Kaktovik has just started implementing a 12 percent bed tax for hotel/motel accommodations. The change in the level of hotel occupancy is difficult to quantify at this point because the timing and amount of local consultations and mobilization activities are uncertain and may vary.

At the regional level, the NSB government is anticipated to receive increased property tax revenues. Property tax payments would start to accrue during the construction phase. The State imposes oil and gas property taxes at a rate of 20 mills.[66] A local tax is levied on the State's assessed value for oil and gas property in the borough and is subject to local property tax limitations. The current NSB property tax rate is 18.5 mills (the state portion of the property tax is 1.5 mills). Total NSB property tax revenues through 2050 are estimated to amount to about $1,139 million (in 2017 dollars).

At the State level, there are several potential sources of revenues that could be generated from petroleum development in the program area. State government revenues during the production phase would include royalty payments, corporate income tax payments, severance tax payments, and continuation of property tax payments. The property tax payments would be based on the assessed valuation of the facilities developed on-site.

As noted above, the State portion of the property tax is 1.5 mills, and is estimated to amount to $92 million through 2050 (in 2017 dollars). State corporate income tax is calculated as 9.4 percent of the Alaska share of worldwide income for each corporation. The model, however, does not take into consideration corporate worldwide income (which is unknown at this time) but simply evaluates all the costs and revenues and the resulting State income tax, given the 9.4 percent income tax rate.

Severance tax or production tax payments are based on the current tax rate of 35 percent of the production value, which is the value at the point of production, less all qualified lease expenditures (net value). Qualified lease expenditures include certain qualified capital and operating expenditures. Total estimated state taxes and royalties are shown in **Table 3-40**.

Any additional oil production in the North Slope extends the life of the TAPS and increased revenues for the State. Oil revenues depend on the oil production levels and the price of oil at the wellhead. Higher TAPS throughput results in lower pipeline tariffs and higher wellhead value. The State would receive higher revenues resulting from oil production in the region.

[66] A mill is a monetary unit worth 1/1,000th of a dollar.

The assumed federal royalty rate is 16.67 percent of the wellhead value for oil. The expectation is that 50 percent of the federal royalties are shared with the State. Potential annual average State royalties could amount to about $936 million.

Other government revenues expected to accrue during the construction phase include ROW payments and gravel royalties; these estimates are not available at this time.

Local Public Infrastructure and Local Businesses

Given that the oil field workers would be housed in work camps located at the CPFs and drill pads and away from the community of Kaktovik, there would be no anticipated increase in demand for local services and other public infrastructure in the community of Kaktovik.

Consultations and mobilization during leasing, permitting, and exploration and through the development phase could increase the number of people going in and out of the community. These could create temporary increases in demand for accommodations, travel services, retail services, and other personal services.

Local businesses, including KIC and its subsidiaries, could receive greater revenues during the exploration, development, and production of petroleum resources in the program area.

Alternative B (Preferred Alternative)

The potential economic effects under Alternative B would be similar in magnitude to the economic effects discussed in the section above. There could be unquantifiable differences in the level of economic effects, however, because of the lease stipulations and ROPs under Alternative B, as follows:

- Additional consultations with local, state, and federal stakeholders
- Additional studies that would be required for permitting
- Delays in exploration and development due to closures of certain environmentally sensitive areas
- Reductions in surface disturbance
- Additional facilities that could be required to address limited road access to the CPFs
- Additional infrastructure, such as bridges, that could be required to avoid environmentally sensitive areas

Some of these actions could result in higher employment and income effects due to additional expenditures that would be incurred to comply with the standard operating procedure, including additional spending on consultation, studies, and required orientation programs. Some of these actions could also result in delays in exploration, development, and production and would therefore also delay potential employment and income effects, as well as revenues that could accrue to the local, State, and federal governments. For example, some of the lease stipulations could result in deferred revenues and taxes due to delays in drilling or lower taxes and revenues due to increased costs, which reduce severance taxes and profits. The stipulations and ROPs that could affect the timing and magnitude of the economic effects are Lease Stipulations 3 and 4, and ROPs 7, 10, 29, 32, 34, 36, 40, 41, and 46.

Alternative C

The potential economic effects under Alternative C would be similar to the economic effects discussed in the section above. As noted above, there could be differences in economic effects from the lease stipulations, but these effects would be difficult to quantify at this time; this is because the level and timing of activities could vary, depending on how each industry player would react under this alternative.

Alternative D

The potential economic effects under Alternatives D1 and D2 would be similar in magnitude to the economic effects discussed in the section above; however, the higher level of restrictions under this alternative could reduce the amount of oil produced, could defer or reduce potential government revenues and taxes, and could result in lower economic revenues, relative to the other action alternatives. Alternative D2 could have even lower economic effects due to the reduction in acres available for lease.

Transboundary Impacts

While transboundary impacts are addressed in other sections of this EIS, they are not included in this economic analysis section. That is because it is focused on evaluating the potential direct and indirect effects of leasing activities on the local, regional, and statewide economy. While post-leasing activities could result in contracts for materials, equipment, and services with companies outside of the US, quantifying these transboundary effects would be too speculative at this time.

Cumulative Impacts

Oil production from the North Slope is projected to decline from 522,000 barrels per day in FY 2018 to 493,000 barrels per day in FY 2027, as production from existing fields continues to decline (ADNR 2018b). Production from newer development projects, such as Point Thomson, GMT1, GMT2, and Willow, are expected to contribute to oil production in the next 10 years.

Point Thomson was brought online in April 2016, with production facilities designed to produce and reinject (cycle) 200 million cubic feet per day of gas and produce up to 10,000 barrels per day of natural gas condensate. This project opens the eastern North Slope to development and would lead to increased production into TAPS.

Project construction for GMT1 is well underway and is already producing oil. Peak workforce at GMT1 during construction is estimated to be 700 and the estimated peak monthly production is estimated to be between 25,000 to 30,000 barrels of oil per day (BOPD) (gross). GMT2 could begin construction in early 2019, with first oil planned for late 2021. The development plan is for up to 48 wells, with 36 wells being permitted initially. The project is estimated to cost $1.5 billion to develop, and peak production is expected to be 35,000 to 40,000 BOPD. The master development plan for the Willow Project was submitted to the BLM in 2018 to start the EIS process. The proposed action includes the construction, operation, and maintenance of a CPF; the construction of up to five well pads, with up to 50 wells on each pad; roads for field access and in-field transportation; an airstrip; a system of pipelines; and a temporary island in the Beaufort Sea to facilitate the delivery of modules for the project (BLM 2018i).

Willow is estimated to hold between 400 and 750 million barrels of recoverable oil equivalent, with peak production rates of about 100,000 barrels per day. The development is estimated to cost $2 billion to $3 billion over 4 to 5 years after a final investment decision is made. Oil production could start in the 2024 to 2025 time frame (Bailey 2018).

The oil and gas leasing program and subsequent exploration, development, and production activities in the program area would increase oil production in the North Slope and, increase TAPS throughput, increase economic activity at the local, regional, and State level due to direct industry spending on labor, materials, and services, increase government revenues from shared royalties, tax payments such as property taxes, corporate income taxes, severance taxes, and other local taxes, increase job opportunities for Alaskans, including residents of communities in the NSB, and increase labor income in regions where industry spending would occur and where the oil and gas workforce resides.

There would be no additional economic effects under Alternative A since there would be no petroleum development without leasing. The non-use and passive use values of the Coastal Plain and its other ecosystem service values (although not quantified in this analysis) would maintain their current value and would not be diminished by oil and gas leasing development.

The potential cumulative impacts on the economy under the action alternatives would be similar; however, there may be differences in employment, income, and revenues due to differences in how the various lease stipulations under each of the action alternatives would affect industry response and spending. The non-use and passive use values of the Coastal Plain and its other ecosystem service values (although not quantified in this analysis) would be diminished from their current value by oil and gas leasing development. The effects of climate change described under *Affected Environment* above, could influence the rate or degree of the potential cumulative impacts.

3.4.11 Public Health

Affected Environment

The BLM NPR-A IAP/EIS (2012, Section 3.4.12) analyzed the public health status in the NSB, based on demographic and health infrastructure through 2010; it is incorporated by reference in this EIS. The BLM analysis considers all eight villages of the NSB, a broader perspective than the analysis for this EIS, which focuses primarily on the village of Kaktovik, due to its proximity to the program area.

Section 3.4.3 identifies four primary subsistence study communities: Kaktovik, Nuiqsut, Arctic Village, and Venetie. They are included in the discussion of public health issues related to subsistence activities, diet, and nutrition. Additionally, Gwich'in and Inuvialuit tribes in Canada have subsistence ties to the Arctic Refuge and the PCH. Public health issues related to changes in subsistence harvesting for Canadian villages are included in *Transboundary Impacts*.

Under NEPA regulations, projects that require an EIS must include an analysis of health impacts associated with federal actions. The discussion below is consistent with recent NEPA analyses on the North Slope by including a broad description of health conditions (BLM 2012). The wider scope of analysis results from changing expectations for what constitutes a sufficient examination of human health in the regulatory process. North Slope residents, the NSB municipality, and others have advocated strongly for the inclusion of a more systematic and broad-based appraisal of human health-related issues in the EIS process. This was corroborated by comments received during the scoping period. This EIS does not analyze specific developments in the program area; therefore, a health impact assessment was not completed for this analysis. Health impact assessments are expected to be developed for future development projects that would require additional NEPA analysis.

Oil and gas development has had mixed impacts on the North Slope. Specific to oil and gas development, the NSB Baseline Community Health Analysis Report (NSB 2012, page 45) provides the following commentary:

> The health impacts of oil and gas development in the NSB are complex, as it has touched many aspects of community life in the region. Following the formation of the NSB, oil and gas revenues have created employment opportunities, provided money for essential services and infrastructure, and raised the average household income. An influx of outside interests and money can also create conflict, alter social structure, and divide communities, affecting community well-being. Real and potential impacts on the environment and subsistence are also ongoing sources of tension and concern.

Data Sources

This document updates information, where possible, including use of the 2015 NSB census (NSB 2015b), updated Alaska Department of Health and Social Services vital statistics (ABVS 2018), Alaska Behavioral Risk Factor Surveillance System (BRFSS) results (BRFSS 2017), and epidemiology trends.

More health data are available for the NSB than for Kaktovik because of its small population size and the scope of many of the data sources. Where possible, data for Kaktovik are used, and NSB health data were used when Kaktovik health data were unavailable. The population of the NSB is small and when separated into only the village of Kaktovik, sample sizes decrease even more. Small populations mean small numbers of annual cases , with potentially large fluctuations from year to year. For this reason, rates of uncommon diseases or health conditions in the affected environment must be interpreted with caution.

Health Overview

NSB residents' leading causes of death from 2011to 2013 were identical to the leading causes of death in the state: cancer, heart disease, unintentional injury, and chronic lower respiratory disease (ABVS 2018). Although the top four causes of deaths in the NSB from 2011 to 2013 were the same as the top four causes statewide, the age-adjusted rates for cancer, unintentional injury, and chronic lower respiratory disease were higher in the NSB (ABVS 2018). Suicide ranked as the fifth highest cause of death in the NSB from 2011 to 2013 and was the sixth highest cause of death in Alaska for that same period (ABVS 2018).

The NSB 2012 report tracks NSB death rates for the last several decades. Cancer death rates have increased since the late 1980s, as well as death rates for heart disease. Chronic lower respiratory rates have been increasing since the mid-1990s, while unintentional death rates have declined during the same period (NSB 2012).

Eighty-two percent of Kaktovik residents reported very good to excellent health; this is higher than the NSB average of 65 percent (NSB 2015b). In the 1990s, NSB residents were more likely to report very good health than other Alaskans. This shifted in the early 2000s, when NSB residents were much less likely to report good health. This is reflected in the 2012 NPR-A IAP EIS, where 46 percent of NSB residents reported good to excellent health, compared with 56 percent of Alaskans (BLM 2012); however, a comparison of survey results from 2010 and 2015 for Kaktovik residents shows a 32 percent increase in residents reporting very good to excellent health (NSB 2015b).

Health Effect Categories

The Alaska Department of Health and Social Services Health Impacts Assessment Program has identified Alaska-specific key health effect categories to summarize information on characteristics that may be affected by development projects. These health effect categories address key health determinants, provide the basis for evaluating potential health effects, and are used to summarize public health data for the NSB and Kaktovik (ADHSS 2015).

Social Determinants of Health

DEMOGRAPHICS

In 2010, the village of Kaktovik had 239 residents, with 88 percent Iñupiat or Native Alaskan (**Table N-2** in **Appendix N**). The population is very young, with the median age under 30 and a large proportion of the population under 18 years old. This age structure influences the health conditions likely to be observed in Kaktovik, since younger populations are more likely to experience higher rates of infectious diseases, unintentional injuries, and some mental illnesses. Older populations, in contrast, tend to exhibit higher rates of chronic conditions, such as heart disease, diabetes, arthritis, and cancer.

The economy is one of the fundamental drivers of population health and wellness. Kaktovik residents face fluctuating employment markets with limited job opportunities and chronic levels of unemployment and underemployment. Economic indicators for Kaktovik are discussed in **Section 3.4.10**.

Poverty has a strong negative impact on health due to chronic stress, poor nutrition, and problems with access to health care. Kaktovik residents below the poverty line were 3.8 percent from 2012 to 2016, which is lower than the NSB and State poverty rates of 11.2 percent and 10.1 percent, respectively (**Table N-1** in **Appendix N**).

Graduation rates from 2013 to 2017 for Kaktovik were 73 percent, which is lower than the NSB and State graduation rates of 88 and 92 percent, respectively (US Census ACS 2017). The Alaska Department of Education and Early Development reports the 2016-2017 four-year adjusted graduation rate for the NSB school district as 78 percent and for Harold Kaveolook School in Kaktovik as 100 percent, although there were only two graduating students. These graduation rates compare to 78 percent statewide (ADEED 2017).

Between 1999 and 2008, life expectancy at birth for a resident of the NSB was estimated as 71.9 years, compared with 75.6 years for Alaskans overall, although the estimate was similar to that for Alaska Natives statewide (NSB 2012). From 1980 to 2014, life expectancy on the North Slope of Alaska increased 8.14 years, which was larger than the national increase of 5.3 years (Dwyer-Lindgren et al. 2017). NSB infant death rates have declined since their peak in 1978 to 1992 (NSB 2012); however, they remain twice the State rate (ADHSS 2018a). Low birth rates are also higher in the NSB than in the State (ADHSS 2018a).

Mental Health

Mental health is a critical component of overall health. From 2013 to 2017, NSB residents reported 3.4 days of poor mental health per month, which is identical to the results for all Alaskans and slightly lower than for Alaska Natives statewide (BRFSS 2017). Suicide has been one of the top five leading causes of death since 1992, including the period from 2011 to 2013 (ABVS 2018). Alcohol use was self-reported to be lower in the NSB (29 percent) than among Alaska Native people statewide (44 percent) and among all Alaskans (56 percent; BRFSS 2017); however, it continues to be a factor in injuries (NSB 2012). Tobacco use was reported as higher in the NSB (36 percent) than statewide use (22 percent; BRFSS 2017).

Cultural Continuity

Cultural continuity, or "being who we are," has been linked to numerous positive health outcomes, including reduced rates of suicide (ADHSS 2018a). NSB communities identified speaking a native language and participating in subsistence activities as important indicators of community health and cultural continuity. In 2017, 32 percent of NSB residents spoke a language other than English at home (US Census ACS 2017); however, the NSB 2015 census observed a decrease in households that spoke Inupiaq at home from 1998 to 2015 for Kaktovik households (NSB 2015b). Participation in subsistence activities is high throughout the NSB. In 2015, nearly 99 percent of NSB households participated in subsistence activities, and at least 95 percent of NSB Iñupiaq households reported consuming subsistence foods (NSB 2015b).

Accidents and Injuries

Accidents are an important cause of injury and death in Kaktovik and were the third leading cause of death in the NSB from 2011 to 2013 (ABVS 2018). Off-road vehicles accounted for 18 percent of injury deaths among North Alaska Natives, most which are snowmachine accidents (AN EpiCenter 2009). Motor vehicle accidents are not common in Kaktovik, due to the limited road system (NSB 2015a).

The Alaska Trauma Registry reports that the NSB has the highest rates of hospitalizations due to injuries in the state (141 per 100,000), over double the state average (BLM 2012). Deaths due to injury were higher from 2011 to 2013 for the NSB, compared with statewide rates, by approximately 40 percent (ABVS 2018). High risk-taking behavior, much of which is associated with alcohol consumption, is thought to contribute to many injuries. The unique social and physical environments in Alaska's north also contribute to high injury rates (BLM 2012).Suicide was the leading cause of injury death for the NSB between 1999 and 2005, comprising 39 percent of all injury deaths. This is among the highest suicide rates in Alaska, at 73.5 deaths per 100,000 (AN EpiCenter 2009).

Food, Nutrition, and Subsistence Activity

Subsistence is important for the people of Kaktovik for both food and cultural sustenance (see **Section 3.4.3**). The village's subsistence area extends into the program area and adjacent land and waters bounded on the south by the headwaters and the tributaries of the Hulahula, Jago, and Salderochit Rivers, west to the Sagavanirktok River and Dalton Highway, east to Demarcation Bay, and north about 60 miles in the Beaufort Sea.

Nuiqsut residents harvest resources that migrate through the Arctic Refuge, and their whaling grounds sometimes extend offshore of the program area (**Map 3-40** in **Appendix A**). Arctic Village and Venetie subsistence use areas do not overlap the program area, but both villages consider caribou a primary food source and central to their cultural identity. Primarily they harvest caribou from the PCH. For more detail on Nuiqsut, Arctic Village, and Venetie subsistence patterns, see **Section 3.4.3**.

Kaktovik's primary subsistence resources are caribou, sheep, bowhead whale, bearded seal, fish, and waterfowl (NSB 2015a). Approximately 60 percent of the subsistence harvest consists of marine mammals (**Table 3-30**). Kaktovik residents hunt for bowhead whales from July to September in offshore areas between 15 and 30 miles from shore, between Camden Bay and Tapkaurak Lagoon. Bearded seal and ringed seal are other marine mammal sources. Hunting occurs from March to September, with most success in July and August between Prudhoe Bay and Demarcation Bay, with a maximum distance of 30 miles from the shore.

Caribou are another primary source of subsistence harvest and are hunted along the coast during the summer by boat and inland during the winter by snowmachine. Caribou can be hunted year-round, but mostly during July and August, when they are in their prime condition. Arctic cisco and Arctic char/Dolly Varden are the primary fish species and are harvested primarily in July and August, during the summer migration of the fish along the coast from the Mackenzie River to the Colville River (NSB 2015a).

According to 2015 NSB census data, 42 percent of Kaktovik Iñupiaq residents depended on subsistence foods for over half of their diet, and 13 percent of Kaktovik Iñupiaq households depended on subsistence foods for almost all their diet. Sharing the harvest is an important objective in subsistence lifestyles; 42 percent of households shared half or more of their harvests with others in the community (NSB 2015b).

One hundred percent of Nuiqsut households report using subsistence resources and 95 percent participate in one or more subsistence harvesting activities. Ninety-eight percent of Arctic Village residents report receiving subsistence harvests. For Venetie, 99 percent of the households report using subsistence resources and 86 percent participate in subsistence activities.

Food Security

Food security can be a source of stress in rural Alaskan households. Residents in these communities often utilize both store-bought food and wild food for their total household consumption (Kofinas et al. 2016). In the 2015 NSB census, 37 percent of household heads reported difficulty getting healthy food for meals, and 25 percent reported that there were times when there was not enough food to feed the household (NSB 2015b). Forty percent of Kaktovik households reported as food insecure. Approximately 24 percent of Kaktovik households indicated that half of their diet consisted of wild foods (Kofinas et al. 2016). Additionally, for Kaktovik residents, 10 percent of household heads reported there were times when there was not enough food for the household. Most NSB household heads (71 percent) indicated that this was due to a lack of store-bought foods (NSB 2015b). Approximately 38 percent of Venetie households indicated that half of their diet consisted of wild foods, and 34 percent of Venetie households reported as food insecure (Kofinas et al. 2016).

FOOD SHARING

NSB communities have strong sharing networks for subsistence resources. Most subsistence resources used in a community are harvested by a smaller percentage of the households. For Kaktovik and Wainwright, a study found that a household harvested only approximately 25 percent of the subsistence resources consumed in a year. This shows the sharing that occurs within and between communities and the importance of community to sustain a subsistence diet (ADHSS 2018a). Close kinship ties between Venetie and Arctic Village provide a source of resilience and a strong sharing relationship between the two villages (Kofinas et al. 2016). See **Section 3.4.3** for more information on food sharing for the affected villages.

Exposure to Potentially Hazardous Materials

Residents of the NSB are concerned about environmental contamination, particularly as it relates to contamination of subsistence food sources. In a recent survey, 44 percent of Iñupiaq village residents reported concerns that fish and animals could be unsafe to eat (Poppel et al. 2007).

Air quality issues in rural Alaska villages include diesel emissions, indoor air quality, road dust, solid waste burning, and wood smoke. Arctic residents are particularly vulnerable to indoor air pollution due to tightly sealed houses and poor ventilation, as well as prolonged time spent indoors. NSB residents are also concerned about air pollution generated by oil and gas activities. Assessments of air pollution in Nuiqsut, 173 miles west of Kaktovik, have found that pollutant concentrations are generally well below the NAAQS (BLM 2018a).

Researchers also sampled air and water for VOCs in Nuiqsut using EPA methods. Over half of the air samples contained VOCs, though none of the VOC concentrations exceeded air quality standards and regional screened levels set by multiple federal agencies. VOCs specifically associated with crude oil development were either not detected or were found at very low concentrations (below all standards and regional screening levels for all of the collected samples). None of the water samples had VOC concentrations that exceeded ADEC water quality standards (ANTHC 2011).

Aside from actual exposure to environmental contamination, the perception of exposure to contamination is also linked with known health consequences. Perception of contamination may result in stress and anxiety about the safety of subsistence foods and avoidance of subsistence food sources, with potential nutrition-related diseases as a result. The NSB regularly tests subsistence harvest to monitor the potential for contamination. According to NSB studies, contaminant levels are below levels of concern for human health (NSB 2019).

The ADEC identified 22 potentially contaminated sites in Kaktovik. These were former landfills and dump sites, the tank farm terminal, and DEW Line network facilities. Five of the sites are still active; the cleanup for the remaining 17 sites has been completed (ADEC 2018c), although cleanup thresholds could have changed since the date of closure (ADEC 2017b).

Infectious Diseases

Reportable infectious (communicable) diseases include tuberculosis, hepatitis, and diarrheal diseases, such as giardiasis. Overall, the number of cases of infectious diseases reported in the NSB are low, and trends in reportable infectious diseases in the NSB are comparable to those occurring statewide, except for sexually transmitted diseases (NSB 2012).

In 2018, the age-adjusted *Chlamydia trachomatis* rate was nearly three times higher for the northern region (includes the North Slope Borough, Northwest Arctic Borough, and Nome Census Area) than the rate statewide and higher than any other region in Alaska (ADHSS 2019). In 2012 and 2013, gonorrhea rates for the northern region were 6 to 7 times higher than the rate statewide. In the last 5 years, gonorrhea rates have decreased in the northern region while increasing statewide. For 2017, gonorrhea rates were higher than the Alaska statewide rate by approximately 50 percent (ADHSS 2018b).

Noncommunicable and Chronic Diseases

Cancer and cardiovascular disease are the top two causes of death in the NSB. Age-adjusted rates for both were higher than the statewide rates (ABVS 2018). Due to the small sample sizes for the NSB, these numbers should be treated with caution as large swings are possible in short time periods.

The most common cancers in the NSB are lung/bronchus, colon/rectum, prostate, and breast. These are also the most common four cancers across the state and the US. Age-adjusted rates of lung and colorectal cancers in the NSB from 1996 to 2007 are approximately double the national rates; however, rates of prostate and breast cancers are close to half the national rate (BLM 2012).

Cardiovascular disease prevalence has been increasing in the NSB, but death has been decreasing, likely due to improvements in medical intervention. Smoking, excess weight, and diabetes have been increasing in the NSB and are risk factors for cardiovascular disease (BLM 2012).

Excess weight, obesity, and diabetes are linked with an increased risk of developing a number of other chronic health problems, including high blood pressure, heart disease, arthritis, certain cancers, and some types of respiratory problems. The prevalence of overweight or obese NSB residents from 2013 to 2017 was 73.7 percent, which was higher than for Alaska Native people statewide (68.2 percent) and for all of Alaska (66.5 percent; BRFSS 2017). According to the NSB 2015 census, 65.3 percent of Kaktovik residents were either overweight or obese, compared with 71 percent for all of the NSB (NSB 2015b).

Chronic lower respiratory disease is one of the most frequently cited health concerns among NSB community members (BLM 2012). It is the fourth leading cause of death in the NSB and Alaska (ABVS 2018). Several environmental factors trigger or worsen chronic lower respiratory disease symptoms; these are exposure to tobacco smoke, exhaust from heating sources, and outdoor and indoor air quality. Arctic residents spend prolonged time in tightly sealed houses with poor ventilation, and they are vulnerable to poor indoor air quality. High rates of smoking for NSB residents likely contribute to high respiratory disease rates (BLM 2012).

Water and Sanitation

Public utilities are an important component of community health and wellness. Safe drinking water and sewage treatment prevent the spread of many serious transmissible diseases. Insufficient heating has been linked with poor health outcomes, particularly in children and older people (BLM 2012).

The NSB provides utilities for all Kaktovik. Public facilities include water and sewer treatment plants and a landfill. Kaktovik's infrastructure has had several upgrades in recent years. A buried water and sewer treatment system for the village was completed in 2003. Freshwater sources are small thaw lakes and ponds, a few deep stream channels, and Fresh Water Lake, which is about 0.7 mile from the village. Water is pumped in the summer into the treatment plant and then into two storage tanks for winter use (NSB 2015a). Ninety-nine percent of Kaktovik residents have running water, compared to 92 percent for the NSB (NSB 2012).

Health Services Infrastructure

The US Health Resources and Services Administration designated the NSB as a health professional shortage area for primary care providers (HRSA 2019). The NSB and the Arctic Slope Native Association are jointly responsible for delivering health services to residents. Kaktovik maintains a clinic that is staffed by medical personnel via the Community Health Aide Program. This clinic does not have a physician or physician's assistant in residence. The closest hospital to Kaktovik is the Samuel Simmonds Memorial Hospital in Utqiaġvik, 311 miles northwest. Cases are referred to Fairbanks or Anchorage if they cannot be adequately treated in Utqiaġvik (BLM 2012).

The leading clinical assessments made by community health aides in the NSB villages including Kaktovik in 2005–2006 include respiratory or ear-nose-throat problems, injuries, and preventative care (NSB 2012). The primary outpatient visit diagnoses at Samuel Simmonds Memorial Hospital were managing chronic health conditions, such as high blood pressure, diabetes, and arthritis, and treating acute respiratory infections (NSB 2012).

Climate Change

Further disruptions to subsistence patterns from global environmental and climatic changes could foreseeably have adverse effects on Kaktovik resident health, including changes to subsistence harvests; see **Section 3.4.3**. Changes to subsistence migration patterns and changing weather patterns and sea ice conditions could make travel more hazardous, increasing the risk of injury and trauma. Widespread thawing of permafrost would affect Kaktovik residents' ability to store meat in deep cellars. This would increase the amount of spoiled food and the potential for food-borne illness (USACE 2012). According to an Alaska Native Tribal Health Consortium report on climate change in Nuiqsut, residents are noticing changes in weather, plants, animals, and the land. These changes are raising concerns about food and water security, transportation safety, and increased stress affecting mental health (ANTHC 2014).

Direct and Indirect Impacts

Issuance of oil and gas leases under the directives of Section 20001(c)(1) of PL 115-97 would have no direct impacts on the environment because by itself a lease does not authorize any on the ground oil and gas activities; however, a lease does grant the lessee certain rights to drill for and extract oil and gas subject to further environmental review and reasonable regulation, including applicable laws, terms, conditions, and stipulations of the lease. The impacts of such future exploration and development activities that may occur because of the issuance of leases are considered potential indirect impacts of leasing. Such post-lease activities could include seismic and drilling exploration, development, and transportation of oil and gas in and from the Coastal Plain; therefore, the analysis considers potential impacts on public health from on-the-ground post-lease activities.

Potential impacts on public health and safety from post-lease activities could stem from a number of different pathways identified in the eight health effect categories.

Alternative A

Under Alternative A, no federal minerals in the Coastal Plain would be offered for future oil and gas lease sales. Alternative A would not establish and administer a competitive oil and gas program for the leasing, development, production, and transportation of oil and gas in and from the Coastal Plain in the Arctic Refuge. Current management actions would be maintained, and resource trends would continue, as described in the Arctic Refuge CCP (USFWS 2015a). Under Alternative A, no impacts on public health and safety would occur from oil and gas development in the program area.

Impacts Common to All Action Alternatives

This section discusses potential impacts on public health and safety that are common to all alternatives. The potential public health effects of the proposed leasing program are evaluated based on the hypothetical development scenario (**Appendix B**). It is a set of assumptions that reflect possible industry-wide exploration, development, and production activities. Common types of direct and indirect effects on public health associated with oil and gas development in the program area are changes in subsistence harvest patterns; increased travel time for subsistence harvesting; changes in air and water quality and noise pollution; increases in Kaktovik resident, village of Kaktovik, and NSB revenue; and changes in public health service use and access.

This section does not assess health impacts. It analyzes various leasing alternatives and does not analyze specific developments. Health impact assessments would be used during future NEPA analyses of specific development projects after the lease sales are complete.

Social Determinants of Health

Economic growth and employment that are associated with future resource development can exert impacts on the health of populations. Most income for Kaktovik residents and the NSB would be made during the development and production phases of a potential project (see **Section 3.4.10**) Increased income for Kaktovik residents and families has the potential to improve health through increases in the standard of living, reductions in stress, and opportunities for personal growth and social relationships (BLM 2012); however, there are adverse impacts of economic growth as well. With other oil and gas development in the NSB, increased income and employment have been found to be associated with an increase in social disruption (BLM 2012). Not all residents would experience benefits related to increased employment and income associated with development of the program area.

Most oil and gas industry jobs in the North Slope have gone to transient workers, and oil and gas development in the program area is not expected to directly employ a large proportion of Kaktovik residents. The primary employment and income impacts on Kaktovik residents is anticipated to be indirect as a result of increased revenues to the NSB and village of Kaktovik, which allows for increased program spending and hiring. For a full description of socioeconomic impacts, see **Sections 3.4.4**.

No changes are anticipated to rates of infant deaths or low birth rates under any of the action alternatives.

Oil and gas workers would be housed at on-site camps for all stages of development. Camp housing would have restrictions on drug and alcohol use, and interactions between oil and gas workers and Kaktovik residents would be minimal outside of the oil and gas camps. The influx of workers would not be expected to increase drug, alcohol, or tobacco rates for Kaktovik residents

Oil and gas development may have both beneficial and adverse impacts on mental health. The potential for increased revenue and employment may reduce stress and anxiety, but concerns about environmental contamination, potential impacts on subsistence access and resource availability, health impacts from spills, and other impacts from development, both real and perceived, could increase stress and disease susceptibility for some residents.

Increases in stress could affect many social determinants of health, including substance abuse, domestic violence, and poor maternal and child health, which are already factors in NSB communities, including Kaktovik. Native women and girls experience substantially higher rates of domestic and other violence than others. Oil and gas development in or near Native communities in the US may raise the already high risk of violence on Native women and girls (ILRC 2018). The strong community ties noted above would possibly lessen some of the stress and reduce impacts. Since only a few Kaktovik residents would work directly for oil and gas operators and housed outside of Kaktovik, impacts on community cohesion and from social isolation should be minimal. Effects on social determinants of health from all stages of oil and gas development are complex. There would be a combination of probable beneficial impacts on nutrition and mental health from increased employment and income, with possible long-term impacts on mental health and general health status from increased stress levels.

Accidents and Injuries

Indigenous populations in the Arctic and elsewhere have very high rates of accidents and trauma. Clinical assessments at the Kaktovik clinic include a high percentage of injuries and accidents (NSB 2012). The high incidence of accidents is partly due to the risks associated with subsistence activities, especially given the hostile environment of northern Alaska (BLM 2012).

Future oil and gas development in the program area has the potential to increase the risk of injuries and accidents during subsistence activities. Oil and gas development in the program area is expected to affect caribou herd movements and to alter subsistence hunting patterns for Kaktovik residents (see **Section 3.4.3**). The disturbance of wildlife by industrial activity is likely to result in hunters traveling farther afield and possibly into unfamiliar terrain to harvest stocks.

Future oil and gas development is not expected to increase the Kaktovik road system from its current extent but would develop permanent and seasonal roads in the program area. If Kaktovik residents have easy access to program-related roads, it is likely that some would use the roads to access subsistence harvesting areas, particularly when overland snowmachine travel is difficult. As oil and gas development expands and access to program roads increases, so would the risk of accidents and injuries due to conflicts between oil and gas traffic and subsistence users on oil and gas roads. The highest potential would be during the development and production phases, where most employees would be in the program area (BLM 2012). ROP 18 requires that all roads developed for an oil and gas project be designed, constructed, maintained, and operated to avoid or minimize impacts on subsistence use (**Table 2-3**).

Under all the action alternatives, the main impact on accidental injuries would result from either altered travel patterns or increased travel time for subsistence activity. Under all the action alternatives, future development of fixed facilities in areas of traditional use is likely to result in voluntary displacement of subsistence. This potential impact would be most significant if large numbers of hunters avoid territory close to Kaktovik. All action alternatives have the same potential for development close to the village of Kaktovik.

Food, Nutrition, and Subsistence Activity

Under all of the action alternatives, there would be mixed effects on diet and nutrition. Increased incomes may have a beneficial effect on Kaktovik residents' ability to engage in subsistence activities. The increased incomes may provide funds to support subsistence activities and also to increase the ability to purchase foods from the store, thus reducing food insecurity (NSB 2012).

Dietary changes could result from the displacement or contamination of food sources, avoidance or loss of traditional harvesting lands, and increased reliance on store-bought foods. Consumption of traditional foods is associated with reduced risk of chronic diseases, such as diabetes, hypertension, cardiovascular disease, and stroke (BLM 2012). Store-bought food in rural Alaskan villages tends to have low nutritional value, and the cost of buying nutritious foods is often prohibitively expensive. When subsistence resources become less accessible and people rely more heavily on store-bought foods, the nutritional value of the diet decreases, and the risk of chronic diseases increases. In addition, 10 percent of Kaktovik household heads reported times when there was not enough food for their household (NSB 2015b). Studies have found a variety of adverse health impacts from food insecurity, including obesity, poor psychological functioning among children, poor cardiovascular health, and lower physical and mental health ratings. The costs associated with harvesting subsistence resources, the year-to-year variability in subsistence harvest, and the high cost of store-bought food all contribute to high rates of food insecurity. Increased incomes could provide more resources to support subsistence activities or to purchase food from the store, resulting in improved food security and possibly nutrition. The likelihood of impacts on subsistence harvests under all action alternatives is discussed in **Section 3.4.3**. Impacts to caribou migratory patterns and avoidance of development areas are expected from oil and gas development. In general, impacts would be greatest during the development phase of projects. Certain types of impact sources, such as construction and seismic noise, would be most likely to occur during the exploration and development phases. Seismic activity could occur throughout the program area, not just those areas open to lease.

Kaktovik residents are also likely to avoid areas of heavy development. Threats to subsistence activities and harvest patterns are a primary source of ongoing stress in North Slope communities. Avoidance of productive land could reduce harvests and worsen dietary and nutritional outcomes independent of any direct impact on the animals themselves. Kaktovik residents would be the most affected by potential oil and gas development, with lesser impacts possible for the communities of Nuiqsut, Venetie, and Arctic Village. Any reductions in the success of subsistence harvests would accelerate the transition from subsistence resources to store-bought foods, worsening nutritional outcomes and food insecurity. ROP 36 would allow affected communities to participate in planning and decision-making to reduce impacts from development on subsistence activities.

Exposure to Potentially Hazardous Materials

Activities associated with future oil and gas exploration and development can affect human health via changes to air and water quality or an increase in noise pollution.

Air Quality

Air quality impacts are similar for all action alternatives, as each alternative permits up to 2,000 acres of development and the point sources and their locations are unknown at this point. **Section 3.2.2**, Air Quality, describes the impacts of potential oil and gas development on air quality. The primary sources of airborne emissions are construction dust, road dust, vehicle and machinery emissions, flaring and venting of gas, burning of refuse, and emissions from power generation and other sources, primarily during exploration, development, and production. The air pollutants emitted by these activities have been linked with a range of health effects, including asthma, chronic bronchitis, decreased pulmonary function, and cardiovascular events (BLM 2012).

Both the EPA and the State of Alaska have established legal limits for air pollution to protect public health (**Section 3.2.2**). Air quality changes are most likely to occur at and near the areas of oil and gas development. If the development areas are distant from Kaktovik, potential impacts on the health of Kaktovik residents as a whole are unlikely to be seen and overall impact on human health is likely to be low. Those most likely to be affected are those who stay in cabins or other residences near development areas. In particular, dust from construction or traffic could be an issue. Since limited information exists to estimate air quality impacts for all action alternatives, site-specific analysis would be performed at the time a project is proposed to determine actual impacts at sensitive receptor locations and to identify any measures necessary to reduce impacts on air quality and public health.

Based on previous development projects and studies on the North Slope, the overall potential impact on human health is likely to remain low as all action alternatives are likely to be below applicable air quality standards for all phases of development (**Section 3.2.2**); however, people who are particularly vulnerable to respiratory problems (such as children, the elderly, and people with certain chronic illnesses) could experience health problems at locations or during episodes with poorer air quality.

Water Quality

As described in **Section 3.2.10**, future oil and gas development could affect water quality through accidental spills or releases or as the byproduct of construction, excavation, or human habitation. The risk of accidental spills or releases would be highest during exploration, development, and production. Water quality has the potential to affect the health of Kaktovik residents through contamination of drinking water or through contamination of rivers and waterways near subsistence cabins or camps.

Water could be contaminated through accidental discharges into watercourses that supply human water sources, particularly in areas of cabins or transient subsistence uses of the land; however, the likelihood of any such discharge occurring with the resultant human exposure is low, given the lease stipulations and BMPs around waste prevention, handling, disposal, spills, and public safety. If exposure occurred under these circumstances, the exposure would likely be short term and intermittent and would be unlikely to lead to significant health effects. No development is allowed on Barter Island, so no impacts on Kaktovik's drinking water supply are expected.

Contamination of Food Sources

Section 3.4.3 states that there is a low likelihood of contamination of subsistence food sources, with the possible exception of contamination through an oil spill. This is supported by current low measurable impacts, despite high levels of oil and gas activities on the North Slope in the past. Although studies have found elevated levels of contaminants in several species, the levels found in subsistence foods in the North Slope area appear at present to be generally low and are lower than what would trigger public health concern (NSB 2006). Except in the event of a major spill (see **Section 3.2.11**), there are likely to be only negligible health effects from contamination of food sources as a result of any of the action alternatives.

Despite the current safety of traditional foods in the program area, Kaktovik residents remain concerned that oil and gas activities could potentially increase contaminant loads of subsistence foods to a level that would threaten human health. The perception of contamination may result in stress and anxiety about the safety of subsistence foods and avoidance of subsistence food sources, with potential changes in nutrition-related diseases as a result. These health impacts (perceived or real) arise regardless of whether or not there is any contamination at levels of toxicological significance; the impacts are linked to the perception of contamination, not to measured levels. Monitoring contaminants in subsistence foods (ROP 7) would help address subsistence user concerns related to contaminants and identify potential human health issues.

NOISE

Noise levels could increase due to future construction or operation of oil and gas facilities, resulting in potential effects, ranging from minor irritation and annoyance to more severe health outcomes. Given the likely location of development away from Kaktovik, individuals at cabins or camps near developments would be most affected. Seismic exploration could occur across the entire program area, not just those areas available for lease. It could increase noise impacts on subsistence cabins or camps. ROP 37 would require operators to notify all potentially affected subsistence use cabin and campsite users before seismic activity begins. Noise impacts would be most likely to occur during development of potential projects, with lesser impacts expected during exploration, production, and abandonment and reclamation.

Noise from future air traffic and other sources could create a nuisance around camps and cabins, possibly reducing their use as a base for subsistence harvests. Development-related noise could cause irritation, annoyance, or sleep disturbance among individuals who experience it (BLM 2012).

Noise could also disrupt and displace caribou herds, resulting in changes to subsistence patterns, with impacts as described under *Accidents and Injuries* above. Residents on the North Slope have observed changes to caribou herd movements due to noise from helicopters, small aircraft, and seismic testing (SRB&A 2009a). Until site-specific development activities are proposed, the extent of this effect is not possible to determine. ROP 34 would minimize the effects of low-flying aircraft on subsistence activities and local communities, thereby reducing potential noise impacts from air traffic (**Table 2-3**).

Infectious Diseases

None of the action alternatives would result in a large increase of outside workers into Kaktovik, and only a small number of Kaktovik residents would be likely to work in the oil and gas fields, away from their family and community. Primarily, oil and gas works would be housed in on-site camps, with few interactions between oil and gas employees and Kaktovik residents outside of the camps. Increased rates of infectious diseases would be unlikely, but could occur throughout all stages of oil and gas development. During the development and production phases there would be the highest number of employees expected in the program area (see **Section 3.4.10**).

Noncommunicable and Chronic Diseases

NSB and Kaktovik residents have age-adjusted mortality rates higher than the state rates for cancer, cardiovascular disease, and chronic respiratory diseases. These diseases have a variety of risk factors, only a few of which might be affected by oil and gas development in the program area: air quality, exposure to hazardous materials from spills, and chronic stress levels.

Kaktovik and NSB residents have high levels of respiratory disease, and commenters noted it as a concern during scoping (BLM 2018d). Emissions have been linked to respiratory diseases and cardiovascular diseases, especially particulate matter (EPA 2009); however, as discussed above and in **Section 3.2.2**, Air Quality, air emissions from all phases of oil and gas development would be unlikely to degrade air quality to levels associated with effects on the health of Kaktovik residents. The development and production phases would have the highest levels of emissions.

ROP 6 would require emission inventories and baseline air monitoring before any specific project developed in the program area begins (**Table 2-3**). Those results would be analyzed at the project level after the lease sales are complete. Based on other oil and gas development on the North Slope, it is unlikely that air emissions during any stage of oil and gas development would reach levels that could increase respiratory or cardiovascular disease rates for Kaktovik residents.

Another possible pathway for increased disease susceptibility in Kaktovik residents is large oil spills. The risk of a large spill would be low, and required clean up measures would include worker health protection and exclusion zones to minimize potential exposure to hazardous materials for Kaktovik residents.

As described above and in **Section 3.4.3**, Subsistence Uses and Resources, potential changes in subsistence patterns are unlikely to result in substantial changes to diet and would not likely result in changes to obesity and rates of diabetes.

The NSB 2012 report notes that there are no known links between any stage of oil and gas development on the North Slope and chronic diseases. Impacts on rates of cancer, cardiovascular disease, and chronic respiratory disease would be unlikely.

Water and Sanitation

Oil and gas operators would provide on-site water and sanitation services for the worker camps. No changes in access to or cost of water and sanitation services in Kaktovik are anticipated during any phase of oil and gas development. Increases in NSB revenues could result in additional funding for water and sanitation facilities in Kaktovik; however, the current capacity of the water and sewer systems is adequate for projected population growth (NSB 2015a)

Health Services Infrastructure

Future oil and gas development would occur outside of Kaktovik and would be fully self-contained. Local Kaktovik health care services would not be affected by an influx of oil and gas workers because the worker camps would provide health services to them. There could be a slight increase in accidents due to changes in subsistence harvesting patterns, but these would be sporadic and well in the capacity of the Kaktovik local clinic and Samuel Simmonds Memorial Hospital in Utqiaġvik.

Anticipated tax revenues from oil and gas development under all action alternatives would support the current level of health care services in Kaktovik, would allow for increased funding of existing health and social programs, and should not affect demand. Episodic increases in disease occurrence, such as respiratory disease resulting from poor air quality, have the potential to cause short-term strain on the health care system; however, no such occurrences are likely under any of the action alternatives.

Alternative B (Preferred Alternative)

Under Alternative B, the types of potential impacts on public health and safety would be the same as those described above (*Impacts Common to All Action Alternatives*). The duration of all types of impacts would be long term for the duration of operation in the program area.

Under Alternative B, 721,200 acres of PCH calving habitat area would be available for leasing, which would result in the greatest potential impact on calf survival and overall PCH numbers out of all alternatives. Caribou is a primary subsistence species for Kaktovik residents. Any threat to herd numbers or contamination of meat would increase the likelihood and severity of health impacts resulting from changes in diet and nutrition and would worsen the current trends away from a traditional diet. These changes could extend outside the program area to other communities such as Arctic Village, Venetie, and other Alaskan and Canadian communities that harvest from the PCH. In addition, changes to caribou herd numbers or movement could increase the distance and time that Kaktovik hunters travel and increase the potential for accidents or injury.

Potential impacts on subsistence resource availability would occur primarily for Kaktovik residents. Impacts from all stages of oil and gas development could extend outside the program area to other communities, such as Nuiqsut, Arctic Village, and Venetie, and to other Alaskan and Canadian communities that harvest the PCH; however, substantial changes to PCH caribou demographics are not expected and detrimental changes to diet and nutrition, as outlined in *Impacts Common to All Action Alternatives*, would not occur.

Alternative C

The types of potential impacts under Alternative C would be the same as those described under Alternative B but of lower intensity. Under Alternative C, 476,600 acres of PCH calving habitat area would be NSO. In addition, Alternative C would impose greater TLs on human activity in the PCH post-calving habitat area than Alternative B. Potential impacts on PCH demographics would be reduced under Alternative C, compared with Alternative B, reducing the potential for detrimental impacts on diet and nutrition from reductions in subsistence harvests.

Alternative D

The types of potential impacts under Alternatives D1 and D2 would be the same as those described under Alternative B; however, the intensity of subsistence impacts would be substantially less under Alternatives D1 and D2. Less than half of the calving grounds offered for sale under Alternative B would be offered for sale under Alternatives D1 and D2, and more lands would be subject to development and TLs. Alternatives D1 and D2 would limit the density of development in areas closed to lease sales or with NSO restrictions, which would retain the ability of caribou to navigate through those areas. Alternative D2 would be somewhat less likely to affect subsistence uses and resources, when compared with Alternative D1. This is because of the greater restrictions under Alternative D2 on development in caribou summer habitat. Protection of caribou calving areas would decrease the likelihood of diet changes and slow the trend from traditional foods to store-bought food.

Transboundary Impacts

Impacts on diet, nutrition, and subsistence activities may extend outside the US to the Inuvialuit, Gwich'in, and other user groups of Canada. Transboundary impacts would primarily occur in relation to subsistence harvests of PCH caribou, but Canadian users also harvest other migratory resources. As noted in **Section 3.4.3**, approximately 85 percent of the PCH harvest occurs in Canada; the NWT Gwich'in, Vuntut Gwich'in, and Inuvialuit are the primary Canadian users in terms of number harvested (**Figure 3-6** in **Appendix A)**.

While the likelihood of large-scale changes in caribou herds is low, Alternative B would allow for the greatest amount of development in the calving areas of the PCH and it has the greatest potential to affect PCH demographics. Alternative D2 would make available the fewest acres for leasing and would have the least potential to affect PCH caribou demographics.

Impacts on Canadian communities would be similar to those in Arctic Village and Venetie with no expected changes to diet or nutrition from changes in PCH caribou numbers. Concerns about possible contamination of caribou would continue for Canadian communities, with increased stress levels, as discussed under *Contamination of Food Sources*, above. ROP 7 would require operators to monitor subsistence species for signs of contamination and to mitigate any observed contamination.

Cumulative Impacts

As described in **Appendix F**, there are a significant number of activities planned or approved on the NSB and the program area. The village of Kaktovik and its residents have been buffered by the surrounding Arctic Refuge, which has limited oil and gas development in the immediate vicinity. Air and water quality in and around the village remains relatively untouched, subsistence harvests have not been noticeably affected, and the influx of oil and gas revenue for the NSB has improved infrastructure in the village.

Kaktovik residents indicated they no longer approach or cross the Canning River because of oil and gas activity to the west of it. Forecast projects would further increase development west of the program area (see **Appendix F**); these are the Alaska LNG project and Alaska Stand Alone Gas Pipeline, and oil and gas development in the Colville River region including the CD5, GMT2, Willow, and Nanushuk developments. There is still a high rate of accidents and injury, primarily because subsistence activities and food security for Kaktovik households remain a concern.

Future development offshore in the Beaufort Sea could affect Kaktovik residents by interfering with marine mammal movement patterns, such as the Beaufort Sea Outer Continental Oil and Gas Lease Sale and Liberty Project (see **Appendix F**). This could increase the risk of accident and injury by changing the subsistence harvest patterns and requiring more time on the water to harvest animals. In addition, the success rate for harvesting marine mammals could decline, reducing subsistence food for Kaktovik households and increasing food security concerns.

The action alternatives would have similar contributions to the cumulative effects on public health for Kaktovik residents with the pathways described above. All action alternatives would continue the ongoing transition from a subsistence-based diet to one that includes store-bought food. This is because oil and gas development could interfere with the success of subsistence activities, due to the area available for subsistence use shrinking overtime and long-term changes in subsistence use patterns. Alternatives C and D would lessen the potential adverse impacts of oil and gas development by protecting the PCH calving range, including TLs in post-calving range and insect relief areas and larger buffers on important waterways and the coastal area. Alternative B would allow the most widespread industrial activity, with resulting potential impacts on subsistence harvest efforts, and could accelerate the transition away from a traditional diet and the subsequent increases in health risks.

As discussed in **Section 3.4.3**, cumulative impacts on subsistence could alter subsistence use areas and availability for Iñupiaq, Gwich'in, and Inuvialuit subsistence users, including alterations of migration patterns and changing weather patterns from climate change. Over time, reductions in subsistence harvests could have an adverse effect on diet and nutrition and could accelerate the transition from a subsistence-based diet to one that includes a higher proportion of store-bought food. The effects of climate change described under *Affected Environment*, above, could influence the rate or degree of the potential cumulative impacts. Current levels of contamination of traditional food and water supplies in the region are low and, in the absence of major spills or accidents, are unlikely to significantly change under any action alternative.

Rates of accident injury are very high for Kaktovik residents. Disruptions to subsistence harvest patterns and conflicts between uses of the land can lead to an increased risk of injury in hunters. This is in addition to the risk of unpredictable weather and sea ice conditions associated with climate change. All action alternatives would increase the likelihood of potential injury due to industrial use of land previously used only for subsistence activity.

Increasing economic development and revenues to the local governments under all the action alternatives would support maintenance and improvement of Kaktovik infrastructure and systems. The direct and indirect employment resulting from oil and gas exploration and development, combined with the government and ANCSA corporation revenues, are all major contributors to the positive health changes in the NSB over the last few decades. The activities under all action alternatives would contribute substantially to these ongoing impacts, with greater levels of employment generally more likely to be associated with good health.

3.5 Unavoidable Adverse Effects

Unavoidable adverse effects would be expected to occur during oil and gas exploration, development, and production under the alternatives considered in this EIS. Many adverse impacts could be lessened by Lease Stipulations and ROPs but would not be completely eliminated or reduced to negligible levels. Some are short-term impacts, while others may be long-term impacts. In the event of a large oil spill, many of the adverse effects discussed would occur. These have been described for each resource in **Sections 3.1** to **3.4**.

Depending on the location and extent of oil and gas operations and adopted mitigation, unavoidable adverse effects could include the following:[67]

- Loss of soil productivity and sand and gravel resources, largely from construction of roads and pads and gravel mine development
- Changes in surface flow and drainage patterns due to construction of roads and pads and surface water withdrawal for ice roads, dust abatement, and operations
- Loss of vegetation habitat, including wetlands, due to construction of roads and pads and gravel mine development
- Loss, alteration, or fragmentation of wildlife habitat
- Changes in wildlife migration or travel patterns
- Continued change in access to and availability of subsistence resources

Before surface-disturbing activities begin, oil and gas leasing regulations (43 CFR 3104) require the operator on the ground to be covered by a bond. This bond provides monetary assurance to the BLM that the company would reclaim the pads, wells, and any associated surface disturbance to the standards of the BLM Authorized Officer. This is determined at the time of reclamation, thus allowing the BLM to take an adaptive management approach. On abandonment, the BLM would consider current data, technologies available, and the current resource situation in its determinations on specific reclamation. Additionally, the BLM retains the ability to increase the bond amount at any time during the lease, based on a recalculation of liability, such as an increased number of wells or a history of noncompliance with its operational standards. It is the intent of the BLM to apply the bonding requirements listed at 43 CFR 3134 to the Coastal Plain.

3.6 Relationship Between Local Short-Term Uses and Long-Term Productivity

This section discusses the short-term effects of the leasing alternatives, including the potential use of the program area for oil and gas exploration and development, versus the maintenance and enhancement of potential long-term productivity of the program area's environmental resources.

[67]Note that this list presents only a summary of possible unavoidable adverse effects. Refer to Section 4.9 of the 2012 Final IAP/EIS (BLM 2012) for a more complete discussion of similar unavoidable adverse effects that could occur post-leasing.

Short term in this discussion refers to the total duration of activities that could occur as a result of the leasing alternatives, primarily oil and gas exploration and production, whereas long term refers to an indefinite period extending beyond the termination of the action. Specific impacts vary in kind, intensity, and duration according to the activities occurring at any given time. Activities during the production life of oil and gas leases executed based on the decision in the ROD for this EIS may result in chronic impacts over a longer period. Over the long term—several decades after completion of abandonment activities—natural environmental balances are generally expected to be restored, though that balance would not for all resources mean a return to the exact state prior to original disturbance.

For a discussion of short-term uses of the program area for hydrocarbon development and production activities versus the maintenance and enhancement of potential long-term productivity of environmental resources of the program area, see **Sections 3.1** to **3.4** of this document; see Section 4.10 of the NPR-A EIS (BLM 2012) for a description of the indirect impacts that would occur post-leasing.

3.7 Irreversible and Irretrievable Commitments of Resources

Irreversible or irretrievable commitments of resources refer to impacts on or losses of resources that cannot be reversed or recovered. For a detailed description of irreversible or irretrievable commitments of resources from oil and gas development that could occur post-leasing, see Section 4.11 of the NPR-A EIS (BLM 2012). There would be some irreversible or irretrievable commitments of resources that are described in greater detail in **Sections 3.1** to **3.4**, as follows:

- Removal of hydrocarbons from the reservoir
- Energy consumption associated with the exploration, construction, and operation phases
- Permanent ground disturbance and permanent change resulting from gravel removal
- Surface water consumption for drilling and other industrial purposes with wastewater disposal via underground injection
- Loss of visual resource quality in the Coastal Plain
- Loss or abandonment of wildlife habitat
- Loss or change in subsistence use of the program area, depending on final abandonment plans
- Loss of cultural and paleontological resources

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Glossary

Acidophilus: Acid-loving (as in bacteria or plants); growing well in an acid medium.

Active floodplain: The flat area along a water body where sediments are deposited by seasonal or annual flooding; generally demarcated by a visible high water mark.

Aerial: Consisting of, moving through, found in, or suspended in the air.

Alluvial: Sedimentary material consisting mainly of coarse sand and gravel.

Alternatives: The different means by which objectives or goals can be attained. One of several policies, plans, or projects proposed for decision-making.

Ambient: Used to describe the environment as it exists at the point of measurement and against which changes (impacts) are measured.

Ambient air quality standard: Air pollutant concentrations of the surrounding outside environment that cannot legally be exceeded during fixed time intervals and in a specific geographic area.

Amphidromous: Describes fish that spawn and overwinter in rivers and streams but migrate during the ice-free summer from these freshwater environments into coastal waters for months to feed.

Anadromous: Describes fish that mature in the sea and swim up freshwater rivers and streams to spawn. Salmon, steelhead, and sea-run cutthroat trout are examples.

Anchor field: An oil and gas field containing sufficient quantities of recoverable oil and gas to support the construction of infrastructure and processing facilities; satellite fields can then be constructed using the anchor field facilities.

Anoxic: The condition of an environment in which free oxygen is lacking or absent.

Anthropogenic: Of, relating to, or resulting from the influence of humans on nature.

Anticline: An inverted bowl-shaped structure formed when sedimentary rock layers are folded to produce an arch or elongated dome.

Aquatic: Growing, living in, frequenting, or taking place in water; in this Leasing EIS, used to indicate habitat, vegetation, and wildlife in freshwater.

Archaeological resource: Any material remains of human life or activities that are at least 50 years of age and that are of archaeological interest (30 CFR 550.105).

Aufeis: Thick ice that builds up as a result of repeated overflow.

Authorized Officer (BLM): Designated BLM personnel responsible for a certain area of a project; for the Leasing EIS, generally this would be the BLM State Director.

Available: When referring to oil and gas leasing, available lands could be offered. Lands that are already leased could be offered for leasing if the existing lease ends.

Bank: (1) The rising ground bordering a lake, river, or sea; or of a river or channel, for which it is designated as right or left as the observer is facing downstream. (2) An elevation of the sea floor or large area, located on a continental (or island) shelf and over which the depth is relatively shallow but sufficient for safe surface navigation (e.g., Georges Bank); a group of shoals. (3) In its secondary sense, used only with a qualifying word such as “sandbank,” “gravel bank,” or “spoil bank,” a shallow area consisting of shifting forms of silt, sand, mud, and gravel.

Barrel: Unit of measurement consisting of 42 gallons of oil or other fluid.

Baseline data: Data gathered before a proposed action to characterize pre-development site conditions.

Biodegradable: Capable of being broken down by the action of living organisms, such as microorganisms.

Biological assessment (BA): A document prepared by or under the direction of a federal agency; addresses listed and proposed species and designated and proposed critical habitat that may be in the action area and evaluates the potential effects of the action on such species and habitat.

Black water: Discharge that includes wastewater from any or all of the following: toilets, urinals, and sewage treatment systems.

Bonding capacity: An amount, determined by market analysts, based on a government entity’s prior bonding experience, actual repayment performance, and its ability to service future, periodic debt. It affects the ability of municipalities to issue and sell bonds to generate funds for capital improvements.

Bottom-fast ice: Ice that is firmly attached or grounded to the bottom of a water body, which is often frozen from top to bottom.

Brackish: Water that is intermediate between salt water and freshwater; often occurs at the mouths of rivers, where freshwater mixes with salt water.

Brine: General description of water that is produced with oil. The water is associated with the oil-producing formation and can have varying amounts of dissolved salts.

Brood: A group of young birds being cared for by an adult bird; typically the surviving hatchlings from one or more clutches of eggs.

Buffer Area: A spatial zone created to enhance the protection of a specific conservation area, often peripheral to the area.

Bureau of Land Management (BLM): An agency of the United States government, under the US Department of the Interior, responsible for administering certain public lands of the United States.

Burin: A tool flaked into a chisel point for inscribing or grooving bone, wood, leather, stone, or antler.

Calving area: A large area where large mammals, particularly ungulates such as caribou, congregate to give birth to their young.

Capital expenses: The money spent to purchase or upgrade physical assets, such as buildings or machinery.

Caribou Study Community: Any community that is in game management subunits that overlap with the PCH or CAH herd ranges, and which have Federal Subsistence Board customary and traditional use determinations for those herds.

Carrion: Dead or dying animal flesh.

Class I air quality area: One of 156 protected areas, such as national parks over 6,000 acres, wilderness areas over 5,000 acres, national memorial parks over 5,000 acres, and international parks that were in existence as of August 1977, where air quality should be given special protection. Federal Class I areas are subject to maximum limits on air quality degradation called air quality increments (often referred to as prevention of significant deterioration [PSD] increments). All areas of the United States not designated as Class I are Class II areas. The air quality standards in Class I areas are more stringent than national ambient air quality standards.

Climate Change: Climate is described by the National Weather Service (NWS) as the most recent 30-year averages of meteorological parameters, such as temperature, precipitation, humidity, and winds; thus, climate change is defined here as the longer-term (longer than 30 years) changes in such variables at regional or global scales.

Coastline: The area where the contiguous land (excluding nearshore marine waters, lagoons, and barrier island habitats) meets the ocean.

Council on Environmental Quality (CEQ): An advisory council to the president, established by the National Environmental Policy Act of 1969. It reviews federal programs for their effect on the environment, conducts environmental studies, and advises the president on environmental matters.

Comprehensive Environmental Response Compensation and Liability Act of 1980 (CERCLA): Authorizes funds administered by the Environmental Protection Agency to identify and clean up hazardous waste sites; also known as Superfund.

Code of Federal Regulations (CFR): A codification of the general and permanent rules published in the *Federal Register* by the executive departments and agencies of the federal government.

cfs: Cubic feet per second; 1 cfs equals 448.33 gallons per minute.

Commercial field: Oil or natural gas fields that can be produced such that they provide a suitable return on investment.

Commercial oil or natural gas reserves: Resources that can be produced such that they provide a suitable return on investment.

Commercially recoverable: See *Commercial oil or natural gas reserves*, above.

Concern: A point, matter, or question raised by management or the public that must be addressed in the planning process.

Conglomerate: Sedimentary rock consisting of gravel and small boulders.

Consistency determination: A finding by a state or federal agency that a project or agency action is consistent with a required agency program, guideline, or regulation, such as the Alaska Coastal Zone Management Program.

Consultation: Exchange of information and interactive discussion; when capitalized it refers to consultation mandated by statute or regulation that has prescribed parties, procedures, and timelines, such as Consultation under NEPA or Section 7 of the Endangered Species Act.

Controlled surface use (CSU): A category of moderate constraint stipulations that allows some use and occupancy of public land, while protecting identified resources or values and is applicable to fluid mineral leasing and all activities associated with fluid mineral leasing, such as truck-mounted drilling and geophysical exploration equipment off designated routes and construction of wells and pads. CSU areas are open to fluid mineral leasing, but the stipulation allows the BLM to require special operational constraints, or the activity can be shifted more than 656 feet to protect the specified resource or value.

Criteria: Data and information that are used to examine or establish the relative degrees of desirability of alternatives or the degree to which a course of action meets an intended objective.

Criteria air pollutants: The six most common air pollutants in the US: carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3), particulate matter (both PM_{10} and $PM_{2.5}$ inhalable and respirable particulates), and sulfur dioxide (SO_2). Congress has focused regulatory attention on these six pollutants because they endanger public health and the environment, are widespread throughout the US, and come from a variety of sources. Criteria air pollutants are typically emitted from many sources in industry, mining, transportation, electricity generation, energy production, and agriculture.

Cultural resources: Culturally valued aspects of the environment that generally include historic properties, other culturally valued pieces of real property, cultural use of the biophysical environment, and intangible sociocultural attributes such as social cohesion, social institutions, lifeways, religious practices, and other cultural institutions.

Cumulative effect or impact: The impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (federal or non-federal) or person undertakes such actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over time.

Deferred: When referring to oil and gas leasing, indicates that lands would not be offered for lease until a specified period has expired. For example, a 10-year deferral would mean that the deferred lands would not be offered for leasing until for 10 years after the Record of Decision establishes the 10-year deferral.

Demersal: Living near, deposited on, or sinking to the seabed.

Density: The number of individuals per a given unit area.

Deposit: A natural accumulation, as of precious metals, minerals, coal, gas, and oil, that may be pursued for its intrinsic value, such as a gold deposit.

Development: The phase of petroleum operations that occurs after exploration has proven successful and before full-scale production. The newly discovered oil or gas field is assessed during an appraisal phase, a plan to fully and efficiently exploit it is created, and additional wells are usually drilled.

DEW-Line: Distant Early Warning Line. A site designed and built during the Cold War as the primary line of air defense warning of an “over the pole” invasion of North America.

Dilution: Mixing or thinning and therefore decreasing a certain strength or concentration.

Dispersion: Distributing or separating into lower concentrations or less dense units.

Dissociable: Able to break up into simpler chemical constituents.

Diversity: An expression of community structure; high, if there are many equally abundant species; low, if there are only a few equally abundant species; the distribution and abundance of different plant and animal communities and species in the area covered by a land and resource management plan.

Draft Environmental Impact Statement (DEIS): The draft statement of the environmental effects of a major federal action, which is required under section 102 of the National Environmental Policy Act and released to the public and other agencies for comment and review.

Drill pad: A drilling site, usually constructed of local materials such as gravel.

Drilling fluid (mud): A preparation of water, clay, and chemicals circulated in a well during drilling to lubricate and cool the drill bit, flush rock cuttings to the surface, prevent sloughing of the sides of the hole, and prevent the flow of formation fluids into the bore-hole or to the surface.

Duck pond: A small, flat-bottomed plastic receptacle placed under a vehicle to catch and contain any contaminated fluids that may melt or drip from the underside of the vehicle.

Economically recoverable: See *Commercial oil or gas reserves*, above.

Effect: Environmental change resulting from a proposed action. Direct effects are caused by the action and occur at the same time and place, while indirect effects are caused by the action but are later in time or farther removed in distance, although still reasonably foreseeable. Indirect effects may include growth-inducing and other effects related to induced changes in the pattern of land use, population density, or growth rate and related effects on air and water and other natural systems, including ecosystems. Effect and impact are synonymous, and both are used in this document.

Employment: Labor input into a production process, measured in the number of person-years or jobs; the number of jobs required to produce the output of each sector. A person-year is approximately 2,000 working hours by one person working the whole year or by several persons working seasonally. A job may be 1 week, 1 month, or 1 year.

Endangered species: Any species of animal or plant that is in danger of extinction throughout all or a significant portion of its range; plant or animal species identified by the Secretary of the Interior as endangered in accordance with the 1973 Endangered Species Act.

Energy budget: The flow of energy through an organism or ecosystem. For an organism, it is the amount of energy being absorbed (e.g., food) in relation to the amount of energy expended and lost as heat.

Environment: The physical conditions that exist in an area, such as the area that would be affected by a proposed project, including land, air, water, minerals, flora, fauna, ambient noise, and objects of historic or aesthetic significance; the sum of all external conditions that affect an organism or community to influence its development or existence.

Environmental assessment (EA): A concise public document, for which a federal agency is responsible, that serves to (1) briefly provide sufficient evidence and analysis for determining whether to prepare an environmental impact statement or a finding of no significant impact; (2) aid an agency's compliance with the National Environmental Policy Act when no environmental impact statement is necessary; and, (3) facilitate preparation of an environmental impact statement when one is necessary. .

Environmental impact statement (EIS): An analytical document prepared under the National Environmental Policy Act that portrays the potential impacts of the environment of a preferred action and its possible alternatives. An ElS is developed for use by decision-makers to weigh the environmental consequences of a potential decision.

Environmental justice: The fair treatment and meaningful involvement of all people, regardless of natural origin or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people, including racial, ethnic, or socioeconomic groups, should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of federal, state, local, and tribal programs and policies. Executive Order 12898 directs federal agencies to achieve environmental justice as part of their missions by identifying and addressing disproportionately high adverse effects of agency programs, policies, and activities, on minority and low-income populations

Erosion: The wearing away of the land surface by running water, wind, ice, or other geologic agents, including gravitation creep.

Eskimo: An ethnonym (name given to a group by another group) referring to speakers of the Inuit language family who live in the Arctic and Subarctic regions of North America—Canada, Greenland, and Alaska—and eastern Siberia.

Essential fish habitat (EFH): As defined by Congress in the interim final rule (62 FR 66551), "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." For the purpose of interpreting the definition of EFH habitat, "waters" are aquatic areas and their associated physical, chemical, and biological properties; "substrate" is sediment underlying the waters; "necessary" refers to the habitat required to support a sustainable fishery and the managed species contribution to a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers all habitat types that a species uses throughout its life cycle.

Estuary: A partially enclosed body of water formed where freshwater from rivers and streams flows into the ocean, mixing with the salty seawater. Estuaries and the lands surrounding them are places of transition from land to sea, and from freshwater to salt water.

Ethnographic: Of or pertaining to the descriptive and analytical study of the culture of particular self-defined groups or communities.

Exception: A one-time exemption to a lease stipulation, determined on a case-by-case basis.

Exploration: The search for economic deposits of minerals, gas, oil, or coal through the practices of geology, geochemistry, geophysics, drilling, shaft sinking, and mapping.

Exploratory unit: Normally embrace a prospective area delineated on the basis of geological or geophysical inference and permit the most efficient and cost-effective means of developing underlying oil and gas resources.

Fast-ice zone: Area along the coast covered by sea ice that is continuous with and attached to the shoreline.

Feasible: Capable of being accomplished in a successful manner within a reasonable time, taking into account economic, environmental, legal, social, and technological factors.

Federal Register: The official journal of the federal government of the United States, containing government agency rules, proposed rules, and public notices.

Final environmental impact statement (final EIS): A revision of the draft environmental impact statement that includes public and agency comments on the draft.

Fisheries habitat: Streams, lakes, and reservoirs that support fish populations.

Fishery: The act, process, occupation, or season of taking an aquatic species.

Floodplain: The lowland and relatively flat area adjoining inland waters, including, at a minimum, that area subject to a 1 percent or greater chance of flooding in any given year.

Fluvial: Of or relating to a stream or river.

Fossil: Evidence or remnant of a plant or animal preserved in the earth's crust, such as a skeleton, footprint, or leaf print.

Fossil fuel: Petroleum, natural gas, and coal; fuel derived from biological material that was deposited into sedimentary rocks.

Frequency: The number of samples in which a plant or animal species occurs, divided by the total number of samples.

Fugitive dust: Particles suspended randomly in the air, usually from road travel, excavation, or rock loading operations.

Game management unit (GMU): A geographic division made by the Alaska Department of Fish and Game for the management of fish and wildlife in the State. Different GMUs have different hunting and fishing seasons, bag limits, and other harvest rules.

Geology: The scientific study of the origin, history, and structure of the earth; the structure of a specific region of the earth's surface.

Geomorphic: Pertaining to the structure, origin, and development of the topographical features of the earth's crust.

Gill net: Made of one or more layers of mesh, used to catch fish by entanglement as they attempt to swim through the net.

Glacial drift: Unsorted sediments deposited by glaciers and not subsequently reworked by water; coarse-grained materials, such as rock and sand, suspended in a fine-grained matrix, such as silt. The term applies to all mineral material transported by a glacier and deposited directly by or from the ice or by running water emanating from a glacier.

Global warming: An increase over time of the average temperature of the earth's atmosphere and oceans. It is generally used to describe the temperature rise over the past century or so and the effects of humans on the temperature rise.

Gray water: Discharge that includes wastewater from any or all of the following: kitchen sink, shower, drinking water, and laundry.

Greenhouse effect: A process by which thermal radiation from a planetary surface is absorbed by atmospheric greenhouse gases and is reradiated in all directions. Since part of this reradiation is toward the earth's surface and the lower atmosphere, it elevates the average surface temperature above what it would be in the absence of the gases.

Greenhouse gas (GHG): A gas that absorbs and emits thermal radiation in the lowest layers of the atmosphere. This process is the fundamental cause of the greenhouse effect. The primary greenhouse gases that are considered air pollutants are carbon dioxide, (CO_2), methane (CH_4), nitrous oxide (N_2O), and chlorofluorocarbons (CFCs).

Groundwater: Water found beneath the land surface in the zone of saturation below the water table.

Habitat: The natural environment of a plant or animal, including all biotic, climatic, and soil conditions, or other environmental influences affecting living conditions. The place where an organism lives.

Hazardous air pollutants (HAPs): Also known as toxic air pollutants, those that cause or may cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental and ecological effects. The Environmental Protection Agency is required to control 187 hazardous air pollutants. Examples of HAPs are benzene (found in gasoline), perchlorethlyene (emitted from dry cleaning facilities), and methylene chloride (used as a solvent).

Hazardous waste: As defined by the Environmental Protection Agency, a waste that exhibits one or more of the following characteristics: ignitability, corrosivity, reactivity, or toxicity. Hazardous wastes are listed in 40 CFR 261.3 and 171.8.

Headwaters: The upper reaches of a stream where it forms.

Heavy Equipment: Heavy-duty vehicles, specially designed for executing construction tasks, most frequently, ones involving earthwork operations.

Hydrocarbon: A naturally occurring organic compound composed of hydrogen and carbon. Hydrocarbons can occur in molecules as simple as methane (one carbon atom with four hydrogen atoms), but also as highly complex molecules, and can occur as gases, liquids, or solids. The molecules can have the shape of chains, branching chains, rings, or other structures. Petroleum is a complex mixture of hydrocarbons.

Hydrologic system: The combination of all physical factors, such as precipitation, stream flow, snowmelt, and groundwater that affect the hydrology of a specific area.

Impermeable: Not permitting passage of fluids through its mass.

Impoundment: The collection and confinement, usually of water (in the case of mining, tailings materials), in a reservoir or other storage area.

Increment: An amount of change from an existing concentration or amount, such as air pollutant concentrations.

Incidental Take Regulation (ITR): Governs the authorization of take of small numbers of marine mammals within a specified geographic region that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant. ITRs prescribe permissible methods of taking and other means of effecting the least practicable adverse impact on the affected species.

Indigenous: Having originated in and being produced, growing, living, or occurring naturally in a particular region or environment.

Indirect impact: Impact caused by an action but later in time or farther removed in distance, although still reasonably foreseeable.

Infrastructure: The underlying foundation or basic framework; substructure of a community, such as schools, police, fire services, hospitals, water, and sewer systems.

Insect-relief area: An area of the North Slope with relatively low numbers of insects that caribou use for relief from insects.

Interstitial ice: Found in cavities or lodged between soil grains or rock crevices.

Irretrievable: Applies to losses of production, harvest, or commitment of renewable natural resources. For example, some or all of the wildlife forage production from an area is irretrievably lost during the time an area is used as an oil or gas development site. If the use changes, forage production can be resumed. The production lost is irretrievable, but the act is not irreversible.

Irreversible: A term that applies primarily to the use of nonrenewable resources, such as minerals or cultural resources, or to those factors that are renewable only over long time spans, such as soil productivity. Irreversible also includes loss of future options.

Isobath: Depth interval contour, as commonly mapped for lake or ocean bottoms.

Jurisdictional wetland: A wetland area delineated and identified by specific technical criteria, field indicators, and other information, for the purposes of public agency jurisdiction. The US Army Corps of Engineers regulates “dredging and filling” activities associated with jurisdictional wetlands. Other federal agencies that can become involved with matters that concern jurisdictional wetlands include the US Fish and Wildlife Service, the Environmental Protection Agency, and the Natural Resource Conservation Service.

Landfast ice: Stationary ice that is continuous with, and attached to, the shoreline and extends out into the waterbody.

Landform: Any physical, recognizable form or feature on the earth’s surface having a characteristic shape, which is produced by natural causes. Landforms provide an empirical description of similar portions of the earth’s surface.

Land management: The intentional process of planning, organizing, programming, coordinating, directing, and controlling land use actions.

Landscape: The sum total of the characteristics that distinguish a certain area on the earth’s surface from other areas; these characteristics are a result not only of natural forces, but also of human occupancy and use of the land. An area composed of interacting and interconnected patterns of habitats (ecosystems), which are repeated because of geology, landforms, soils, climate, biota, and human influences throughout the area.

Land status: The ownership status of lands.

Land use allocation: The assignment of a management emphasis to particular land areas with the purpose of achieving the goals and objectives of some specified use(s) (e.g., campgrounds, wilderness, logging, and mining).

Laterally discontinuous: Not continuous in the horizontal plane. For example, in an area with laterally discontinuous permafrost, the permafrost is not uniformly found across the entire area without interruption.

Lead: Long cracks in the ice, used by both whales and boats to travel through the water.

Letter of Authorization (LOA): Authorization issued by the USFWS for incidental takes that may cause death or serious injury to marine mammals for a term of five years or less. The LOA must be in accordance with Incidental Take Regulations.

Listed species: Species that are listed as threatened or endangered under the Endangered Species Act of 1973 (as amended).

Long-term impacts: Impacts that normally result in permanent changes to the environment. An example is the loss of habitat due to development of a gravel pit. For each resource, the definition of long-term may vary.

Major Construction Activity: Creation or construction of infrastructure using heavy equipment, causing surface disturbance.

Management activity: A human activity imposed on a landscape for the purpose of harvesting, traversing, transporting, or replenishing natural resources.

Management area: An area delineated on the basis of management objective prescriptions.

Management concern: An issue, problem, or condition that influences the range of management practices identified in a planning process.

Management direction: A statement of multiple use and other goals and objectives, and the associated management prescriptions, standards, and guidelines for attaining them (36 CFR 219.3).

Marine: Of, found in, or produced by the sea.

Masu: A starchy tuber found in arctic and subarctic regions (vernacular is “Eskimo potato”).

Mean: A statistical value calculated by dividing the sum of a set of sample values by the number of samples. Also referred to as the arithmetic mean or average.

Mean high water mark: With respect to ocean and coastal waters, the line on the shore established by the average of all high tides. It is established by survey based on available tidal data (preferably averaged over a period of 18.6 years because of the variations in tide). In the absence of such data, less precise methods to determine the mean high water mark are used, such as physical markings, lines of vegetation or comparison of the area in question with an area having similar physical characteristics for which tidal data are readily available.

Modification: A change to a lease stipulation either temporarily or for the life of the lease.

Migratory: Moving from place to place, daily or seasonally.

Mitigation: Steps taken to: (1) avoid an impact altogether by not taking a certain action or parts of an action; (2) minimize an impact by limiting the degree or magnitude of the action and its implementation; (3) rectify an impact by repairing, rehabilitating, or restoring the affected environment; (4) reduce or eliminate an impact over time by preserving and maintaining operations during the life of the action; and, (5) compensate for an impact by replacing or providing substitute resources or environments (40 CFR Part 1508.20).

Memorandum of Understanding (MOU): Usually documents an agreement reached among federal agencies.

Muktuk: Eskimo delicacy consisting of the skin and the thin layer of subcutaneous fat of whales.

National Environmental Policy Act (NEPA): An act declaring a national policy to encourage productive and enjoyable harmony between humankind and the environment; promote efforts to prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of humanity; enrich the understanding of the ecological systems and natural resources important to the nation; and establish a Council on Environmental Quality.

Net present value (NPV): The difference between the discounted value (benefits) of all outputs to which monetary values or established market prices are assigned and the total discounted costs of managing the planning area.

National Pollutant Discharge Elimination System (NPDES): A program authorized by sections 318, 402, and 405 of the Clean Water Act, and implemented by regulations 40 CFR 122. The NPDES program requires permits for the discharge of pollutants from any point source into waters of the United States.

Nearshore: Marine waters within the Arctic Refuge boundary.

No-Surface-Occupancy (NSO): An area that is open for mineral leasing but does not allow the construction of surface oil and gas facilities in order to protect other resource values. Facilities such as essential roads, pipelines, a dock, and a seawater treatment/desalinization plant may be allowed in these areas on a case-by-case basis.

Non-Associated Gas: Gas in a reservoir having little or no crude oil.

NO_x: Mono-nitrogen oxides, including nitric oxide (NO) and nitrogen dioxide (NO_2). It is formed when naturally occurring atmospheric nitrogen and oxygen are combusted with fuels in automobiles, power plants, industrial processes, and home and office heating units.

Objective: A concise, time-specific statement of measurable planned results that respond to pre-established goals. An objective forms the basis for further planning to define the precise steps to be taken and the resources to be used to achieve identified goals.

Offshore: (1) In beach terminology, the comparatively flat zone of variable width, extending from the shoreface to the edge of the continental shelf. It is continually submerged. (2) The direction seaward from the shore. (3) The zone beyond the nearshore zone where sediment motion induced by waves alone effectively ceases and where the influence of the sea bed on wave action is small in comparison with the effect of wind. (4) The breaker zone directly seaward of the low tide line.

Oiled: Having oil on skin, fur, or feathers after coming into contact with an oil spill.

Ordinary High Water Mark: The line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas.

Ozone: Form of oxygen found largely in the stratosphere; a product of the reaction between ultraviolet light and oxygen.

Particulates: Small particles suspended in the air, generally considered pollutants.

Pelagic: Pertaining to the ocean and especially to animals (typically marine mammals, birds, or fish) that live at the surface of the ocean away from the coast.

Per capita income: Total income divided by the total population.

Performance-based stipulation: A stipulation applied to a lease that provides a stated objective that must be met, along with requirements and guidelines, but provides some leeway as to how that objective can be met and maintained by the lessee; compare to prescriptive-based stipulation.

Permafrost: Permanently frozen ground.

Permanent oil and gas facilities: Production facilities, pipelines, roads, airstrips, production pads, docks, seawater treatment plants, and other structures associated with oil and gas production that occupy land for more than one winter season. Material sites and seasonal facilities, such as ice roads, are excluded, even when the pads are designed for use in successive winters. Gravel mines are also included as permanent oil and gas facilities.

Permeability: The property or capacity of a porous rock, sediment, or soil for transmitting a fluid; a measure of the relative ease of fluid flow under unequal pressure.

Photoperiod: In reference to cycles of light and darkness, the length of time that uninterrupted light is present, generally the length of daylight in a given 24-hour period.

Physiographic province: A region having a particular pattern of relief features or land forms that differs significantly from that of adjacent regions (e.g., Arctic Coastal Plain).

Pingo: A low conical hill or mound forced up by hydrostatic pressure in an area underlain by permafrost and consisting of an outer layer of soil covering a core of solid ice. Pingos range from 6 to 160 meters in height.

Plant community: A vegetation complex, unique in its combination of plants, which occurs in particular locations under particular influences. A plant community is a reflection of integrated environmental influences on the site, such as soils, temperature, elevation, solar radiation, slope aspect, and precipitation.

Pollution: Human-caused or natural alteration of the physical, biological, and radiological integrity of water, air, or other aspects of the environment that produce undesired effects.

Polygon: A surface landform resulting from repeated freeze-thaw cycles common in permafrost areas. Polygons are bounded by troughs of ice or water and generally occur in networks that form regular geometric designs with multiple square sides of nearly equal lengths.

Polynyas: Non-linear openings in the sea ice.

Pool: A subsurface oil accumulation.

Porosity: The ratio of the volume of void space in a material (e.g., sedimentary rock or sediments) to the volume of its mass.

Potable: Suitable, safe, or prepared for drinking, as in potable water.

Pot hunting: The removal or theft of artifacts from cultural resource sites by untrained individuals for profit and recreation.

Prescriptive-based stipulation: A stipulation applied to leases with exacting requirements applying to lessee activities; compare to performance-based stipulation.

Prevention of significant deterioration (PSD): A special permit procedure established in the Clean Air Act, as amended, used to ensure that economic growth occurs in a manner consistent with the protection of public health and preservation of air quality related values in national special interest areas.

Pristine: Pure, original, and uncontaminated.

Prospect: An area of exploration in which hydrocarbons have been predicted to exist in commercially recoverable quantities.

Public scoping: A process whereby the public is given the opportunity to provide oral or written comments about the influence of a project on an individual, the community, and/or the environment.

Pulse: A group of whales; the term is applied to whales migrating across the Chukchi and Beaufort seas, when there are more individuals in each pod of whales and more pods than usual.

Putrescible: Liable to decay.

Pyrogenic: Producing or produced by heat.

Raptor: Bird of prey; includes eagles, hawks, falcons, and owls.

Recharge: Absorption and addition of water into the zone of saturation.

Record of Decision (ROD): A document separate from, but associated with, an environmental impact statement, which states the decision, identifies alternatives (specifying which were environmentally preferable), and states whether all practicable means to avoid environmental harm from the alternative have been adopted, and, if not, why not (40 CFR 1505.2).

Reclamation: Reclamation helps to ensure that any effects of oil and gas development on the land and on other resources and uses are not permanent. The ultimate objective of reclamation is ecosystem restoration, including restoration of any natural vegetation, hydrology, and wildlife habitats affected by surface disturbances from construction and operating activities at an oil and gas site. In most cases, this means a condition equal to or closely approximating that which existed before the land was disturbed.

Recoverable reserves: Oil and gas reserves that may be recoverable by the application of technology, but not necessarily commercially recoverable.

Regulated air pollutants: Pollutants first set forth in the Clean Air Act of 1970 and are the basis upon which the Federal government and state regulatory agencies have established emission thresholds and regulations. Regulated air pollutants include criteria air pollutants, hazardous air pollutants (HAPs), volatile organic compounds (VOCs), and greenhouse gases. The same pollutant may be regulated under more than one of the regulatory standards.

Reservoir (oil or gas): A subsurface body of rock having sufficient porosity and permeability to store and transmit fluids. Sedimentary rocks are the most common reservoir rocks because they have more porosity than most igneous and metamorphic rocks and form under temperature conditions at which hydrocarbons can be preserved. A reservoir is a critical component of a complete petroleum system.

Resident: A species that is found in a particular habitat for a particular time period (e.g., winter resident or summer resident) as opposed to a species found only when passing through during migration.

Required Operating Procedure (ROP): Procedures carried out during proposal implementation which are based on laws, regulations, executive orders, BLM planning manuals, policies, instruction memoranda, and applicable planning documents.

Rideup: A raised-relief ice formation that is formed when a moving ice sheet is forced up and over other structures such as land or ice.

Riffles: Stream segments where the water is relatively shallow, current velocity is relatively high, and sediments are coarse; riffles are located in between areas of deeper, slower water (pools).

Rift zone: Zone of faulting where rocks are pulled apart.

Right-of-way (ROW): Public lands that the BLM authorizes a holder to use or occupy under a grant; examples are roads, pipelines, power lines, and fiber optic lines.

Riparian: Occurring adjacent to streams and rivers and directly influenced by water. A riparian community is characterized by certain types of vegetation, soils, hydrology, and fauna and requires free or unbound water or conditions more moist than that normally found in the area.

Risked mean: The arithmetic average of all possible resource outcomes weighted by their probabilities. Risked (unconditional) estimates of resources such as oil or natural gas consider the possibility that the area may be devoid of those resources. Statistically, the risked mean may be determined through multiplication of the mean of a conditional distribution by the related probability of occurrence.

Rolligon: A brand name or make of wheeled vehicle that exerts low pressure on the ground and is designed to travel across sensitive areas such as tundra with minimal disturbance.

Sanitary/Domestic Wastewater: Water-borne human wastes or graywater from dwellings, commercial buildings, institutions, or similar structures. Domestic wastewater includes the contents of individual removable containers used to collect and temporarily store human wastes.

Satellite field: An oil reserve located near an existing oil development, allowing shared use of the infrastructure.

Scenic River: River designation, under the Federal Wild and Scenic Rivers Program, on the basis of undisturbed and scenic character. Scenic rivers are given special management criteria by federal agencies.

Scoping process: A part of the National Environmental Policy Act process; early and open activities used to determine the scope and significance of the issues, and the range of actions, alternatives, and impacts to be considered in an Environmental Impact Statement (40 CFR 1501.7).

Sediments: Unweathered geologic materials generally laid down by or within waterbodies; the rocks, sand, mud, silt, and clay at the bottom and along the edge of lakes, streams, and oceans.

Seismic: Relating to or denoting geological surveying methods involving vibrations produced artificially by explosions.

Sensitive species: Plant or animal species that are susceptible or vulnerable to activity impacts or habitat alterations. Species that have appeared in the *Federal Register* as proposed for classification or are under consideration for official listing as endangered or threatened species.

Setback: A distance by which a structure or other feature is set back from a designated line.

Short-term impacts: Impacts occurring during project construction and operation, and normally ceasing upon project closure and reclamation. For each resource, the definition of short-term may vary.

Significant: The description of an impact that exceeds a certain threshold level. Requires consideration of both context and intensity. The significance of an action must be analyzed in several contexts, such as society as a whole, and the affected region, interests, and locality. Intensity refers to the severity of impacts, which should be weighted along with the likelihood of its occurrence.

SO_x: Sulfur oxides, including sulfur dioxide (SO_2). A product of vehicle tailpipe emissions.

Sociocultural: Of, relating to, or involving a combination of social and cultural factors.

Socioeconomic: Pertaining to or signifying the combination or interaction of social and economic factors.

Soil horizon: A layer of soil material approximately parallel to the land surface that differs from adjacent genetically related layers in physical, chemical, and biological properties.

Solid waste: Garbage, refuse, and/or sludge produced during oil and gas exploration and development activities.

Spawning: Production, deposition, and fertilization of eggs by fish.

Special use permit: A permit issued under established laws and regulations to an individual, organization, or company for occupancy or use of federal or state lands for some special purpose.

Spill Prevention Control and Countermeasure Plan (SPCC): A plan that the Environmental Protection Agency requires to be on file within six months of project inception. It is a contingency plan for avoidance of, containment of, and response to spills or leaks of hazardous materials.

Standard: A model, example, or goal established by authority, custom, or general consent as a rule for the measurement of quantity, weight, extent, value, or quality.

Stipulation: A requirement or condition placed by the Bureau of Land Management on the leaseholder for operations the leaseholder might carry out within that lease. The Bureau of Land Management develops stipulations that apply to all future leases within the Arctic Refuge Coastal Plain.

Stratigraphic trap: An oil or gas reservoir in which the hydrocarbons are trapped because of a lateral change in the physical characteristics of the reservoir or a change in the lateral continuity of the rocks.

Strike: The act of throwing a darting gun harpoon with a black powder or penthrite bomb into a whale. A strike may or may not result in a dead whale, which may or may not result in a landed whale. The International Whaling Commission considers and counts the number of strikes and landed whales in their quota allocation to the US government (and hence to the Alaska Eskimos). Unused strikes can be transferred to other individuals or groups harvesting whales.

Subsistence: Harvesting of plants and wildlife for food, clothing, and shelter. The attainment of most of one's material needs (e.g., food and clothing materials) from wild animals and plants.

Subsistence Uses: 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 nonedible 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.

Talik: An unfrozen section of ground found above, below, or within a layer of discontinuous permafrost. These layers can also be found beneath waterbodies in a layer of continuous permafrost.

Technically recoverable: Amount of oil or gas that can be recovered from a formation using current technology and practices.

Terrestrial: Of or relating to the earth, soil, or land; inhabiting the earth or land.

Thermokarst: Land-surface configuration that results from the melting of ground ice in a region underlain by permafrost. In areas that have appreciable amounts of ice, small pits, valleys, and hummocks form when the ice melts and the ground settles unevenly.

Threatened species: A plant or animal species likely to become an endangered species throughout all or a significant portion of its range within the foreseeable future.

Timing limitation (TL): This stipulation, a moderate constraint, is applicable to fluid mineral leasing, all activities associated with fluid mineral leasing (e.g., truck-mounted drilling and geophysical exploration equipment off designated routes, and construction of wells and pads), and other surface-disturbing activities (i.e., those not related to fluid mineral leasing). Areas identified for TL are closed to fluid mineral exploration and development, surface-disturbing activities, and intensive human activity during identified time frames. This stipulation does not apply to operation and basic maintenance, including associated vehicle travel, unless otherwise specified. Construction, drilling, completions, and other operations considered to be intensive are not allowed. Intensive maintenance, such as workovers on wells, is not permitted. TLs can overlap spatially with no surface occupancy and controlled surface use, as well as with areas that have no other restrictions.

Total petroleum system: The combination of geologic components and processes necessary to generate and store hydrocarbons, including a mature source rock, migration pathway, reservoir rock, trap, and seal. Includes all the petroleum generated by related source rocks and resides in a volume of mappable rocks. Geologic processes act upon the petroleum system and control the generation, expulsion, migration, entrapment, and preservation of petroleum.

Traditional knowledge: An intimate understanding by indigenous peoples of their environment, which is grounded in a long-term relationship with the surrounding land, ocean, rivers, ice, and resources. This understanding includes knowledge of the anatomy, biology, and distribution of resources; animal behavior; seasons, weather, and climate; hydrology, sea ice, and currents; how ecosystems function; and the relationship between the environment and the local culture.

Transfer payment: Money given by the government to citizens, such as Social Security, welfare, and unemployment compensation.

Trophic system: The process and organisms that move food energy through the ecosystem, often termed a food chain.

Tundra: Level or undulating treeless plain characteristic of northern Arctic regions, consisting of black mucky soil with permanently frozen subsoil and a dense growth of mosses, lichens, dwarf herbs, and shrubs.

Turbidity: A measure of the amount of suspended sediment in water.

Tussock: A small area of grass that is thicker or longer than the grass growing around it.

Unavailable: When referring to oil and gas leasing, unavailable lands would not be offered for oil and gas leasing.

Unconventional oil and gas: Reservoir oil and gas that cannot be efficiently extracted using conventional methods, examples include shale gas and tar sands.

Vibroseis: A device which uses a truck-mounted vibrator plate coupled to the ground to generate a wave train up to seven seconds in duration and comprising a sweep of frequencies. The recorded data from an upsweep or downsweep (increasing or decreasing frequency respectively) are added together and compared with the source input signals to produce a conventional-looking seismic section. The device is used increasingly in land surveys instead of explosive sources.

Volatile Organic Compounds (VOCs): A group of chemicals that react in the atmosphere with nitrogen oxides in the presence of sunlight and heat to form ozone. VOCs contribute significantly to photochemical smog production and certain health problems. Examples of VOCs are gasoline fumes and oil-based paints.

Waiver: A permanent exemption to a stipulation or lease.

Waterbody: A jurisdictional Water of the United States (see 33 CFR 328.4). Examples of ‘‘waterbodies’’ include streams, rivers, lakes, ponds, and wetlands.

Waterflooding: The injection of water into geological reservoirs to maintain or increase pressure in the reservoir and thereby assist in the extraction of oil.

Water quality: The interaction between various parameters that determines the usability or non-usability of water for on-site and downstream uses. Major parameters that affect water quality include: temperature, turbidity, suspended sediment, conductivity, dissolved oxygen, pH, specific ions, discharge, and fecal coliform.

Wetlands (biological wetlands): Those areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstance do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands include habitats such as swamps, marshes, and bogs (see jurisdictional wetlands).

Wild and Scenic Rivers: Those rivers or sections of rivers that are free of impoundments, with shorelines or watersheds still largely primitive and shorelines largely undeveloped, but accessible in places by roads.

Wilderness: A wilderness, in contrast with those areas where man and his works dominate the landscape, is hereby recognized as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain. An area of wilderness is further defined to mean in this Act an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions and which (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; (3) has at least five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition; and (4) may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value.

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