U.S. Fish & Wildlife Service

Arctic National Wildlife Refuge

Revised Comprehensive Conservation Plan

Final Environmental Impact Statement

Wilderness Review

Wild and Scenic River Review

Volume 1

U.S. Fish and Wildlife Service Mission

The mission of the U.S. Fish and Wildlife Service is working with others to conserve, protect, and enhance fish, wildlife, plants, and their habitats, for the continuing benefit of the American people.

National Wildlife Refuge System Mission

The mission of the National Wildlife Refuge System is to administer a national network of lands and waters for the conservation, management, and, where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.

This Comprehensive Conservation Plan describes programs that may exceed future budget allocations and therefore does not constitute specific commitments for future staff increases, project details, or funding.

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Volume 1
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Prepared by Arctic Refuge and the Alaska Region of the U.S. Fish and Wildlife Service in cooperation with the National Aeronautics and Space Administration

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Acronyms

ADEC	Alaska Department of Environmental Conservation
ADFG	Alaska Department of Fish and Game
ADNR	Alaska Department of Natural Resources
AIWFMP	Alaska Interagency Wildland Fire Management Plan
ANILCA	Alaska National Interest Lands Conservation Act
ANCSA	Alaska Native Claims Settlement Act
ASRC	Arctic Slope Regional Corporation
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BLM-AFS	Bureau of Land Management Alaska Fire Service
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CRMP	Comprehensive River Management Plan
DOI	Department of the Interior
EA	environmental assessment
EIN	easement identification number
EIS	environmental impact statement
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FMP	Fire Management Plan
FNSB	Fairbanks North Star Borough
GIS	Geographic Information System
GMU	Game Management Unit

GPS	Global Positioning System
I&M	Inventory and Monitoring
ICRMP	Integrated Cultural Resource Management Plan
IWSRCC	Interagency Wild and Scenic Rivers Coordinating Council
KIC	Kaktovik Iñupiat Corporation
LCC	Landscape Conservation Cooperative
LPP	Land Protection Plan
MPA	Marine Protected Area
MRA	Minimum Requirement Analysis
NASA	National Aeronautics and Space Administration
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
NPR-A	National Petroleum Reserve-Alaska
NPS	National Park Service
NWPS	National Wilderness Preservation System
NWSRS	National Wild and Scenic Rivers System
ORV	outstandingly remarkable value
PLO	Public Land Order
PUNA	Public Use Natural Area
RIT	Refuge Information Technician
RNA	Research Natural Area
ROC	region of comparison
ROD	record of decision
SNAP	Scenarios Network for Alaska Planning
TUS	transportation or utility systems

USFS	U.S. Forest Service
USGS	U.S. Geological Survey
VUMP	Visitor Use Management Plan
WSA	Wilderness Study Area
WSP	Wilderness Stewardship Plan

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A Note about Wilderness Terminology

Throughout this Plan, the term "wilderness" has different meanings depending on the context in which it is used. To clarify the intent of these different meanings, the following conventions are used:

"w"ilderness versus "W"ilderness

Arctic Refuge is currently comprised entirely of wildlands that host natural, undeveloped conditions, a range of special values, and provide opportunities for isolated and primitive recreation. Refuge staff works to protect these qualities and special values throughout the Refuge. The word "wilderness" ("w" not capitalized) and the phrase "wilderness characteristics" are used when describing these qualities and special values across Arctic Refuge as a whole. The word "wilderness" (not capitalized) is also used as an adjective when describing the wilderness qualities referenced in the Alaska National Interest Lands Conservation Act (ANILCA) Section 101(b) ("wilderness resource values") and Section 304(g) ("wilderness value").

The word "Wilderness" ("W" capitalized) is used when it refers specifically to Refuge lands designated by Congress as part of the National Wilderness Preservation System. "Wilderness character" is a phrase from the Wilderness Act used to summarize the qualities the agency is mandated to preserve within designated Wilderness. These include the maintenance of "untrammeled," "natural," and "undeveloped" conditions and the provision for "solitude or primitive and unconfined recreation." Note that these qualities are essentially the same as the wilderness characteristics found across all the wildlands of Arctic Refuge, including the approximately 60 percent of the Refuge currently under Minimal Management (see Chapter 2, Section 2.3.3). However, by statute, the Wilderness Act requires the Refuge provide a very high level of protection to these qualities of Wilderness character within designated Wilderness.

For More Information

"Wilderness" and related terms, such as "wilderness characteristics," "Wilderness character," and "wilderness values" are defined in Appendix M. For an explanation of the differences between Minimal Management and the management of designated Wilderness, see Chapter 2 (Sections 2.3.3 and 2.3.4) and Chapter 3 (Table 3-3).

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A Note about Acreages

Various acreages are reported throughout this Comprehensive Conservation Plan (Plan, Revised Plan for Arctic National Wildlife Refuge (Arctic Refuge, Refuge). These acreages come from many sources, including:

- Official land surveys
- Warranty deeds, patents, and other legal documents
- Public Laws, Public Land Orders (PLOs), Executive orders, etc.
- Geographic Information Systems (GIS) data

All acreages reported in this document are estimates of the true area represented on the ground. Some of these estimates are inherently more accurate, or closer to ground conditions, than are others. For example, surveys performed by a licensed land surveyor provide the most accurate acreage estimates. Acreages obtained from GIS data are typically less accurate. Acreages obtained from Public Laws, PLOs, and other legislation may or may not be derived from land surveys, making it difficult to ascertain the accuracy of these estimates. Because of the range of sources from which acreages are obtained, the following guidelines have been used to report acreages in this Plan.

- When reporting acreages that are based on surveys, patents, deeds, and interim conveyances, the reported acreage is that which is specified by the survey or legal document. These acreages will be reported to two decimal places.
- We handle acreages from laws, regulations, and other legal documents in two ways. If we are citing what the document said, we report the acreage as it is specified in the legal document, whether or not the acreage values are derived from actual surveys. We also use GIS to map acreages from laws, regulations, etc., and GIS-derived acreages may not agree with those in the legal document.
- When reporting acreages derived solely from GIS data, the acreages are rounded to take into account the approximation of digitally-constructed parcel boundaries. The magnitude of rounding is determined by the following:

ROUNDING FACTORS		EXAMPLES	
Acreage Range	**Round Up to Nearest**	**GIS-derived Acreage**	**Rounded Up To**
0 - 99	1	27.1857	28
100 - 999	10	133.5374	140
1,000 - 9,999	100	4,729.3048	4,800
10,000 - 99,999	1,000	87,637.1057	88,000
100,000 – and higher	10,000	684,304.5108	690,000

A Note about Acreages

- Very large acreages (in the millions) will be displayed in the text as a number with two decimal places (e.g., "19.64 million acres"). These acreages are still rounded per the tables here and should not be assumed to be highly accurate acreages such as from surveys or legal documents.

Based on these noted accuracy issues and guidelines, there may be cases in this Plan where the summation of individual acreages may not coincide with anticipated total acreages. This is to be expected given the inherent accuracy limits of the various acreage estimates.

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1. Introduction

Arctic National Wildlife Refuge (Arctic Refuge, Refuge) encompasses approximately 19.64 million acres[1] of land and water in northeastern Alaska (Map1-1) and is administered by the U.S. Fish and Wildlife Service (Service) as a unit of the National Wildlife Refuge System (Refuge System). This Comprehensive Conservation Plan (Plan, Revised Plan) is a revision of the 1988 Plan currently used to manage Arctic Refuge. The Revised Plan describes six alternatives for Refuge management and assesses the effects of implementing each of the alternatives. The Revised Plan, when finalized, will replace management direction described in the 1988 Plan (Service 1988a) and associated record of decision (Service 1988b). The Revised Plan covers all of Arctic Refuge, including the Refuge's coastal plain.

The question of oil and gas development on Arctic Refuge, particularly development of the Refuge's coastal plain (also known as the "1002 Area"), is of special interest to many groups. Neither the Service nor the Department of the Interior (DOI) has any legal authority under current law to allow oil and gas exploration, leasing, development, or production in Arctic Refuge. Section 1003 of ANILCA specifically prohibits oil and gas leasing, development, and production anywhere in the Refuge. Congressional authorization to conduct an exploration program in the 1002 Area expired when, on June 1, 1987, DOI provided Congress with a report and record of decision (ROD) on the future management of the 1002 Area of the Refuge in compliance with ANILCA 1002(h). The report and decision have remained with Congress ever since. Until Congress takes action to change the provision of ANILCA 1003 or to implement the 1987 report, the Service will not and cannot permit oil and gas leasing in the Refuge under any of the alternatives in the Plan. When Congress makes a management decision, that action will be incorporated into the Plan and implemented.

Chapter 1 provides background information on the framework used to develop this Plan, including the reason the Service revised the 1988 Plan; legal and policy guidance for Refuge management; an overview of the purposes for establishing the Refuge and the special values of Arctic Refuge; the Refuge's vision and goals; and an explanation of the planning process, including how the public is involved, what planning issues were identified by the public and Refuge staff, and how these issues are addressed in the Plan.

1.1 Purpose and Need for Action

Comprehensive conservation plans are dynamic documents requiring periodic review and updating, and much has changed since the initial Arctic Plan was completed in 1988. Revision of the Plan is also prescribed by Section 304(g) of the Alaska National Interest Lands Conservation Act of 1980 (ANILCA), as amended, which directs the Secretary of the Interior to prepare and, from time to time, revise a comprehensive conservation plan for each refuge in Alaska.

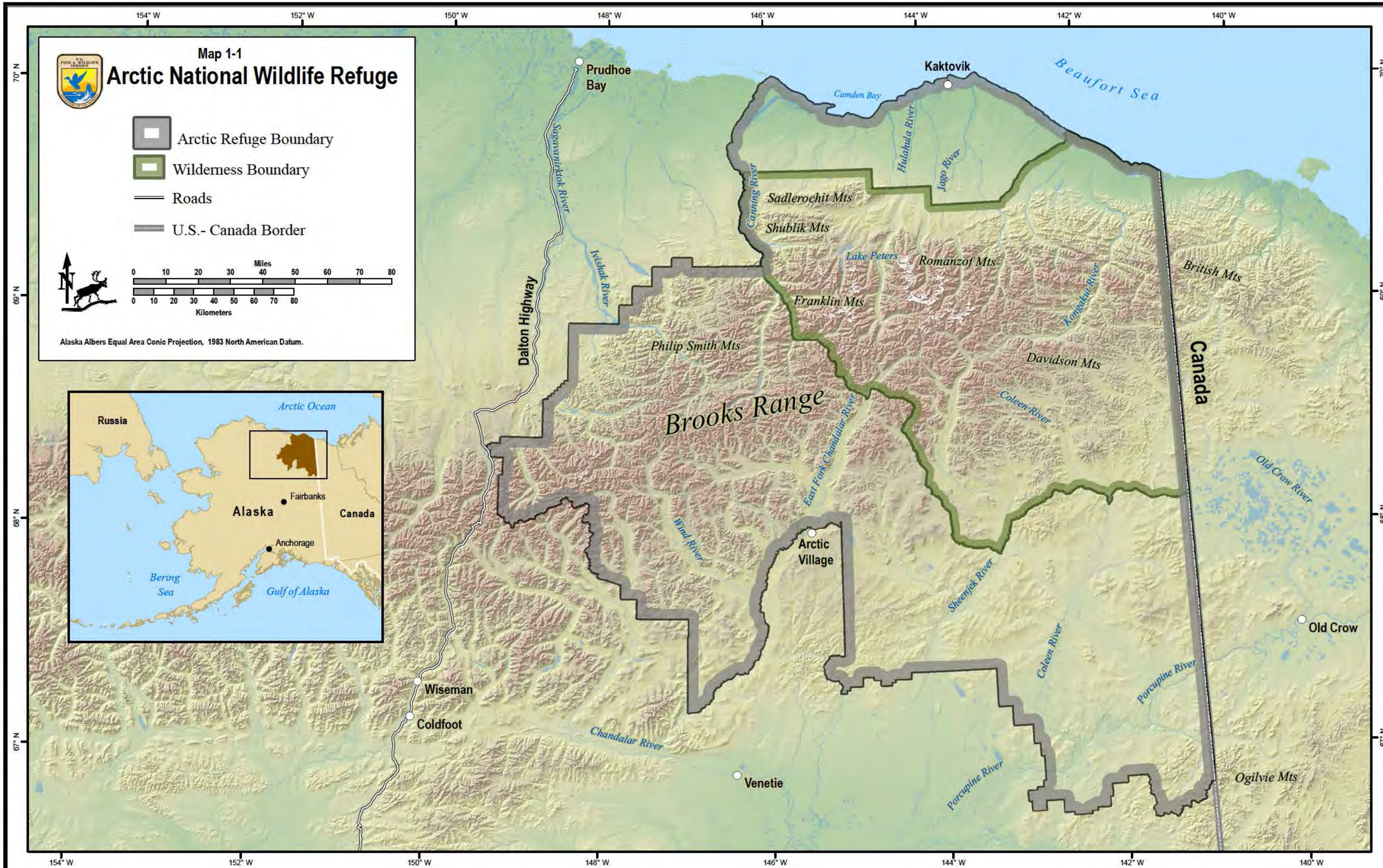
The purpose of this planning process is to develop a Revised Plan for Arctic Refuge to provide management direction for the next 15 years. The revision follows guidance found in

[1] Acreages in this Plan are derived from many sources and may not agree with previously published values, including the draft Revised Plan. For more information, please refer to "A Note about Acreages" in the front pages of this volume.

ANILCA and other Federal laws, primarily the National Wildlife Refuge System Administration Act of 1966 (Refuge Administration Act), as amended by the National Wildlife Refuge System Improvement Act of 1997, and the National Environmental Policy Act of 1969 (NEPA), as amended.

Revising the Comprehensive Conservation Plan allows the Service to do the following:

- Update management direction related to national and regional policies and guidelines used to implement Federal laws governing Refuge management
  - The National Wildlife Refuge System Improvement Act became law in 1997 and includes new requirements for Refuge management.
  - National policies put in place since 1988 provide direction for Wilderness stewardship, public use, wildlife conservation, and ecosystem management.
- Describe and maintain the resources and special values of Arctic Refuge
- Incorporate new scientific information on resources of the Refuge and surrounding areas
  - New information about fish, wildlife, and habitats is available as more has been learned about the status of wildlife populations and how these populations use the Refuge.
  - Climate change has emerged as a factor potentially affecting all aspects of the Refuge environment; while future effects are uncertain, climate change scenarios must be considered in management decisions.
  - Cumulative effects of industrial development and other uses of lands outside of Refuge boundaries could potentially affect the fish, wildlife, and habitats of the Refuge. Uses of adjacent lands and human demographics have changed since the last Plan was completed, and they must be considered when developing the new Plan.
- Evaluate current Refuge management direction based on changing public use of the Refuge and its resources
  - Public use of the Refuge has changed, contributing to cumulative impacts, potential conflicts, and concerns about the quality of people's experiences.
  - A Federal Subsistence Management Program was initiated in 1990 in cooperation with the State of Alaska (State) to ensure federally qualified subsistence users have a priority opportunity for consumptive use of fish and wildlife resources on Federal public lands.
  - The Dalton Highway was opened to the public in 1994, providing new ways to access the Refuge and changing patterns of use.
- Ensure the purposes of the Refuge and the mission of the Refuge System are being fulfilled
- Ensure opportunities are available for interested parties to participate in the development of management direction


Map 1-1
Arctic National Wildlife Refuge
Arctic Refuge Boundary
Wilderness Boundary
Roads
U.S.- Canada Border
Miles
0 10 20 30 40 50 60 70 80
0 10 20 30 40 50 60 70 80
Kilometers
Alaska Albers Equal Area Conic Projection, 1983 North American Datum.
Russia
Arctic Ocean
Fairbanks
Alaska
Canada
Anchorage
Bering Sea
Gulf of Alaska
154° W
152° W
150° W
148° W
146° W
144° W
142° W
140° W
70° N
69° N
68° N
67° N
Prudhoe Bay
Kaktovik
Beaufort Sea
Camden Bay
Hulahula River
Jago River
Canning River
Sagavanirktok River
Sadlerochit Mts
Shublik Mts
Lake Peters
Romanzof Mts
British Mts
Ivishak River
Franklin Mts
Kongakut River
Dalton Highway
Philip Smith Mts
Davidson Mts
Canada
Brooks Range
East Fork Chandalar River
Coleen River
Old Crow River
Wind River
Arctic Village
Sheenjek River
Old Crow
Coleen River
Porcupine River
Wiseman
Coldfoot
Chandalar River
Venetie
Porcupine River
Ogilvie Mts

- Provide a systematic process for making and documenting resource management decisions
- Establish broad management direction for Refuge programs and activities
- Provide continuity in Refuge management
- Establish a long-term vision for the Refuge
- Establish management goals and objectives
- Define compatible uses
- Provide additional guidance for budget requests
- Provide additional guidance for planning work and evaluating accomplishments

1.2 Planning Context

Arctic Refuge is part of a diverse system of 556 wildlife refuges stretching across the nation. The Refuge is administered to meet its purposes and to serve the broad mission of the National Wildlife Refuge System.

Vast, natural, and wild, Arctic Refuge serves a distinctive function in the Refuge System. The Refuge offers the opportunity to protect a range of tangible and intangible values in addition to the traditional fish, wildlife, and habitat values and focal species conservation found on most refuges. In making decisions affecting the future of Arctic Refuge, we remain mindful not only of the Refuge's purposes and the System's mission, but also of the need to sustain the special values that inspired the Refuge's establishment. We honor our vision that this is a place deserving respect, and we will manage it with humility and restraint.

1.2.1 The U.S. Fish and Wildlife Service

Part of the DOI, the Service is the principal Federal agency responsible for conserving, protecting, and enhancing the nation's fish, wildlife, plants, and their habitats. In addition to the Refuge System, the Service operates national fish hatcheries, fishery resource offices, and ecological services field stations. The Service enforces Federal wildlife laws, administers the Endangered Species Act, manages migratory bird populations, restores nationally important fisheries, conserves and restores wildlife habitats such as wetlands, and helps foreign governments with their conservation efforts. It oversees the Federal Aid in Wildlife Restoration Program, which distributes to State fish and wildlife agencies hundreds of millions of dollars derived from excise taxes on fishing and hunting equipment.

The mission of the U.S. Fish and Wildlife Service is:

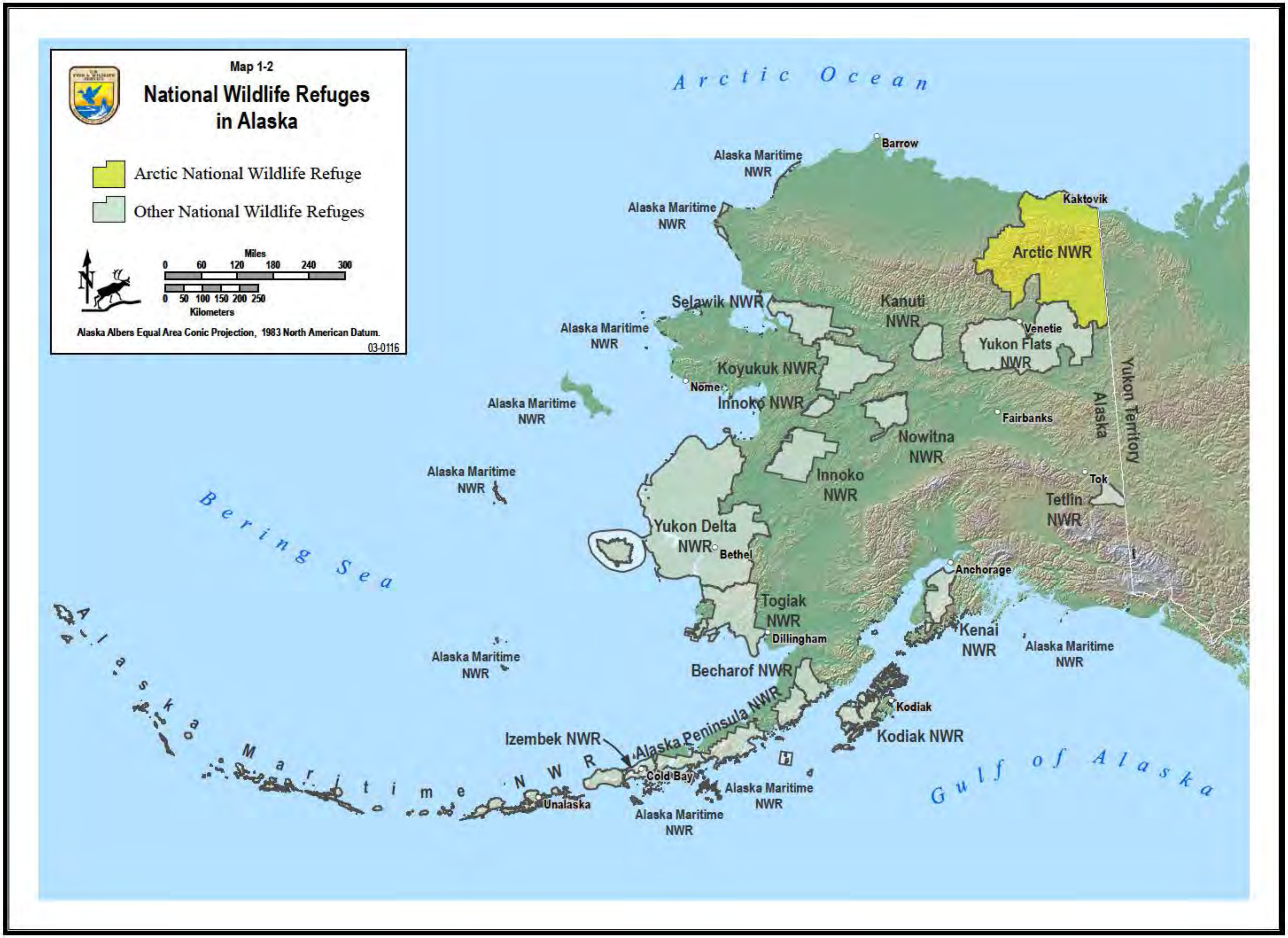
> *"Working with others to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people."*

1.2.2 The National Wildlife Refuge System

The National Wildlife Refuge System comprises approximately 150 million acres of Federal lands, encompassing 556 national wildlife refuges, six national monuments, thousands of small wetlands, and other special management areas. Refuge System lands are located in all 50 states and the territories of the United States.

The Refuge System was created to conserve fish, wildlife, plants, and their habitats. This conservation mission provides Americans with opportunities to participate in compatible wildlife-dependent recreation, including fishing and hunting, on Refuge System lands and to better appreciate the value of and need for fish and wildlife conservation.

There are 16 national wildlife refuges in Alaska (Map 1-2). These refuge lands contain a wide range of habitats with varied terrain, including mountains, glaciers, tundra, grasslands, wetlands, lakes, woodlands, rivers, and coastlines. Together, the 16 refuges comprise 83.35 million acres of land and water, and constitute approximately 56 percent of the Refuge System.


Map 1-2
National Wildlife Refuges in Alaska
Arctic National Wildlife Refuge
Other National Wildlife Refuges
Miles
0 60 120 180 240 300
0 50 100 150 200 250
Kilometers
Alaska Albers Equal Area Conic Projection, 1983 North American Datum.
03-0116
Arctic Ocean
Barrow
Alaska Maritime NWR
Kaktovik
Arctic NWR
Selawik NWR
Kanuti NWR
Venetie
Yukon Flats NWR
Koyukuk NWR
Nome
Innoko NWR
Fairbanks
Nowitna NWR
Alaska
Yukon Territory
Innoko NWR
Tok
Tetlin NWR
Bering Sea
Yukon Delta NWR
Bethel
Anchorage
Togiak NWR
Dillingham
Kenai NWR
Becharof NWR
Alaska Peninsula NWR
Kodiak
Kodiak NWR
Izembek NWR
Cold Bay
Unalaska
Alaska Maritime NWR
Gulf of Alaska

The mission of the National Wildlife Refuge System is:

> *"To administer a national network of lands and waters for the conservation, management, and, where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans."* (National Wildlife Refuge System Administration Act of 1966, as amended)

1.2.3 Principles for Managing the National Wildlife Refuge System

The Refuge Administration Act, as amended, states that each refuge shall be managed to fulfill both the purposes for which the individual refuge was established and the mission of the Refuge System. When there is a conflict between refuge purposes and the mission, the purposes of the refuge shall take priority. The act requires that any refuge use support the purposes of the refuge and not materially interfere with or detract from the purposes of the refuge or fulfillment of the mission of the System. The 1997 amendments to the Refuge Administration Act identified a number of principles to guide management of the Refuge System. They include the following:

- Conserve fish, wildlife, and plants, and their habitats within the Refuge System
- Maintain the biological integrity, diversity, and environmental health of the Refuge System
- Carry out the mission of the Refuge System and the purposes of each refuge (except that if a conflict exists, refuge purposes are protected first)
- Coordinate, interact, and cooperate with adjacent landowners and State fish and wildlife agencies
- Maintain adequate water quantity and water quality to meet refuge and Refuge System purposes and acquire necessary water rights under State law
- Maintain hunting, fishing, wildlife observation and photography, and environmental education and interpretation as the priority general public uses of the Refuge System
- Provide opportunities for compatible wildlife-dependent public uses within the Refuge System
- Provide enhanced consideration for wildlife-dependent uses over other public uses in planning and management within the Refuge System
- Provide increased opportunities for families to experience compatible wildlife-dependent recreation, particularly traditional outdoor activities such as fishing and hunting; and
- Monitor the status and trends of fish, wildlife, and plants within each refuge

To maintain the health of individual refuges and the Refuge System as a whole, managers must anticipate future conditions. Managers must endeavor to avoid adverse impacts and ensure that Refuge purposes, goals and objectives are met. Effective management also depends on acknowledging resource relationships and acknowledging that refuges are parts of larger ecosystems. Refuge managers work together with partners—including other refuges, Federal and State agencies, tribal and other governments, Native organizations, and non-governmental organizations and groups—to protect, conserve, enhance, or restore native fish, wildlife, plants, and their habitats.

1.3 Legal and Policy Context

Most refuges are created by legislation or executive action that defines the purpose for creating the unit and largely dictates how the refuge will be managed. However, management is also guided by other laws, regulations, and policies, and in the case of Alaska refuges, agreements with the State of Alaska. This section identifies the laws and the policy guidance that are integral in the development of this Plan.

1.3.1 Legal Guidance

Operation and management of refuges throughout the Refuge System are directed by a wide array of laws, treaties, and executive orders. Among the most important are the Refuge Administration Act, as amended by the National Wildlife Refuge System Improvement Act; the Refuge Recreation Act; and the Endangered Species Act. In Alaska, ANILCA provides specific direction to the management of refuges and, in some instances, supersedes provisions of the Refuge Administration Act and Refuge System Improvement Act. Brief descriptions of these and other pertinent legal documents that influence management of Arctic Refuge are included in Appendix A.

For national wildlife refuges in Alaska, the Alaska Native Claims Settlement Act of 1971 (ANCSA) and ANILCA, as amended, provide key management direction. ANILCA defined provisions for refuge planning and management, and authorized studies and programs related to wildlife and wildland resources, subsistence opportunities, and recreation and economic uses. ANILCA also provided specific direction for the management of designated Wilderness areas and wilderness study areas in the State of Alaska.

Arctic National Wildlife Range (Arctic Range, Range) was created in 1960 by Public Land Order (PLO) 2214. In 1980, ANILCA re-designated the Range as part of Arctic National Wildlife Refuge and provided four purposes that guide management of the entire Refuge (see Section 1.4 for more information on the history and purposes of the Range and the Refuge).

ANILCA also designated 7.16 million acres[2] of the Refuge as Wilderness. The Wilderness Act of 1964 established the National Wildlife Preservation System and prescribed policy for management of designated Wilderness areas. The purposes of the Wilderness Act are within and supplemental to the purposes of the Refuge, subject to the exceptions found in ANILCA.

The Wild and Scenic Rivers Act of 1968 established the National Wild and Scenic Rivers System and designated certain rivers as wild, scenic, or recreational. It authorized the Secretary of the Interior to study areas and submit proposals to the President and the Congress for additions to the system. This document includes a review of Refuge rivers and their potential for inclusion in the National Wild and Scenic Rivers System.

[2] Acreages in this Plan are derived from many sources and may not agree with previously published values, including the draft Revised Plan. For example, in 1980 ANILCA stated eight million acres of Wilderness were designated in the Refuge. However, newer technologies, such as Geographic Information Systems (GIS), estimate the size of the designated Wilderness area as 7.16 million acres. The boundaries did not change, just the estimated measurement of the area within the boundary. For more information, please refer to "A Note about Acreages" in the front pages of this volume.

1.3.2 Policy Guidance

Programmatic guidance and policy documents provide additional direction for management of national wildlife refuges. These documents include:

- U.S. Fish and Wildlife Service Manual
- Director's orders
- National policies
- Handbooks
- Director's memoranda
- Regional directives

Although it is not practical to provide information about all of these documents in this Plan, they are critical to management of the Refuge. Much of the management direction described in Chapter 2 and in other parts of this Plan is influenced by guidance from these programmatic and policy documents.

Several of these documents direct that an ecosystem approach be used in Refuge management. In other words, we must consider the health of the entire ecosystem when managing Arctic Refuge. This concept requires close coordination with other stakeholders. Appendix B describes the coordination and consultation conducted during the planning process, and Appendix C provides a brief description of the national and regional management plans and programs considered during development of this Plan.

By Refuge System policy, wilderness reviews are required elements of comprehensive conservation plans. The purpose of the wilderness review is to identify and recommend to Congress lands and waters that merit inclusion as part of the National Wilderness Preservation System. The Service is conducting a wilderness review as part of this Revised Plan (see Appendix H). Each alternative in this document includes a recommendation for new or no new Wilderness based on this evaluation and the management directions of the alternative.

1.3.3 Planning Requirements

Section 304(g) of ANILCA directs that comprehensive conservation plans be developed for each refuge. It also specifies procedures for developing these plans. The following must be identified and described prior to developing a plan for any refuge:

- The populations and habitats of the fish and wildlife resources of the refuge
- The special values of the refuge and any other archaeological, cultural, ecological, geological, historical, paleontological, scenic, or wilderness values of the refuge
- Areas in the refuge suitable for use as administrative sites or visitor facilities, or for visitor services, as provided for in ANILCA sections 1305 and 1306
- Present and potential future requirements for access with respect to the refuge, as provided for in ANILCA Title XI
- Significant problems that may adversely affect the populations and habitats of fish and wildlife

The Service uses refuge-specific comprehensive conservation plans to:

- Designate areas in the refuge according to their respective resources and values
- Specify the programs for conserving fish and wildlife and the programs related to maintaining the special values of the refuge that are proposed in each area

- Specify the uses in each area that may be compatible with the major purposes of the refuge
- Set forth those opportunities provided in the refuge for fish- and wildlife-oriented recreation, ecological research, environmental education, and interpretation of refuge resources and values, if such recreation, research, education, and interpretation is compatible with purposes of the refuge.

According to ANILCA, the National Wildlife Refuge System Improvement Act of 1997, Service planning policy (602 FW 3), and NEPA, the Service must ensure adequate and effective interagency coordination and public participation during the planning process. Interested and affected parties such as State agencies, tribal governments, Native organizations, non-governmental organizations, and local and national residents who may be affected by decisions in the Plan must be provided meaningful opportunities to present their views. Prior to adopting the Plan, the Service will publish a notice of its availability in the Federal Register, make copies available in regional offices of the Service throughout the United States, and provide opportunities for public review and comment.

1.3.4 Coordination with the State of Alaska

This Plan was developed in consultation with the Alaska Department of Fish and Game (ADFG) and the Alaska Department of Natural Resources (ADNR). The Service routinely consulted with ADFG and ADNR personnel during the planning process, and representatives from these agencies were on the planning team.

ADFG has primary responsibility for managing Alaska's resident fish and wildlife populations. On Refuge lands, the Service and ADFG share responsibility for managing fish and wildlife resources in their natural diversity and both are engaged in fish and wildlife conservation, management, and protection programs. In 1982, the Service and ADFG signed a Master Memorandum of Understanding that defines the cooperative management roles of each agency and sets the framework for cooperation between the two agencies (Appendix B). The Service and ADFG recommitted to this formal agreement in 2006.

The State of Alaska establishes fishing, hunting, and trapping regulations at the direction of the Alaska Boards of Fisheries and Game. These regulations apply to Federal public lands unless found to be inconsistent with Refuge purposes, goals, and objectives and they are superseded by Federal regulations. In consultation with the State, if the Service determines restrictions on hunting or fishing are needed, they are implemented through a rule making or through closures or restrictions under 50 CFR 36.42 or through Federal Subsistence Board regulations in 50 CFR 100.10(d)(4).

The State is divided into 26 game management units (GMUs), most of which are further divided into subunits. Management objectives are developed for game populations in each GMU. ADFG management objectives for the Refuge's big-game and fish populations are described in Chapter 4.

ADNR, a key management partner, manages all State-owned land, water, and surface and subsurface resources except fish and wildlife.[3] ADNR's Division of Mining, Land, and Water

[3] See Chapter 4, Section 4.1 (especially Sections 4.1.2.7 and 4.1.2.8), and Appendix E, for more information about State-owned land, water, and surface and subsurface resources within the boundaries of Arctic Refuge.

manages the State's water and land interests in the Refuge, including water rights, navigable waters, submerged lands under navigable waters, and rights-of-way over Refuge lands. The division is also responsible for developing management plans for State lands. Appendix B provides additional information about key State programs.

1.3.5 Coordination with Tribes

The United States has a unique legal and political relationship with Alaska Native tribal governments. The United States recognizes Alaska Native tribes as sovereign governments that are self-governing under Federal law. Under its "trust responsibility" to tribes, the Federal government has an obligation to protect tribal resources and uphold the rights of indigenous peoples to govern themselves on tribal lands. In recognition of this relationship, and pursuant to Executive Order 13175 (November 6, 2000), the DOI's Alaska Policy on Government-to-Government Relations (January 18, 2001), the President's Executive Memorandum on Tribal Consultation (November 5, 2009), and DOI Policy on Consultation with Indian Tribes published in 2011, the Refuge has sought to engage in regular and meaningful consultation and collaboration with tribal officials in the development of the Revised Plan. We have consulted with nine tribes having geographic or cultural ties to Arctic Refuge. For detailed information on tribal coordination conducted as part of this planning effort, see Appendix B.

1.3.6 Coordination with ANCSA Corporations

On August 10, 2012, the Secretary of the Interior supplemented the 2011 DOI Policy on Consultation with Indian Tribes with a requirement to consult with ANCSA corporations on actions or activities that may have a substantial direct effect on Alaska Native corporations, including corporation lands, waters, or resources. Please refer to Appendix B for more information on Native corporation coordination conducted as part of this planning effort.

1.3.7 Coordination with Cooperating Agencies

The Council on Environmental Quality (CEQ) regulations (40 CFR parts 1500–1508) and DOI NEPA implementing regulations (43 CFR Part 46) require lead agencies to request participation of cooperating agencies early in the NEPA process. Cooperating agencies are any Federal, State, tribal, or local government, including Native corporations, that have jurisdiction by law or special expertise, such as relevant capabilities or knowledge. Arctic Refuge is surrounded by lands and waters managed by other Federal agencies or non-Federal authorities, including State, tribal, and Canadian governments (Map 1-3). We contacted 11 of these agencies and governments to ask whether they would be interested in cooperating agency status. The National Aeronautics and Space Administration became a cooperating agency on the Revised Plan in January 2012. Appendix B provides details about cooperating agency coordination.

1.4 Arctic Refuge Establishment and Purposes

Refuge purposes provide the foundation for determining the future conditions of the Refuge, the opportunities it provides, and related administrative provisions. The Refuge's special values, vision statement, goals, and objectives are rooted in these purposes.

1.4.1 Initial Establishment of Arctic Range and the Purposes Set Forth

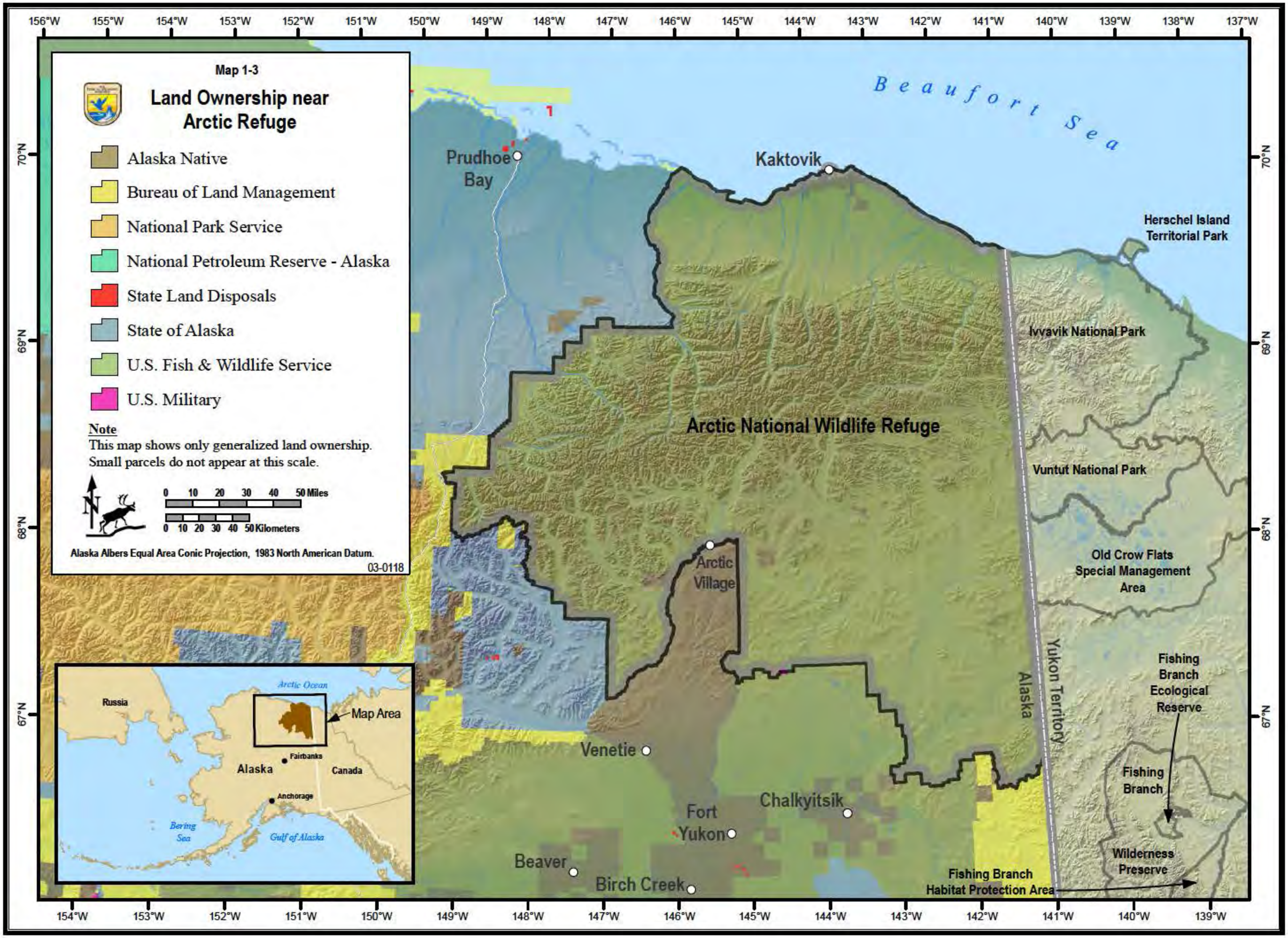
In the mid-1950s, national and Alaskan conservationists and sportsmen embarked on a long, hard-fought campaign to preserve the northeast corner of Alaska, initially referred to as "The Last Great Wilderness" (Collins and Sumner 1953). Concerned by the rapid loss of wildlands in the lower 48 states following World War II, proponents sought to establish a vast ecosystem-scale conservation unit, intended to be unprecedented not only in size, but also in the range of values and opportunities its preservation would perpetuate.

The area was initially examined by the National Park Service and proposed as an Arctic Wilderness International Park. However, Olaus and Margaret Murie of the Wilderness Society, and other leaders of the effort, decided that status as a national wildlife range, administered by the Service, would be most politically feasible and most likely to protect the area's special values and opportunities. In 1957, the Fairbanks-based Tanana Valley Sportsmen's Association petitioned DOI to establish Arctic Range. Their proposal requested perpetuation of the area's "primeval features," "maintenance of undisturbed ecological conditions," and "preservation of wilderness conditions" (Tanana Valley Sportsmen's Association 1959). Innumerable conservation, civic, scientific, and sportsmen's organizations joined in lobbying for the area's preservation.

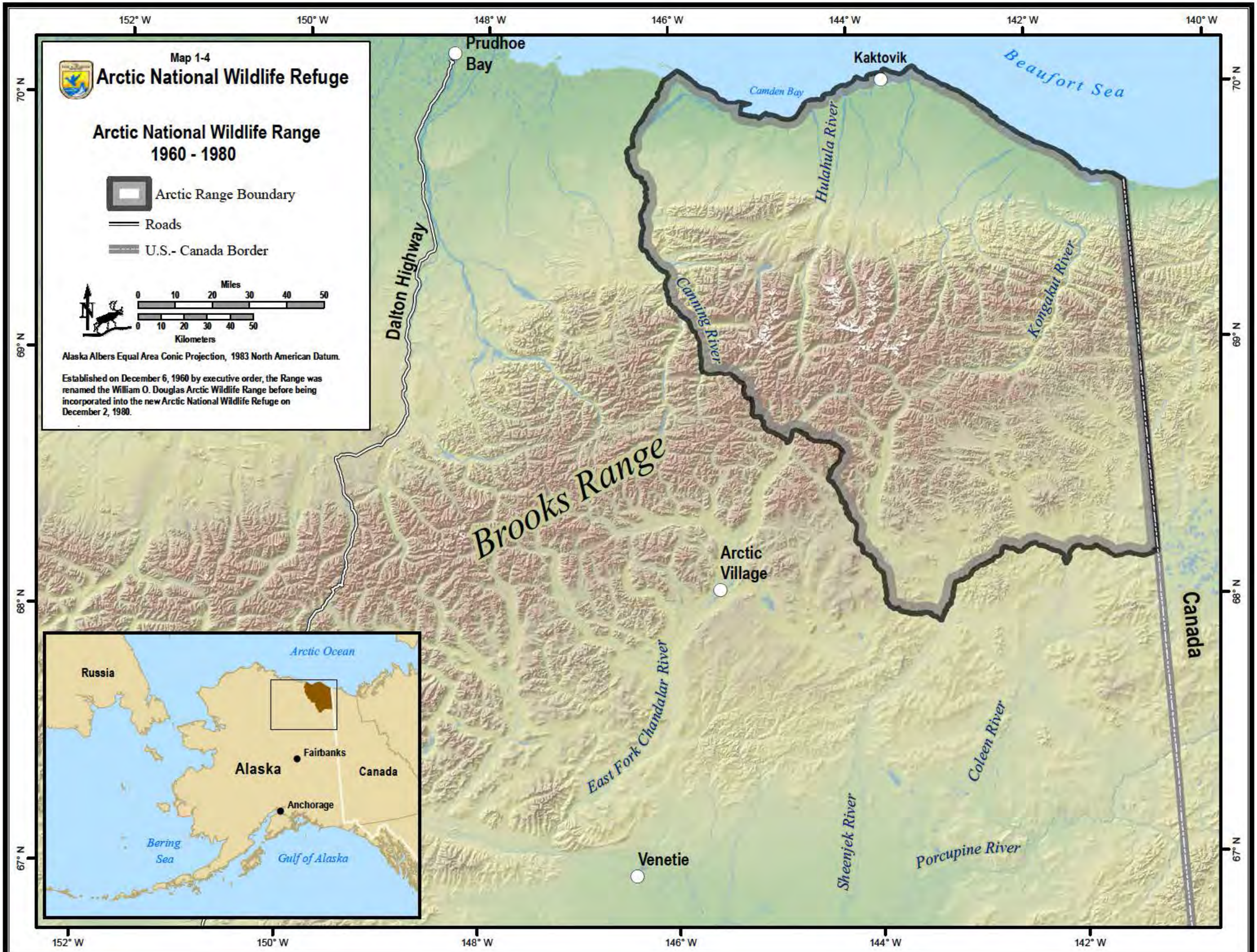
Although there was widespread support for the proposal, there were many opponents as well, and the issue was hotly debated in Alaska and elsewhere. The Alaska Department of Fish and Game and Mines, the Anchorage Chamber of Commerce, and both of Alaska's senators were among those that voiced their opposition. Critics argued the proposal would hinder development of the area and limit game management options, among other concerns.

On December 6, 1960, the Eisenhower administration established the 8.83-million-acre Arctic National Wildlife Range through Public Land Order (PLO) 2214 (Map 1-4). In its brief statement of purpose, PLO 2214 proclaimed the Range was established "to preserve unique wildlife, wilderness, and recreational values." The second clause of the PLO, while not a Range purpose, authorized the Secretary of the Interior to permit hunting and trapping in the Range.

Never before had a wildlife range or refuge been established to "preserve . . . values." An extensive body of congressional testimony, numerous historic reports and records, and secondary source materials provide understanding of Range establishment and the three founding values (Kaye 2006). These sources provide the context for preserving these values where they still apply—to the lands and waters of the old Range (see Section 1.4.2.2). Research in the fields of biology, ecology, and wilderness and recreation management guide our development of policies, practices, and specific provisions for meeting Range purposes.



Map 1-3
Land Ownership near Arctic Refuge
Alaska Native
Bureau of Land Management
National Park Service
National Petroleum Reserve - Alaska
State Land Disposals
State of Alaska
U.S. Fish & Wildlife Service
U.S. Military
Note
This map shows only generalized land ownership. Small parcels do not appear at this scale.
0 10 20 30 40 50 Miles
0 10 20 30 40 50 Kilometers
Alaska Albers Equal Area Conic Projection, 1983 North American Datum.
03-0118
Beaufort Sea
Prudhoe Bay
Kaktovik
Herschel Island Territorial Park
Ivvavik National Park
Arctic National Wildlife Refuge
Vuntut National Park
Old Crow Flats Special Management Area
Arctic Village
Yukon Territory
Alaska
Fishing Branch Ecological Reserve
Fishing Branch
Wilderness Preserve
Fishing Branch Habitat Protection Area
Venetie
Fort Yukon
Chalkyitsik
Beaver
Birch Creek
Arctic Ocean
Russia
Map Area
Fairbanks
Alaska
Canada
Anchorage
Bering Sea
Gulf of Alaska



Map 1-4
Arctic National Wildlife Refuge
Arctic National Wildlife Range
1960 - 1980
Arctic Range Boundary
Roads
U.S.- Canada Border
Miles
0 10 20 30 40 50
0 10 20 30 40 50
Kilometers
Alaska Albers Equal Area Conic Projection, 1983 North American Datum.
Established on December 6, 1960 by executive order, the Range was renamed the William O. Douglas Arctic Wildlife Range before being incorporated into the new Arctic National Wildlife Refuge on December 2, 1980.
152° W
150° W
148° W
146° W
144° W
142° W
140° W
70° N
69° N
68° N
67° N
Prudhoe Bay
Kaktovik
Beaufort Sea
Camden Bay
Hulahula River
Canning River
Kongakut River
Dalton Highway
Brooks Range
Arctic Village
Canada
East Fork Chandalar River
Coleen River
Sheenjek River
Porcupine River
Venetie
Russia
Arctic Ocean
Alaska
Fairbanks
Anchorage
Canada
Bering Sea
Gulf of Alaska

1.4.1.1 Wildlife Purpose

One purpose of the Arctic Range was to protect wildlife and its habitats. The leaders of the campaign to establish the Range intended the word "wildlife" to refer to all indigenous species and that natural behavior, interactions, and cycles would continue without human manipulation. In the words of campaign leader Olaus Murie, the intention was to maintain "the whole assemblage of living things which go to make up the rich life of that piece of country" (Murie 1958).

In the context of the emerging science of ecology, "wildlife value" emphasized the interrelatedness of all life forms and their environments, and the integrity of the underlying ecological and evolutionary processes. The area's "great scientific value," as characterized by plant ecologist Leslie Viereck (1959), was that it could serve "as a basis for understanding changes that take place in other areas disturbed by man." For many, caribou became the symbol of an untrammeled landscape—a wilderness free of the human intent to alter, control, and subjugate nature for utilitarian purposes.

1.4.1.2 Wilderness Purpose

The wilderness purpose of the Range encompassed tangible and intangible values, including but not limited to preservation of the area's natural and scenic condition and the wild character of its creatures and natural processes. The Range was to serve as a natural laboratory—a place to study how nature functions when left alone. Also inherent in the wilderness purpose was a cultural heritage value. This was to be a living legacy, a remnant of the American wilderness that helped shape our national character and identity and the sense of a "great beyond" that people feared was vanishing. The Range's wilderness qualities were to be timeless and its benefits enduring.

There were also symbolic, less tangible existence values associated with wilderness. The Range was perceived as having value in itself and value to those who would never visit but might find satisfaction and inspiration in just knowing it existed. The Range's wilderness purpose reflected the values and attitudes toward nature that its founders were concurrently working to place in what became the Wilderness Act of 1964. As Range proponent and Wilderness Act author Howard Zahniser (1956) wrote, "To know the wilderness is to know a profound humility, to recognize one's littleness, to sense dependence and interdependence, indebtedness, and responsibility." This was to be a place of humility and restraint for managers and visitors.

1.4.1.3 Recreation Purpose

The Range was intended to offer a special kind of recreation, an authentic wildlands experience of a type increasingly hard to find elsewhere. The recreation purpose provided for a range of activities, including backpacking, river floating, hunting, fishing, wildlife watching, photography, and base-camping. But it was the natural, undeveloped character of the setting that was seen to afford a unique experience. The Range's extreme remoteness, natural condition, and wild character, unsurpassed anywhere on American soil, were to provide a degree of physical and psychological separation from the reminders of modern civilization. As Range proponent Margaret Murie (1979) wrote, "It was a world that compelled all of our interest and put everything else out of mind."

The Range was also to be an adventuring ground, the antithesis of the commercial and convenience oriented tourism that national parks were promoting at the time. Many agreed with Olaus Murie that Americans needed areas where enjoyment was earned through effort. Here the sense of freedom, exploration, and discovery were to prevail; the opportunity to encounter challenge and experience true independence and self-reliance were to be perpetuated.

1.4.2 The Alaska National Interest Lands Conservation Act

On December 2, 1980, President Carter signed ANILCA into law, establishing new Federal conservation units across the State, enlarging several existing units, and designating Wilderness areas and wild and scenic rivers. ANILCA also provided provisions specifying how these areas were to be managed, protected, and made available for public use.

ANILCA established Arctic National Wildlife Refuge. The boundaries of the Refuge encompassed approximately 19.64 million acres and incorporated the Arctic Range[4] into Arctic Refuge. ANILCA designated 7.16 million acres of the Refuge as Wilderness, designated three wild rivers, and established four purposes for Refuge management (see Section 1.4.2.1).

ANILCA designation offered more protection to the area than was afforded by the original Arctic Range (PLO 2214). Under ANILCA, Arctic Refuge was closed to all forms of appropriation under the public land laws, including the mineral leasing and mining laws. In addition, congressional designation as a unit of the National Wildlife Refuge System meant that any proposed changes to the Refuge's boundaries or to Refuge uses would require congressional authorization.

Section 101(b) of ANILCA summarizes the general intent of all conservation system units in Alaska by stating:

> *"It is the intent of Congress in this Act to preserve unrivaled scenic and geological values associated with natural landscapes; to provide for the maintenance of sound populations of, and habitat for, wildlife species of inestimable value to the citizens of Alaska and the Nation, including those species dependent on vast relatively undeveloped areas; to preserve in their natural state extensive unaltered arctic tundra, boreal forest, and coastal rainforest ecosystems; to protect the resources related to subsistence needs; to protect and preserve historic and archeological sites, rivers, and lands, and to preserve wilderness resource values and related recreational opportunities, including but not limited to hiking, canoeing, fishing, and sport hunting, within large arctic and subarctic wild lands and on free-flowing rivers; and to maintain opportunities for scientific research and undisturbed ecosystems."*

[4] On February 29, 1980, about nine months before passage of ANILCA, the Arctic National Wildlife Range was renamed the William O. Douglas Arctic Wildlife Range by Presidential Proclamation 4729.

1.4.2.1 Arctic Refuge's Purposes

Section 303(2)(B) of ANILCA set forth the following purposes for Arctic Refuge. ANILCA purposes are shown in italics.

(i) *to conserve fish and wildlife populations and habitats in their natural diversity including, but not limited to, the Porcupine caribou herd (including participation in coordinating the Western Arctic caribou herd), polar bears, grizzly bears, muskox, Dall sheep, wolves, wolverines, snow geese, peregrine falcons and other migratory birds, and Arctic char and grayling*

Consistent with the Refuge's original intent to be inclusive of all species, ANILCA Section 102(17) clarifies, "The term 'fish and wildlife' means any member of the animal kingdom…"

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

This purpose recognizes the role the Refuge plays in meeting several treaty obligations related to conservation of the fish and polar bears that inhabit both Alaska and Canada, and the migratory birds shared by many nations (See Appendices A and F).

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

ANILCA Title VIII provides a number of provisions to ensure that, consistent with other Refuge purposes, rural residents have the continued opportunity to use Refuge lands and resources to meet their physical, economic, traditional, and other needs (see Chapter 4, Section 4.4.4).

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

This purpose recognizes the protection of water resources is central to conservation of fish and wildlife and their encompassing ecological systems and processes. This purpose establishes an explicit, but unquantified, Federal reserved water right for surface waters and groundwater in the Refuge.

1.4.2.2 Relationship of Range and Refuge Purposes

According to ANILCA Section 305, the 1960 establishing purposes of the Range continue to guide management of lands in the original Range "except to the extent that they are inconsistent with this Act [ANILCA] or the Alaska Native Claims Settlement Act and, in any such case, the provisions of such Acts shall prevail." In light of ANILCA Sections 101(b) and 305, we believe the Range purposes are consistent with the ANCSA, ANILCA, and the Refuge purposes set forth in ANILCA. Therefore, the Range purposes still apply to the lands and waters that were part of the original Range.

1.4.2.3 Designated Wilderness

ANILCA Section 702(3) designated 7.16 million acres, most of the original Range, as Wilderness. Section 102(13) of the act clarifies the term "wilderness" has "the same meaning as when used in the Wilderness Act." Although ANILCA recognized the unique conditions in Alaska and provided a number of exceptions to the Wilderness Act's provisions, the basic purposes of the Wilderness Act continue to apply. The Refuge's designated Wilderness is to remain "an area where the earth and its community of life are untrammeled by man." The area is to remain natural and undeveloped, "retaining its primeval character and influence," and to provide "opportunities for solitude or a primitive and unconfined type of recreation, and be devoted to the public purposes of recreational, scenic, scientific, educational, conservation and historical use" (The Wilderness Act of 1964).

The purposes of the Wilderness Act are additional purposes of the designated Wilderness portion of the Refuge. The purposes of the Wilderness Act are to:

> *"Secure an enduring resource of wilderness; protect and preserve the wilderness character of areas within the National Wilderness Preservation System (NWPS); administer the NWPS for the use and enjoyment of the American people in a way that will leave these areas unimpaired for future use and enjoyment as wilderness; and gather and disseminate information regarding the use and enjoyment of wilderness areas."*

1.4.2.4 Wild Rivers

ANILCA Sections 602(39)(42)(43) and 605(a) designated those portions of the Ivishak, Sheenjek, and Wind rivers within the boundaries of the Refuge as wild rivers pursuant to the Wild and Scenic Rivers Act, as amended by ANILCA Section 606. The purposes of the Wild and Scenic Rivers Act (1968) are to ensure:

> *"certain selected rivers of the Nation which, with their immediate environments, possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural or other similar values, shall be preserved in free-flowing condition, and that they and their immediate environments shall be protected for the benefit and enjoyment of present and future generations."*

1.5 Special Values of Arctic Refuge

Section 304(g)(2)(B) of ANILCA requires that prior to developing a comprehensive conservation plan, the Secretary of the Interior "shall identify and describe the special values of the refuge, as well as any other archeological, cultural, ecological, historical, paleontological, scenic, or wilderness value of the refuge." To meet this requirement, the Service drew upon a variety of sources that reflect the range of values the Refuge holds for the American public. These sources included: documents related to the original and ANILCA Refuge purposes; comments received from the public during previous planning processes; meetings with stakeholders; a review of media accounts of the Refuge; two studies of Refuge visitors; a study examining national interest in the Refuge; and scientific reports. The following special values summarize the most prominent Refuge values that emerged from examination of these sources.

1.5.1 Wilderness Characteristics

Arctic Refuge exemplifies the idea of wilderness—to leave some remnants of this nation's natural heritage intact, wild, and free of the human intent to control, alter, or manipulate the natural order. Embodying tangible and intangible values, the Refuge's wilderness characteristics include natural conditions, natural quiet, wild character, and exceptional opportunities for solitude, adventure, and emersion in the natural world.

1.5.2 Ecological Values

The distinguishing ecological aspect of the Refuge—and a major reason for its establishment—is that this single protected area encompasses a wide range of arctic and subarctic ecosystems, their unaltered landforms, and native flora and fauna. The Refuge is a place of free-functioning ecological and evolutionary processes, exhibiting a high degree of biological integrity, natural diversity, and environmental health. Bordered on the east by two Canadian national parks and on the south by the Yukon Flats National Wildlife Refuge, the Refuge preserves the core of what is one of the world's largest trans-boundary protected areas.

1.5.3 Wildlife Values

The Refuge's diverse fauna includes at least 47 species of terrestrial mammals, including several high-profile and special-status species: polar and grizzly bears, wolf, wolverine, Dall's sheep, moose, muskox, and two free-roaming caribou herds. Some species, like the Alaska marmot, occur in few other places. At least 42 species of fish inhabit waters in the Refuge. At least 201 species of birds depend upon the Refuge for at least some portion of their lifecycles, their migrations reaching remote corners of the earth. Of central importance is the ecological context in which these species occur, with their natural behavior, interactions, cycles, and ecological roles continuing.

1.5.4 Rivers

About 160 named rivers and streams, and several hundred unnamed waterways, flow through the Refuge. The large number of unmodified, free-flowing rivers is noteworthy. Three are designated as part of the National Wild and Scenic Rivers System—the Sheenjek, Wind, and Ivishak—but the Refuge ensures perpetuation of the remote, undeveloped, primeval nature of all rivers within its boundaries. Some tranquil, some tumultuous, their character is as varied as the spruce forests, ramparts, canyons, gorges, and open tundra through which they flow. They play an important role in shaping the landscape and delivering energy and elements to downstream ecosystems. Ancient travel corridors for wildlife and Native people, they also provide diverse opportunities for today's seekers of adventure, solitude, and escape.

1.5.5 Landscape Scale and Features

From its southern forests across the precipitous mountain divide to its coastal lagoons and islands along the Beaufort Sea, this unfragmented 19.64-million-acre Refuge—the size of South Carolina—spans six major physiographic zones. Its vastness encompasses wetlands and lakes, warm springs, aufeis fields, pingos, the highest peaks and largest glaciers in the Brooks Range, broad valleys, steep river canyons and ravines, waterfalls, fossil beds, caverns and sheer walls of folded and faulted rock, mesas, pinnacles, and spires. They represent the unending variety of this landscape's physical features—many dramatically scenic, others quietly sublime, many remaining nameless, and some perhaps undiscovered.

1.5.6 Scientific Values

As intended, the Refuge has become a natural laboratory of international importance. The ecological processes, natural diversity, and free function of natural communities in the Refuge provide unsurpassed opportunities for scientific understanding of wildlife, ecology, geophysics, and the changing climate. Numerous long-term investigations provide insights into the natural world, both as it functions naturally and as it responds to large-scale, human-caused influences, such as global climate change. These studies also provide a basis for evaluating and minimizing impacts in developed areas.

1.5.7 Native Culture and Subsistence

Arctic Refuge encompasses the traditional homeland of Iñupiat and Gwich'in peoples and perpetuates opportunities for their continuing traditional subsistence uses, skills, and relationships with the land. Their contemporary use sites are often shared with millennia-old archeological sites—part of the living link between the past and present. This land provides opportunities for us all to understand and respect the diversity of human history, culture, and lifeways.

1.5.8 Historic and Heritage Values

While the story of the Refuge's establishment chronicles the emergence of an ecology-based approach to landscape management and protection, it also reveals the nation's desire to perpetuate part of its cultural heritage. The Refuge represents deep-rooted American cultural values about frontiers, open spaces, and wilderness. It is one of the finest representations of the wilderness that helped shape our national character and identity and has always been part of the American psyche.

1.5.9 Recreational Values

The Refuge is renowned for the opportunities it provides for adventure, exploration, independence, and solitude. Whether visitors come to hunt, view, or photograph wildlife, for the challenge of an arduous backpacking trek or river float, or just to enjoy the area's stark beauty from the comfort of a base camp, they can find themselves immersed in a world apart, free from the distractions of modern civilization. The Refuge remains a place where a sense of adventure, mystery, and discovery still prevails.

1.5.10 Hunting Values

Hunters played a critical role in establishing the original Range, advocating a place for the adventurous pursuit of game "in the tradition of the highest form of the sport" (Murie 1956). This setting rewards those seeking to challenge themselves under primitive conditions. The Refuge's remote expanses can test a hunter's skill, fortitude, and self-reliance. It perpetuates opportunities for a kind of adventurous hunting experience that is becoming increasingly rare.

1.5.11 A Symbolic Value

Since the first efforts to establish a "Last Great Wilderness," most people who value this landscape have been less interested in how it can be used than in what its continued preservation represents. Millions who will never set foot in the Refuge find satisfaction, inspiration, and even hope in just knowing it exists. The Refuge represents the hope of a past generation that one of the finest remnants of our natural inheritance will be passed on, undiminished, to future generations. For many people, the question of the Refuge's future has now come to symbolize daunting questions the nation faces regarding energy policy, sustainability, and our effect upon the larger biosphere we jointly inhabit.

1.6 Arctic Refuge Vision and Goals

1.6.1 Refuge Vision Statement

Arctic Refuge staff developed the following statement about their vision for the Refuge's future, drawing upon its purposes, special values, and the unique role it serves in the Refuge System:

> *This untamed arctic landscape continues to sustain the ecological diversity and special values that inspired the Refuge's establishment. Natural processes continue and traditional cultures thrive with the seasons and changing times; physical and mental challenges test our bodies, minds, and spirit; and we honor the land, the wildlife and the native people with respect and restraint. Through responsible stewardship, this vast wilderness is passed on, undiminished, to future generations.*

1.6.2 Refuge Goals

Goals are descriptive, open-ended, and often broad statements of desire for a refuge's future. They convey a purpose but do not define measurable units. Goals for Arctic Refuge are directed towards carrying out the Refuge's mandates and achieving its purposes. Goals are derived from the Refuge's purposes, special values, vision statement, and various other laws, policies, and guidance. Refuge management must work toward meeting all these goals:

Goal 1: Ecological processes continue to shape the Refuge, and to the greatest degree possible, these processes remain free of the intent to alter the natural order, including the dynamics of fish and wildlife populations and their relationships with natural habitats.

Goal 2: The Refuge preserves its wilderness values and characteristics, maintains its natural state in unaltered condition, and designated Wilderness is managed consistent with the intent of the Wilderness Act and ANILCA.

Goal 3: The ecological functions and natural flow regimes of the Refuge's aquatic ecosystems, including headwater streams, rivers, springs, wetlands, lakes, and lagoons, are documented and protected, and designated Wild Rivers and the Marine Protected Area are managed in a manner consistent with their special designations.

Goal 4: The Refuge, in consultation with appropriate parties, addresses concerns about proposed actions that may substantially or directly affect subsistence or cultural resources, rural subsistence or cultural uses, or the rights of tribes.

Goal 5: The Refuge provides a range of opportunities for wildlife-dependent and wilderness-associated recreational activities that emphasize adventure, independence, self-reliance, exploration, and solitude or primitive and unconfined recreation while protecting the Refuge's natural conditions and special values.

Goal 6: The effects of climate change on Refuge resources are evaluated through research, monitoring, and local traditional knowledge, and these effects are considered in Refuge management decisions.

Goal 7: Refuge staff and partners conduct research and monitoring in support of the Refuge's role as an internationally recognized benchmark for naturally functioning arctic and subarctic ecosystems.

Goal 8: In consultation with appropriate parties, the Refuge documents, conserves, and protects cultural resources, both historic and prehistoric, to allow visitors and community members to appreciate the interconnectedness of the people of the region and their environment.

Goal 9: Refuge staff provides outreach information to distant audiences, individuals who enter the Refuge, and people in gateway communities, to enhance their understanding, appreciation, and stewardship of Refuge lands and resources.

1.7 The Planning Process

This section describes the process used to develop this Revised Plan and environmental impact statement (EIS). The process is consistent with the planning requirements specified in Section 304(g) of ANILCA; the Refuge System Administration Act, as amended by the National Wildlife Refuge System Improvement Act; the Service's planning policy (602 FW 1 and 3); the National Environmental Policy Act (42 U.S.C. 4321-4347); and the Council on Environmental Quality's Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act (40 CFR 1500–1508). The Service used an eight-step planning process to revise the Plan for Arctic Refuge (Figure 1-1):

1) Design the planning process (preplanning)
2) Initiate public involvement and scoping
3) Identify significant issues
4) Develop and analyze alternatives
5) Prepare draft Plan
6) Prepare a final EIS and adopt the Revised Plan
7) Implement, monitor, and evaluate the Plan
8) Review and revise the Plan as necessary

Figure 1-1. The Planning process

1.7.1 *Design the Process*

During the fall of 2009, the Service began reviewing the 1988 Arctic Refuge Plan to determine how it should be revised. The Service found that, in most cases, on-the-ground management actions were meeting Refuge purposes. However, some management direction needed to be updated. New laws, such as the Refuge System Improvement Act, new regulations and policies, and other changes, such as Federal management of subsistence harvests of fish and wildlife on Alaska refuges, needed to be included in the Plan.

The Service identified all relevant laws, regulations, policies, and other direction that would be considered during revision of the Plan. These are discussed in the legal and policy context sections earlier in this chapter (Section 1.3), and additional detail can be found in Appendix A. The Service formed a planning team to review the available data on Refuge resources and human uses; the team also identified areas that would require additional work.

1.7.2 *Initiate Public Involvement and Scoping*

This step informed people that the Plan revision process was beginning and that the Service was soliciting ideas on what issues should be addressed in the Revised Plan. Formal scoping began with publication of the Notice of Intent to revise the Arctic Refuge Comprehensive Conservation Plan and prepare an EIS, which was published in the Federal Register on April 7, 2010 (75 FR 17763).

In April 2010, a planning update announcing the Plan revision and seeking comments was mailed to more than 2,000 individuals; local businesses; local, State and Federal agencies; and organizations nationwide. The planning update contained information about the Refuge, the planning process, and some preliminary issues identified by Refuge staff. The mailing included a comment form so the public could make suggestions or identify other issues or concerns that should be addressed during the revision of the Plan.

An Arctic Refuge planning website was developed during fall 2009 to keep the public informed about planning efforts, involvement opportunities, and decisions. The website was periodically updated with key documents and information about the Plan, including a link to the Notice of Intent, press releases, the April 2010 planning update, and all posters and materials developed for public meetings. The intent was to provide the same information to internet users as to those people attending meetings or receiving mailings. Through the website, the public could request inclusion on the Plan mailing list or submit an electronic version of the April comment form.

Eight public open house meetings were held—five in communities adjacent to or within the boundaries of Arctic Refuge; one in Washington, DC; one in Anchorage; and one in Fairbanks (Table 1-1).

Table 1-1. Location, dates, and attendance of scoping meetings

Community	Meeting Date	Attendance
Fort Yukon	April 20, 2010	59
Arctic Village	April 26, 2010	32
Venetie	April 29, 2010	56
Washington, DC	May 4, 2010	44
Anchorage	May 11, 2010	149
Fairbanks	May 13, 2010	168
Kaktovik	May 20, 2010	26
Barrow	June 4, 2010	12

Attendance at these meetings ranged from 12 to 168 individuals. A total of 94,061 individuals and organizations provided written and oral comments during the scoping process. An independent contractor reviewed, coded, and analyzed the responses over a three-month period during the summer of 2010. Appendix J summarizes the scoping comments.

1.7.3 Identify Significant Issues

The planning team reviewed the issues raised by the public, Refuge staff, other Service divisions and Federal agencies, tribal governments, and the State to identify the significant planning issues to be addressed in the Revised Plan. Significant issues are those the Refuge can control and may be handled differently in each of the alternatives. Sections 1.8 and 1.9 further describe planning issues. Chapter 3 describes the identified significant planning issues in detail.

1.7.4 Develop and Analyze Alternatives

After the significant planning issues were identified in August 2010, the planning team met and developed a set of six draft alternatives that would meet the Refuge's purposes and goals and comply with the Service and Refuge System missions. In April 2011, a planning update was sent to interested individuals and to State, Federal, and local government agencies in the affected area summarizing the draft alternatives and announcing the Plan's availability for public review and comment. Chapter 3 describes the six alternatives, and Chapter 5 provides an analysis of the potential environmental, social, and economic impacts of each alternative.

1.7.5 Prepare Draft Plan and Environmental Impact Statement

The draft EIS described six alternatives (including a "No Action" alternative) for managing Arctic Refuge during the next 15 years or until the next Plan revision. It included an analysis of the potential impacts of implementing each alternative and a description of management actions common to all alternatives. The Service provided a 90-day public review and comment period on the draft Plan and EIS. During the public review period, the Service hosted public meetings and formal public hearings, as outlined in Table 1-2.

Three types of public meetings were held, and the type held in a given community is identified in Table 1-2. The definitions for each meeting type are:

- Open House = posters on display, PowerPoint presentation played on loop, and Service staff available to answer questions.
- Community Meeting = posters on display, PowerPoint presentation given at meeting, and public question and answer session between Service staff and attendees, during which comments were captured on flip chart paper.
- Public Hearing = formal testimony recorded and transcribed.

In Arctic Village, Fort Yukon, Kaktovik, and Venetie, posters were set up, and Service staff was available to answer questions informally before the public was given the opportunity to provide recorded testimony. A translator was available in Arctic Village, Fort Yukon, Kaktovik, and Venetie.

At each meeting, copies of the draft EIS and the separately bound "Planning Update Number 3: Summary of Draft CCP, June 2011," were made available for the public to review and take home. At all meetings, written communications were accepted. Additionally, writing materials were provided at each meeting for attendees to use to submit communications on site.

1.7.6 Prepare and Adopt a Revised Plan

The planning team reviewed and analyzed all public comments received on the draft Revised Plan and EIS. The draft was modified as needed to develop the Revised Plan and final EIS. Following a 30-day public review of the Revised Plan, the regional director will issue a record of decision (ROD) that describes the alternative that will be implemented and the rationale the regional director used to make the decision. The Service will publish a Notice of Availability in the Federal Register and distribute the Revised Plan and ROD to interested parties.

Table 1-2. Meeting locations, date, types, and attendance for the draft Plan and EIS

Location	Type/Date/Time	Number of Non-Speakers[1]	Number of Speakers[2]	Total Attendees
		Anchorage		
US Fish and Wildlife Service Regional Office	Open House: 9/20/2011	39	n/a	39
Wilda Marston Theatre	Public Hearing: 9/21/2011	75	71	146
		Fairbanks		
Pioneer Park Civic Center	Open House: 8/24/2011	51	n/a	51
Carlson Center	Public Hearing: 10/19/2011	59	102	161
		Arctic Village		
Community Hall	Community Meeting[3]: 10/4/2011	67	n/a	67
Community Hall	Public Hearing: 11/14/2011	6	4	10
		Fort Yukon		
Tribal Hall	Community Meeting & Public Hearing[3]: 10/28/2011	23	11	34
		Kaktovik		
City Hall	Community Meeting[3]: 10/25/2011	22	n/a	22
City Hall	Public Hearing: 11/3/2011	24	6	30
		Venetie		
Community Hall	Community Meeting: 9/1/2011	20	n/a	20
Community Hall	Public Hearing: 11/15/2011	1	3	4
Totals		**387**	**197**	**584**

[1] This represents the number of people who signed in at the welcome table but did not speak. This number may be underestimated because not everybody signed in.

[2] The number of speakers was collected only for meetings where a court reporter transcribed proceedings (Public Hearings).

[3] These dates represent rescheduled dates.

1.7.7 Implement, Monitor, and Evaluate Plan

After distributing the ROD and Revised Plan, Refuge staff will begin implementing any management changes called for in the Plan (Chapter 6). Monitoring—measuring resource and social conditions to ensure progress is being made toward meeting Refuge purposes, goals, and objectives—is a critical component of management. Monitoring helps determine if management actions are effectively meeting the objectives. The Refuge will use an adaptive management approach in which information gained from monitoring will be used to evaluate and, as needed, modify Refuge management actions.

1.7.8 Review and Revise Plan

Service policy directs Arctic Refuge staff to review the Revised Plan yearly to assess any need for change in management direction. The Refuge will revise the Plan when important new information becomes available, when ecological conditions change, or when the need for revision is identified during a review. If major changes are proposed, public meetings may be held, and a new environmental analysis may be needed. The Service will consult with appropriate State agencies, Native governments, and others during future revisions. Full review and revision of the Plan is scheduled to occur every 15 years, or more often, if deemed necessary. Arctic Refuge staff will continue to inform and involve the public through the appropriate means, mainly on the Refuge website and through community meetings, mailings, and email alerts.

1.8 Planning Issues

The Service defines an "issue" as any unsettled matter that requires a management decision, such as an initiative, opportunity, resource management problem, threat to a Refuge resource, conflict in use, public concern, or presence of an undesirable resource condition. In December 2009, Refuge staff began identifying issues. The public identified additional issues at open houses and hearings; through comment forms distributed with the first planning update and available on the Refuge's website; and through visits with local residents and community leaders. By August 2010, 37 issues had been identified for consideration during revision of the Plan. These are identified in Appendix D, Table D-1.

Some of the 37 identified issues have been, or could be, addressed through existing laws, regulations, or policies. Others were best addressed in the Refuge's goals and objectives (see Chapter 2) and/or through step-down planning (see Chapter 6). Other issues were determined to be outside the scope of the Plan (see Chapter 3, Section 3.1.2). Those issues that remained were considered significant. Significant issues are: (1) issues in our jurisdiction to address, (2) issues for which we can suggest different actions or alternatives, and/or (3) issues that will influence the ROD. These issues were addressed through the development of the alternatives, presented in Chapter 3. The Refuge's role in identifying and analyzing significant issues was to consider objectively a wide range of approaches that could be taken to address each issue.

1.9 Significant Planning Issues

Three planning issues were identified for consideration during revision of the Arctic Plan. The Revised Plan provides Arctic Refuge the opportunity to address the planning issues in a variety of ways (alternatives). They are:

1. Should one or more areas of the Refuge be recommended for Wilderness designation?
2. Should additional wild and scenic rivers be recommended for inclusion in the National Wild and Scenic Rivers System?
3. How will the Refuge manage Kongakut River visitor use to protect resources and visitor experience?

These issues are discussed in detail in Chapter 3. The environmental analysis presented in Chapter 5 discusses the effects to the significant planning issues of implementing each alternative.

1.10 Concerns Affecting Fish, Wildlife and Habitats

Section 304(g)(2)(E) of ANILCA directs the Service to identify and describe in comprehensive conservation plans the significant problems that may adversely affect fish and wildlife populations and habitats. This section highlights concerns identified by the public and by Refuge staff regarding fish, wildlife, and habitats on Arctic Refuge. This write-up refers the reader to other sections of the Revised Plan where they can find more detailed descriptions of the concerns.

1.10.1 Climate Change

Scientific evidence confirms the earth is undergoing a change in climate. Climate analyses suggest that warming in the 20th century was greater than warming during any other century in the past 1,000 years, and the 1990s were likely the warmest decade in 1,000 years (Mann et al. 1999, Folland et al. 2001). The arctic climate has warmed rapidly during the past 50 years, with annual average temperatures increasing nearly twice as fast as the rest of the world (Arctic Climate Impact Assessment 2005). Warming in Alaska rose sharply beginning in 1977, concurrent with large scale arctic atmosphere and ocean regime shifts (Parson et al. 2000). The greatest warming has occurred during winter and spring.

The documented and projected changes in northern Alaska as a result of a warming climate affect nearly every aspect of the environment. Evidence to date suggests the Refuge will experience less predictable weather, thawing permafrost, increased thermokarst events, increased coastal erosion, more groundwater flow, earlier break-up and delayed freeze-up, increased water temperature and alkalinity of lakes, decline in soil moisture, earlier snowmelt, increased shrub cover, longer growing season, diminishing sea ice, and advancing tree line (Hinzman et al. 2005). Climate change research predicts Alaska's northern region will experience a decline in wetlands, increased fire frequency and intensity, shifts in the distribution and composition of plant communities, change in the ranges and breeding behavior of wildlife species, increased likelihood for the establishment of invasive species, and the increased possibility of wildlife disease and insect outbreaks (Karl et al. 2009). These changes may affect fish, wildlife, and habitats through increased mortality, increased sediment in rivers, changes in water chemistry and river flow, a longer open water season, changes in aquatic ecology, changes in vegetation, increased insect activity, and increased nesting periods and range extensions for birds. Changes in habitat and wildlife due to climate warming will, in turn, affect arctic and subarctic people who rely on natural resources for food, transportation, and cultural identity (Arctic Climate Impact Assessment 2005).

The arctic system, as we currently know it, could be very different in the future. Whether and how plants and animals might adapt to and survive these changes is difficult to predict for most species. According to the Refuge's management policies and guidelines, the Refuge will generally adopt a non-intervention approach to climate change (Chapter 2, Section 2.4.10.1). Refuge staff will allow natural systems to adapt and evolve, and we will accept that some species may be replaced by others more suited to the changing climate. Goal 6 and its associated objectives (see Chapter 2, Section 2.1.6) commit Refuge staff to monitor biological components vulnerable to climate change, evaluate the effects of climate change on resources in the Refuge, collaborate with others on studying climate change effects, consider climate change and non-climate stressors when making management decisions, and avoid actions that resist the effects of climate change.

For more on climate change, please refer to Chapter 4. Section 4.2.3.1 describes observed temperature and precipitation trends in Arctic Refuge, and Section 4.2.3.2 discusses current projections for future climate in the Refuge. Section 4.2.6.1 identifies observed and projected permafrost trends. A discussion of the impacts of climate change was added to each of the following topic areas: water resources (Section 4.2.9), vegetation (Sections 4.3.3 and 4.3.4), fish (Section 4.3.5.4), birds (Section 4.3.6.11), and mammals (scattered across the various species descriptions in Section 4.3.7).

1.10.2 Non-native, Invasive, and Pest Species

Invasive species are non-native species that, when introduced, have the potential to cause substantial amounts of harm to the environment, human health, or economic well-being. Pests are those organisms (vertebrates, invertebrates, plants, and microorganisms and their vectors) that are detrimental to fish, wildlife, human health, or fish and wildlife habitats. Pests also include noxious weeds and other organisms, which are classified as pests by law (Administrative Manual 30 AM 12).

Non-native and invasive plant and animal species have been reported and documented in Alaska (Hébert 2001, McClory and Gotthardt 2008). Most invasive plants occur in and adjacent to major population centers in the southeast, southcentral, and interior regions of the State or are distributed along the ferry, road, and railway systems (AKEPIC 2011). Non-native plants are currently uncommon on the North Slope (McKendrick 2000), and Arctic Refuge has few documented non-native plants (see Chapter 4, Section 4.3.3.5).

Invasive species and pests have the potential to adversely affect wildlife populations and habitats and cause harm to threatened or endangered species, natural diversity, or subsistence resources, and the Service is concerned that invasive species or pests could become established on the Refuge. The effects of accelerating climate change could result in pests or non-native mammal, birds, or insects expanding their ranges into the Refuge as vegetation, temperature, and precipitation change. Future development of natural resources or transportation and utility corridors in northern and northeastern Alaska could increase risk of invasion by non-native species because many invasive plants tend to colonize disturbed sites. Visitors to the Refuge might inadvertently introduce or spread pests or invasive plant species or animals to Refuge lands via their clothing, footwear, recreational gear, and other equipment or materials.

In Chapter 2, Section 2.4.12.8, the Plan explains how the Service would manage Arctic Refuge in the case of non-native, invasive, or pest species. To reduce the potential introduction or spread of invasive plants in Arctic Refuge, pelletized weed-free feed is the only allowable food for pack animals, and straw and hay is prohibited as bedding for dogs. The Refuge will include weed inventories as part of all habitat inventories, and if invasive plants are detected, control measures will be considered. Should a non-native species become established on the Refuge, or a species that occurs naturally in areas adjacent to the Refuge moves into the Refuge as a result of climate change, that species could be managed as part of the Refuge environment provided it does not materially interfere with nor detract from fulfilling the mission of the Refuge System or the purposes of Arctic Refuge. In general, however, the presence of non-native species on Arctic Refuge is not consistent with Refuge purposes or with Refuge System policies.

1.10.3 Diseases

Certain disease organisms, viruses, or vectors of disease (e.g., rabies or parasites) may threaten human health or the health and survival of native wildlife or plant species. Disease may already have played a role in the decline of some animal populations on Arctic Refuge. Disease or copper deficiency, exacerbated by long winters and short growing seasons, are factors that may have caused the decline of moose populations along the Canning River (Lenart 2008). Diseases and parasites may be affecting rates of successful production and adult survival in muskoxen (K. Beckmen, veterinarian, ADFG, pers. comm.)

Climate change could result in intensified disease effects. Stress caused by temperature-induced drought could make trees and shrubs more susceptible to disease and pathogens. Warming water temperatures could increase the incidence of disease and parasites in fish (Reist et al. 2006). Dall's sheep in Arctic Refuge could become vulnerable to an increased incidence of existing or novel diseases and parasites. Warmer and longer summers could increase the incidence of diseases such as lungworm, which would negatively affect muskox populations (Kutz et al. 2004).

In an effort to control disease in Arctic Refuge, the Service will implement domestic animal restrictions. Domestic sheep, goats, and camelids (e.g., llamas and alpacas) will be prohibited on the Refuge to prevent the transmission of disease, especially to Dall's sheep. Regulations will be promulgated by the Refuge for non-commercial uses of these domestic animals (see Chapter 2, Section 2.4.12.9).

1.10.4 Wildlife Harvest and Predator Control

The State of Alaska currently conducts predator control in some parts of Alaska to increase populations of certain species for human harvest (e.g., moose) or to achieve population management targets. Game Management Unit (GMU) 26B contains both State-owned land and a portion of Arctic Refuge. The Alaska Board of Game authorized intensive management of brown bear in GMU 26B, with the exception of Refuge lands, in an attempt to lessen predatory pressure on the GMU's muskox population. Because bears may wander widely, this action may impact wildlife populations on Arctic Refuge, and serves as an example of how intensive management could run contrary to the goals, objectives, management policies, and guidelines for Arctic Refuge.

On Arctic Refuge, all native species are considered integral and interdependent members of a natural community of life. According to the Refuge's management policies and guidelines (see Chapter 2, Section 2.4.12.7), Refuge management will strive to enable the natural behavior, interactions, and population dynamics of all species to continue. Except in emergencies, the Refuge will not employ or allow any management technique intended to interfere with natural wildlife dynamics by reducing the abundance of some species to increase the abundance of others. Separate refuge compatibility determinations addressing specific proposals will be required for State management activities that propose predator management, fish and wildlife control (with the exception of emergency removal of animals posing an immediate threat to human health and safety), or any other un-permitted activity that could alter ecosystems on the Refuge (Chapter 2, Section 2.4.9.1).

In the last two decades, caribou, sheep, muskoxen, and moose populations have fluctuated in Arctic Refuge, with some showing prolonged periods of decline (see Chapter 4, Section 4.3.7.4). Dall's sheep, which are valued for subsistence, general hunting and viewing on Arctic Refuge, is at the northern extent of its range and is vulnerable to overharvest. Similarly, moose is another species upon which local subsistence hunters are heavily reliant, and moose populations could be overharvested if there is insufficient data for managers to make well-informed decisions. Understanding the full range of factors that drive ungulate populations is essential for understanding and predicting population trends, and for managing subsistence and other harvests. It will also be necessary to develop an improved understanding of local predator-prey relationships that impact ungulate populations, and to this end, monitoring of grizzly bears and wolves will be necessary. Additionally, the assessment of the effects of hunting on the demographics and genetics of wildlife populations are inconsistent in the scientific literature, and Refuge staff believes additional and more definitive studies need to be done. Monitoring species status and trends is a priority for the Refuge, and specific work investigating potential causes of population declines and other population-level changes will be appropriately described through the Refuge's Inventory and Monitoring step-down plan, which will include a Research Plan (see Chapter 2, Section 2.1.1, and Chapter 6, Section 6.3.3).

The Refuge staff continues to participate in cooperative studies with ADFG, the Yukon Territory government, and others to ensure that species will be conserved now and into the future.

1.10.5 Land Development Adjacent to the Refuge

Private, State-owned, and federally-managed lands near and adjacent to Artic Refuge have the potential to be developed for minerals, energy, transportation, infrastructure, and recreational access. Interest in energy and resource development remains particularly high in northern and northeastern Alaska, including in the 1002 Area of the Refuge.

Potential concerns for fish, wildlife, and habitats from land and resource development projects include fuel spills, contaminants, noise, dust, and loss or fragmentation of habitat from road building and support facilities. Such developments could degrade water quality; reduce instream flows; alter water tables; increase pressure on fishery and wildlife resources; displace animals from nesting, birthing, and rearing sites; disrupt migration patterns; and/or increase conflicts between users and with local subsistence activities.

Information on projects and plans in the vicinity of the Refuge are included in Appendix C. Coordinated planning efforts among agencies, lease-holders, and private landowners is critically necessary to help address regional impacts and mitigate the potential effects to fish, wildlife, and habitats in Arctic Refuge.

1.10.6 Effects of Visitor Access and Activities

Arctic Refuge is renowned as a premiere wilderness that provides unsurpassed opportunities for adventure, exploration, independence, and solitude. The Refuge is also internationally recognized as a place for the study of naturally functioning arctic and subarctic ecosystems. The Refuge's reputation attracts people from around the world. While visitation is relatively low compared to some other refuges and federally-managed lands in Alaska (i.e., those with road access), habitats such as wetlands and tundra are particularly sensitive to disturbance given the Refuge's high-latitude location and corresponding short growing season. Additionally, wildlife species such as Dall's sheep that are at the northern extent of their range may be especially sensitive to disturbances and small changes to habitat conditions.

Refuge visitors have the potential to damage fish and wildlife habitats, particularly at campsites and access points such as landing areas (see Chapter 5). Damage can include destruction of soil structure, removal of the uppermost organic layers of soil, soil erosion, melting of permafrost, and ground subsidence due to melting of buried ice and permafrost. Water quality and aquatic habitats can be affected by increased runoff and sediment loading at heavily used sites. Visitors can trample vegetation, break trees and shrubs, and potentially introduce invasive plants. Most disturbances to vegetation and soils are site-specific and restricted to areas receiving repeated use, such as airplane landing areas, hunting camps near fixed-wing aircraft-accessible sites, and campsites used by floaters. Visitors may also displace and disturb wildlife, especially those with young, and exclude animals from travel corridors such as riparian areas and adjacent habitats. Hunting, trapping, and other consumptive uses could affect the demographics and genetics of wildlife populations, although more definitive studies need to be done.

The Refuge is committed to addressing impacts from visitors and other Refuge users, and the goals and objectives in the Revised Plan outline several programs (see Chapter 2, Section 2.1). Refuge management programs will protect and maintain the biological integrity, diversity, and environmental health of the Refuge. Data on abundance, distribution, and population trends for the fish, wildlife, and plants of the Refuge will provide baseline knowledge of Refuge resources and help guide adaptive management for the conservation of natural diversity. Sites that have been degraded or impaired will be restored, and a variety of monitoring programs, such as for water quality and quantity, will be implemented. In addition, the Refuge's visitor management and biological programs will coordinate on future step-down plans, including the Visitor Use Management Plan. The Refuge's management policies and guidelines provide direction for fish, wildlife, habitat, and ecosystem management as well as management of visitor use and access (Chapter 2, Section 2.4).

1.10.7 Coastal Resource Management

Coastal areas of Arctic Refuge provide key habitats to a range of fish and wildlife species. Many of these species are associated with cultural or subsistence values and are sensitive to environmental change. Chapter 4, Sections 4.2.1.7 and 4.2.9.3 provide detailed descriptions of the Refuge's coastal areas. The Refuge's coastal lagoons are generally shallow and are wholly or partially sheltered by barrier islands. However, substantial increases in air temperature and storm frequency, combined with decreases in summer sea ice in recent decades, have increased erosion along the southern Beaufort Sea coastline (Wendler et al. 2010).

In 2009, all marine waters located within the Refuge's boundaries were designated as part of the National Marine Protected Area System. There are no special conditions for managing the Refuge's Marine Protected Area (MPA), but designation provides the Service with an opportunity to study and better understand the ecological quality and function of the Refuge's coastal areas (see Chapter 2, Section 2.1.3). The MPA may be affected by loss of sea ice, changes in freshwater input, increased rates of coastal erosion or accretion, increased shipping activity, offshore development, oil spills, and introduction of invasive species associated with marine shipping. We know relatively little about near shore marine ecosystems of the Refuge and their relationships with terrestrial ecosystems.

It is important to the Service to sustain healthy coastal habitats, particularly given the potential influence of future off-Refuge development. Species that depend on healthy nearshore marine systems include shorebirds, waterfowl, marine and anadromous fishes, and polar bears. Lagoons and large river deltas are particularly biologically important. Refuge staff will conduct inventory and monitoring activities that support management of the MPA to protect and enhance its natural heritage. We will work with others to ensure adequate spill response capabilities; develop proactive measures for limiting introduction of invasive species; investigate relationships between terrestrial, coastal, and marine environments; and develop environmental education and outreach programs that focus on the Refuge's marine ecosystem.

1.10.8 Polar Bear Viewing

In the past eight years, polar bear viewing activity on Refuge lands and private lands within the boundaries of Arctic Refuge has been increasing. In the fall, polar bears are attracted to the remains of bowhead whales harvested by residents of Kaktovik, and this provides opportunities for visitors and residents to see these large carnivores. Commercial interests and enterprises have started catering to members of the public who want to see polar bears in the wild.

The Service's Marine Mammals Management division and Arctic Refuge staff cooperate to monitor the fall influx of bears near Kaktovik and assist the community in developing guidelines for polar bear viewing. To minimize potential disturbance to polar bears, the Service has intensified public education and outreach about polar bear safety. The cooperative management program is designed to achieve conservation goals for the species, reduce human-bear conflicts, and educate the community and visitors about human-bear safety. Managers at Arctic Refuge share concerns about potential future developments for polar bear viewing in the region that could include the use of tour ships, helicopters, and other methods used in other parts of the circumpolar north where polar bear viewing occurs. More information is included in Chapter 4, Section 4.3.7 (Polar bears) and Section 4.4.5.10.

1.10.9 International Treaty Obligations

ANILCA requires the Refuge to fulfill international treaty obligations of the United States with respect to fish, wildlife, and their habitats. As part of a larger network of conservation authorities in the U.S., Canada, and the circumpolar north, the Refuge plays an important role in meeting treaty and agreement obligations related to conservation of the fish, wildlife, marine mammals, and migratory birds shared by many nations. Among these are migratory bird treaties with Canada, Mexico, Japan, and Russia, and the Convention on Nature Protection and Wildlife Conservation in the Western Hempishere. The Agreement on the Conservation of Polar Bears is an agreement between the governments of Canada, Denmark, Norway, the former USSR, and the United States. In 1987, the U.S. and Canadian governments signed an agreement concerning the conservation of the Porcupine caribou herd, and in 2002, these nations signed the Yukon River Salmon Agreement. Please refer to Appendix A, Section A.1.1 for more information about these treaties and agreements.

The Service and Refuge staff work directly with groups such as the Porcupine Caribou Management Board, International Porcupine Caribou Board, Vuntut and Ivavik National Parks, Old Crow Management Area, Arctic Borderlands Ecological Knowledge Cooperative, Northwest Territories Department of Environment and Natural Resources, Environment Yukon, the Canadian Wildlife Service, and Conservation of Arctic Flora and Fauna to address international concerns regarding fish, wildlife, and habitats. The Refuge is committed to continuing this work and to collaborating with land management units, resource management agencies, and conservation organizations on mutual fish and wildlife resource issues, fish and wildlife resource inventory and monitoring efforts, and climate change documentation (see Chapter 2, Section 2.1.7).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2. Goals, Objectives, Management Policies, and Guidelines

This chapter includes sections addressing two major topics: Refuge goals and objectives, and Refuge management policies and guidelines. Refuge goals and objectives and Refuge management policies and guidelines are features of the alternatives (described in detail in Chapter 3). Chapters 2 and 3 must be read together for a full view of the alternatives.

This chapter includes the following sections:

- Section 2.1 identifies Refuge goals and objectives that would be implemented if any of the action alternatives (B-F) is selected.
- Section 2.2 provides an overview of Refuge policies and guidelines.
- Section 2.3 describes land management categories on Alaska's national wildlife refuges. Note that the Moderate Management and Intensive Management categories are not used nor proposed for use on Arctic National Wildlife Refuge (Arctic Refuge, Refuge).
- Section 2.4 describes Arctic Refuge management policies and guidelines in detail.
- Section 2.5 is a summary table comparing allowed activities, uses, and facilities by management category.

2.1 Refuge Goals and Objectives

Arctic Refuge purposes, vision statement, and special values (see Chapter 1) provide the framework for developing goals and objectives for managing the Refuge. Goals are broad statements of desired future conditions. Objectives are concise statements of what the Refuge wants to accomplish.

Objectives identified for one goal are often applicable to other goals. To avoid unnecessary duplication, each objective is listed only under the goal that represents the clearest connection.

The full range of objectives presented here provides an overview of the management priorities currently being addressed or that shall be addressed during the life of the Comprehensive Conservation Plan (Plan, Revised Plan). The objectives span three broad periods, relative to when the Revised Plan is approved: ongoing and immediate priorities (years 1-3), short-term priorities (years 4-8), and long-term priorities (9 or more years).

2.1.1 Goal 1: Ecological processes continue to shape the Refuge, and to the greatest degree possible, these processes remain free of the intent to alter the natural order, including the dynamics of fish and wildlife populations and their relationships with natural habitats.

Ongoing and Immediate Priorities (Years 1-3)

Objective 1.1: Refuge Management—Management programs will continue to support, protect, and maintain the Refuge's unique role as a benchmark for exceptional biological integrity, environmental health, and wildness in the National Wildlife Refuge System.

<u>*Rationale:*</u> Ecological processes shape the environment and influence biological structure and function at genetic, species, and community levels. In the National Wildlife Refuge System,

biological integrity, environmental health, and wildness vary—from degraded and/or extensively altered by human impacts, to natural and intact. No landscape retains absolute biological integrity, environmental health, and wildness. However, Arctic Refuge is widely recognized as anchoring the natural end of the spectrum of ecological and environmental conditions in the Refuge System.

Strategy: When considering whether proposed activities support or detract from the Refuge's biological integrity, environmental health, or wildness, Refuge managers must weigh all the factors identified by establishing purposes, laws, policy, and science. Wherever possible, we will avoid management actions that may diminish biological integrity, environmental health, or wildness, while focusing on preventing or minimizing human-caused impacts to resources and ecological processes that the Refuge can control or influence. We acknowledge that climate change and other external factors the Refuge cannot control may change resource conditions and the course of ecological and evolutionary processes. Thus, maintenance of some current conditions may be unattainable. In such cases, the Refuge will avoid interventions intended to maintain current conditions in favor of allowing species and communities to adapt and evolve.

Objective 1.2: Inventory and Monitoring of Wildlife and Habitats—Upon Plan adoption, Refuge biologists will begin revising the Ecological Inventory and Monitoring (I&M) Plan for Arctic Refuge. The I&M Plan will be consistent with regional U.S. Fish and Wildlife Service (Service) guidelines, and will be finalized following the Ecological Review (see Objective 1.4).

Rationale: Data on abundance, distribution, and population trends for the fish, wildlife, and plants of the Refuge provide baseline knowledge of Refuge resources and help guide adaptive management for conservation of natural diversity. An intensive program to inventory the biological resources of the Refuge and monitor their status and trends over time has been in place for many years. The Refuge is vast and biologically diverse, however, and gaps still exist in our knowledge of biological resources, water quality and quantity, air quality, and the ecological processes that affect them. Current efforts are guided in part by the Refuge's draft Ecological I&M Plan, which was completed in 2000. That plan needs updating to reflect recent priorities and information needs and to bring it into compliance with the Service's national and regional standards. The I&M Plan will also benefit from the Ecological Review, which is a peer review of the Refuge's biological programs.

Strategy: In the I&M Plan, Refuge biologists will summarize available ecological data (including geospatial databases) and information on physical processes such as hydrological regimes and climate. The I&M Plan will include an ecosystems model for the Refuge that illustrates ecological relationships among plants, fish, wildlife, and their habitats. It will also identify data gaps, including geospatial data needs for change detection and resource monitoring, and will assist in prioritization of future I&M needs. I&M sampling designs and field protocols will be peer reviewed, and data management procedures will be addressed. The I&M Plan will be consistent with guidance provided by the National Wildlife Refuges Inventory and Monitoring Program. The Refuge will solicit input from Service experts and partners during revision of the I&M Plan, including the Alaska Department of Fish and Game (ADFG), U.S. Geological Survey (USGS), academic institutions, and science-based non-governmental organizations. Much of this input will be provided by those invited to serve on the Refuge's Ecological Review panel (see Objective 1.4). The I&M Plan will be implemented immediately upon completion. We expect the I&M Plan will be completed within four years.

Objective 1.3: Applied Research—Coincident with revision of the I&M Plan, Refuge biologists will prepare a Research Plan that identifies and prioritizes needs for applied research, and identifies potential cooperators.

Rationale: Biological inventories will document the species and habitats present on the Refuge, and monitoring will allow us to track the status and trends of those species and habitats over time. To further develop effective conservation measures for the Refuge, research is needed to understand why species occur where they do and what factors affect population sizes and movements, as well as to evaluate potential threats to natural diversity on the Refuge. Much of the biological research that occurs on the Refuge relies on partnerships between the Service and ADFG, USGS, other U.S. Federal and Canadian agencies, academic institutions, and science-based non-governmental organizations. We will promote research that contributes to conservation of Refuge species and their habitats.

Strategy: The Research Plan will be prepared concurrently with the I&M Plan (Objective 1.2) and will be incorporated as an appendix to the I&M Plan. It will receive peer review by a multidisciplinary team during the Refuge's Ecological Review to ensure relevance and project prioritization. The Research Plan will be reviewed annually in conjunction with work planning and budgeting, and it will be revised as needed based on staff review of new information obtained through inventory, monitoring, and research, and on emerging management needs.

Objective 1.4: Ecological Review—Within three years of Plan approval, Refuge staff will conduct an Ecological Review of the Refuge's biological program and draft I&M and Research plans.

Rationale: The Ecological Review will be an evaluation of our biological program by a panel of ecologists, fish and wildlife biologists, physical scientists, and land managers. Members of the panel will represent State and Federal agencies, academia, non-governmental organizations, and independent scientists. The review will help ensure that our inventory, monitoring, and research efforts are appropriate, effective, and efficient. The review will serve as the basis for revision and refinement of the draft I&M and Research plans.

Strategy: We will convene a scientific review panel that includes Service and other specialists with expertise in arctic and subarctic ecosystems of North America. The panel's recommendations will be considered as we subsequently revise our draft I&M and Research plans, and will be implemented in future inventory, monitoring, and research efforts.

Objective 1.5: Fire Management—Managers will maintain a fire management program on Arctic Refuge that allows wildland fires to continue their ecological role and that protects human life and, where appropriate, property and cultural resources.

Rationale: The primary goal of the Refuge's fire management program is to maintain the natural wildland fire regime to the greatest degree possible. This goal recognizes the important and ongoing role of fire as a natural process in the creation and maintenance of the ecological diversity and natural dynamics central to the purposes of the Refuge. However, all fire management decisions must first consider the protection of human life and, where appropriate, the protection of property and cultural resources. Fire suppression and preventative fuels reduction may sometimes be necessary to achieve this balance.

Drier conditions and longer summers tied to global climate change are expected to result in increased wildland fire activity on the Refuge in coming years. Despite these potential changes to the fire regime, Refuge managers anticipate that it will continue to be important to allow naturally occurring fires to shape Refuge ecosystems.

Strategy: An approved Fire Management Plan (FMP) is a prerequisite to conducting wildland fire management activities. The Refuge FMP provides a framework for making fire management decisions, and outlines a unified strategy for managing wildland fire on all Refuge lands. The FMP is a dynamic document and will be reviewed each year using the Service's nationally established process (FWS Fire Management Handbook 2012). Refuge managers will conduct a full revision of the FMP whenever major changes in management are proposed or in concert with revisions to the Refuge Comprehensive Conservation Plan. This review and revision process ensures that the objectives and strategies for fire management in the FMP remain consistent with general management direction in the Revised Plan.

Objective 1.6: Fish and Wildlife Management Proposals—Refuge staff will participate in State of Alaska Boards of Fisheries and Game and Federal Subsistence Board processes to ensure the Refuge's purposes, goals, and objectives are considered in evaluation of proposals that could affect resources inside the boundaries of the Refuge.

Rationale: The Alaska Board of Fisheries and Game conserve and develop fish and wildlife resources on Federal public lands, unless State regulations are incompatible with the Refuge's purposes, goals, objectives, and management policies and guidelines or are preempted by Federal law. The State of Alaska's Board of Fisheries is responsible for conservation and development of the State's commercial, sport, subsistence, and personal-use fisheries. The Board of Game is responsible for conservation and development of the State's wildlife resources. The Federal Subsistence Board is the decision making body that oversees the Federal Subsistence Management Program, which is a multi-agency effort to provide the opportunity for a subsistence way of life by rural Alaskans on Federal public lands and waters while maintaining healthy populations of fish and wildlife. Various advisory committees or councils advise these boards, and they meet periodically to deliberate proposals that affect management of fish and wildlife. Regulations enacted by these boards may affect the taking of fish and wildlife on Arctic Refuge.

Strategy: Refuge staff will monitor proposals and evaluate potential effects on Refuge resources in relation to Refuge purposes, goals, and objectives and applicable policies and laws governing management of the Refuge. The Refuge will provide comments as appropriate to the decision making bodies on proposed actions.

Objective 1.7: Land Protection Plan—Within three years of Plan approval, complete an Arctic Refuge Land Protection Plan.

Rationale: Service policy requires the development of a Land Protection Plan (LPP) to identify and prioritize areas of high-quality habitat on private lands inside the boundaries of the Refuge for acquisition by the Service. The LPP will discuss a full range of alternative methods and means for land and resource conservation, including fee simple purchase, conservation easements, and cooperative management agreements to achieve Refuge purposes, goals, and objectives. The Service only acquires land from willing sellers and only when other methods and means are not appropriate, available or effective. Refuge managers must also consider management priorities and availability of funds when approached by private landowners with land conservation proposals.

Strategy: In evaluating the most appropriate method to achieve the conservation goals, Refuge managers will consider effects of proposed land acquisitions on local residents. The United States has a unique legal and political relationship with Alaska Native tribal governments and Native corporations to provide regular and meaningful involvement in the decision making process regarding issues effecting cultural and subsistence resources, subsistence and traditional uses, or other activities that may have tribal or Native corporation implications. In consideration of public comments and the sensitivities of land acquisitions and exchanges in the Refuge, the time frame for completing the LPP will be within 1-3 years. Until the Refuge starts the LPP, the Service will continue to offer to purchase inholdings from willing sellers when funding is available.

Short-term Priorities (Years 4-8)

Objective 1.8: Status of Rare Species—Within five years of Plan approval, efforts to identify and determine the status of rare species will be initiated, with special emphasis on those that are threatened, endangered, declining, or otherwise at risk.

Rationale: Detection of rare species is critical to characterizing natural diversity and levels of variation, but it is often difficult, expensive, and time consuming. Special emphasis is necessary to achieve adequate inventory and monitoring efforts for such species.

Strategy: We will consult with multiple sources to identify species for this objective, including federally designated threatened and endangered species lists, the State of Alaska Wildlife Action Plan, U.S. Fish and Wildlife Service Birds of Conservation Concern, Arctic and Northwestern Interior Forest Landscape Conservation Cooperatives (LCCs), and the National Wildlife Refuge System I&M Program.

Long-term Priorities (9+ years)

Objective 1.9: Long-term Ecological Monitoring—Within 10 years of Plan approval and following completion of the I&M Plan and acquisition of baseline inventories, Refuge biologists will implement necessary changes to the Refuge's Long-term Ecological Monitoring Program to ensure relevancy and sustainability of long-term monitoring efforts.

Rationale: Long-term ecological monitoring data is essential for detecting changes in Refuge resources and ecological systems over time, and will support development of conservation strategies. The Refuge implemented a Long-term Ecological Monitoring Program in the mid-1990s. Protocols and results from the first 20 years of that program will be evaluated as part of the Refuge's Ecological Review and I&M Plan revision.

Strategy: We will revise the Refuge's Long-term Ecological Monitoring Program based on recommendations from the Ecological Review; subsequent peer review of proposed projects; and results of ongoing inventory, monitoring, and research projects. We will also consider emerging issues, Refuge priorities, and budgetary constraints. Any changes in monitoring targets or protocols will be specified in the revised I&M Plan. Long-term ecological monitoring will be conducted in partnership with others, including the National Wildlife Refuge System I&M Program, LCCs, the Refuge System Branch of Air Quality, National Park Service (NPS) Vital Signs Monitoring Program, USGS Alaska Climate Science Center, and ADFG.

2.1.2 Goal 2: The Refuge preserves its wilderness values and characteristics, maintains its natural state in unaltered condition, and designated Wilderness is managed consistent with the intent of the Wilderness Act and ANILCA.

[NOTE: Objectives 2.1 through 2.5 apply only to areas of the Refuge in designated Wilderness. Objectives 2.6 and 2.7 apply to lands in designated Wilderness and those under Minimal Management.]

Immediate Priorities (Years 1-3 and Ongoing)

Objective 2.1: Integrated Wilderness Management—Designated Wilderness will be managed comprehensively as a component of all programs that affect the designated area's physical, biological, and experiential values.

Rationale: Wilderness, like the ecosystems it encompasses, is a composite resource with interrelated parts. Our mandate to protect Wilderness character is integrally dependent upon maintaining the designated area's biological and physical components in their natural and untrammeled condition, and in protecting experiential conditions that may depend upon wilderness characteristics. Thus, analysis of all programs and projects proposed for designated Wilderness (scientific, public use, law enforcement, information and outreach, aviation etc.) will include consideration of their potential to enhance or detract from the area's Wilderness character.

Strategy: Refuge managers will develop a process/checklist to ensure the staff adequately considers potential effects of all programs and projects on Wilderness character. This includes ensuring that required Minimum Requirement Analyses (MRAs) are completed by qualified staff members and that minimum impact practices, such as those promoted by the Leave No Trace Center for Outdoor Ethics, are incorporated into field operating procedures.

Objective 2.2: Minimum Requirement Analysis—A Minimum Requirement Analysis (MRA) will be completed for all Refuge management activities in designated Wilderness.

Rationale: MRAs help Arctic Refuge maintain the character and unique values of its designated Wilderness. Requests for administrative and resource management activities, including scientific research, are analyzed through a process called an MRA. Conducting an MRA is the best way to determine what the impacts of a proposed project might be on Wilderness character and helps managers decide and document both if and how they should conduct management actions in designated Wilderness (610 FW 1 and 2).

Strategy: Refuge managers will conduct MRAs for all proposed Refuge management activities (i.e., administrative) in designated Wilderness on Alaska Refuges. All MRAs will be reviewed once every five years or when major changes are proposed for activities.

Objective 2.3: Wilderness Training—All Refuge staff working in designated Wilderness will be required to complete Wilderness stewardship, MRA, and minimum impact methods training within two years of assuming their work duties in Wilderness.

Rationale: Designated Wilderness is a unique resource with numerous laws, regulations and policies, and minimum impact management techniques that protect the physical, biological, symbolic, and experiential components of Wilderness. Specialized knowledge is needed by Refuge staff working in Wilderness to understand these complex legal requirements, the philosophical underpinnings of designated Wilderness, and techniques for its management.

Strategy: All Refuge staff working in designated Wilderness will be required to complete Wilderness stewardship, MRA, and minimum impact methods training (such as Leave No Trace). At least one Refuge staff member will be trained in minimum impact techniques, methods, and/or guidelines (such as Leave No Trace principals) at the Master Educator Level. The Refuge will provide materials on minimum impact techniques to all permitted guides.

Objective 2.4: Wilderness Stewardship Plan—Immediately upon approval of the Revised Plan, Refuge managers will initiate a multi-year planning process to develop a Wilderness Stewardship Plan for the Refuge's designated Wilderness.

Rationale: Wilderness Stewardship planning helps ensure appropriate management of designated Wilderness, with its various qualities and opportunities, and is required by Service policy. Development of a Wilderness Stewardship Plan (WSP) will also provide the Service and the public the opportunity to consider and plan for a variety of designated Wilderness experiences.

Strategy: The WSP will contain indicators, standards, conditions, or thresholds that define adverse impacts on Wilderness character and values that will trigger management actions to reduce or prevent those impacts. It will describe ongoing and needed monitoring and research, appropriate and compatible uses and commercial services. It will also describe MRAs for Refuge management activities. The Refuge will coordinate the Wilderness Stewardship and Visitor Use Management planning processes (Objective 5.4) through concurrent scoping, preplanning, data collecting, public involvement, and planning decisions.

Objective 2.5: Administrative Facility at Lake Peters—Within two years of Plan approval, Refuge managers will complete required analyses to potentially remove one or more buildings at Lake Peters, and any identified building(s) will be removed within four years of Plan approval.

<u>*Rationale:*</u> The G. William Holmes Research Station, located on the east side of Lake Peters, was originally established in the late 1950s by the Department of the Navy as a substation of the Naval Arctic Research Laboratory in Barrow, Alaska. In 1999, the footprint from the original facility was altered and reduced. The facility now includes a bunkhouse (448 square feet), a cookhouse (360 square feet) with a full kitchen, a warehouse (320 square feet) to store tools and equipment, a 500-gallon fuel spill containment structure, and a newly renovated outhouse. The remote site is in both designated Wilderness and a Public Use Natural Area (PUNA). It is costly to access and maintain. The facility is too large for current and projected needs, and some of the public asked us to remove the facility during scoping for the Plan.

<u>*Strategy:*</u> The appropriate level of environmental analysis will be completed, including any required consultation, such as with the State Historic Preservation Office. The Refuge manager will develop a detailed project proposal that identifies the specific actions to be taken, and if any structures are identified for removal, how and when the work will be accomplished; an MRA would also be completed on the proposed work. If approved, the project will be implemented and all work completed within four years of Plan approval.

Objective 2.6: Monitoring Wilderness Characteristics— Refuge staff will monitor, through protocols developed in step-down plans, the characteristics commonly associated with designated Wilderness and other wildlands. These include Minimal Management areas and other areas that are essential components of the Refuge's special values (Chapter 1, Section 1.5).

Rationale: Relevant, reliable, and cost-effective indicators of change in characteristics that are essential components of the Refuge's special values are needed to determine if those qualities are stable, improving, or degrading over time. These wilderness characteristics include biophysical elements (e.g., undeveloped conditions, natural appearances, free-functioning ecosystems, native flora and fauna), and conditions conducive to experiential opportunities (e.g., solitude, natural quiet, adventure, primitive and unconfined recreation).

Strategy: Three step-down planning efforts will be initiated soon after approval of the Plan: an Ecological I&M Plan (Objective 1.2), a Visitor Use Management Plan (Objective 5.4), and a WSP (Objective 2.4). Collectively, and in an integrated manner, the monitoring components of these plans will enable trends in wilderness characteristics to be described, quantified, and addressed. Monitoring of these characteristics will be conducted both on lands in Minimal Management and those in designated Wilderness, although the WSP may also specify monitoring of additional qualities related to Wilderness character in designated Wilderness as outlined in the Interagency Keeping It Wild strategies (U.S. Forest Service 2008).

Objective 2.7: Restoration of Impaired Sites—Refuge staff will expand efforts to restore wilderness characteristics to sites in Wilderness and Minimal Management lands that have been impaired or degraded.

Rationale: Activities related to public use, military operations, and other agencies and institutions have resulted in localized impairment of wilderness characteristics and visitor experiences. Many of these impairments predate the original Range's establishment in 1960 and its expansion and designation as Arctic Refuge in 1980, degrade wilderness characteristics, and conflict with some Refuge goals.

Strategy: Refuge staff will work with other agencies, volunteers, private land and allotment owners, and permit holders to identify, prioritize, and restore affected sites. Actions include removing trash, barrels and contaminants, rehabilitating extensively impaired camp sites, cleaning up debris and contaminants around abandoned cabin sites and hunting guide camps, and removing downed civilian aircraft, military aircraft and debris, and spent rockets and debris left by the National Aeronautics and Space Administration (NASA). The Refuge will continue to seek funding and military assistance for further cleanup and contaminant removal at Formerly Used Defense Sites, and for removal of heavy equipment left along the old bulldozer trial in the southeastern portion of the Refuge. The Refuge is committed to initiating rehabilitation of at least one site per year. The Service will complete required environmental analyses for proposed activities and will consult or coordinate as appropriate with other agencies, such as the State Historic Preservation Office. To complement recovery of impaired sites and prevent further impacts, the Refuge will expand law enforcement and conduct outreach related to Refuge regulations (Objectives 5.7 and 9.2) and minimum impact practices (Objective 9.2). For more on restoration, see Objective 5.4.

2.1.3 Goal 3: The ecological functions and natural flow regimes of the Refuge's aquatic ecosystems, including headwater streams, rivers, springs, wetlands, lakes, and lagoons, are documented and protected, and designated Wild Rivers and the Marine Protected Area are managed in a manner consistent with their special designations.

Ongoing and Immediate Priorities (Years 1-3)

Objective 3.1: Marine Protected Area—Marine waters of the Refuge within the National Marine Protected Areas (MPA) Network will be collaboratively studied and managed to protect the area's natural heritage values and enhance public recognition of Arctic Refuge MPA through environmental education and outreach.

Rationale: In 2009, all marine waters in the Refuge were designated an MPA as part of the National MPA System to conserve the area's natural heritage. Arctic Refuge MPA may be impacted by loss of sea ice, changes in freshwater input, increased rates of coastal erosion or accretion, increased shipping activity, offshore development (e.g., oil spills), and introduction of invasive species associated with marine shipping. We know relatively little about nearshore marine ecosystems of the Refuge and their relationships with terrestrial ecosystems. Designation of the marine waters of the Refuge as an MPA is intended to: (1) facilitate collaborative work with other MPAs regionally and nationally on issues of common conservation concern; (2) foster greater public and international recognition of the marine resources of the Refuge; and (3) prioritize acquisition of resources to meet key monitoring and research needs.

Strategy: As a basis for managing the MPA, the Refuge needs a better understanding of natural variability in nearshore ecosystems and the relationships between marine and terrestrial systems. Refuge staff will conduct inventory and monitoring activities that support management of the MPA to protect and enhance the Area's natural heritage. We will maintain and enhance collaborative efforts to improve understanding of lagoon ecosystems, monitor coastal erosion and accretion, quantify input of freshwater and associated constituents to coastal ecosystems, and evaluate potential impacts of climate change on lagoon ecosystems. Existing and future efforts will include working with partners in the Arctic Landscape Conservation Cooperative. We will continue working with others to ensure adequate spill response capabilities; develop proactive measures for limiting introduction of invasive species; investigate relationships between terrestrial, coastal, and marine environments; and develop environmental education and outreach programs that focus on the Refuge's marine ecosystem.

Objective 3.2: Water Rights—Refuge managers will establish legal protection for water quality and quantity to support Refuge purposes.

Rationale: Water of sufficient quality and in sufficient quantity is a necessary component of fish and wildlife habitat and population management. It is also specifically identified in ANILCA as a primary purpose of the Refuge, and it is a core component of the Refuge System's mission "to administer a network of lands and waters" for future generations.

Though the Refuge has Federal reserved water rights to meet its purposes, it is Service policy to work within the State's water rights system when practicable. During 1994-1998 the Service identified water bodies on Arctic Refuge most likely to experience competing water uses and applied to the Alaska Department of Natural Resources (ADNR) for instream flow reservations for fish and wildlife purposes. As of this writing, 152 instream flow reservations have been filed with ADNR, but no reservations have been adjudicated. Though each reservation has a priority date (i.e., the date of application) and identifies an amount or elevation of water to be reserved, the amount of water reserved is not quantified until adjudicated.

Strategy: The strategy of the Refuge System in Alaska is to work within State statutes to obtain State-based instream flow reservations for fish and wildlife purposes, as practicable, and to explore other options, including Federal reserved water rights, when necessary.

Objective 3.3: Water Resource Inventory and Assessment—Refuge staff will work with the Service's regional Water Resource Branch to complete a water resource inventory and assessment within one year of Plan approval.

Rationale: A water resource inventory and assessment provides an inventory and assessment of existing water quantity and quality data and information on water rights, management, and potential threats, which is essential to identify data gaps and prioritize data collection needs.

Strategy: The water resource inventory and assessment is a coordinated effort conducted by regional Refuges Inventory and Monitoring staff and Refuge staff. The initial stages of the assessment will provide an inventory of existing information about water resources in the Refuge, including water sources, water quality and quantity, water rights, and threats to water resources. Information from the water resource inventory and assessment will contribute to Comprehensive River Management Plan (CRMP) baseline resource assessments (Objective 3.5). The information will also be used to identify data gaps and potential threats, make recommendations for addressing potential threats, prioritize inventory and monitoring efforts, and strategize to reduce potential impacts to water resources.

Short-term Priorities (Years 4-8)

Objective 3.4: Water Quality and Quantity—Refuge staff will monitor water quality and quantity at appropriate intervals at previously sampled sites and at additional locations to document baseline conditions and changes over time.

Rationale: Water samples have been collected at selected lakes and at Formerly Used Defense Sites on the Refuge's North Slope for water quality analyses, and results are being tabulated and reported. Further, there is an ongoing program to monitor river gages on the Refuge to provide flow estimates to support water-rights applications (Objective 3.2), as well as biophysical monitoring and research. These data will contribute to CRMP baseline resource assessments (Objective 3.5). Local tribes have also expressed concerns about water quality and quantity in relation to transportation and subsistence resources such as fish.

The comprehensive data set collected in 1988 and 1989 serves as baseline data for water quality and contaminants levels in key ecological media on the Refuge's coastal plain. Those data showed water quality and contaminants levels in the expected range for relatively pristine, undeveloped Arctic areas. The exceptions occurred around Kaktovik; for example, fuel-based petroleum hydrocarbons were detected in the sediments of Kaktovik Lagoon. In the 20 years since these baseline data were collected, environmental changes have occurred in the Arctic, including changes in contaminant transport and mobilization due to climate change. The effects of these changes on the quality and contaminants levels of coastal plain lakes, ponds, and wetlands are unknown.

Strategy: Within five years, we will take samples at previously sampled sites to document changes over time. Water quality samples will also be taken at additional ecological monitoring sites, at rafting put-in and/or take-out locations, and at other popular public use areas to monitor potential human impacts and establish baseline values. We will continue to pursue funding and partnerships to maintain and enhance river-gaging efforts as needed.

We will seek funding through partnerships to repeat collection of water quality and contaminants data on the Refuge's coastal plain. The comparison between the 1990 results and these newly acquired data will provide insight into water quality and contaminants changes in undeveloped Arctic ecosystems experiencing climate change. We will seek publication of data and analyses in peer-reviewed scientific publications and will transmit results through outreach to researchers, other agencies, and the public.

Objective 3.5: Comprehensive River Management Plans for designated Wild Rivers—Refuge staff will initiate a baseline resource assessment and Comprehensive River Management Plans (CRMP) for each currently designated wild river within five years of Plan completion and, for any newly designated rivers, within three years of their designation.

Rationale: The Wild and Scenic Rivers Act requires land managers to complete a CRMP within three years of a river being designated. Three rivers on Arctic Refuge were designated in 1980 with the passage of ANILCA, but their CRMPs have not been developed. The assessment and plan for each wild river will incorporate all elements required by the Wild and Scenic Rivers Act, including descriptors of desired conditions and user capacities. The CRMPs will ensure that management of the Refuge's wild rivers compliments and is consistent with management of other areas of the Refuge. Periodic monitoring of public use impacts (e.g., campsite condition, human waste accumulation, visitor experience, etc.) will provide valuable feedback as to whether management is successfully maintaining each river's outstandingly remarkable values (ORVs).

Strategy: Baseline resource assessments will document current conditions related to the river's free-flowing condition, water quality, and ORVs. Data collection will follow guidance of the Interagency Wild and Scenic Rivers Coordinating Council (IWSRCC) (2010). The river management plans will identify measurable indicators, thresholds, and intervals for long-term monitoring and a suite of management actions.

The Refuge's wild rivers serve as suitable locations for ongoing inventory and monitoring of water quality and quantity, one of the Refuge's ANILCA purposes, and monitoring efforts identified in the CRMPs will be coordinated with the I&M program and other efforts (see also Objectives 1.2, 2.4, 2.6, 3.3, 3.4, and 5.4).

The Service will fund and staff the baseline assessment and CRMP for each of the three designated wild rivers and train employees on the Wild and Scenic Rivers Act and wild and scenic rivers management. An interdisciplinary team will conduct resource assessments and gather data during the preplanning field season. Staff could come from the Refuge, the regional office, other Service stations, or detailed from universities or other resource agencies with expertise. The team may also work closely with the Service's regional and national wild and scenic rivers coordinators to help inform and educate agency employees.

2.1.4 Goal 4: The Refuge, in consultation with appropriate parties, addresses concerns about proposed actions that may substantially or directly affect subsistence or cultural resources, rural subsistence or cultural uses, or the rights of tribes.

Ongoing and Immediate Priorities (Years 1-3)

Objective 4.1: Formal Consultation—Refuge managers will consult with Alaska Native tribes and Native corporations in government-to-government fashion at least annually on all proposed actions and Refuge uses that may affect the tribes or corporations.

Rationale: The United States has a unique legal and political relationship with American Indian and Alaska Native tribal governments as set forth in the Constitution of the United States, treaties, statutes, court decisions, Executive orders, and policies. In recognition of this relationship, the President issued Executive Order 13175 (Consultation and Coordination with Indian Tribal Governments) on November 6, 2000, which provides guidelines to all Federal agencies for how to establish regular and meaningful consultations with tribal officials. In January 2001, the Department of the Interior (DOI) established the Alaska Policy on Government-to-Government relations. A Presidential Memorandum was signed in 2009, and the DOI Policy on Consultation with Indian Tribes was published in 2011. In August 2012, the DOI Policy on Consultation with Indian Tribes was supplemented with the requirement to consult with Alaska Native Claims Settlement Act (ANCSA) corporations on actions or activities that may have a substantial direct effect on Alaska Native corporations, including corporation lands, waters, or resources. These policies reaffirm the Federal government's commitment to operate within a government-to-government relationship with Indian and Alaska Native peoples.

Consultation will occur whenever a Federal action with tribal or Native corporation implications is proposed, including the decision making process for that action. Examples of such actions are the preparation of a management plan for an area near tribal lands or Refuge-proposed changes in management of subsistence resources. In Alaska, formal consultation with tribes and Native corporations is necessary for successful Refuge management, and the Refuge will continue to communicate about ongoing and future research, monitoring, and management activities. The Refuge can strengthen cultural and community ties and its conservation mission by making good-faith efforts to understand Iñupiat and Gwich'in perspectives and official positions in a mutual, transparent, and formal manner.

Strategy: Pursuant to these directives, Refuge managers will engage in formal consultation with tribal officials and Native corporations for all actions and decision making processes that could have implications for tribes or Native corporations. When considering such an action, the Refuge shall notify the appropriate Alaska Native tribes and/or regional or village corporations of the opportunity to consult at least 30 days prior to scheduling a meeting. In this notice, the Refuge will provide a description of the topic to be discussed in sufficient detail to allow tribal leaders and Native corporation executives to fully engage in the consultation. The Refuge will give tribal leaders and Native corporation executives the opportunity to provide feedback prior to consultation, including requests for technical assistance or clarification on the consultation process. All aspects and stages of the consultation process shall be documented.

Objective 4.2: Subsistence Opportunities—Refuge managers will provide opportunities for continued subsistence uses essential to the physical, economic, traditional, cultural, and social existence of federally qualified rural residents. We do this through working with local communities, advisory groups, and tribes and by participating in Federal and State regulatory processes (ANILCA Section 801(1)).

Rationale: The Refuge is mandated by ANILCA Section 303 (2)(B) to provide for subsistence uses by federally qualified subsistence users. ANILCA states in Section 802(2) that "nonwasteful subsistence uses of fish and wildlife and other renewable resources shall be the priority consumptive uses of all such resources on the public lands of Alaska when it is necessary to restrict taking in order to assure the continued viability of a fish or wildlife population or the continuation of subsistence uses of such population." ANILCA Section 810 also stipulates that when the Refuge contemplates "whether to withdraw, reserve, lease, or otherwise permit the use, occupancy, or disposition of public lands," it must evaluate the effects of such uses on subsistence uses and needs. If the Refuge determines that a significant restriction is likely to occur, it must follow the Section 810 notice and hearing requirements. The Refuge may proceed with an action that would significantly restrict subsistence uses only if it first determines a significant restriction is necessary, the action will involve the minimal amount of public lands for the proposed action, and reasonable steps will be taken to minimize adverse impacts on subsistence uses and resources.

Strategy: Regular meetings in rural communities are the most effective way to explain Federal and State regulations and policies regarding conservation of fish and wildlife populations and discuss issues of local concern to subsistence users. It is essential that affected parties communicate and work cooperatively towards achieving common subsistence use and management goals. Refuge mangers will continue to conduct annual meetings in Arctic Village, Fort Yukon, Kaktovik, and Venetie to share information and maintain an active dialogue with local residents about subsistence management. Refuge staff will continue to work cooperatively with tribal and village councils to issue Federal registration and drawing hunt permits as prescribed in the Federal Subsistence Harvest Regulations for Refuge lands, including current hunt permits for moose, muskoxen, and sheep. The Refuge will also continue to conduct 810 evaluations when needed.

Objective 4.3: Refuge Information Technician (RIT) Program—Refuge managers will continue to enhance regular communications in Arctic Village, Kaktovik, and other rural communities through the RIT Program and will seek funding to place an RIT in Venetie and Fort Yukon within five years.

<u>Rationale:</u> Locally hired RITs are vital liaisons between Refuge staff and members of rural communities lacking ready access to staff in Fairbanks. Potential roles for RITs include exchanging information with local residents, answering questions from visitors, assisting with monitoring and research, providing logistics for studies, advising staff on community issues and concerns, and providing translation services when necessary. Many local residents are more comfortable interacting with a familiar person who better understands the local language, culture, and community. Currently the Refuge has RITs in Kaktovik and Arctic Village.

Venetie tribal lands are surrounded by Refuge lands—Arctic Refuge to the north, east and west, and Yukon Flats National Wildlife Refuge to the south. Arctic Village and Venetie Village are located in the Venetie Tribal Lands and village residents share membership in the Native Village of Venetie Tribal Government. There are strong family ties and shared traditional use areas between the villages of Venetie, Fort Yukon, and Arctic Village. The Refuge must maintain close contact with these communities, and RITs based in Venetie and Fort Yukon could improve communication and strengthen cooperation in those villages.

<u>Strategy:</u> Facilitated by the RIT program, the Refuge will communicate, consult, and maintain relationships with various groups in these villages to ensure continued opportunities for subsistence uses on Refuge lands and waters. Arctic Refuge will work with the Yukon Flats National Wildlife Refuge and will consult and partner with the villages of Venetie and Fort Yukon regarding the placement and recruitment of RITs in these communities and these positions will be shared with Yukon Flats National Wildlife Refuge.

Objective 4.4: Village Harvest Monitoring Programs—Within two years of Plan approval, Refuge staff will work with partners to expand and implement annual community-based subsistence monitoring programs for harvest of fish and wildlife by residents of Arctic Village, Venetie, Kaktovik, and Fort Yukon.

<u>Rationale:</u> Compliance with the current Federal and State individual harvest reporting system is low and unreliable for most rural villages. The majority of the data on subsistence harvest in the Refuge was collected in the 1980s and may not accurately portray current patterns in subsistence use, demographics, harvest amounts, hunting seasons, locations, or community needs. The Refuge currently needs up-to-date subsistence harvest data for fish and wildlife species to address regulatory proposals to the Federal Subsistence Board and the State Boards of Fish and Game. A community-supported harvest monitoring program with implementation protocols based on timely and accurate harvest information is needed to ensure long-term conservation of subsistence species of fish and wildlife and subsistence uses for federally qualified subsistence users.

<u>Strategy:</u> Effective community involvement and close relationships between the Refuge and local governments and communities are critical in conducting accurate subsistence harvest monitoring programs in Arctic Village, Venetie, and Kaktovik. The most effective way for the Refuge to implement this objective is through coordination and partnerships with local communities, tribal governments, village corporations, the Council of Athabascan Tribal Governments, Tanana Chiefs Conference, North Slope Borough, Alaska Migratory Bird Co-

management Council, ADFG, Arctic Borderlands Ecological Knowledge Cooperative, and the Service's Office of Subsistence Management and Division of Marine Mammals Management. Village subsistence harvest surveys should be implemented by respected and trusted local residents. Village residents must be closely involved with the collection and sharing of subsistence harvest data for fish and wildlife species. These surveys should be conducted at least once a year in each village.

Objective 4.5: Manage Subsistence Use Data—Refuge staff will establish a managed network of compiled historical and contemporary subsistence use data for use in making subsistence-related decisions on Refuge lands and waters.

Rationale: Comprehensive and ethnographic-based studies of subsistence uses on Refuge lands are relatively dated and small in number. Subsistence use information can include a substantially large body of cultural, social, and economic information. A small list includes: types of fish, wildlife, berries, and plant materials used; cultural or economic significance; location and intensity of subsistence activities; demographics; harvest amounts and community needs; hunting seasons and practices; barter and trading practices; and community or household needs. A comprehensive review of existing information is needed to identify gaps in the data and to identify priorities for future subsistence research and monitoring. This information is needed to ensure traditional subsistence use and knowledge is thoroughly and accurately considered in Federal and State proposals for subsistence regulations, as well as Refuge management actions.

Strategy: Within one year of Plan approval, the Refuge will work with partners to compile existing subsistence use data, both contemporary and historical, and develop a comprehensive and functional repository of this information. Original data will be kept in a manner and location to be determined by the affected tribal governments. Multiple sources of published and unpublished subsistence use and harvest data reside with various agencies, organizations, tribal governments, and village councils. We will compile sources of scientific data, traditional knowledge, and ethnographic information through formal partnerships with local tribal and village councils, Native corporations, the Council of Athabascan Tribal Governments, Tanana Chiefs Conference, North Slope Borough, International Porcupine Caribou Board, ADFG, the Alaska Migratory Bird Co-management Council, and the Service's Office of Subsistence Management and Division of Marine Mammals Management.

Short-term Priorities (Years 4-8)

Objective 4.6: Historical Access—Within six years of Plan approval, Refuge staff will begin a historical access study, in cooperation with local tribal governments, Native communities, elders, and the State of Alaska, to understand the historical access patterns and inform management decisions on access.

Rationale: ANILCA provides that "use for subsistence purposes of snowmachines, motor boats, and other means of surface transportation traditionally employed" (Section 811(b)) and "use of snowmachines… motorboats, airplanes, and non-motorized surface transportation methods for traditional activities" (Section 1110(a)) shall be permitted subject to reasonable regulation. A study of historical access to the lands and waters that now comprise Arctic Refuge will help determine where and what activities have occurred on the Refuge. An understanding of historical access will assist the Refuge in monitoring and managing current and future access.

Strategy: In preparation for the historical access study, Refuge managers will formally consult with local tribal governments and Native corporations, and seek cooperation with Native organizations and communities to interview elders and other long-term residents to find out what people did on lands that became Refuge and what methods of access they used. Time is of essence for interviewing and recording elders who have a close and long connection to the land. The historical access study will include a thorough review of Refuge annual narratives reports, the 1988 Plan, and other relevant documents and publications of a historical nature.

2.1.5 Goal 5: The Refuge provides a range of opportunities for wildlife-dependent and wilderness-associated recreational activities that emphasize adventure, independence, self-reliance, exploration, and solitude or primitive and unconfined recreation while protecting the Refuge's natural conditions and special values.

Ongoing and Immediate Priorities (Years 1-3)

Objective 5.1: Access for a Range of Visitor Opportunities—Refuge managers will continue to provide access for a range of compatible recreational activities, including hunting, fishing, wildlife observation, photography, camping, backpacking, river floating, and mountaineering.

Rationale: One purpose of the original Arctic Range was to "preserve unique … recreation values," and through ANILCA Section 101(b), Congress declared its intent "to preserve wilderness resource values and related recreational opportunities…." Arctic Refuge provides a superlative setting for a variety of compatible recreational activities, and, consistent with maintaining the wilderness resource values upon which their special character depends, the Service will continue to provide opportunities for visitor access.

Strategy: Public access to the Refuge will continue to be guided by the access provisions of ANILCA (Section 1110) and other applicable laws and policies. Means of access, including aircraft, motorboats, snowmobiles, and non-motorized surface transportation, are subject to reasonable regulation to protect the Refuge's natural and other values. ANILCA did not differentiate between users, but rather provided for the use. Uses will not be prohibited in any area of the Refuge unless, after a public process involving notice and hearing in the vicinity of the Refuge, the use is determined to be detrimental to the area's resource values. To help facilitate public access, the Refuge will continue working with permitted transportation and guide service providers to ensure that, to the degree practical, needed or desired services are available. Through the Refuge's website and other means, information will be provided to enable the public to access and enjoy the Refuge safely and with minimal impact (Objective 9.2). Through identification and administration of existing 17(b) easements, access across Native corporation lands to Refuge lands will be provided, consistent with applicable laws and policies (Objective 5.6 and Chapter 2, Section 2.4.14.10).

Objective 5.2: Visitor Independence, Self-reliance, and Freedom—Consistent with resource protection, Refuge managers will continue to maximize opportunities for visitors to experience independence, self-reliance, and freedom by minimizing on-site contacts and acknowledging that in wilderness, there can be risk.

Rationale: Information on visitor experiences and preferences gained through scoping comments, previous planning efforts, the 2008 Visitor Study, media accounts, and personal contacts indicates that freedom and independence are highly valued components of visitors' experiences. They are vulnerable, however, to well-intended and often small measures that make the visitor's experience more convenient or predictable. Consistent with resource protection, the Refuge will strive to avoid the incremental and cumulative erosion of these experiences and consider them in the development and implementation of all visitor use programs and policies.

Strategy: Visitor outreach will emphasize self-reliance. We will provide awareness that in this arctic landscape there can be risk but through proper preparations, visitors can still have the opportunity to experience freedom and independence. Visitor programs will consider independence, self-reliance, and freedom as valued and legitimate trip components. Managers will employ the least intrusive means of visitor use management including minimizing our on-site contacts with visitors, especially in designated Wilderness. Outreach specialists will provide visitor programs and other informational materials to visitors before they enter the backcountry to minimize intrusion on visitor experience. Outreach will include strategically providing recreational information as a way to encourage dispersing use amongst sites, thereby helping to relieve real or perceived overcrowding or resource impacts. Outreach staff will also prioritize the methods they use to reach visitors (in descending order): web-based; off-Refuge in gateway communities at interagency and community visitor centers and kiosks; distribution by commercial service providers; staff contacts at airports, remote landing areas, and transportation hubs; and finally, as known resource issues emerge, remote field contacts by Refuge staff and enforcement officers.

Objective 5.3: Adventure, Challenge, Exploration, and Discovery—Consistent with resource protection and visitor safety, Refuge managers will perpetuate opportunities for visitors to experience adventure, challenge, exploration, discovery, and a sense of the unknown by minimizing placement of recreational facilities on Refuge lands.

Rationale: Information on visitor experiences and preferences indicates these dimensions are central to those seeking authentic adventure and expeditionary opportunities for which the Refuge is renowned. Recreational improvements such as bridges, hand rails, established trails, and directional signs may diminish experiences for many visitors to Arctic Refuge. Standard information recommending trip routes, river crossings, best fishing areas, and featuring landmarks would also diminish the area's quality as an adventuring ground. General information can be provided that enables visitors to access and enjoy the Refuge in a safe and environmentally sound manner and that enhances their appreciation of the increasingly rare opportunity for discovery.

Strategy: To perpetuate opportunities for adventure, challenge, exploration, and discovery, managers will avoid placing permanent directional signs, designated trails, and/or structures (i.e., visitor centers, kiosks, bridges, hand rails, etc.) on Refuge lands, especially in the designated Wilderness area. Temporary damage control signing or actions may become necessary from time to time. Outreach specialists will provide visitor programs and other informational materials to visitors before they enter the backcountry to minimize intrusion on visitor experience (see Objective 5.2).

Objective 5.4: Visitor Use Management Plan—Refuge staff will complete a Visitor Use Management Plan (VUMP) that evaluates a range of management options and provides visitor opportunities while protecting, sustaining, and where necessary, restoring the natural conditions and special values of Arctic Refuge.

Rationale: Arctic Refuge functions as a nationally important benchmark for wilderness characteristics and exceptional visitor experiences in a premier setting, unique within the Refuge System. Public access to Refuge lands for recreation is allowed, subject to the provisions in Section 1110 of ANILCA. The Refuge Improvement Act mandates Refuge managers provide the public with opportunities for wildlife-dependent recreation. Managers may provide other recreational opportunities for the public to use and enjoy Refuge lands if these activities are compatible with the purposes of the Refuge and the conservation mission of the Service.

Arctic Refuge has important local, state, and national constituents and partners that must be considered when developing visitor use programs and policies. The Refuge's public constituencies and professional partners expect Refuge managers to effectively manage visitor uses to maintain quality experiences and protect habitats and wildlife on Refuge lands. Managers at the Refuge have decided that options for visitor use management would be best addressed through a public planning process.

Strategy: Visitor use management is defined as the dynamic process of planning for and managing all aspects of visitor use and the setting in which that use occurs. This is accomplished through a diverse range of strategies and tools to sustain desired resource conditions and visitor experiences. Aspects of visitor use include levels of use, timing and distribution of use, and activities and behaviors of visitors. Strategies and tools may include outreach, site management, regulation, enforcement, and rationing or allocation.

Refuge managers will immediately begin the VUMP following approval of the Revised Plan. The VUMP will evaluate private recreation and recreation supported by commercial service providers and the effects of these on visitor experiences and resources on Refuge lands. Managers estimate the VUMP will take 3-5 years to complete. Refuge managers, working with a planning team, will concurrently prepare the VUMP and a WSP (Objective 2.4). The VUMP will address visitor use issues identified during this planning process and assess visitor impacts and information needs. The management strategies prescribed in the Revised Plan will be used in the interim to manage visitor use during the development of these step-down plans.

The Service will recruit an experienced recreation planner to lead the Refuge staff, planning team, and partners in developing and implementing the VUMP. This planning process and environmental analysis will include substantial public involvement at the village, local, state, and national levels. Public input will help managers decide what specific conditions and visitor experiences will be available to the public at Arctic Refuge. The desired conditions and experiences will meet Refuge purposes and protect and sustain the Refuge's special values. Managers will determine what actions they can use to affect these conditions and experiences. Managers expect the VUMP will propose a range of management actions that will be considered for the entire Refuge. In the designated Wilderness area, managers will focus on the least intensive and least visible actions. The VUMP will be used by managers to determine tools and schedules for monitoring desired conditions and experiences, and actions for restoring conditions where necessary.

Objective 5.5: Commercial Visitor Services—Refuge managers will continue to authorize commercial visitor services to facilitate wildlife-dependent and other compatible public recreation activities such as transportation services and guided backpacking, hunting, fishing, and float trips.

<u>*Rationale:*</u> Arctic Refuge is large and remote and some visitors desire the services of commercial operators to provide access and/or guide services to enjoy recreational opportunities provided by the Refuge. Commercial services can be provided on national wildlife refuges and must be monitored to ensure they are compatible with Refuge purposes. Commercial services are authorized through the Service's special use permit system, which was designed to meet the mission of the Service while allowing for responsible commercial activities. The Wilderness Act prohibits commercial enterprises but authorizes commercial visitor services to the extent they are necessary to realize the recreational purposes of the designated Wilderness area. Commercial visitor services on all Refuge lands are subject to provisions found in ANILCA. Managers at the Refuge value the assistance of the commercial service providers in reporting visitor use trends and resource impacts, informing visitors about resource values, and providing key messages about stewardship of Refuge lands.

<u>*Strategy:*</u> Refuge managers will continue to issue special use permits for commercial services that support recreation on Refuge lands. Refuge staff will manage the use of commercial activities through special conditions in those permits. Refuge managers and their staff will continue to work with commercial service providers to give information to their clients about Refuge regulations, resource concerns, and special values. The VUMP will further address

concerns about commercial services identified during public involvement for both this Plan and the step-down planning process (see Objective 5.4).

Objective 5.6: Visitor Management Coordination with Neighbors—Refuge staff will continue to coordinate with landowners, in and adjacent to the Refuge, to increase respect for private lands and to encourage a conservation ethic and stewardship behaviors in both visitors and landowners.

Rationale: Refuge managers will work with visitors and Refuge neighbors to address public use impacts, such as trespass, trash, and other issues of concern to adjacent landowners and on private lands inside the boundaries of Arctic Refuge that may result from public use of Refuge lands. Neighbors include the Arctic Slope and Doyon regional corporations, tribal councils, Native corporations, allotment and other private landowners, and the Toolik Lake Research Station. Refuge managers will work with the neighboring landowners, commercial operators, and others to develop solutions to public use impacts that are acceptable to all parties.

Strategy: Refuge managers and their staff will increase outreach to visitors at access points and other places near the boundaries of the Refuge. Managers will closely cooperate with the Alaska Native corporations in the area to develop a detailed land status map that can be used by the general public to navigate to 17(b) easements and locate public and private lands. This map will be posted on the Refuge's website to help visitors plan their trips to Arctic Refuge. The map will be given to all commercial operators to give to their clients and posted on kiosks at all Refuge access points. Other strategies may be developed during preparation of the VUMP.

Objective 5.7: Coordinated Law Enforcement—Managers at Arctic Refuge will work with Refuge officers and other authorities to strengthen and unify their law enforcement efforts on Refuge lands and waters to promote conservation stewardship.

Rationale: Arctic Refuge is vast and remote with boundaries adjacent to Alaska coastal waters, Canada, the Dalton Highway, Venetie Tribal Lands, Yukon Flats National Wildlife Refuge, and State and Native corporation lands. Rangers from Gates of the Arctic National Park and Alaska Wildlife Protection Officers occasionally share use of our field facilities at the Galbraith Lake, Big Ram Lake, and Lake Peters.

Strategy: Refuge law enforcement officers will continue to conduct regular patrols on the Refuge and improve partnerships with other Federal and State law enforcement authorities in the area. Refuge officers will work together with officers from the Service's Office of Law Enforcement, the Alaska State Troopers, Village Police Officers, Bureau of Land Management (BLM), NPS, U.S. Coast Guard, Royal Canadian Mounted Police, Canadian Wildlife Service, and Parks Canada to coordinate activities, resource availability, and operations in the field. Subject to appropriate land management designations and the nature of law enforcement actions, the Refuge and its law enforcement partners will coordinate with the appropriate jurisdictions to conduct, in priority order: 1) immediate enforcement actions in urgent cases for all Refuge lands; 2) patrols in specific places based on known resource threats; and 3) occasional routine patrols. These coordinated efforts will benefit resource protection on the Refuge.

There are two officers on the staff of Arctic Refuge, one of which is an Alaska Native. Officers from the Yukon Flats National Wildlife Refuge, also operated out of the Service's Fairbanks office, are available to assist on Arctic Refuge when needed. One of these officers is an Alaska Native. Refuge managers will also seek funding and authorization to hire one additional law enforcement officer to work in Arctic Refuge (and be stationed near the Refuge) and share enforcement duties with neighboring Yukon Flats and Kanuti refuges. To help address subsistence and resource issues, Refuge officers will continue targeted patrols in and around Native villages and subsistence areas, and at access points during key visitation times such as general hunting seasons.

Objective 5.8: Visitor Study—Refuge staff will maintain long-term data that informs Service leadership and Refuge managers about why people visit Arctic Refuge, what they experience, and their preferences.

Rationale: To best serve the visiting public, the Refuge needs to understand and monitor trends in the experiences and preferences of Refuge visitors.

Strategy: Motivations, experiences and preferences of Refuge visitors were sampled in the 2008 Arctic National Wildlife Refuge Visitor Study (Christensen and Christensen 2009). The study provided important information about the qualities of the Refuge, experiences that are most important to visitors, reasons people visit the Refuge, demographic information, and opinions of visitors regarding current and potential actions to manage recreation on Refuge lands. Refuge staff will work with researchers and the State to repeat this study beginning in 2013, with long-term monitoring intervals to be determined through the VUMP and WSP. The 2013 study will provide information important for the development of the VUMP (Objective 5.4) and the WSP (Objective 2.4). The study design may be modified somewhat after completion of these two step-down plans so that relevant data can be collected and used to inform the management actions and monitoring programs prescribed in these plans.

Short-term Priorities (Years 4-8)

Objective 5.9: Aircraft Landing Impacts—Refuge managers will implement strategies to address impacts to sensitive vegetation caused by aircraft landings on Refuge lands.

Rationale: The vast majority of access to the Refuge, for both administrators and recreational visitors, is by aircraft. Aircraft landings on sensitive tundra surfaces are creating new landing areas and causing visible scarring and occasionally rutting. These types of impacts are directly related to public use and, increasingly, are a source of complaint.

Strategy: As part of the Visitor Use Management and Wilderness Stewardship planning processes, the Refuge will work closely with commercial air service providers and other interested parties to: 1) ensure that safety remains a primary concern; 2) document the condition and trends in established and emerging landing areas; 3) examine availability of durable landing areas, recognizing their often ephemeral nature; 4) identify and engage key partners and the general public in discussion about landing area conditions; and 5) formulate and implement management strategies that protect the land, vegetation, and wilderness characteristics.

2.1.6 *Goal 6: The effects of climate change on Refuge resources are evaluated through research, monitoring, and local traditional knowledge, and these effects are considered in Refuge management decisions.*

Ongoing and Immediate Priorities (Years 1-3)

Objective 6.1: Effects of Climate Change—Coincident with revision of the I&M Plan, Refuge biologists will evaluate potential effects of climate change on Refuge resources, and incorporate study of these effects into the revised I&M program.

Rationale: Climate change is intensified at high latitudes, making the Refuge particularly vulnerable to ecological effects. Long-term monitoring studies are needed to detect changes that may be subtle and/or cumulative. To ensure that monitoring efforts for potential climate-change effects will be consistently applied and peer reviewed, they should be specified in the Refuge's I&M and Research plans (Objectives 1.2 and 1.3).

Strategy: We will incorporate assessment of climate change effects into our ecological inventory, monitoring, and research programs. Evaluation of potential climate change effects will be based on literature review, e.g., the Arctic Climate Impact Assessment (2005) and the work of the Intergovernmental Panel on Climate Change (e.g., IPCC 2007a, b, c). Work will be conducted with partners, including the National Wildlife Refuge System I&M program, the Arctic and Northwestern Interior Forest LCCs, North Slope Science Initiative, USGS Alaska Climate Science Center, the State of Alaska, tribal governments, and Native corporations. Modeling of future scenarios will also be pursued to evaluate potential effects of climate change on Refuge resources, including threatened and endangered species, species at risk of endangerment (e.g., birds of conservation concern (Service 2008a)), vulnerable habitats, and fish and wildlife species important for subsistence.

Objective 6.2: Consider Climate Change and Non-climate Stressors—Refuge managers will consider climate change and other non-climate stressors when making management and administrative decisions.

Rationale: The effects of climate change are exacerbated at high latitudes, including Arctic Refuge. Contemporary climate change has already affected habitats in the Refuge, and more severe future effects are likely. At the same time, other stressors such as development in adjacent areas or along wildlife migration routes, air pollution transported to the Refuge from industrial and other human activity, contaminants, and disturbance may have cumulative effects on resources in the Refuge.

Strategy: Identification of stressors and evaluation of their effects on species and ecosystems in the Refuge will be addressed through I&M and research planning and implementation (Objectives 1.2 and 1.3). The Refuge Manager will consider effects of current and likely future climate change and other stressors when evaluating management activities such as monitoring and research, special use permitting, and changes to wildlife harvest regulations. Maintaining migratory pathways and reducing non-climate stressors when possible will facilitate adaptation of fish and wildlife to climate change. Strategies to mitigate effects of stressors may be implemented, consistent with Refuge goals, objectives, and management guidelines.

Objective 6.3: Collaboration on Climate Change—Refuge managers and scientists will maintain and enhance their involvement in broad-scale programs studying the effects of climate change in arctic and subarctic environments.

Rationale: Climate change and other environmental perturbations occur on a worldwide scale and include many potential effects and broad-scale considerations that are beyond the expertise or capacity of Arctic Refuge staff. We need to collaborate with specialists from diverse fields of expertise to address issues of broad-scale environmental change.

Strategy: We will strengthen collaboration with others on climate change research and monitoring (e.g., Arctic and Northwestern Interior Forest LCCs, National Wildlife Refuge System I&M Program, USGS Alaska Climate Science Center, Study of Environmental Arctic Change, Global Observation Research Initiative in Alpine Environments, International Tundra Experiment, Arctic Coastal Dynamics, Arctic Borderlands Ecological Knowledge Cooperative). Our efforts will include evaluation of abiotic and biotic components, plus modeling efforts to predict environmental changes. Management decisions will incorporate the best available science, but we will acknowledge the uncertainty of predictions and be adaptive to accommodate changing situations. In addition, the Refuge will work with local villages and tribes to collect traditional ecological knowledge of how the region's fish, wildlife, habitats, and ecosystems are responding to climate change.

Objective 6.4: Non-intervention Approach—For the foreseeable future, Refuge Managers will avoid actions aimed at resisting the effects of climate change on wildlife and ecosystems. Rather, managers will allow natural systems to adapt and evolve in response to changing climatic conditions.

Rationale: There are many unknowns related to climate change and its effects on wildlife and ecosystems. Actions such as active habitat manipulations designed to resist climate change effects by maintaining the status quo are impractical on the scale of Arctic Refuge, have potential to conflict with the Refuge's special values, and are likely to have unintended ecological consequences.

Strategy: Direct manipulations to resist effects of climate change on wildlife and ecosystems will generally be avoided. Rather, climate change adaptation will be facilitated by management actions designed to reduce non-climate related stressors that are under the control or influence of the Refuge. Examples may include actions that minimize disturbance to wildlife during vulnerable periods or protect Refuge habitats and migratory pathways from visitor-related impacts.

Long-term Priorities (9+ years)

Objective 6.5: Monitoring Biological Components Vulnerable to Climate Change—Monitoring targets within the Refuge's Long-term Ecological Monitoring Program will include biological components identified in the Ecological Review as vulnerable to climate change.

Rationale: Successful monitoring of climate change effects is inherently a long-term commitment because changes may be gradual and initially obscured by natural inter-annual variation or by effects of other, more direct anthropogenic stressors.

Strategy: As part of our Long-term Ecological Monitoring Program (Objectives 1.2 and 1.9), specific efforts will focus on climate-vulnerable species and ecological communities, or lands for which the Service has trust responsibility. We will implement protocols identified in our I&M and Research plans and evaluated in our Ecological Review to acquire information related to climate-mediated effects on Refuge resources.

2.1.7 Goal 7: Refuge staff and partners conduct research and monitoring in support of the Refuge's role as an internationally recognized benchmark for naturally functioning arctic and subarctic ecosystems.

Ongoing and Immediate Priorities (Years 1-3)

Objective 7.1: Collaborative Research—Refuge staff will support and/or participate in collaborative studies of arctic and subarctic ecological and physical systems that depend upon the essentially undisturbed environments and ecological processes on the Refuge.

Rationale: The Refuge is vast, and direct human impacts are rare to a degree that is increasingly uncommon in the modern world. Those who campaigned to establish the original Range stressed its value as a natural laboratory for understanding ecological systems. The size and diversity of the Refuge and the complexity of ecological processes that can be studied here necessitates cooperation and collaboration with scientists in diverse fields of specialization.

Strategy: We will seek funding and partnerships to participate in broad-scale collaborative studies of arctic and subarctic ecosystems. The Refuge is well positioned to contribute to broader understanding of how these ecosystems are changing and how such changes will affect the biosphere. Partners will represent State and Federal governmental agencies, academic institutions, non-governmental organizations, private industry, and tribes. We will actively participate in the Arctic and Northwestern Interior Forest LCCs, and the National Wildlife Refuges I&M Program. We will continue ongoing efforts such as collaboration with the Arctic and Boreal Long Term Ecological Research sites, the Arctic Coastal Dynamics Program, national and international bird and mammal working groups (e.g., Muskox Working Group, Porcupine Caribou Technical Committee, Arctic Shorebirds Demographic Network), and other regional, national, and international programs. When appropriate, biological staff will seek publication of research results in peer-reviewed literature. Staff will also transmit results though public media and other outreach methods to educate the public about the ecology of the Refuge and its scientific values.

Objective 7.2: International Treaties and Agreements—Refuge managers will continue to work with international partners to effectively manage resources at the landscape scale.

Rationale: ANILCA requires the Refuge to fulfill international treaty obligations of the United States with respect to fish and wildlife and their habitats. This purpose recognizes the role the Refuge plays in meeting treaty and agreement obligations related to conservation of the fish, wildlife, marine mammals, and migratory birds shared by many nations. The Refuge is part of a larger network of conservation authorities in the U.S., Canada and the circumpolar north that share resource responsibilities and concerns with agencies, conservation units, and other international working groups such as the Porcupine Caribou Management Board, International Porcupine Caribou Board, Vuntut and Ivavik National Parks, Old Crow Management Area, Arctic Borderlands Ecological Knowledge Cooperative, Northwest Territories Department of Environment and Natural Resources, Environment Yukon, the Canadian Wildlife Service, and Conservation of Arctic Flora and Fauna.

Strategy: We will coordinate and cooperate with adjacent land management units, resource management agencies, and conservation organizations on mutual fish and wildlife resource issues, fish and wildlife resource inventory and monitoring efforts, and climate change documentation. We will work cooperatively with Native Alaskan and First Nations people on conserving subsistence resources, and we will support the efforts of the Service offices of Migratory Bird Management, Marine Mammals Management, and others to fulfill treaty obligations involving Refuge resources.

Short-term Priorities (Years 4-8)

Objective 7.3: Encouraging Scientific Research by Cooperators—Within four years of Plan approval, Refuge biologists will develop and implement protocols and priorities that identify and encourage scientific research necessary for making informed management decisions, while ensuring that work conducted by cooperators is appropriate and compatible with Refuge purposes and special values, and the I&M and Research plans (see Objectives 1.2 and 1.3).

Rationale: The expertise and resources that scientific cooperators provide are essential for understanding complex ecological and physical systems on the Refuge. By identifying research needs and providing cooperators with a streamlined permitting process that also ensures appropriate protection of Refuge resources, we will attract specialists with skills that complement those of the Refuge's staff and ultimately result in more informed management decisions.

Strategy: As part of the I&M and Research planning efforts (Objectives 1.2 and 1.3), we will evaluate the process for permitting scientific work in the Refuge to ensure that high-priority scientific endeavors are encouraged. We will work with partners in the scientific community to address research needs in a collaborative manner, while ensuring that Refuge resources are protected (e.g., by conducting an MRA when research is proposed in designated Wilderness) and permit stipulations are met.

2.1.8 Goal 8: In consultation with appropriate parties, the Refuge documents, conserves, and protects cultural resources, both historic and prehistoric, to allow visitors and community members to appreciate the interconnectedness of the people of the region and their environment.

Ongoing and Immediate Priorities (Years 1-3)

Objective 8.1: Collaboration, Partnerships, and Traditional Knowledge—Refuge managers and other staff will continue to consult with local tribes and Native corporations and work with Native elders and others who possess knowledge of the area's cultural and traditional uses, landscapes, habitats, and resources to gain an understanding of past conditions and current observations.

Rationale: Local elders with knowledge of the area before the Refuge was established possess valuable information regarding past ecological conditions and traditional uses of Refuge lands. Time is of essence for interviewing and recording elders who have a close and deep connection to the land. Historical knowledge of species occurrence, abundance, and distribution, and of weather and ecosystem changes will help focus and direct future studies. Cooperative efforts will help bring together traditional ecological knowledge and western science to promote conservation of wildlife and wild landscapes for future generations.

Strategy: Refuge staff will increase existing efforts to collect traditional ecological knowledge from village elders. Interviews will focus on traditional access, changing landscapes, cultural resources, wildlife, and other important subsistence resources, and will start within two years. Information will be incorporated into a searchable database. The Refuge will continue to collaborate with the Arctic Borderlands Ecological Knowledge Cooperative, Native organizations such as the Council of Athabascan Tribal Governments, North Slope Borough, Tanana Chiefs Conference, and the tribal governments of Fort Yukon, Kaktovik and Venetie, and Arctic Village Council to collect and document traditional knowledge. Other partners could include the University of Alaska and the State of Alaska.

Objective 8.2: Cultural Resource Management, Monitoring, and Law Enforcement—Refuge staff will work with other cultural resource professionals to conserve and protect cultural resources by identifying important sites and areas at risk for vandalism or exposure from wind, water, or other environmental forces and by providing trained staff to monitor these sites with periodic site visits and law enforcement patrols.

Rationale: The Refuge has long-term responsibilities for cultural resources on Refuge lands and is directed by several laws and policies to manage and protect these resources (see Section 2.4.10.5). Training for appropriate staff on the kinds and value of cultural resources will provide the Refuge with several tools to manage cultural resources, monitor at-risk sites, and incorporate cultural resource values in their resource protection message. Identification of specific problem areas for monitoring will target high-profile activity areas for maximum deterrence. Cultural resource protection will be more effective if those conducting law enforcement patrols on the Refuge are aware of the locations of important resources and efforts are focused on those areas where resources are at greatest risk for vandalism or loss.

Strategy: Basic cultural resource, historic preservation, and consultation training will be provided to Refuge managers, other full-time and seasonal staff, and volunteers and will focus on how to protect archeological and historic resources and the legal and policy requirements for consultation and conservation of cultural resources. Refuge staff will complete training within two years of Plan's approval, or for new hires, within two years of assuming duties. Law enforcement personnel should receive specialized training. Upon Plan approval, law enforcement staff will incorporate patrols of known sites at risk into their resource protection activities. Sites will be added to these patrols as they are identified (see Objectives 5.7 and 8.4). Other Refuge staff will also monitor impacts to important cultural sites in conjunction with ongoing field work, when possible, or through targeted activities when needed.

Short-term Priorities (Years 4-8)

Objective 8.3: Integrated Cultural Resource Management Plan (ICRMP)—Service staff will prepare an ICRMP to improve conservation of cultural resources and provide guidance for cultural resource management on Refuge lands.

Rationale: An approved ICRMP has never been prepared for the Refuge. The ICRMP will contain an overview of Service cultural resource management authorities, responsibilities, and compliance requirements. It will identify inventories, archival research, ethnographic research, field surveys, evaluations, protections, and communications efforts that have taken place on the Refuge. The Refuge will work to develop partnerships and agreements for cooperative projects with museums, universities, Native organizations and tribal governments, and other institutions. This allows the partners to pool scarce resources and increase the amount of work they can complete. The Service will benefit from working with recognized experts and elders in the region and increase the value of its work to protect cultural resources.

Strategy: Within three years of Plan approval, Service staff will initiate preplanning by preparing an overview of Service cultural resource management authorities, responsibilities, and compliance requirements. Service staff will also conduct archival research to identify and begin compiling cultural inventories, reports and data, which will be incorporated into a searchable cultural resource database. Refuge and other Service staff will then initiate the ICRMP with formal tribal and Native corporation consultation and the establishment of agreements and partnerships. The planning process will be conducted deliberately to fully meet our consultation and collaboration requirements. We will seek out partnerships with Alaska Native organizations such as Tanana Chiefs Conference, Council of Athabascan Tribal Governments, the Gwich'in Steering Committee, the North Slope Borough, Arctic Slope Regional Corporation, and First Nation groups. Other partners such as the State Historic Preservation Office, regional historical societies, traditional chiefs and village leaders, and the University of Alaska will be cooperatively involved in identifying future research and conservation needs for cultural resources on the Refuge. We expect to have an approved plan completed within six years of implementation of the Revised Plan. Refuge staff will consult with tribes and Native organizations and the regional historic preservation officer to revise the ICRMP every 10 years based on review of new information obtained through inventory, monitoring, and research. The Refuge will work with these partners to compile, store, manage, and share historical and contemporary data on cultural resources to both inform and enhance their conservation.

Long Term Priorities (9+ Years)

Objective 8.4: Improve Management through Increased Knowledge of Cultural Resources—Increase the knowledge and effectiveness of the Refuge's management of cultural resources through surveys of high priority historical, archaeological, and other cultural sites; literature searches; gathering oral histories and place name information; and compiling a comprehensive Cultural Resource Atlas and Archive.

Rationale: Section 110 of the National Historic Preservation Act requires all land-managing Federal agencies take action to identify, evaluate, and nominate to the National Register of Historic Places those historic properties that meet the criteria set forth in 36 CFR 800. Only limited areas of the Refuge have been systematically studied, leaving the vast majority unknown to archaeologists. A high degree of regional site variability exists in Arctic Refuge, but many questions about why such diversity exists and how it developed and was maintained are not well understood. In addition to addressing questions about regional and temporal variability, surveys in unknown areas will provide immediate and useful information on site locations, characteristics, and conditions needed to effectively manage these resources. This information will allow continued and focused research on prehistoric and historic cultural resources, including environmental and cultural change over time. Archaeological, cultural, and historical resources are irreplaceable archives of human and environmental history. Much valuable cultural, historic, and scientific information about the Refuge is contained in existing published and unpublished material. Similarly, place names contain an enormous amount of information on traditional uses, culturally important places, historic camps and settlements, and other cultural information. This information is an untapped archive that could potentially benefit both the Refuge and surrounding communities. Accessing place name information will recognize the critical role of local people in the natural and cultural heritage of the Refuge. Compiling all known information will make it possible to evaluate information needs and data gaps, and to set priorities for surveys and research in archaeological and historic site protection, public interpretation, and historic ecological information that is useful in wildlife and habitat management.

Strategy: Surveys will be conducted at a level sufficient to evaluate eligibility of sites for inclusion on the National Register of Historic Places without requiring a follow-up visit. While actual surveys will be conducted as funding and personnel become available, the initial identification of priority areas and scoping for the surveys should be completed as part of the Integrated Cultural Resources Management Plan (Objective 8.3). In the case of an emergency, such as severe erosion at an important site, the Refuge will take immediate action to survey and document the threatened resource. The Refuge will also review published and unpublished materials about archaeological, historical, and ethnographical resources in collaboration with local tribes, elders, Native organizations, and the University of Alaska Fairbanks. The directory and atlas should include a comprehensive Geographic Information System of place names for use by Refuge staff. A working database should be completed within 10 years of approval of the Revised Plan and should be periodically updated as new information is gathered.

Objective 8.5: Administrative History—Within 10 years of a Final Plan, the Service will create a comprehensive administrative and scientific history of the Refuge as a legacy for future managers, staff, and the public.

Rationale: Over time, Refuge staff and former employees have amassed a wealth of institutional information on the history of the Refuge. An organized and accessible comprehensive inventory will make the information available to Service staff, researchers, and the public, and identify gaps to be filled by collection of oral histories or archival research. It is especially important that oral histories be carefully documented.

Strategy: The Service will inventory and organize records for the Refuge's history and compile and conduct oral histories from key people associated with the Refuge's past.

2.1.9 Goal 9: Refuge staff provides outreach information to distant audiences, individuals who enter the Refuge, and people in gateway communities, to enhance their understanding, appreciation, and stewardship of Refuge lands and resources.

Ongoing and Immediate Priorities (Years 1-3)

Objective 9.1: Communicating with Distant Public—Refuge staff use the Internet and other communication technologies, and will add new technologies when appropriate, to provide timely and accurate information to the public about Refuge resources and purposes, management and conservation, and impacts, such as changing climate.

Rationale: Refuge staff relies on the Internet and other digital communication for almost all its contact with the public because the Refuge is large and remote. Most people who visit Arctic Refuge come from a distance and need information before they arrive, and most people who request information about Refuge lands and wildlife are also far away. Refuge staff recognizes that to keep future pathways of communication open to diverse national and international audiences, it must adopt new technologies and media as these become readily available to the public. These technology based outreach efforts are meant to supplement and inform, not replace, genuine on-the-land nature experiences. Staff shares information with the public about all aspects of the Refuge, its management, its physical and natural processes, and the impacts of climate change and other stressors on these processes.

Strategy: Refuge staff will continue to support and expand an extensive website at http://arctic.fws.gov/, maintain an email address at arctic_refuge@fws.gov, and host an active Facebook page at http://www.facebook.com/arcticnationalwildliferefuge. It will add additional social media sites as public desire and staff availability allow. Refuge staff will continue to use best practices in interpretation, environmental education, and other outreach methods. Examples of technology-based outreach efforts include responding to public email inquiries and producing information about invasive weeds, tundra swans, polar bear viewing, climate change impacts, limiting visitor impacts, commercial permits, wildlife art and education projects, and much more.

Objective 9.2: Inform Refuge Users—Refuge staff will continue to provide Refuge orientation and information and will increase outreach to Refuge users about opportunities, specially designated areas, minimum impact techniques and other best practices, and regulations to provide a quality experience and minimize human impacts to Refuge resources and values.

Rationale: A variety of people use Refuge lands. These individuals may be recreational visitors, subsistence users, scientific researchers, commercial operators, Refuge staff, and others. Arctic Refuge presents unique and potentially life-threatening challenges to those who travel into the Refuge. Some Refuge lands have special designations, such as Wilderness and Wild Rivers, which affect their use. Refuge staff recognizes the importance of providing information to Refuge users so they can adequately prepare for and safely enjoy their time in the Refuge.

Strategy: Refuge staff distributes a variety of outreach products directed at the needs of those who travel into the Refuge. Outreach topics include designated Wilderness and wild rivers, minimum impact protocols, "Kids in Nature," bear viewing guidelines, bear conflict prevention, identification of and respect for private lands in and adjacent to the Refuge, limiting invasive plants, minimizing impacts where people tend to concentrate, and adequate trip preparation to ensure self-reliance. Refuge staff uses the Internet, mailings, kiosks and posters, and volunteers and staff in visitor centers and other locations to ensure that Refuge users have access to needed information.

Objective 9.3: Gateway Communities—Refuge staff, including Refuge Information Technicians (RITs) and volunteers, provide outreach information and participate in collaborative outreach activities in gateway communities to benefit participants and promote conservation of wildlife and natural landscapes.

Rationale: Close working relationships with communities can improve communication; inform residents, including students, about the Refuge and its programs; and help resolve community concerns about visitor impacts or Refuge management activities.

Strategies: Refuge staff, RITs, and volunteers will cooperate with community members and groups in the gateway communities of Kaktovik, Arctic Village, Coldfoot, Fort Yukon, and Fairbanks to address outreach issues that are of interest to residents and Refuge staff, and to undertake actions that directly connect the public with the natural world. Methods for implementing this objective include visitor centers and information kiosks, brochures, school presentations, and community presentations. RITs will be employed to improve communications between staff and residents in their communities, including translating outreach and environmental education information into Gwich'in and Inupiaq languages.

Long-term Priorities (9+ Years)

Objective 9.4: National Interest—Refuge staff will, on a 15-year cycle, perform a National Interest Study to inform the Service about the diverse national interests and values that Arctic Refuge holds for the broader public.

Rationale: Arctic Refuge, part of the National Wildlife Refuge System that is managed for the benefit of all Americans, continues to appear in the national spotlight. Refuge staff should be aware of the range of opinions the American public holds concerning the Refuge and its future. An unbiased and cost-effective way to assess the full range of public opinions is to conduct a nationwide (including Alaska) survey of all news articles and other published documents to assess how they characterize the Refuge.

Strategy: The 2009 Arctic Refuge National Interest Study (Christensen and Christensen 2009) surveyed news articles and other documents that identified the various opinions and values—tangible and intangible—Americans hold regarding Arctic Refuge and the issues relating to it. The study used well-tested computer techniques to analyze the content of articles and documents in a comprehensive database. Refuge staff will repeat this study every 15 years to determine how Americans' beliefs about, and values for, the Refuge change or persist over time.

2.2 Overview of Arctic Refuge Management Policies and Guidelines

Sections 2.3 through 2.5 describe direction for the management of Arctic Refuge. This direction is primarily guided by provisions in ANILCA; the National Wildlife Refuge System Administration Act, as amended by the National Wildlife Refuge System Improvement Act; the Refuge Recreation Act; the Endangered Species Act; the Alaska Native Claims Settlement Act; the Wilderness Act; and other national and regional regulations, policies, and guidance developed to implement these laws and the purposes of Arctic Refuge (Appendix A).

The management policies and guidelines published in comprehensive conservation plans for refuges in Alaska evolve over time in response to changing laws, policies, ecological conditions and understandings, and public awareness and preferences. These policies and guidelines vary among refuges because some refuges have unique purposes, and most have a unique set of special values. Refuge managers in Alaska are required by Section 304(g)(2)(B) of ANILCA to identify and describe the special values of a refuge before preparing a plan. This Plan describes 11 special values for Arctic Refuge that we determined should be protected and perpetuated through comprehensive Refuge management (Chapter 1, Section 1.5). A number of the established policies and guidelines were modified to enable managers at Arctic Refuge to meet this Refuge's specific purposes, perpetuate its special values, and continue its role and function in the larger National Wildlife Refuge System (Refuge System). Arctic Refuge's special values served as the primary basis for the unique management policies and guidelines found in this Plan and played a major role in developing the vision statement, goals, and objectives for the Plan. Management will primarily defer to natural processes and refrain from manipulating populations, habitats, and landscapes until all viable alternatives, including no actions, have been considered.

We changed Habitat Management (Section 2.4.11.1), Fish and Wildlife Population Management (Section 2.4.12), Fish and Wildlife Control (Section 2.4.12.7), and Fishery Restoration and Enhancement (Section 2.4.12.10) because in other plans these sections allowed for the use of management techniques, or actions, that substantially conflict with the relevant special values identified and described for Arctic Refuge. Examples of such management actions are mechanical habitat manipulation, water impoundments, fishery enhancement structures, and moving species to parts of the Refuge where they had not historically existed. Use of these techniques and tools at Arctic Refuge would substantially detract from the special values and distinctive role of Arctic Refuge within the larger Refuge System.

We changed Recreation and Public Use (Section 2.4.15), Public Use Facilities (Section 2.4.16), Cabins (Section 2.4.16.1), and Helicopters (Section 2.4.14.3). These revised sections of the Plan restrict various developments, facilities, public use cabins, and helicopter landings for recreational purposes because these would substantially detract from the existing conditions of the recreation setting and recreation opportunities, as reflected in the special values section of the Plan. For example, ANILCA allows public use cabins, but it does not mandate that refuges provide such structures. Managers at Arctic Refuge have decided not to provide public use cabins to protect and perpetuate unique recreational values (Chapter 1, Section 1.5.9).

This modified direction is unique to Arctic Refuge and is not intended to establish precedents or standard management policies and guidelines for other national wildlife refuges in Alaska or future comprehensive conservation plans developed by the Service.

The descriptions of the land management categories presented in this Revised Plan are not identical to those in the existing 1988 Plan for Arctic Refuge (Service 1988a). Until the Revised Plan is adopted for Arctic Refuge, if there is any conflict between the existing Plan and the new management categories, the direction in the existing Plan will take precedence over that contained in these guidelines for the management categories unless the conflict is the result of changes in law, judicial ruling, or other non-discretionary guidance.

2.3 Management Categories

Five management categories (Intensive, Moderate, Minimal, Wilderness, and Wild River) are used to describe the management levels throughout the Alaska refuges. A management category is used to define the level of human activity and development that is appropriate for a specific area of a refuge. A management category is a set of management directions applied to an area based on its resources and existing and potential activities or uses. These categories have been adopted and applied to accomplish Refuge purposes and achieve management goals. Lands in Arctic Refuge currently fall into three management categories: Minimal, Wild River, and Wilderness (Alternative A, Section 3.2.2). The Management Activities Table (Table 2-1)shows the administrative, public, and commercial activities and facilities that may be allowed in each management category and under what conditions. Direction is presented for the Intensive and Moderate Management categories to provide a basis of comparison and to be available if the Plan is amended to include either of these management categories. In Table 2-1, management categories that do not apply to current and proposed management of Arctic Refuge are shown over a grey background.

2.3.1 Intensive Management

The Intensive Management category is designed to allow compatible management actions, public facilities, and economic activities that may result in alterations to the Refuge environment. In Intensive Management areas, the presence of human developments and interventions may be very apparent. Roads, buildings, and other structures are likely to be seen. Intensive Management is applied to the smallest area reasonable to accommodate human developments and interventions.

Ecological processes or habitats may be modified through human intervention in an Intensive Management area. Habitats may be highly modified to enhance conditions for one or more species. For example, water regimes may be artificially controlled to improve habitat for waterfowl.

Substantial levels of public use may be accommodated and encouraged through alterations and modifications to the environment such as pavement, buildings, developed campgrounds, and other facilities. Public facilities are designed to provide a safe and enjoyable experience of the resources on Refuge lands and to increase understanding of fish and wildlife and their habitats for a wide range of visitors. Facilities are designed to accommodate a substantial number of visitors while protecting resources on Refuge lands from damage and visitor impacts.

Compatible economic activities or uses of resources on Refuge lands that result in alterations to the environment may be authorized in Intensive Management areas. All economic activities or uses must be compatible with Refuge purposes and the mission of the Refuge System. Economic activities or uses require official authorizations such as special use permits.

2.3.2 Moderate Management

The intent of Moderate Management is to allow compatible actions, public uses, commercial activities or uses, and facilities that may result in changes to the Refuge environment that are temporary or permanent but small in scale and that do not disrupt ecological processes. The natural landscape is the dominant feature of Moderate Management areas, although signs of human activities may be visible.

The intent of Moderate Management is to provide, restore, or enhance habitats to maintain healthy populations of plants and animals where ecological processes predominate. For example, logging and prescribed burning may be used to convert mature forests to an early seral stage to enhance browse for moose. In general, management facilities, both temporary and permanent, will be allowed for the purposes of gathering data to understand and manage resources and ecological systems of the refuges. Structures will be designed to minimize visual impact.

Public facilities provided in Moderate Management are designed to protect Refuge habitats and natural resources while allowing the public to enjoy and use resources on Refuge lands in relatively low numbers dispersed over a large area. The Moderate category also allows shorter-term enjoyment of resources on Refuge lands in focused areas as a means to concentrate visitors and impacts. The emphasis is on small facilities that encourage outdoor experiences. Facilities such as public use cabins, rustic campgrounds, kiosks, boardwalks, viewing platforms, trails, and toilets may be provided. Facilities will be designed to blend with the surrounding environment to minimize visual impacts.

Compatible economic activities may be allowed where impacts to ecological processes and habitats are temporary (e.g., small-scale logging where an earlier seral stage meets management goals; support facilities for commercial service providers; or cabins that encourage enhanced public use). All economic activities and facilities require authorizations such as special use permits.

2.3.3 Minimal Management

Minimal Management is designed to maintain Refuge environments with minimal or no evidence of human modifications or changes. Habitats are allowed to change and function through ecological processes. Administration will ensure that the resource values and environmental characteristics identified in a refuge's comprehensive conservation plan are conserved. Public uses, economic activities or uses, and facilities shall minimize disturbance to habitats and resources. Ground-disturbing activities are to be avoided whenever possible.

Management actions in this category focus on understanding ecological systems and monitoring the health of resources on Refuge lands. Generally, no roads or permanent structures are allowed (except cabins). Temporary structures may be allowed in situations in which removal of the structure is planned after the period of authorized use, and the site can be rehabilitated using native plantings from the immediate adjacent area. Existing cabins may be allowed for administrative, public, subsistence, commercial, or economic (e.g., guiding) purposes. New subsistence or commercial cabins may be authorized if no reasonable alternatives exist. Public use or administrative cabins may be constructed if necessary for health and safety.

Public use of Refuge lands is encouraged for hunting, fishing, wildlife observation and photography, interpretation and environmental education, and subsistence activities. Public use facilities are generally not provided. Mechanized and motorized equipment may be allowed when the overall impacts are temporary or where its use furthers management goals.

If a transportation or utility system, as defined in Section 1102 of ANILCA, is proposed to cross an area in Minimal Management, the authorization process will incorporate a corresponding amendment to the comprehensive conservation plan to change the management category in the affected area from Minimal to Moderate or Intensive Management, as appropriate.

Compatible economic activities may be allowed where the evidence of those activities does not last past the season of use, except as noted in the preceding discussion of cabins. The primary economic activities are likely to be commercially-supported recreational activities such as hunting, fishing, hiking, river floating, and sightseeing. All economic activities and facilities require authorizations such as special use permits.

2.3.4 Wilderness Management

The Wilderness Management category applies to areas designated by Congress as units of the National Wilderness Preservation System (NWPS). The Refuge manages approximately 7.16 million acres of designated Wilderness in the northeast section of the Refuge. Any areas proposed for designation under the Wilderness Act will be managed under Minimal Management, consistent with Section 1317(c) of ANILCA and Service policy. Designated Wilderness will be managed under the Wilderness Act of 1964 and the special provision of ANILCA. Because the designated Wilderness area in Arctic Refuge is part of the NWPS, the Service recognizes that responsibilities for managing designated Wilderness go beyond the mission of the Service. For the designated Wilderness area, the purposes of the Wilderness Act are within and supplemental to the other purposes for which Arctic Refuge was established. (See Section 2.4.20 for guidelines on management of designated Wilderness areas in Alaska.)

The history and intent of the Wilderness Act encourages managers to hold a broad perspective of the Refuge landscape, one that extends beyond managing designated Wilderness solely as wildlife habitat. It is managed as an area "retaining its primeval character and influence." Designated Wilderness provides visitors with opportunities for "solitude or a primitive and unconfined type of recreation." Recreation in designated Wilderness areas has been characterized by an array of experiences such as discovery, self-reliance, remoteness, closeness to nature, challenge, self-reflection, and freedom from societal and managerial constraints (e.g., Hollenhorst and Jones 2001, Landres et al. 2008, Patterson et al. 1998).

Designated Wilderness areas are managed for a number of purposes, including preservation of experiential and symbolic values that are important to people. Wilderness areas are "devoted to the public purposes of recreational, scenic, scientific, educational, conservation, and historical use" (Wilderness Act, Section 4(b)). Research has shown that some values of designated Wilderness areas extend beyond their boundaries to people who may never visit but who benefit from the protection of ecological processes—benefits such as clean air and water and the knowledge that such places exist (Cordell et al. 1998). In managing designated Wilderness, Refuge managers are encouraged to consider, in decision making, off-site and symbolic values, as well as on-site and tangible experiences and resource values.

Permanent structures are generally prohibited. Exceptions include historic and cultural resources and, in certain circumstances, administrative structures or cabins that predate ANILCA; cabins that are necessary for trapping activities; and public use cabins necessary for the protection of human health and safety. Facilities and structures are rustic and unobtrusive in appearance.

Compatible commercial services or uses of designated Wilderness areas are generally limited to those activities that facilitate solitude and a primitive, unconfined type of recreation (e.g., guided fishing, hunting, and river floating or hiking into designated Wilderness areas). All commercial services and facilities require authorizations such as special use permits.

Actions such as prescribed fires or invasive species control may be conducted when it is necessary to protect life or property or when it is necessary to restore, maintain, or protect the aforementioned characteristics of designated Wilderness.

All Refuge management activities in designated Wilderness must be supported by an MRA whether or not any prohibited uses are proposed. Normally prohibited uses (e.g., motor vehicles, motorized equipment, helicopters, structures, installations, temporary roads, etc.) will be approved only where found to be the minimum necessary to manage the area as Wilderness.

2.3.5 Wild River Management

The Wild River Management category applies to those rivers and corridors of adjacent lands that have been designated by Congress as part of the Wild and Scenic Rivers System under the Wild and Scenic Rivers Act of 1968. It is the policy of the United States that "certain selected rivers of the Nation which, with their immediate environments, possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural or other similar values, shall be preserved in free-flowing condition, and that they and their immediate environments shall be protected for the benefit and enjoyment of present and future generations" (P.L. 90-542, Section 1(b)). Other protected values of designated rivers may include features of scientific importance, archaeological resources, and aesthetic qualities.

In the Wild River Management category, water bodies are maintained in natural, free-flowing, and generally undisturbed conditions. Each river in the Wild and Scenic Rivers System has particular values for which it was designated, and management of a wild river must protect those specific values. Management actions will focus on understanding, monitoring, and maintaining the natural resources, ecosystem function, and aesthetics of the river corridor.

All designated rivers on refuges in Alaska are classified as wild rivers. Wild rivers are those rivers or sections of rivers that are free of impoundments, with shorelines or watersheds still largely primitive and waters unpolluted. Any portion of a wild river that is in designated Wilderness is subject to the provisions of both the Wilderness Act and the Wild and Scenic Rivers Act; in case of conflict between the provisions of these laws, the more restrictive provisions apply. Permanent structures generally are not allowed, with the exception of historic and cultural resources and, in certain limited circumstances, subsistence or administrative cabins and associated structures. Cabins, temporary structures, and hardened sites should not be visible from the river; where this is not practicable, facilities and structures are to be rustic or unobtrusive in appearance. Refuge managers will provide opportunities for low-impact, backcountry recreation experiences.

ANILCA designated those portions of the Ivishak, Sheenjek, and Wind rivers in the boundaries of the Refuge as wild rivers under the Wild and Scenic Rivers Act. Sixty-one miles of the 95-mile long Ivishak River lie in Arctic Refuge. A 191-mile segment of the Sheenjek River is classified as wild. The Wind River, also classified as wild, flows for 102 miles and is entirely in Arctic Refuge. Please refer to Section 4.1.3.4 in Chapter 4 for more information about these wild rivers.

The Wild and Scenic Rivers Act requires the Service to preserve the values and characteristics of these wild river corridors in Arctic Refuge. Compatible uses of the Ivishak, Sheenjek, and Wind wild river corridors will be allowed where those activities do not detract from their (outstandingly remarkable) special values. Primary commercial activities or uses are likely to be recreation services such as guided float trips, sightseeing, photography, fishing, and hunting trips. All commercial activities and facilities require authorizations such as special use permits.

2.3.6 Special Management Areas

Special management lands are managed in one of the categories described previously with added requirements related to their establishment and special status. Special management areas in Arctic Refuge include the Firth- Mancha Research Natural Area (RNA), the Shublik Springs RNA, the Neruokpuk Lakes Public Use Natural Area (PUNA), and the Arctic National Wildlife Refuge Marine Protected Area (MPA). Please see Chapter 4 for more information about these lands.

2.3.6.1 Management of Selected Lands

The Service retains management responsibility for lands selected but not yet conveyed to Native village and regional corporations or to the State of Alaska. The appropriate Native corporation or agency of the State will be contacted and its views considered prior to issuing a permit involving these lands. Fees collected for special use or right-of-way permits will be held in escrow until the selected lands are conveyed or relinquished. Management of selected lands will be the same as for adjacent Refuge lands.

2.3.6.2 Alaska Native Claims Settlement Act Section 22(g)

Section 22(g) of the Alaska Native Claims Settlement Act (ANCSA) provides that those Refuge lands established prior to December 18, 1971, and conveyed under that act remain subject to the laws and regulations governing the use and development of the Refuge. The compatibility standard, as it applies to activities occurring on these lands, is described in 50 CFR 25.21(b)(1). In addition, the Service retains the right of first refusal on village corporation lands if these lands are ever offered for sale. Arctic Refuge will work with landowners to balance the commercial development and use of 22(g) lands with the protection of resources important to Refuge purposes.

Arctic Slope Regional Corporation (ASRC) received a large tract of subsurface through the Chandler Lake Land Exchange of August 9, 1983. Under the agreement, the United States transferred subsurface rights under Kaktovik Iñupiat Corporation (KIC) lands on the Refuge's coastal plain (more than 90,000 acres) in exchange for 101,272 acres of private surface lands in Gates of the Arctic National Park. The commercial development of oil and gas from ASRC's acquired subsurface in the Refuge is contingent upon an act of Congress, as provided in ANILCA Sections 1002 and 1003. ASRC may remove sand and gravel from these lands, provided they follow provisions in the Chandler Lake Exchange agreement that specify how and where sand and gravel pits are located and developed. The exchange included land use stipulations to ensure the conveyance of the subsurface to ASRC would not "undermine the essential integrity of the Arctic National Wildlife Refuge and will not frustrate the purposes of the Refuge." The stipulations remain with the land even if it is sold or exchanged.

2.4 Management Policies and Guidelines

2.4.1 Introduction

Refuge management is governed by Federal laws such as the National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. 668dd), as amended, (Refuge Administration Act); National Wildlife Refuge System Improvement Act of 1997, an amendment to the Refuge Administration Act (P.L. 105-57) (Refuge Improvement Act); Wilderness Act (P.L. 88-577); and ANILCA. Refuge management is directed by regulations implementing these laws; treaties; Service policies; and principles of sound resource management—all of which establish standards for resource management or limit the range of potential activities and uses that may be allowed on the refuges.

ANILCA authorizes traditional activities such as subsistence, the exercise of valid commercial fishing rights, hunting, fishing, and trapping in accordance with State and Federal laws. Service regulations state that "public recreation activities within the Alaska national wildlife refuges are authorized as long as such activities are conducted in a manner compatible with the purposes for which the areas were established" (50 CFR 36.31(a)). Such recreation activities include but are not limited to sightseeing, nature observations and photography, hunting, fishing, boating, camping, hiking, picnicking, and related activities. The Refuge Administration Act, as amended by the Refuge Improvement Act, defines "wildlife-dependent recreation" and "wildlife-dependent recreational use" as "hunting, fishing, wildlife observation and photography, or environmental education and interpretation" (16 U.S.C. § 668ee). These public activities are encouraged and emphasized in visitor management programs on refuge lands in Alaska.

2.4.2 Human Safety and Management Emergencies

When management emergencies occur on the Refuge, it may be necessary to deviate from management policies and guidelines discussed in this Plan. Actions not normally allowed on the Refuge or under a specific management category, as shown in Table 2-1, may be allowed when needed during or as a result of management emergencies.

Management emergencies include threats to human health and safety and threats to resources on Refuge lands. For example, emergencies could arise that jeopardize threatened or endangered species, natural diversity, water quality and/or quantity, or subsistence resources. The introduction of an invasive species is another example of a management emergency. In management emergencies, the Refuge manager is authorized to take whatever prudent and reasonable actions are necessary.

For emergencies not related to human health and safety, the manager must consider the immediate and long-term effects of potential response actions on all Refuge purposes, goals, objectives, and special values. Urgent situations that require actions taking longer than 30 days require a compatibility determination, National Environmental Policy Act (NEPA) compliance, and an ANILCA Section 810 evaluation of potential impact to subsistence.

2.4.3 Land Exchanges and Acquisitions

Under Section 1302 of ANILCA, and subject to certain restrictions, the Service may acquire by purchase, donation, or exchange any lands inside the boundaries of Alaska refuges. Proposed land exchanges or acquisitions must benefit fish and wildlife resources, satisfy other purposes for which the Refuge was established, or be necessary to satisfy other national interests.

In 1988, Congress amended the general exchange of Section 1302 by requiring an Act of Congress before the Secretary can convey "by exchange or otherwise, land or interests in lands within the Coastal Plain of the Arctic National Wildlife Refuge" (P.L. 100-395). The amendment addressed Congressional concerns that exchanges could ultimately preempt the authority of Congress to make the decision of whether to lease and develop oil and gas resources of the coastal plain.

Other laws provide the Service authority to purchase conservation easements (Service Manual 341 FW 1, Exhibit 1) or enter into cooperative management agreements to satisfy Refuge purposes, national interests, or other objectives.

2.4.4 Land Protection Plans

DOI and Service policies require development of a step-down plan, called a land protection plan, to address priorities for habitat conservation inside Refuge boundaries. LPPs inform private landowners what land inside Refuge boundaries the Service would like to see conserved for fish and wildlife habitat. The plans do the following:

- Identify the private lands inside Refuge boundaries that the Service believes have important conservation values
- Display the relative protection priority for each parcel
- Discuss alternative means of land and resource conservation
- Analyze the impacts on local residents of acquisition

The Service acquires land, or land interests such as conservation easements, only from those landowners who are willing to sell, and it only does so when other methods of achieving goals are not appropriate, available, or effective. Sometimes resource conservation goals can be met through cooperative management agreements with landowners or by similar means. The Service and Arctic Refuge will work with all landowners to ensure that overall fish, wildlife, and habitat values in the Refuge are conserved.

- A land protection plan for Arctic Refuge is scheduled to be completed in 5–8 years of approval of this plan.

A pre-acquisition environmental site assessment is required for all real property proposed for acquisition by the Service or for public domain lands returning to Service jurisdiction (Service Manual 341 FW 3).

2.4.5 Appropriate Refuge Uses

Comprehensive conservation plans include a review of the appropriateness and compatibility of existing uses and any planned future public uses of Refuge lands. All uses of a national wildlife refuge over which the Service has jurisdiction must be determined to be appropriate under the Appropriate Refuge Uses Policy (Service Manual 603 FW 1). An appropriate use of a national wildlife refuge is a proposed or existing use that meets at least one of the following four conditions:

1. The use is a wildlife-dependent recreational use as identified in the Refuge Improvement Act, Section 5(2) (i.e., "hunting, fishing, wildlife observation and photography, or environmental education and interpretation").
2. The use contributes to fulfilling Refuge purpose(s), the Refuge System mission, or goals or objectives described in a Refuge management plan approved after October 9, 1997, the date the Refuge Improvement Act was signed into law.
3. The use involves the take of fish and wildlife under State regulations.
4. The Refuge manager has evaluated the use following guidelines in the Service Manual 603 FW 1.11 in the subsequent text and found it appropriate.
    a. Do we have jurisdiction over the use?
    b. Does the use comply with applicable laws and regulations (Federal, State, tribal, and local)?
    c. Is the use consistent with applicable Executive orders and DOI and Service policies?
    d. Is the use consistent with public safety?
    e. Is the use consistent with goals and objectives in an approved management plan or other document?
    f. Has an earlier documented analysis not denied the use, or is this the first time the use has been proposed?
    g. Is the use manageable with available budget and staff?
    h. Will this be manageable in the future with existing resources?
    i. Does the use contribute to the public's understanding and appreciation of the Refuge's natural or cultural resources, or is the use beneficial to the Refuge's natural or cultural resources?
    j. Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality, compatible, wildlife-dependent recreation in the future?

This Plan identifies those existing and proposed uses that were found appropriate and for which compatibility determinations were drafted for public review (refer to the compatibility determinations for any temporal, geographic, or other stipulations specific to the use (Appendix G)):

- State of Alaska Routine Wildlife Management Activities
- Commercial Air Transportation Services
- Commercial Big-game Hunting Guide Services
- Commercial Recreational Fishing Guide Services
- Commercial Recreational Guide Services
- Commercial Videography and Audio Recording

- Commercial Shore-Fast Sea Ice Access
- Non-Wildlife-Dependent Recreational Activities
- Reburial of Human Remains per State and Federal Guidelines
- Recreational (General) Fishing
- General Hunting
- Furbearer Trapping (Non-Subsistence)
- Scientific Research
- Subsistence Harvest of House Logs
- Subsistence Activities
- Waste Cleanup and Site Remediation
- Wildlife Observation, Wildlife Photography, Environmental Education, and Interpretation

All current appropriate use documentation for Arctic Refuge is on file at the Refuge headquarters and the Alaska regional office. If additional activities or uses not addressed in this Plan are proposed for the Refuge, the Refuge manager will determine if they are appropriate uses following the guidance in Service Manual 603 FW 1.

2.4.6 Compatibility Determinations

The Refuge Administration Act states, "the Secretary [of the Interior] is authorized, under such regulations as he [or she] may prescribe, to … permit the use of any area within the [Refuge] System for any purpose, including but not limited to hunting, fishing, public recreation and accommodations, and access whenever he [or she] determines that such uses are compatible … "

A compatible use is a proposed or existing wildlife-dependent recreation use or any other use of a national wildlife refuge that, based on sound professional judgment, would not materially interfere with nor detract from the fulfillment of the Refuge System mission or the purposes for which a national wildlife refuge was established. Economic activities or uses must contribute to achieving Refuge purposes and the Refuge System mission.

A refuge compatibility determination is the document that results from the analysis and public review conducted by the Service to find an activity or use compatible or not compatible with the purposes of a refuge. Compatibility determinations are not required for refuge management activities, except economic activities. They are also not required where statute directs mandatory approval of the activity, as in the case of facilities for national defense.

Arctic Refuge will follow normal administrative procedures for stopping an activity or use that is found to be incompatible. For example, the Refuge manager will not issue a special use permit for any new activity or use that is found to be incompatible. In the case of an existing activity or use already under permit, the Refuge manager will work with the permit holder to modify the activity or use to make it compatible or will terminate the permit.

Ending incompatible activities or uses on Refuge lands that do not require a special use permit or other formal authorization, or that cannot be addressed by other Federal or State agencies, will require the Refuge to go through the normal rulemaking process. This will include publishing the proposed regulations in the Federal Register and providing adequate opportunity for public comment.

Compatibility determinations for existing hunting, fishing, wildlife observation and photography, and environmental education and interpretation must be re-evaluated with the preparation or revision of a comprehensive conservation plan or at least every 15 years, whichever is earlier. Compatibility determinations for all other activities or uses on Refuge lands must be re-evaluated every 10 years or earlier if conditions change or new information about an activity or use and its effects becomes available.

Compatibility determinations prepared concurrently with comprehensive conservation plans or step-down management plans undergo public review and comment at the same time as the draft Plan and associated NEPA document (Service Manual 603 FW 2.11I). For compatibility determinations prepared separately from a Refuge plan, the Service will determine the appropriate level of public review and comment through a tiered approach based on the complexity and controversy of the use and the level of impact to the Refuge (Service Manual 603 FW 2.12A(9)). Additional details on applying compatibility standards and completing Refuge compatibility determinations are found in the compatibility regulations at 50 CFR (parts 25, 26, and 29) and in the Service Manual (603 FW 2).

Appendix G of this Plan contains the signed compatibility determinations for activities or uses on Arctic Refuge, and each includes a summary of the public comments received on the draft compatibility determinations. To review completed compatibility determinations for all refuges in Alaska, go to http://alaska.fws.gov/nwr/planning/completed.htm.

2.4.7 Mitigation

In the interest of serving the public, it is the policy of the Service, throughout the nation, to seek to prevent, reduce, or compensate for losses of fish, wildlife, and their habitats, and uses thereof, from land and water development. To that end, the Service developed a Mitigation Policy in 1981 that includes measures ranging from avoiding an activity that results in loss of such resources to seeking compensation by replacement of or substitution for resource loss.

The Service will promulgate regulations, develop stipulations, and issue permits to reduce or eliminate potential adverse impacts resulting from compatible activities that may be authorized under this Plan. These regulations, stipulations, and permits would mitigate impacts in a variety of means, as stipulated in the Mitigation Policy guidelines (Service Manual 501 FW 2.1). The means, in order of application, are as follows:

1. Avoid the impact altogether by not taking a certain action or parts of an action.
2. Minimize impacts by limiting the degree or magnitude of the action and its implementation.
3. Rectify the impact by repairing, rehabilitating, or restoring the affected environment.
4. Reduce or eliminate the impact over time by preservation and maintenance operations during the life of the action.
5. Compensate for the impact by replacing or providing substitute resources or environments.

The Service generally does not allow compensatory mitigation on Refuge System lands. Only in limited and exceptional circumstances related to existing rights-of-way could compensatory mitigation be used to find a use compatible. The Service Manual (501 FW 2 and 603 FW 2) provides more information.

Mitigation may consist of standard stipulations such as those attached to right-of-way permits; special stipulations that may be attached to leases or permits on a site-specific basis; and site- and project-specific mitigation identified through detailed step-down management plans or the environmental assessment process. In all instances, mitigation must support the mission of the Refuge System and must be compatible with the purposes of a refuge. The degree, type, and extent of mitigation undertaken would depend on the site-specific conditions present and the management goals and objectives of the action being implemented.

2.4.8 Coastal Zone Consistency

Federal lands, including lands in the Refuge System, are excluded from the coastal zone (16 U.S.C., Section 1453[1]). The Coastal Zone Management Act of 1972, as amended (P.L. 92-583), directs Federal agencies conducting activities in the coastal zone, or that may affect any land or water use or natural resources of the coastal zone, to conduct these activities in a manner that is consistent with approved State management plans to the maximum extent practicable (15 CFR 930.32). Federal regulations state that "(w)hen Federal agency standards are more restrictive than standards or requirements contained in the State's management program, the Federal agency may continue to apply its stricter standards" (15 CFR 930.39[d]).

The Alaska Coastal Zone Management Act of 1977, as amended, and the subsequent Alaska Coastal Management Program, as amended, and the Final Environmental Impact Statement (1979) had established policy guidance and standards for the review of projects in or potentially affecting Alaska's coastal zone. The State of Alaska had formerly approved coastal management plans for most incorporated cities, municipalities, boroughs, and unincorporated areas in the coastal zone. However, the Alaska Coastal Management Program was terminated on July 1, 2011 (AS 44.66.030). Therefore, a consistency evaluation with the State of Alaska was not necessary for Arctic Refuge's Revised Plan.

2.4.9 Cooperation and Coordination with Others

2.4.9.1 Federal, State, and Local Governments

Arctic Refuge staff will continue to work closely with those Federal, State, and local governments and agencies whose programs affect, or are affected by, the Refuge. State and local government input will be sought during the development of regulatory policies addressing management of the Refuge System (Executive Order 13083, "Federalism"). When possible, the Service will participate in interagency activities (such as joint fish and wildlife surveys and co-funded research), cooperative agreements, sharing data, and sharing equipment and/or aircraft costs to meet mutual management goals and objectives. The Service is the final authority over management of Refuge lands and waters.

The Refuge and the State will maintain a cooperative relationship in managing fish and wildlife resources in the Refuge. The Master Memorandum of Understanding between the Service and ADFG, dated March 13, 1982, defines the cooperative management roles of each agency (Appendix B). In this agreement, the ADFG agreed to "recognize the Service as the agency with the responsibility to manage migratory birds, endangered species, and other species mandated by Federal law, and on Service lands in Alaska to conserve fish and wildlife and their habitats and regulate human use." The State also agreed to "manage fish and resident wildlife populations in their natural species diversity on Service lands." The Service agreed to "recognize the right of the ADFG as the agency with the primary responsibility to manage fish and resident wildlife within the State of Alaska." Both agencies agreed "to recognize that the taking of fish and wildlife by hunting, trapping, or fishing on Service lands in Alaska is authorized in accordance with applicable State and Federal law unless State regulations are found to be incompatible with documented refuge goals, objectives, or management plans." Further discussion of intergovernmental cooperation regarding the preservation, use, and management of fish and wildlife resources is found in 43 CFR 24, "Department of the Interior Fish and Wildlife Policy: State and Federal Relationships."

The Service does not require compatibility determinations for State wildlife management activities on a national wildlife refuge pursuant to a cooperative agreement between the State and the Service where a Refuge manager has made a written determination that such activities support fulfilling Refuge purposes or the Refuge System mission. When the activity proposed by the State is not part of a cooperative agreement or the State is not acting as the Service's agent, a special use permit may be required, and a compatibility determination will need to be completed before the activity may be allowed. If existing or proposed State fish and wildlife management does not conform to the goals, objectives, policies, and guidelines in the Revised Plan, the Service would find the use incompatible and would not allow the use on the Refuge.

Separate Refuge compatibility determinations will be required for specific State management activities that propose predator management, fish and wildlife control (with the exception of emergency removal of animals posing an immediate threat to human health and safety), reintroduction of species, non-native species management, pest management, disease prevention and control, fishery restoration, fishery enhancement, native fish introductions, non-native species introductions, construction of facilities, helicopter and off-road vehicle access, or any other un-permitted activity that could alter ecosystems on the Refuge.

The Service works closely with State and local air quality permitting authorities, the U.S. Environmental Protection Agency (EPA), and other agencies to ensure protection of air quality and air quality-related values on the Refuge. The Federal Land Managers' Air Quality Related Values Workgroup Report (USFS et al. 2010) explains the authorities and the policy and technical requirements of the Service in carrying out these duties. In an effort to reaponsibly expand domestic oil and gas production activities, on June 23, 2011, DOI, the Department of Agriculture, and EPA signed a Memorandum of Understanding that describes an interagency approach to address air quality issues associated with onshore oil and gas development on public lands. The memorandum establishes a common process for the agencies to follow for analyzing potential impacts to air quality and air quality-related values from proposed oil and gas activities on federally managed public lands. The framework in the memorandum is to be used during the NEPA process when making Federal oil and gas decisions and applies at the planning, leasing, or field development stages.

The Service will cooperate with other State agencies such as ADNR and the Department of Transportation and Public Facilities and with local governments on matters of mutual interest—and may enter into informal and formal management agreements.

2.4.9.2 Tribes and Native American Organizations

The United States has a unique legal and political relationship with American Indian and Alaska Native tribal governments as set forth in the Constitution of the United States, treaties, statutes, court decisions, Executive orders, and policies. In recognition of this relationship, the President issued Executive Order 13175 (Consultation and Coordination with Indian Tribal Governments) on November 6, 2000, which provides guidelines to all Federal agencies for how to establish regular and meaningful consultations with tribal officials. In January 2001, DOI established the Alaska Policy on Government-to-Government relations. A Presidential Memorandum was signed in 2009, and the DOI Policy on Consultation with Indian Tribes was published in 2011. In August 2012, the DOI Policy on Consultation with Indian Tribes was supplemented with the requirement to consult with ANCSA corporations on actions or activities that may have a substantial direct effect on Alaska Native corporations, including corporation lands, waters, or resources. These policies reaffirm the Federal government’s commitment to operate within a government-to-government relationship with Indian and Alaska Native peoples.

In 2011, the Federal Subsistence Board began addressing how meaningful government-to-government consultation can occur in the management of fish and wildlife and subsistence uses as envisioned by Congress. The Federal Subsistence Board recently approved an interim government-to-government consultation protocol and an interim government-to-Native corporation (i.e., ANCSA corporations) consultation protocol that will guide its efforts until final protocols are developed. In compliance with DOI Policy, the Service will consult with appropriate ANCSA corporations in the same way it consults with federally recognized tribes. ANCSA corporations include any Alaska Native village corporation, urban corporation, or regional corporation as defined in, or established pursuant to, the ANCSA.

Consultation will occur whenever a Federal action with tribal or Native corporation implications is proposed, including the decision making process for that action. An example of such an action is the preparation of a management plan for an area near tribal lands or a proposed change in the management of subsistence resources. In Alaska, formal consultation with tribes and Native corporations is necessary for successful Refuge management. Arctic Refuge will continue to communicate about ongoing and future research, monitoring, and management activities. The Refuge will work directly with neighboring ANCSA regional and village corporations, Native organizations, and the North Slope Borough regarding Alaska Native subsistence opportunities, interests, and cultural values that may be affected by Refuge programs, plans, or management actions.

2.4.9.3 Owners of Refuge Inholdings and Adjacent Lands

Arctic Refuge will work cooperatively with inholders and adjacent landowners, providing information on Refuge management activities and policies. The Refuge will consult periodically with them regarding topics of mutual interest, respond promptly to concerns over Refuge programs, and participate in cooperative projects (e.g., water quality monitoring, fish and wildlife management).

2.4.9.4 Service Jurisdiction over Waters in Arctic Refuge

Where the United States holds title to submerged lands beneath waters in the Refuge, the Service has jurisdiction over certain activities on the water. In 1980, under ANILCA, the United States Congress established or expanded 16 national wildlife refuges. These areas of land and water may contain both navigable and non-navigable waters. Where water bodies are non-navigable in the Refuge boundaries, the Service has management authority over most activities on water where adjacent uplands are federally owned. Where State of Alaska lands exist beneath navigable water bodies or where the State, a Native corporation, or a Native allottee owns the adjacent uplands inside the Refuge boundaries where the withdrawal process started after statehood, the Service's management authority is more limited.

The Service's statutory authority to manage these lands and waters comes from ANILCA; the Service manages these lands pursuant to the Refuge Administration Act. Under provisions of ANILCA, the Federal Subsistence Board manages fishing for federally qualified subsistence users on all inland waters with a Federal reserved water right within and adjacent to the external boundaries of the refuges (50 CFR 100.3(b)(c)). Fishing also occurs under State regulations throughout the Refuge. Submerged land ownership with Arctic Refuge is discussed in greater detail in Chapter 4, Section 4.1.2.8.

2.4.9.5 Cooperative Wildland Fire Management

The Service Region 7 (Alaska) has entered into a Master Cooperative Wildland Fire Management Agreement (Master Agreement) with:

- State of Alaska, Department of Natural Resources (ADNR)
- United States Department of Agriculture, Forest Service, Alaska Region (Region 10) (USFS)
- United States Department of the Interior (DOI), Bureau of Indian Affairs, Alaska Region (BIA)
- DOI, Bureau of Land Management, Alaska (BLM)
- DOI, Bureau of Land Management, Alaska Fire Service (BLM-AFS)
- DOI, National Park Service, Alaska Region (NPS)

The Master Agreement documents the commitment of those agencies to improve efficiency by facilitating the coordination and exchange of personnel, equipment, supplies, services, and funds in sustaining wildland fire management activities. This includes prevention, preparedness, communication and education, fuels treatment and hazard mitigation, fire planning, response strategies, tactics and alternatives, suppression, and post-fire rehabilitation and restoration. The Master Agreement is also the basis from which the DOI agencies implement DOI Manual 620 (620 DM) and for the USFS to implement Forest Service Manual 5100.

The Master Agreement incorporates the following statewide planning documents:

- The Alaska Statewide Annual Operating Plan addresses issues affecting statewide cooperation and fiscal obligations.
- The Alaska Interagency Wildland Fire Management Plan (AIWFMP) specifies direction for the response to wildland fires that is based on a management option designation, and it provides guidelines to jurisdictional and protection agencies for decision support requirements as the complexity of a wildland fire increases.
- The Alaska Interagency Mobilization Guide identifies policy and agreements that establish the standard procedures that guide the operations of multi-agency and/or multi-jurisdictional logistical support activities. The guide is intended to promote uniformity of logistical support communications, facilitate interagency dispatch coordination, and ensure that the most timely and cost-effective support services are provided.

Individual agency policies and requirements are not superseded by the Master Agreement, the Alaska Statewide Annual Operating Plan, or the AIWFMP. These documents are meant to be used in conjunction with unit-specific fire management plans that reference and cite agency and unit fire management policies, address the unit's enabling legislation and purpose, include a summary of the important resources and values of the unit, and identify, in broad programmatic terms, the direction found in the land and resource management plans, such as goals, objectives, standards, guidelines, and/or desired future conditions as they pertain to fire management.

2.4.9.6 Other Constituencies

Arctic Refuge will inform local communities, special interest groups, and others who have expressed an interest in or are affected by Refuge programs about Refuge management policies and activities. Refuge management will also consider the interests of its large nonlocal and non-visiting constituency when making decisions. The Refuge will seek input from these constituents when issues of local or national interest arise that may affect how the Refuge is managed. When appropriate, local residents and other stakeholders will be asked to participate in Refuge activities so their expertise and knowledge can be incorporated into Refuge management.

2.4.10 Ecosystem and Landscape Management

Species do not function alone; they function together in the environment as part of an ecosystem. Resources on Refuge lands will be managed by employing ecosystem management concepts. Individual species are viewed as integral to the diversity of those ecosystems and, as such, are indicators of the healthy functioning of the entire ecosystem. When the Service identifies species to use as indicators of the health of an ecosystem, it will do so through a rigorous peer-reviewed scientific process involving experts from other Federal agencies, ADFG, and others.

Refuges shall inventory, monitor, and maintain a comprehensive database of information on ecosystem components to help make effective management decisions and ensure proper long-term ecosystem stewardship. This includes regular and recurring monitoring of status and trends of ecosystem components such as fish, wildlife, plants, climatic conditions, soils, and water bodies. All monitoring will employ appropriate disciplines, new technologies, and scientific capabilities whenever practical.

2.4.10.1 Climate Change

Secretarial Orders 3226 (2001) and 3289 (2010), which apply to comprehensive conservation plans, require climate change impacts be considered and analyzed when planning or making decisions in the DOI. Because the arctic region is particularly vulnerable to the effects of climate change, this mandate is especially relevant to Arctic Refuge.

While the Refuge's purposes and goals call for conservation of fish, wildlife, plants, and their habitats in their natural diversity, this may not be possible for some species and ecosystems in the future if the meaning of "conservation" and "natural diversity" continues to be understood in the context of relatively fixed historic ecosystems and species assemblages. There are many unknowns regarding the potential effects of climate change. The Refuge will monitor climate change and its ecological effects and evaluate future scenarios for climate change effects on wildlife and ecosystems, placing emphasis on species that are threatened, endangered, or important for subsistence.

Refuge managers will investigate and consider a full range of responses to potential climate change impacts. For the foreseeable future, however, Refuge managers will generally adopt a non-intervention approach to climate change and will avoid actions aimed at resisting the effects of climate change on wildlife and ecosystems, subject to human safety and management emergencies (see Section 2.4.2). Managers will strive to allow natural systems to adapt and evolve in response to changing climatic conditions (see Chapter 2, Section 2.1.6, Objective 6.4), accepting that some species may be replaced by others more suited to the changing climate.

As the implications of climate change become better understood, the Service may need to re-assess some assumptions underlying the Refuge's purposes. For example, the Service may need to reexamine the meaning of fundamental concepts such as "conserve," "preserve," and "natural diversity," and revise goals and objectives accordingly.

2.4.10.2 Air Quality

The Service's authorities for air quality management and protection are direct mandates of the Clean Air Act and the Wilderness Act. The Wilderness Act requires the Service to protect and preserve the Wilderness character of designated areas, which includes biophysical conditions such as clean air.

The Service is required by the Clean Air Act to preserve, protect, and enhance air quality and the values related to air quality on Service lands, including visibility, plants, animals, soil, water quality, cultural and historical resources, and virtually all resources that are dependent upon and affected by air quality. Air pollutants of concern include mercury and other hazardous air pollutant compounds as well as six Clean Air Act "criteria pollutants:" nitrogen dioxide, sulfur dioxide, carbon monoxide, lead, ozone, and particulate matter. The approach Federal land management agencies, including the Service, take in evaluating air pollution effects is described in detail in the Federal Land Manager's Air Quality Related Values Work Group report (USFS et al. 2010).

Refuge managers are responsible for identifying air pollution threats to designated Wilderness and other resources; identifying air quality-related values; and determining monitoring needs for the refuge unit. The Service's Branch of Air Quality, in the Division of Refuges, is responsible for overall leadership and coordination of the air quality management program and for conducting technical and policy work in coordination with and on behalf of refuge managers (Service Manual 563 FW1).

The Clean Air Act Amendments of 1977 initially classified international parks, national parks (greater than 6,000 acres), national memorial parks (greater than 5,000 acres), and national Wilderness areas (greater than 5,000 acres) as 'Class I' areas; all other protected lands, as well as newly protected areas, were given a 'Class II' designation. Class I areas receive the highest degree of air quality protection under the Clean Air Act.

The Wilderness area in Arctic Refuge was established after the 1977 Clean Air Act Amendments, and was therefore designated as a Class II Wilderness. National wildlife refuges and designated Wilderness areas (greater than 10,000 acres) can be redesignated as Class I by the State as it deems appropriate (Section 164, Clean Air Act, as amended by Public Law 108-201). While certain authorities under the Clean Air Act only apply to Class I areas, Federal land managers are mandated to protect Class II air resources as well. In addition to limits on allowed increases in air pollutant concentrations in clean areas (i.e., Class I and Class II "Increments" under the Clean Air Act's Prevention of Significant Deterioration program), no area is allowed to violate any of the National Ambient Air Quality Standards (40 CFR Part 50). EPA, in partnership with State and local air regulatory agencies, is responsible for implementing these air quality standards.

There are current potential risks to the air quality and related resources in Arctic Refuge. The Refuge manager is working with the Service's Branch of Air Quality to appropriately assess these risks. In addition, the Refuge manager will continue to work with the Branch of Air Quality by participating in regulatory project reviews, environmental evaluations such as NEPA, and other air permitting programs. The Refuge manager will also work with the Service's Air Quality Branch;the Alaska Department of Environmental Conservation; other State, local, and Federal agencies; and the public, as appropriate, in addressing air quality concerns for Arctic Refuge, consistent with the Service's Air Quality Protection Policy (563 FW 1).

2.4.10.3 Water Resources Management

Every national wildlife refuge in Alaska shares the common ANILCA purpose and mandate to ensure, to the maximum extent practicable and in a manner consistent with conservation of fish and wildlife populations in their natural diversity, water quality and necessary water quantity within the Refuge (ANILCA Section 303(2)(B)).

Although the Service has reserved water rights to accomplish the purposes of the Refuge, the Refuge Administration Act and the Service Manual (403 FW 1 through 3) direct the Service to obtain, to the extent practicable, water supplies of adequate quantity and quality for Service facilities, for Refuge purposes, and as trust resources, and to obtain the legal right to use that water through State laws, regulations, and procedures.

The Alaska Region of the Service conducted a water resources threats analysis (Harle 1994) for the purpose of guiding water resource investigations and protecting water resources by acquiring instream water rights. Based on the results of the threats analysis, the Service's regional office developed a strategic plan for systematically quantifying the surface water on refuges in Alaska (Bayha et al. 1997).

Using existing data, or through the collection of hydrologic and biologic data, the Service applies to the State for appropriative water rights, for instream water reservations, and for water withdrawals to meet the Service's needs. Establishing State water rights is only part of a management strategy to protect resources on Refuge lands and to understand ecosystem processes. Hydrologic data allows the Service to: plan floodplain and riparian zone management, estimate flow for ungauged streams, supplement historical or current fisheries and wildlife studies, detect and evaluate naturally occurring or human-induced changes in the hydrologic system, provide stream profile and velocity data for the design of fish weirs or other structures, analyze the impacts of proposed projects on stream flow and water supply, provide a basis for decisions, and provide baseline water quality information.

All facilities and activities on refuges must comply with pollution control standards set by Federal laws (e.g., the Clean Water Act 33 U.S.C. 1251 and the Safe Drinking Water Act 42 U.S.C. 300f); State laws where Federal law so provides; and the regulations, policies, and standards implementing these laws.

2.4.10.4 Visual Resource Management

Visual resource management has two primary purposes: (1) to manage the quality of the visual environment, and (2) to reduce the visual impact of management activities and temporary or permanent facilities. To accomplish these purposes, Arctic Refuge will identify and maintain scenic values and will, within the constraints imposed by this Plan, minimize the visual impacts of Refuge management activities and administrative uses. To the extent practicable, the Refuge will design all activities and facilities on Refuge lands to blend in with the immediately surrounding landscape. The Service will cooperate with other Federal, State, local, tribal, and private agencies and organizations to minimize deterioration of visual resources from activities occurring off Refuge lands and on public and private lands inside Refuge boundaries. These activities can include oil and gas development, both on and offshore, that could potentially deteriorate air quality and visibility in Arctic Refuge.

2.4.10.5 Cultural, Historical, and Paleontological Resources

The Service has long-term responsibilities for cultural resources on Refuge lands. Cultural resources on Refuge lands are managed under a number of laws, Executive orders, and regulations, including the Antiquities Act; the National Historic Preservation Act, as amended; the Archaeological Resources Protection Act; the American Indian Religious Freedom Act; the Native American Graves Protection and Repatriation Act; Executive Order 11593, "Protection and Enhancement of the Cultural Environment"; Executive Order 13007, "Indian Sacred Sites"; the Paleontological Resources Protection Act (Subtitle D); and 36 CFR 800.

The 1980 amendments to the National Historic Preservation Act direct the Service to inventory and evaluate cultural resources for their eligibility for inclusion on the National Register of Historic Places. Pending a complete evaluation, all cultural resources will be considered eligible for the National Register of Historic Places and be protected and managed in accordance with Federal and State laws. All paleontological resources on Arctic Refuge will be protected and managed in accordance with Federal law.

It is illegal to collect archaeological materials and/or paleontological remains on Arctic Refuge without a permit. Historic aircraft will be managed in accordance with the policy published December 20, 1985, in the Federal Register (50 FR 51952). These materials may be collected on Refuge lands only as authorized by a permit issued to a qualified organization or individual. Cultural resource research permits will only be issued to qualified individuals operating under appropriate research designs and with access to appropriate curatorial facilities. Arctic Refuge will encourage archaeologists, historians, ethnologists, and paleontologists from educational institutions and other government agencies to pursue research on Refuge lands as long as their research interests are compatible with Refuge purposes. The Refuge will encourage research that collects data from threatened sites or sites that are important to local communities; researchers will be required to minimize disturbance of intact sites.

The Service must initiate a consultation with the State Historic Preservation Officer, under Section 106 of the National Historic Preservation Act, before it plans to fund, authorize, or otherwise undertake any Federal action that has the potential to directly or indirectly affect any archaeological or historic site. If sites that may be affected are found in the project area, their significance will be evaluated to determine their eligibility for inclusion in the National Register of Historic Places. For eligible sites, consultation will result in a course of action causing the least possible impact. Impacts may be minimized in a variety of ways, including relocation or redesign of a project, site hardening, mitigation through information collection, or cancellation of the project if no alternatives are feasible. Other activities or uses may be precluded to protect archaeological and historic sites. Private interests proposing to conduct commercial activities or uses on Arctic Refuge will normally be required to fund studies necessary for consultation and for mitigation of impacts.

The Refuge will implement Executive Order 13007, "Indian Sacred Sites," allowing access to identified sacred sites and avoiding adversely affecting the physical integrity of these sites. Where appropriate, the Service will maintain the confidentiality of sacred sites.

Further information on cultural resources management can be found in the Service Manual (614 FW 1 through 5) and the Cultural Resources Handbook (Service 1992).

2.4.11 Fish and Wildlife Habitat Management

2.4.11.1 Habitat Management

Habitats are managed in keeping with the purposes, goals, and objectives of a refuge. For Arctic Refuge, habitat management seeks to sustain the highest degree of natural biological diversity, integrity, and environmental health. The intent of management will be to leave habitats unaltered and unmanipulated. Natural habitats will not be modified or improved to favor one species over another. Except as necessary to protect threatened and endangered species or to meet other management emergencies, management will focus on perpetuating the distinctive qualities of natural condition and wild character.

2.4.11.2 Fire Management

Wildland fire is a general term describing any non-structure fire that occurs in the wildland. Wildland fires are categorized into two distinct types:

- Wildfires – Unplanned ignitions (wildland fires started by lightning, volcanoes, or unauthorized human activity) or prescribed fires that are declared wildfires.
- Prescribed Fires - Planned ignitions designed to meet specific management objectives. Prior to ignition, a written and approved prescribed fire plan must exist, and NEPA requirements (where applicable) must be met. Use of prescribed fires must comply with the Alaska Enhanced Smoke Management Plan for Prescribed Fire.

Response to wildland fires is the mobilization of the necessary services and responders to a fire based on ecological, social, and legal consequences, the circumstances under which a fire occurs, and the likely consequences on firefighters, public safety and welfare, natural and cultural resources, and values to be protected. A wildland fire may be concurrently managed to meet Refuge purposes for one or more objectives, and objectives may change as the fire spreads across the landscape. Objectives are affected by changes in fuels, weather, topography; varying social understanding and tolerance; and involvement of other governmental jurisdictions having different missions and objectives. Depending on objectives, valid responses to wildfires on Arctic Refuge include:

- Fire Suppression - the work of extinguishing or confining a fire or a portion of a fire, beginning with its discovery, to protect, prevent, or reduce the loss of identified values. The BLM-AFS Upper Yukon Fire Management Zone provides emergency suppression services on Arctic Refuge under the direction of the Refuge Manager. The highest priority of all suppression actions is ensuring the safety of firefighters and the public.
- Use of Wildland Fire - management of either wildfire or prescribed fire to meet resource objectives specified in this Revised Plan and Fire Management Plan (FMP). Wildfires or portions of fires may remain unsuppressed in order to protect and maintain the ecological integrity of Refuge lands.

Wildland fire will be managed on Arctic Refuge in a manner that, as nearly as possible, allows it to function in its ecological role. All fire management decisions will give consideration to the protection of human life and values identified by neighboring landowners, including Native allotments. Management of fires occurring in designated Wilderness will comply with national and regional policies and will take Wilderness character and values into consideration.

The Service will evaluate and may conduct the full range of activities necessary to protect human life, property, cultural resources, and other identified values, as well as any activities necessary to conserve and protect habitats for the benefit of fish and wildlife. These activities include the use of unplanned and prescribed wildland fires to meet resource objectives, as well as suppression actions when appropriate. Hazardous fuels reduction may be accomplished through prescribed fire, and in some cases through mechanical and other types of treatments. Prescribed fire will not be used on Arctic Refuge for habitat enhancement or restoration. Monitoring, research, fire prevention, preparedness, education, and outreach are also important components of the Refuge fire management program. All activities will be conducted in accordance with Refuge, Service, and DOI policies and approved interagency policy and plans.

The Refuge's FMP identifies and integrates these wildland fire management and related activities in the context of this Revised Plan. It defines a program to manage wildland fires (wildfire and prescribed fire) on the Refuge. The plan is supplemented by operational plans, including prescribed fire burn plans, treatment plans, and prevention plans.

The Refuge FMP is designed to work in concert with the Alaska Interagency Wildland Fire Management Plan (AIWFMP) that was revised March 2010, which specifies direction for initial action and response to wildfires. The AIWFMP establishes four management options—critical, full, modified, and limited—used to direct a range of responses to wildland fire. Refuge lands and facilities have been classified and mapped using these fire management options, which are reviewed annually and revised as necessary. The strategies and tactics used by the Service to manage a wildland fire will be based on objectives identified in the AIWFMP, the Refuge FMP, and the Revised Plan for Arctic Refuge.

2.4.12 Fish and Wildlife Population Management

The Service and the State of Alaska each have directives affecting fish, wildlife, and land management and will work cooperatively to fulfill these responsibilities. On national wildlife refuges, fish and wildlife are managed to meet a refuge's purposes and to fulfill the mission of the Refuge System, and in accordance with the Biological Integrity, Diversity, and Environmental Health Policy.

For Arctic Refuge, ANILCA specified that fish and wildlife populations and their habitats shall be conserved in their natural diversity Refuge-wide. For those portions of the Refuge that were part of the Arctic National Wildlife Range, the 1960 establishing order to preserve unique wildlife and wilderness values also applies to the extent it is not inconsistent with ANILCA purposes. To satisfy these purposes, and subject to management emergencies (Section 2.4.2), the Refuge will focus on enabling the natural behavior, interactions, and cycles of all native species to continue with minimal or no human intervention. The Service's Biological Integrity, Diversity, and Environmental Health Policy supports this approach by mandating maintenance of the variety of life and its processes on Refuge lands (Service Manual 601 FW 3). For the designated Wilderness area, the purposes of the Wilderness Act are within and supplemental to Refuge purposes. The Refuge will maintain Wilderness character in designated Wilderness, subject to the exceptions found in ANILCA.

In the Refuge System, Arctic Refuge exemplifies ecological integrity, biological diversity, and healthy environmental conditions. Arctic Refuge will continue to work with the State of Alaska and other partners to maintain native species diversity and the free-functioning ecological systems and dynamic processes on which that diversity depends to the greatest extent possible.

2.4.12.1 Ecological Inventory and Monitoring Plan

Arctic Refuge has completed a draft Ecological Inventory and Monitoring Plan (I&M Plan) and plans to update the document in the next two years. The I&M Plan will serve as a guide to assess species presence, relative abundance, distribution, and trends in populations of fish, wildlife, and plants. The I&M Plan describes goals, objectives, methods, implications of management, geographic scales, schedules for reporting, and database management for inventory and monitoring studies. The I&M Plan recommends monitoring to address environmental parameters (e.g., weather) and hydrology, soils, and fire history to explain potential changes in the distribution, relative abundance, and populations of fish, wildlife, and plants. Arctic Refuge will review the I&M Plan every two years and update it as needed, and the Service's regional office will review each refuge's I&M Plan every 5–8 years. In fiscal year 2010, the Refuge System received funding to initiate a national I&M program. As this program is developed, the Arctic I&M Plan may be modified to allow information integration and flow at multiple scales from the Refuge to the national level.

2.4.12.2 Scientific Peer Review

Anthropologists, biologists, botanists, ecologists, social scientists, and other Refuge personnel conducting scientific investigations will adhere to Refuge, regional, Service, and DOI policies on scientific conduct, including the publication entitled Management of Fish and Wildlife Service Scientific Publications Recommended Outlets, Procedures, and Policies. The overall goal of scientific peer review is to ensure that information collected, analyzed, interpreted, and reported to the public, and upon which policy and management decisions may be based, meets established standards of the scientific community. To achieve this goal, all study plans and reports to be disseminated outside the originating office must be peer reviewed. The region's peer review procedure is available upon request. The type and level of review shall be commensurate with the potential significance of the scientific information and its likely influence on policy and management actions. The Service has two peer-reviewed outlets, North American Fauna and Journal of Fish and Wildlife Management, which accept manuscripts for publication. Service employees also publish reports and articles of scientific findings in non-Service peer-reviewed journals.

2.4.12.3 Compliance with the Animal Welfare Act

The Animal Welfare Act of 1996, as amended, requires research facilities and Federal agencies to establish an Institutional Animal Care and Use Committee. The role of this committee is to prescribe methods and set standards for the design, performance, and conduct of animal care and use in research. Field studies conducted or authorized by Refuge employees within the purview of the Animal Welfare Act will require review and approval of an Institutional Animal Care and Use Committee. Any Refuge study that involves an invasive procedure or that harms or materially alters the behavior of an animal under study will be reviewed and approved by an Institutional Animal Care and Use Committee prior to implementation. A scientific collection permit is also required from the ADFG under Alaska Administrative Code 5 AAC 92.033.

2.4.12.4 Marking and Banding

The Service will place a priority on cooperating with appropriate partners, including ADFG and their permitting process, when we conduct fish and wildlife capture, marking, banding, radio-collaring, release, tracking, and other information gathering techniques involved with research on Refuge lands. The Service will follow approved protocols and published guidelines during all marking, banding, and related wildlife research and monitoring activities and will draw upon current insights from appropriate scientific disciplines and technologies. As with other management actions, an MRA must be conducted in advance of marking or banding wildlife in designated Wilderness.

2.4.12.5 Threatened or Endangered Species

The Refuge will consult with the Service Ecological Services field office regarding actions that may affect listed, proposed, or candidate species or designated or proposed critical habitat. These actions include Refuge operations, public use programs, private lands and Federal assistance activities, promulgating regulations, and issuing permits (Service and National Marine Fisheries Service 1998).

2.4.12.6 Reintroductions

A species may be introduced on a refuge only if that species is native to that refuge but has been extirpated (i.e., a reintroduction). Non-native species may not be introduced. Definitions of native and non-native species are found in the glossary (Appendix M). Currently there are no species identified for potential reintroduction to the Refuge.

Reintroductions can be useful tools for restoring species to natural ranges and reestablishing natural levels of fish, wildlife, and habitat diversity. Reintroductions would require appropriate NEPA compliance; a review to ensure consistency with the Service's policy on maintaining biological integrity, diversity, and environmental health of the Refuge System (Service Manual 601 FW 3); and an ANILCA Section 810 determination. If the Service was not a partner in the reintroduction, a Refuge compatibility determination would be required. Reintroductions also require extensive coordination with adjacent landowners and with the State. In evaluating the project, the cause(s) of the extirpation shall be evaluated and management actions taken to alleviate the cause(s) prior to reintroduction.

The environmental requirements of the species and the ecological dynamics of the area proposed for the reintroduction will be thoroughly reviewed prior to a reintroduction. Some factors to consider include behavior, diseases, general ecology of the species, habitat requirements, inter- and intra-species competition, life history, genetics, management practices, population dynamics, and predators. The Service shall consider whether there have been noteworthy habitat changes since the species' extirpation (e.g., is the area still in the species' natural range).

2.4.12.7 Fish and Wildlife Control

On Arctic Refuge, all native species are integral and interdependent members of a natural community of life. Management will strive to enable the natural behavior, interactions, and population dynamics of all species to continue. Except in emergencies (see Section 2.4.2), the Refuge will not employ or allow any management technique intended to interfere with natural wildlife dynamics by reducing the abundance of some species to increase the abundance of others.

If determined necessary under subsection 2.4.2 (Human Safety and Management Emergencies), Service or State actions involving the killing, relocation, removal, or sterilization of wildlife for the benefit of another species would require appropriate NEPA compliance and an ANILCA Section 810 determination. If conducted by other than the Service or an agent of the Service, a Refuge compatibility determination would be required. Alternative management actions would need to be evaluated prior to pursuing intensive management activities.

Any proposal to allow or implement a fish and wildlife control activity would also be subjected to public review and done in coordination with the ADFG, local communities, tribal governments, ANCSA Native corporations, and adjacent landowners and/or land managers. If allowed, fish and wildlife control activities will be monitored and evaluated for effectiveness and resource impacts. This section applies only to native species; control or elimination of non-native species would be considered without being considered a management emergency.

2.4.12.8 Management of Non-native, Invasive, and Pest Species

When a non-native species (fish, wildlife, or plant) occurs on a refuge, the Service may control or eliminate that species. However, where a population of a non-native species has already been established on a refuge and this population does not materially interfere with nor detract from the fulfillment of the mission of the Refuge System or the purposes a refuge, the species may be managed as part of the refuge environment.

In general, the presence of non-native species on Arctic Refuge is not consistent with Refuge purposes or with Refuge System policies. Species that occur naturally in areas adjacent to the Refuge and move into the Refuge as a result of climate change and its effects on habitat conditions represent a special case. If the presence of these species do not materially interfere with nor detract from the fulfillment of the mission of the Refuge System or the purposes of Arctic Refuge, and they do not constitute a management emergency such as to threatened or endangered species (see Section 2.4.2), they will be managed as part of the Refuge environment.

Invasive species are non-native species that, when introduced, have the potential to cause substantial amounts of harm to the environment, human health, or economic well-being. The Federal government is prohibited by Executive order, law, and policy from authorizing, funding, or carrying out actions that are likely to cause or promote the introduction or spread of invasive species in the United States or elsewhere (Service Manual 620 FW 1). Refuge managers may conduct habitat management activities to prevent, control, or eradicate invasive species using techniques described through an integrated pest management plan or other similar management plans. Integrated pest management planning for Refuge lands will address the advantages and limitations of control techniques, including chemical, biological, mechanical, and cultural. Management of invasive species on refuges is guided by the National Strategy for Invasive Species Management and is conducted in the context of applicable policy (Service Manual 620 FW 1).

Invasive species can greatly affect land and water resources or plants and animals that use invaded habitats. Therefore, invasive species may interfere with the Refuge's ability to meet its purposes and management goals and may cause harm to threatened or endangered species, natural diversity, or subsistence resources. To manage invasive plants, the Refuge will include weed inventories as part of all habitat inventories. If invasive plants are detected, control measures will be considered. The Refuge will review proposed actions for their potential to introduce or spread invasive plants and will take measures to reduce the risk of spreading invasive plants (e.g., require pelletized weed-free feed for pack animals and prohibit straw and hay bedding for dogs).

Invasive vertebrates may also adversely affect wildlife populations. If invasive vertebrates are detected, control measures will be considered. Climate change may enhance the vulnerability of the Refuge to invasive species, requiring heightened surveillance and potentially aggressive control measures in the future.

Pests are those organisms (vertebrates, invertebrates, plants, and microorganisms and their vectors) that are detrimental to fish, wildlife, human health, fish and wildlife habitat, or established management goals. Pests may be native or non-native and could include invasive plants and other organisms, which are classified as pests (Service Manual 569 FW 1). Climate change may enhance the spread of pests or the vulnerability of their hosts. The Refuge may or may not take actions to resist native pests, subject to our climate change and management emergencies guidelines (see Sections 2.4.2 and 2.4.10.1). Pests on refuges may be controlled to prevent damage to private property. Routine protection against pests for Refuge buildings, structures, and facilities is addressed in Refuge policy (Refuge Manual 9 RM 2 Exhibit 1). Arctic Refuge will coordinate with other landowners and agencies and use integrated pest management practices to enhance the detection, prevention, and management of invasive species and other pests, when appropriate. Use of chemical control measures on refuge lands in Alaska requires NEPA compliance, regional office review, and approval of a pesticide use proposal (Integrated Pest Management Policy 569 FW 1).

2.4.12.9 Disease Prevention and Control

Certain disease organisms, viruses, or vectors of disease (e.g., rabies or parasites) may threaten human health or the health and survival of native wildlife or plant species. These threats may be managed or eliminated after consideration of all reasonable options and consultation with the State and other concerned parties. This will normally only occur when severe resource damage is likely (for example, when harm to threatened or endangered species, natural diversity, or subsistence resources is likely) or when public health or safety is jeopardized. Climate change may create conditions more conducive to introduction or spread of disease organisms and their vectors.

Service Manual 701 FW 7 and Refuge Manual 7 RM 17 contain the Service's policies and procedures concerning disease control and prevention. Additionally, the Service's Aquatic Animal Health Policy (713 FW 1-5) describes standards and procedures for the containment and control of aquatic animal pathogens and diseases on Service-managed lands.

Dall's sheep in Alaska, including Arctic Refuge, are free of domestic livestock diseases and are believed to have very low immunity to many of these diseases. In particular, domestic sheep, goats, and camelids (e.g., llamas and alpacas) are recognized as being at high risk for carrying disease organisms, often asymptomatically, that are highly contagious and cause severe illness or death in Dall's sheep (Garde et al. 2005). Therefore, domestic sheep, goats, and camelids are not allowed on Arctic Refuge. This restriction is subject to promulgation of regulations for non-commercial uses.

2.4.12.10 Fishery Restoration and Enhancement

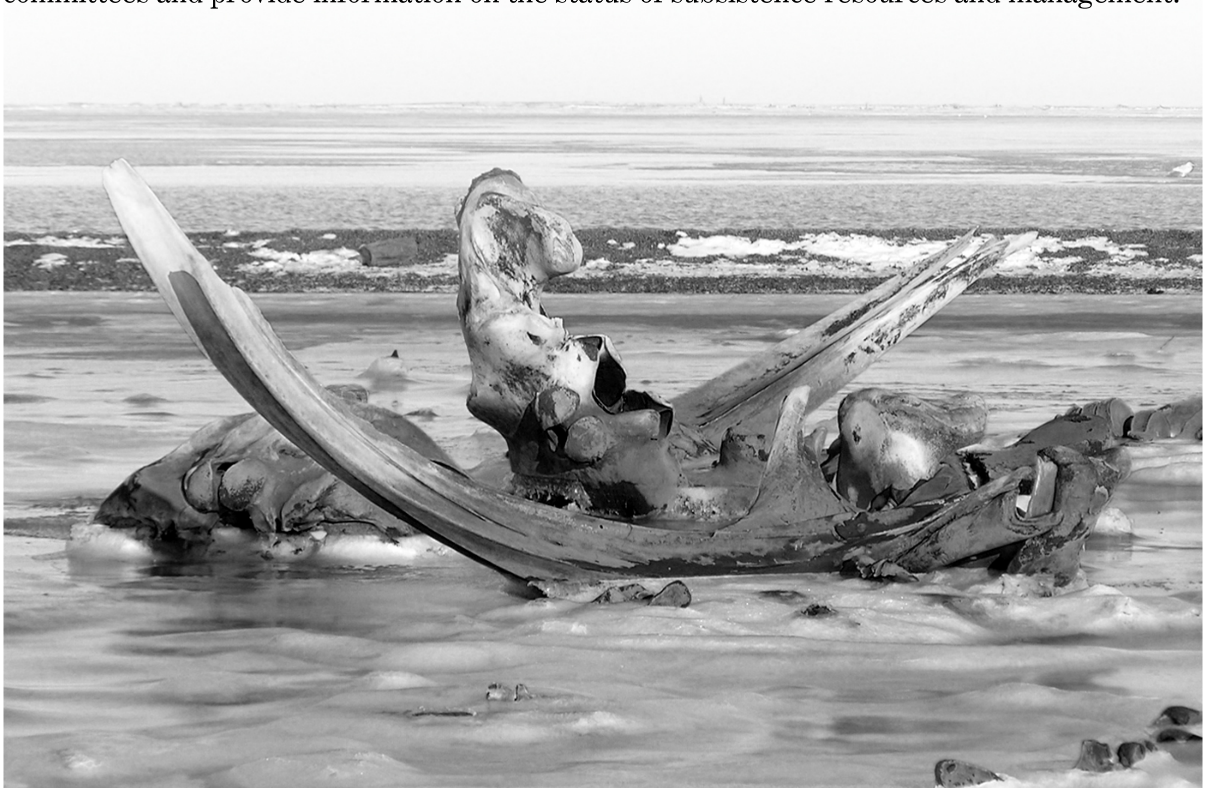
Fish populations and their habitats will be conserved in their natural diversity, with natural population cycles, interactions, and seasonal movements uncontrolled. Currently, fish populations and cycles are believed to be within their normal range of variability and continue to respond to natural processes and landscapes that are substantially free of direct human-caused changes. The Refuge will favor maintaining undisturbed habitat conditions and monitoring populations and harvest of fish. Actions that are needed to restore an aquatic ecosystem back to health, including restoration of fish populations to historic levels, may be allowed, and fishery restoration facilities may be authorized. Fishery restoration projects proposed under the auspices of subsection 2.4.2 (Human Safety and Management Emergencies) would be subject to the provisions of NEPA, an ANILCA Section 810 determination, and a compatibility determination.

Fishery enhancement (i.e., activities applied to a fish stock to supplement numbers of harvestable fish to a level beyond what could be naturally produced based upon a determination or reasonable estimate of historic levels) is inconsistent with the Refuge's purpose to conserve fish and wildlife populations and habitats in their natural diversity and is not allowed in Wilderness, Wild River, and Minimal Management categories.

2.4.13 Subsistence Management

Providing the opportunity for continued subsistence uses by local residents is one of the purposes of Arctic Refuge, as stated in Title III of ANILCA. Title VIII of ANILCA further provides that rural Alaska residents who are engaged in a subsistence way of life be allowed the opportunity to continue using resources in refuges for traditional purposes. These resources include fish and wildlife, house logs and firewood, and other plant materials. Many aspects of subsistence management are addressed outside refuge comprehensive conservation plans. The Federal Subsistence Board, through its rulemaking process, addresses seasons, harvest methods, harvest limits, and customary and traditional use determinations. The Federal Subsistence Board has established Subsistence Regional Advisory Councils to provide meaningful public input to the rulemaking process.

The Refuge will work with its partners to monitor subsistence harvests. The Refuge will supplement the State's ongoing harvest and resource monitoring programs to provide additional information on the status of fish and wildlife populations harvested for subsistence. This monitoring is intended to identify potential problems before populations of fish and wildlife become depleted and to ensure preference is given to subsistence users as required by law. In consultation with local communities, information the Refuge gathers through subsistence monitoring will potentially be shared with the Office of Subsistence Management; Subsistence Regional Advisory Councils and local State fish and game advisory committees; tribes; and others. Refuge staff will attend various subsistence-related meetings, including those of Subsistence Regional Advisory Councils and local State fish and game advisory committees and provide information on the status of subsistence resources and management.



The non-commercial gathering by local rural residents of fruits, berries, mushrooms, and other plant materials for subsistence and of dead standing or down timber for firewood is allowed without a special use permit. Harvest of live standing timber for house logs, firewood, or other activities or uses is allowed, although specific requirements vary by size and location. A special use permit is required to cut live trees greater than six inches diameter at breast height (4½ feet above ground level). No more than 20 live trees between three and six inches diameter at breast height (dbh) can be cut annually without a special use permit. No cutting may be done within 50 feet of a stream, lake, or river; no more than one tree in five may be cut in any specific stand. Cutting live trees less than three inches dbh does not require a special use permit. Timber stocks subject to subsistence activities or uses will be monitored to ensure they remain available over the long term.

Under Section 816 of ANILCA, Refuge lands may be closed to the taking of fish and wildlife if closure is deemed necessary for reasons of public safety, administration, or to ensure the continued viability of particular populations of fish or wildlife. Emergency closure to subsistence taking would be accomplished by the Federal Subsistence Board or its designated officials and would generally occur only after other consumptive activities or uses competing for resources were restricted.

2.4.13.1 Access for Subsistence Purposes

Access to Refuge lands and waters for subsistence uses will be allowed in accordance with Section 811 of ANILCA, subject to reasonable regulation (50 CFR 36.12). Regulations at 50 CFR 36.12(a) allow "… the use of snowmobiles, motorboats, dog teams and other means of surface transportation traditionally employed by local rural residents engaged in subsistence uses …" Regulations at 50 CFR 36.12(d) state that these means of access "… shall be operated in compliance with applicable State and Federal law, in such a manner as to prevent waste or damage to the refuge, and in such a manner as to prevent the herding, harassment, hazing or driving of wildlife for hunting or other purposes."

2.4.13.2 Section 810 Evaluations

The Refuge will evaluate the effects of proposed activities on subsistence activities or uses to ensure compliance with Section 810 of ANILCA. The Refuge will work with the Federal Subsistence Board, Subsistence Regional Advisory Councils, local fish and game advisory committees, tribes, Native corporations, the ADFG, and other appropriate local sources to determine whether a proposed activity would "significantly restrict" subsistence activities or uses. If the Refuge determines that a proposal would probably result in adverse effects to subsistence activities or uses, the Refuge will follow the requirements identified in Section 810 before making a final decision on the proposal.

2.4.14 Public Access and Transportation Management

2.4.14.1 Snowmobiles, Motorboats, Airplanes, and Non-Motorized Surface Transportation

Section 1110(a) of ANILCA allows the use of motorboats, airplanes, snowmobiles (also referred to as snowmachines), and non-motorized surface transportation methods for traditional activities and for travel to and from villages and home sites. Such access shall be subject to reasonable regulations to protect the natural and other values of Arctic Refuge (43 CFR 36.11). Specific areas may be closed to such activities or uses in accordance with these regulations if notice is given and a hearing is held in the vicinity of the area affected. The Refuge manager is responsible for determining when snow cover is adequate to protect the underlying vegetation and soil from damage by snowmobile use. Snowmobiles are only allowed during periods of adequate snow cover and frozen river conditions.

2.4.14.2 Off-Road Vehicles

The regulations at 43 CFR 36.11(g) prohibit the use of off-road vehicles in the Refuge except on routes or areas designated in accordance with Executive Order 11644 or pursuant to a valid special use permit. The definition of off-road vehicles in 50 CFR 36.2 excludes snowmobiles but includes air boats and air-cushion vehicles, along with motorized wheeled vehicles. Off-road vehicles such as all-terrain vehicles (e.g., three- and four-wheeled vehicles) may be authorized only on designated routes or areas and only in Intensive and Moderate Management or by special use permit.

2.4.14.3 Helicopters

The use of a helicopter is prohibited in any area other than at designated landing areas pursuant to the terms and conditions of a permit issued by the Service, or pursuant to a memorandum of understanding between the Service and another party, or involved in emergency or search and rescue operations (43 CFR 36.11(f)(4)). There are no designated landing areas on Arctic Refuge nor are any planned.

Helicopter landings for fisheries and wildlife management activities and scientific research may be authorized under special use permit or other authorization, subject to site-specific stipulations. Helicopter landings for fire operations must comply with the fire management plan for Arctic Refuge and operational guidance in the AIWFMP. Helicopter landings for routine law enforcement patrols are not allowed in designated Wilderness. The Refuge will work with State and Federal law enforcement officials to clarify the difference between use of helicopters for routine patrol and exigent circumstances (where there is probable cause of a violation having been committed) where the landing of helicopters is allowed.

In designated Wilderness, helicopter landings by the Service will not be permitted, except in cases of emergency, unless determined to be necessary through the Minimum Requirement Analysis process.

Helicopter landings for recreational purposes are not allowed in Arctic Refuge.

2.4.14.4 Access to Inholdings

Section 1110(b) of ANILCA ensures adequate and feasible access, for economic or other purposes, across a refuge for any person or entity that has a valid inholding. An inholding is defined as State-owned or privately-owned land, including subsurface rights underlying public lands, valid mining claims, or other valid occupancy that is in or effectively surrounded by one or more conservation system units. The Service will review and process the application in accordance with regulations at 43 CFR 36 and 50 CFR 29, when a right-of-way permit is necessary under this provision (e.g., construction of a permanent facility). Such permits are subject to terms and conditions as specified in the regulations.

2.4.14.5 Temporary Access

Chapter 43 CFR 36.12(a)(2) defines temporary access as "limited, short-term (i.e., up to one year from issuance of the permit) access which does not require permanent facilities for access to State or private lands." Temporary access is limited to survey, geophysical, exploratory, or other temporary activities or uses on non-Federal lands and where access is not otherwise provided in 43 CFR 36.10 or 43 CFR 36.11.

The Refuge will evaluate applications for temporary access across the Refuge and may issue permits with necessary stipulations and conditions to ensure that access granted is compatible with the purposes for which the Refuge was established, complies with the provisions of Section 810 of ANILCA, and ensures that no permanent harm will result to resources on Refuge lands.

2.4.14.6 Subsistence Access

See Access for Subsistence Purposes under Subsistence Management (Section 2.4.13.1).

2.4.14.7 Transportation and Utility Systems

The Congress, through Title XI of ANILCA, determined that "Alaska's transportation and utility network is largely undeveloped and future needs would best be addressed through a continuous decision making process…." To minimize impacts to conservation system units expanded or established by ANILCA, it was necessary to create a single and comprehensive authority for the approval or disapproval of applications for transportation or utility systems (TUS). Title XI provides a detailed definition for a TUS and establishes the procedural requirements, evaluation standards, and actions for a TUS. Chapter 43 CFR 36 provides the specific regulations and procedures for application review, compliance with NEPA, decisions, and appeals.

A TUS, as defined in ANILCA, includes roads, highways, railroads, airports, pipelines, electrical transmission lines, communication systems, and related structures and facilities reasonably and minimally necessary for the construction, operation, and maintenance of such systems. Anyone seeking to acquire a right-of-way over national wildlife refuge lands for a TUS must file an application with the Division of Realty and Natural Resources in the Service's Alaska Regional Office.

The Service will make a decision whether to approve or disapprove a right-of-way for that portion of a TUS that would cross Refuge lands, except for those in designated Wilderness. When the proposed transportation or utility system would cross a designated Wilderness area, the Service tentatively approves or disapproves the application subject to the President's subsequent decision. If the President approves, a recommendation is submitted to Congress for final approval.

A new right-of-way for a TUS across Refuge lands will be granted if the system is found to be compatible with Refuge purposes and meets the criteria outlined in Section 1104(g)(2) of ANILCA and the regulations at 43 CFR 36.7(a)(2), which includes a determination of whether there is any economically feasible and prudent alternative to routing the system through or in a refuge. If approved, permits issued for a TUS will contain terms and conditions as required under regulations at 43 CFR 36.9(b) and 50 CFR 29.21 through 29.24. Rights-of-way that cross any area inside the boundaries of a unit of the Wild and Scenic Rivers System will assure that the stream flow of, and transportation on, the designated river are not interfered with or impeded and that the facility is located and constructed in an environmentally sound manner (ANILCA Section 1107(b); 43 CFR 36.9(c) and (d)). Additional special requirements apply to rights-of-way for pipelines issued under the Mineral Leasing Act of 1920 (30 U.S.C. 185), Section 1107(c) of ANILCA, and regulations at 43 CFR 36.9(d).

When considering an application for a TUS, the authorization process will incorporate a corresponding amendment to a refuge's comprehensive conservation plan to update the desired management category, or categories, of the affected area if the TUS were to be approved.

2.4.14.8 State Transportation Planning

Federal transportation planning regulations require each state to develop a long-range statewide transportation plan in consultation and coordination with other government agencies and the public. In Alaska, transportation projects nominated for funding are evaluated and ranked by the Alaska Department of Transportation and Public Facilities. When appropriate, the Refuge will participate in the State of Alaska transportation planning process and provide input regarding environmental considerations of proposed projects affecting Refuge lands and the resources therein.

2.4.14.9 RS 2477 Rights-of-Way

The State of Alaska identifies numerous claims to roads, trails, and paths across Federal lands under Revised Statute 2477 (RS 2477), a section in the Mining Act of 1866 that states, "The right-of-way for the construction of highways over public lands, not reserved for public uses, is hereby granted." RS 2477 was repealed by the Federal Land Policy and Management Act of 1976, subject to valid existing claims.

Assertion and identification of potential rights-of-way does not establish the validity of these claims nor the public's right to use them. The validity of all RS 2477 rights-of-way will be determined on a case-by-case basis, either through the courts or by other legally binding document. The State has identified, in Alaska Statute 19.30.400, six routes on Arctic Refuge it claims may be asserted as rights-of-way under RS 2477 (Appendix E).

2.4.14.10 17(b) Easements

Section 17(b) of ANCSA of 1971 authorizes the Secretary of the Interior to reserve easements on lands conveyed to Native corporations to guarantee access to public lands and waters. Easements across Native lands include linear easements (e.g., roads and trails) and site easements. Site easements are reserved for use as temporary campsites and to change modes of transportation.

The Service is responsible for administering those public easements inside and outside Refuge boundaries that provide access to Refuge lands. Service authority for administering 17(b) easements is restricted to the lands in the easement. The size, type, and route of 17(b) easements were initially identified on maps filed with conveyance documents. Current maps are available on the internet from the BLM. Conveyance documents also specify the terms and conditions of use, including the acceptable periods and methods of public access. See Appendix E for additional information.

2.4.14.11 Navigation Aids and Other Facilities

Section 1310 of ANILCA authorizes reasonable access to and operation and maintenance of existing air and water navigation aids, communications sites, and related facilities. It authorizes existing facilities for weather, climate, and fisheries research and monitoring subject to applicable laws and regulations. Reasonable access to and operation and maintenance of facilities for national defense and related air and water navigation are provided, including in designated Wilderness.

New facilities shall be authorized only after consultation with the head of the Federal department or agency undertaking the establishment, operation, or maintenance of such facilities and in accordance with terms and conditions to which all parties mutually agree.

2.4.15 Recreation and Other Public Use

Recreation will be managed to perpetuate experiences that are consistent with the Refuge Improvement and Refuge Recreation acts and the provisions described in Section 101 of the ANILCA. Public recreational activities in Alaska national wildlife refuges are allowed as long as such activities are conducted in a manner compatible with the purposes for which the areas were established (50 CFR 36.31). Compatible recreation activities and other visitor uses of Arctic Refuge will continue. Both consumptive (e.g., hunting, fishing, and trapping) and non-consumptive (e.g., wildlife observation and photography) recreation activities and other visitor uses are appropriate. The Refuge Improvement Act identifies compatible hunting, fishing, wildlife observation and photography, and environmental education and interpretation as priority public uses. These activities and uses are encouraged and will receive emphasis in public use management. Other general recreational activities that may not directly depend on wildlife are compatible, including camping, hiking, river floating, and mountaineering (Appendix G).

At Arctic Refuge, recreation will be managed in ways that are consistent with the Refuge's special values (Chapter 1, Section 1.5) and with consideration of public preferences. An Arctic Refuge visitor study and other sources indicate that opportunities to experience wildness, adventure, freedom, independence, self-reliance, solitude, and discovery are highly important to visitors. The Service will strive to maximize these opportunities in designated Wilderness and on Minimal Management lands while maintaining natural conditions and processes.

Consistent with resource protection, the Service will employ the least intrusive means of public use management. Minimum impact techniques, such as those promoted by the Leave No Trace Center for Outdoor Ethics, will be the standard for both public and agency activities. Outreach will be a primary tool for recreation management, using the Refuge's website, brochures, information kiosks, and personal contacts. Educational messages will emphasize the need for self-reliance, including adequate preparation. General information will be provided that enables visitors to access and enjoy the Refuge in a safe and environmentally sound manner that enhances their appreciation of the unique opportunities the Refuge affords. Commercial service providers will continue to play an important role in informing visitors and reporting conditions and trends relative to public use. Informational materials recommending trip routes, river crossings, best fishing areas, or other features will generally be avoided.

However, if voluntary methods fail, other actions may be taken, including limiting commercially-supported recreation; regulating use and access subject to the provisions of Section 1110(a) of ANILCA; and recommending changes in State and/or Federal fishing, hunting, or trapping regulations. When necessary, some recreation opportunities may be seasonally or otherwise restricted to minimize user conflicts and protect the ecological or other values of the Refuge. Any restrictions on public use will follow the public participation and closure procedures at 50 CFR 36, 43 CFR 36, or other applicable regulations. State management tools will also be used where mutually desirable.

A VUMP, a WSP, and other plans will be prepared, with opportunities for public involvement, to describe strategies and provide the specific provisions necessary to fulfill recreation goals and objectives.

There often are subtle differences between subsistence and recreational activities or uses. Subsistence activities or uses are addressed under Subsistence Use Management (Section 2.4.13). When it is necessary to restrict the taking of fish and wildlife on a refuge to protect the continued viability of such populations, the taking of fish and wildlife for non-wasteful subsistence activities or uses shall be accorded priority over the taking of fish and wildlife for other purposes (i.e., recreational), in accordance with Title VIII of ANILCA.

2.4.16 Public Use Facilities

Facilities to support recreational and other public uses may be provided off Refuge lands at gateway communities, developed sites along the Dalton Highway, and administrative sites. Arctic Village, Coldfoot, Fairbanks, and Kaktovik are considered gateway communities for Arctic Refuge. All new facilities will comply with current accessibility standards, and access for the disabled will be considered in all facility upgrades.

Roads, boat launch sites, campgrounds, interpretive sites, kiosks, and permanent signs shall not be placed in Wilderness, Wild River, and Minimal Management areas of the Refuge (i.e., not allowed). Undeveloped landing areas, gravel bars, lakes, and rivers, and areas of ice and snow will continue to be the primary areas for aircraft access. Trails, temporary signs (e.g., during site restoration), hardened campsites, and sanitation facilities (at heavily used access sites) may be developed if necessary to prevent resource damage.

2.4.16.1 Cabins

Consistent with the Refuge's vision, goals, and objectives, public use cabins will not be allowed in Wilderness, Wild River, and Minimal Management areas of the Refuge. Special use permits are required for subsistence and commercial cabins, which are allowed in all management categories. Management of existing cabins and review of proposals for construction of new cabins for traditional uses will be in accordance with the Service's cabin regulations (50 CFR 36.33) and regional cabin policy (RW-1). Private recreational use cabins will not be authorized.

2.4.16.2 Temporary Facilities for the Taking of Fish and Wildlife

The Refuge will allow the use of temporary campsites, tent platforms, tent frames, shelters, and other temporary facilities and equipment directly and necessarily related to the taking of fish and wildlife, provided these facilities are not detrimental to Refuge purposes (ANILCA Section 1316). Regulations to implement commercial use of such temporary facilities are found in 50 CFR 35.6(e). Temporary facilities are subject to reasonable regulations to ensure that they are compatible with Refuge purposes. Tent platforms, tent frames, food caches, smokehouses, and other facilities may be allowed on a temporary basis for the taking of fish and wildlife in Wilderness, Wild River, and Minimal Management categories.

The Refuge may issue special use permits for the commercial use of tent platforms and accompanying frames and walls placed on Refuge lands for more than 12 months, while the use of tent platforms for non-commercial uses is subject to the promulgation of regulations. To ensure protection of resources on Refuge lands, the following special use permit stipulations will be included:

- Tent platforms will be located in a manner that does not displace or compete with existing public uses.
- They will be located away from the vicinity of existing cabins.
- They will be located on sites that are not currently popular campsites.
- They will be located to minimize displacement of wildlife.
- The time of human occupancy will coincide with the State and/or Federal hunting, fishing, and/or trapping season for the species for which the tent platform is being used.
- Tent platforms will be removed at the end of the occupancy period specified in the special use permit.
- To the extent feasible, tent platforms and related materials will be built and placed to blend in and be compatible with the immediately surrounding landscape.
- To the extent feasible, tent platforms and related materials will be screened from water and located so that they are as unobtrusive as possible.

2.4.17 Outreach and Education

Outreach is two-way communication between Arctic Refuge and the public to establish mutual understanding, promote public involvement, and influence public attitudes and behaviors. The Refuge will continue to use partnership opportunities to provide outreach, including working with the Alaska Geographic Association; Alaska Public Lands Information Centers; Friends of Alaska National Wildlife Refuges; local, State, and other Federal agencies; local schools; tribal governments; ANCSA Native corporations; Alaska Native organizations; and others.

Use of outreach as a management tool is a key to the success of many of the management activities outlined in this Plan. Two outreach activities—environmental education and interpretation—are included in the six priority public uses identified in the Refuge Improvement Act. Many other activities are also available for use by the Refuge staff in its outreach program, which may be developed in more detail as a step-down management plan. All outreach activities must be continually evaluated to determine whether they fulfill Refuge management goals and objectives. Arctic Refuge will ensure that outreach services are available to all segments of the public, including those with disabilities and those who speak languages other than English.

Refuge staff will develop informational displays, brochures, websites, minimum impact guidelines, and other outreach materials; visit local schools and communities; attend public meetings and workshops; invite the public to Arctic Refuge headquarters (i.e., open houses); work with the media; and foster outreach partnerships and one-on-one communication.

2.4.18 Commercial Use Management

Commercial activities or uses involve use of a refuge or its resources for a profit. Subsistence activities or uses are not included in commercial activities or uses. Refer to Section 2.4.13 for policies related to subsistence.

Except for mining on valid claims under the 1872 Mining Law, of which there are none located inside the boundaries of Arctic Refuge, other activities where specific property rights are held by groups or individuals other than the Federal government or where specifically exempted by law, the Refuge must comply with NEPA and the compatibility requirements of the Refuge Administration Act before authorizing commercial activities or uses. A written authorization (such as a special use permit) is required to conduct commercial activities on any refuge. Prior to authorizing any commercial or economic use of a natural resource, the Refuge manager must determine that each activity or use, except for proposed activities authorized by ANILCA, contributes to the achievement of Refuge purposes or the Refuge System mission (50 CFR 29.1). Except for commercial services described previously such as air operators and guided recreation, commercial enterprises are prohibited in designated Wilderness areas (Wilderness Act, Section 4(c)).

2.4.18.1 Commercial Recreation Services

Most visitors use the services of commercial air operators or motorboat transporters for access to Arctic Refuge. Wildlife-viewing guides, big-game hunting guides, fishing guides, wilderness guides, recreational guides, polar bear viewing guides, and others support many visitors. All businesses providing recreation services are required, under 50 CFR 27.97, to obtain special use permits to operate on Refuge lands. Where the number of special use permits is limited, Refuge managers will award permits competitively (50 CFR 36.41). Special use permits require compliance with all applicable laws and regulations (e.g., United States Coast Guard licensing regulations). Permit stipulations ensure that camps; travel methods; storage of food, fish, and game meat; and other activities are compatible with Refuge purposes and reduce the potential for impacts to resources and to other people using the Refuge. If problems or conflicts arise relating to commercial recreation activities or uses—such as disturbance of active nests, conflicts with subsistence activities or uses, chronic incidence of bears getting into food, or violations of State or Federal regulations—the Refuge may modify or terminate a specific activity or use under the special use permit stipulations. The Refuge will monitor the number and type of commercial service providers that operate on the Refuge and the number of clients and will, if necessary, further regulate these commercial recreation activities or uses.

Under Section 1307 of ANILCA, local preference is provided for all new commercial visitor services except guiding for hunting and fishing. Regulations defining local preference are at 50 CFR 36.37.

2.4.18.2 Mineral Exploration and Development

Mining – Section 304(c) of ANILCA withdrew all public lands on national wildlife refuges in Alaska from location, entry, and patent under the mining laws, subject to valid existing rights. There are no valid mining claims in Arctic Refuge, therefore exploration, location, entry or patent of Refuge lands under the mining laws of the United States is prohibited. The only exception is the limited exploration allowed as part of the Alaska Mineral Resource Assessment Program (Section 2.4.22 of this chapter).

Oil and Gas Studies – Oil and gas studies include surficial geology studies, subsurface core sampling, seismic surveys, and other geophysical activities. In the "1002" coastal plain area, Service regulations (50 CFR Part 37) presently do not provide for further oil and gas exploration—none of these studies are permitted until authorized by Congress. In Arctic Refuge designated Wilderness, seismic surveys, core sampling, and other studies that require mechanized surface transportation or motorized equipment will not be allowed except as provided for by Section 1010 of ANILCA (i.e., only if conducted by or for a DOI agency). In the wild river corridors, core drilling will not be permitted, except again as provided for under Section 1010. In the rest of the Refuge south of 68° North latitude, all of the oil and gas studies listed may be permitted pursuant to Section 1008(b) of ANILCA. In minimal management areas and proposed wilderness areas south of 68° North latitude, oil and gas studies may be permitted where site-specific stipulations can be designed to ensure compatibility with Refuge purposes and consistency with the management objectives set forth in this Plan.

Oil and Gas Leasing – Section 1003 of ANILCA prohibits production of oil and gas anywhere on Arctic Refuge. No leasing or other development leading to production of oil and gas from the original Arctic Wildlife Range shall be undertaken until authorized by an act of Congress. Thus, unless Congress takes action to change this provision, the Service will not permit oil and gas leasing under any of the alternatives in the Refuge Plan. Should Congress take action to allow oil and gas activities on Arctic Refuge, the Service would necessarily comply with NEPA and related agency policies.

Oil and Gas Support Facilities – The service manages the "1002" coastal plain area as a Minimal Management area, pending Congressional action. Oil and gas support facilities will not be permitted under this management category. Thus, until Congress takes action, the Service will not permit oil and gas support facilities in the Refuge in any of the alternatives in the Plan.

Sand, Gravel, and Other Common Variety (Saleable) Minerals – Common variety minerals—such as sand, gravel, and stone—may be sold pursuant to the Materials Act of July 31, 1947 (30 U.S.C. 601 and 602), as amended. Regulations are found at 43 CFR 3600. Disposal is also authorized under the Refuge Revenue Sharing Act (16 U.S.C. 715s). Also see 612 FW 1 of the Service Manual. Extraction may be authorized, where compatible, in Intensive and Moderate Management areas to support construction and maintenance projects on or near Refuge lands if no reasonable material sites exist off Refuge lands.

Other Mineral Leasing – In general, mineral leasing is not allowed on Refuge lands. Geothermal leasing is not allowed on refuges under Section 1014(c) of the Geothermal Steam Act (30 U.S.C. 1014). Coal mining is also prohibited, subject to valid existing rights, under Section 16 of the Federal Coal Leasing Amendment Act of 1975 (30 U.S.C. 201 Notes) and the Surface Mining Control and Reclamation Act of 1977 (30 U.S.C. 1272; 43 CFR 3400.2). In specific cases of national need, however, mineral exploration, development, or extraction may be permitted under Section 1502 of ANILCA. The President must determine that the national need for the mineral activity outweighs the other public values of the land. Any recommendation by the President would take effect only after enactment of a joint resolution by Congress.

2.4.18.3 Commercial Fishing and Related Facilities

Section 304(d) of ANILCA, addresses commercial fishing and related campsites, cabins, motor vehicles, and aircraft on the Refuge. These facilities and uses in support of commercial fishing are subject to reasonable regulation. Section 304(d) provides for restricting commercial fishing rights if the use is determined to be inconsistent with Refuge purposes and to be a "significant expansion of commercial fishing activities…beyond the level of such activities during 1979." As there were no commercial fishing activities or facilities on Arctic Refuge in 1979, any proposed facilities would be considered new. The Refuge will complete a compatibility determination for any commercial fishery and related facilities and equipment.

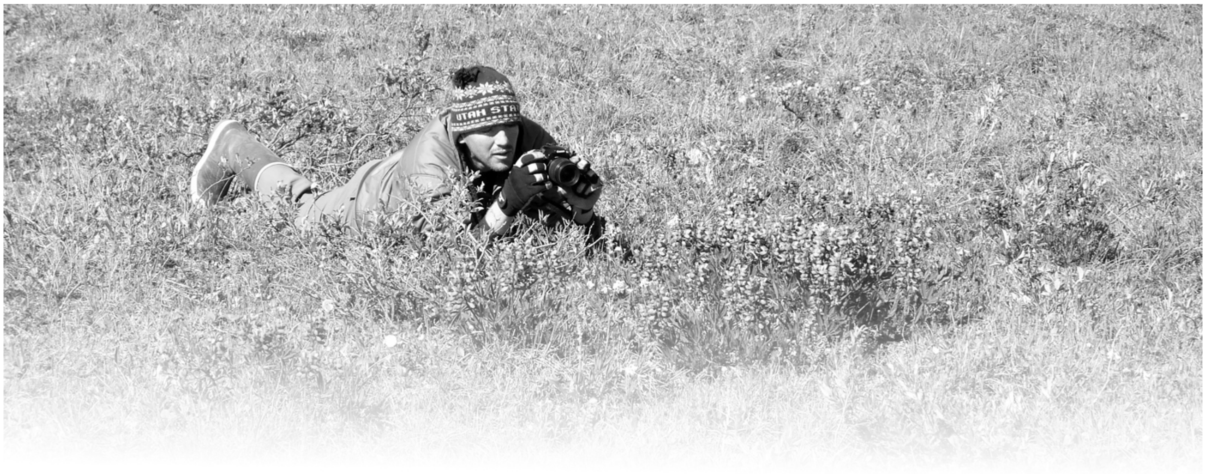
Aquaculture and mariculture (i.e., the cultivation of marine organisms in their native environment) support facilities may be allowed in Intensive Management areas, subject to provisions of State and Federal laws. No Intensive Management areas currently exist or are proposed on the Refuge. Seafood processing plants will not be allowed.

2.4.18.4 Commercial Harvest of Timber and Firewood

Commercial harvest of timber and firewood will only be authorized under a special use permit and when necessary to fulfill overall Refuge management objectives. In Minimal and Wild River Management categories, commercial harvest of timber and firewood to accomplish management objectives will only occur when an approved Refuge fire management plan has identified the need to reduce fuel loads in an area. Applicable Federal and State guidelines for timber management will be followed. Commercial harvest of timber and firewood is not allowed in designated Wilderness.

2.4.18.5 Commercial Gathering of Other Resources

Commercial gathering of other resources (e.g., antlers or mushrooms) requires a special use permit under 50 CFR 27.51 and may be authorized in Intensive and Moderate Management areas.



2.4.18.6 Commercial Filming and Recording Activities

Outside of designated Wilderness, it is Service policy to provide Refuge access and/or assistance to firms and individuals in the pursuit of commercial visual and audio recordings when they are compatible with Refuge purposes or the mission of the Refuge System. Commercial films, television production, or sound tracks made in refuges for other than news purposes require a special use permit or authorization (43 CFR 5.1). Commercial filming or recording activities such as videotaping, audio taping, and photography for the purpose of advertising products and services are subject to an A/V Production Permit (Refuge Manual 8 RM 16).

In designated Wilderness, we generally prohibit commercial filming unless we determine it is necessary to provide educational information about wilderness uses and values and does not degrade the Wilderness character of the area (610 FW 2.12). In cases where we allow such filming in designated Wilderness as a commercial service, permittees will be limited to access methods and equipment that are allowed for the general public including those uses allowed under Section 1110(a) of ANILCA, such as snowmachines, motorboats, airplanes, and nonmotorized surface transportation.

Permits are not required for still photography on Refuge lands open to the public, including commercial still photography, so long as no models or props which are not a part of the site's natural or cultural resources or administrative facilities are used (16 U.S.C. 460l-6d(c)).

2.4.18.7 Other Commercial Uses

Generally, other commercial activities or uses such as grazing, agriculture, and hydroelectric power development will not be allowed. An exception may be made for low-head or small run-of-the-river hydropower facilities. These may be authorized in Intensive and Moderate Management areas on a case-by-case basis. Section 2.4.14.7 provides details about transmission lines, pipelines, and other rights-of-way mentioned in Title XI of ANILCA.

2.4.19 Environmental Contaminants Identification and Cleanup

One goal of the Refuge Administration Act, as amended, is to maintain the biological integrity, diversity, and environmental health of the Refuge System. In support of this goal, the Service studies environmental contaminants that may threaten trust species (i.e., those species for which the Service has primary jurisdiction) and other resources of Arctic Refuge. This work will continue as new concerns are identified and as funding allows.

An assessment of known or suspected contaminant threats is normally completed for each refuge as part of the national Contaminants Assessment Process. During comprehensive conservation plan revisions, existing information will be reviewed, and an assessment of potential contaminant threats will be entered into an electronic database. A contaminant assessment report will also be prepared.

When contaminants are identified on Refuge lands, the Service will initiate discussions with the responsible party or parties to remedy the situation. If the Service caused the contamination, funds will be sought to define the extent and type of the contamination and to remedy it. Appropriate environmental regulations—including the Resource Conservation Recovery Act, Comprehensive Environmental Response and Compensation Liability Act, Oil Pollution Act of 1990, and State of Alaska regulations (e.g., 18 AAC 75)—will be followed during any remediation work that is conducted.

All spills of petroleum products and hazardous materials must be reported to the Alaska Department of Environmental Conservation and to the National Response Center. Incidents also will be reported to the Service's Regional Spill Response Coordinator. The Refuge will refer to the Service's Region 7 Spill Response Contingency Plan and other relevant plans when responding to spills.

2.4.20 Management of Designated Wilderness

Under the Wilderness Management category, designated Wilderness lands are primarily managed to preserve their Wilderness character (see Section 2.3.4). Management of designated Wilderness areas is directed by the specific purposes of a refuge, the mission of the Refuge System, the purposes and provisions of the Wilderness Act of 1964, the provisions of ANILCA, the Service's Wilderness Stewardship Policy (Service Manual 610 FW 1-5), and regional policy (Region 7 Policy Manual RW-29).

In accordance with national (610 FW 5.4) and regional policies (Region 7 Policy Manual RW-29), an MRA will be prepared for Refuge management activities proposed in designated Wilderness. This two-step decision process involves determining if a proposed management activity is necessary to accomplish the purposes of the Refuge, including Wilderness Act purposes, and if so, determining the minimum requirement, which is the least intrusive tool, equipment, device, force, regulation, or practice deemed the minimum necessary to achieve the management objective.

Certain activities are legislatively prohibited in designated Wilderness, including oil, gas, and other mineral leasing and most surface-disturbing activities. Section 4(c) of the Wilderness Act generally prohibits roads, commercial enterprises, motor vehicles, motorboats, other forms of mechanical transport, motorized equipment, the landing of aircraft, and structures and installations in designated Wilderness areas. Provisions of ANILCA, however, provide exceptions to some of these prohibitions for specific purposes, such as allowing motorized public access for traditional activities and for the continuation of pre-existing commercial and private use cabins. Some of the ANILCA provisions affecting public use of designated Wilderness areas in Alaska include:

- Use of Federal lands for campsites, cabins, motorized vehicles, and aircraft landings directly incident to the exercise of valid commercial fishing rights (Section 304(d)).
- The use for subsistence purposes of snowmachines, motorboats, and other means of surface transportation traditionally employed for such purposes by local residents (Section 811).
- The use of snowmachines, motorboats, airplanes, and nonmotorized surface transportation methods for traditional activities and for travel to and from villages and home sites (Section 1110(a)).
- Such rights as necessary for access to State- or privately-owned lands (including subsurface rights), valid mining claims, or other valid occupancy (Section 1110(b)).
- Use of cabins for traditional and customary uses (Section 1303).
- Use of temporary campsites, tent platforms, shelters, and other temporary facilities, and equipment directly and necessarily related to the taking of fish and wildlife (Section 1316).
- Access for mineral assessment purposes, as part of the Alaska Mineral Resources Assessment Program (Section 1010).
- Construction and maintenance of navigation aids and other facilities for administrative purposes (Section 1310).
- Continuation of existing, and construction of new, public use cabins (Sections 1315(c) and (d)).

Under regional policy, the use of chainsaws by rural residents engaged in subsistence activities is allowed. However, motorized generators and water pumps are not allowed (Region 7 Policy Manual RW-4).

Granting rights-of-way for transportation or utility systems through designated Wilderness areas requires Presidential and congressional approval (Section 1106(b) of ANILCA; Sections 2.4.14.7 and 2.4.14.9 of this chapter).

The Refuge will develop a step-down WSP for its designated Wilderness area to address in greater detail its resources, public uses, and management (Chapter 2, Objective 2.4). Specific details will be included on how the broad management direction provided in this Revised Plan will be applied to preserve Wilderness character and values. This step-down plan will be prepared in cooperation with the State of Alaska and other partners. Public involvement will be an essential part of the preparation of this WSP.

2.4.21 Administration of Arctic National Wildlife Refuge

2.4.21.1 Administrative Sites and Visitor Facilities

Under Section 1306 of ANILCA, the Secretary of the Interior may establish administrative sites and visitor facilities, either inside or outside the boundaries of a conservation system unit, in accordance with the unit's management plan and for the purposes of ensuring the preservation, protection, and proper management of the unit. Section 1306(a)(2) further states, "to the extent practicable and desirable, the Secretary shall attempt to locate such sites and facilities on Native lands in the vicinity of the unit."

DOI guidelines, developed in 1995 and implementing Section 1306, require that prior to initiating a search for an administrative site or visitor facility, site-selection criteria be developed, with public input, and all proposals be evaluated according to the site-selection criteria. If it is determined that Native lands satisfy the site-selection criteria and are desirable and practicable for the intended administrative site or visitor facility, the highest-ranked Native lands shall be selected as the preferred site, subject to a specific site evaluation. If no Native lands satisfy the site-selection criteria, the highest-ranked parcel will become the preferred site. Public comments will be considered prior to making a final decision.

Administrative sites include temporary and permanent field camps, residences, offices, administrative cabins, and associated storage, communication, and transportation facilities. The type of administrative site and level of development will be consistent with the management intent of the management category in which it is constructed. Administrative field camps or other administrative facilities in Minimal, Wild River, and Wilderness Management categories may only be allowed when required to meet management objectives, when no reasonable alternative sites exist, and when the facilities are essential to protect the health and safety of employees. New facilities would be the minimum required to meet long-term needs.

Fuel storage or other hazardous material storage in conjunction with administrative sites will meet all Federal and State requirements for spill containment and storage. Hazardous materials stored in the Wild River and Wilderness Management categories will be in small (55-gallon or less) containers.

Administrative facilities that currently exist on Refuge lands include three administrative cabins and an outhouse on the north slope of the Brooks Range at Lake Peters, and two administrative cabins and an outhouse on the south slope of the Brooks Range at Big Ram Lake.

2.4.21.2 Applicability of Refuge Regulations to Off-Refuge Administrative and Visitor Facility Sites

Under 50 CFR 36.1(c), the Service is authorized to enforce regulations concerning public safety and protection of government property, and State fish and wildlife regulations, on administrative and visitor facility sites that may be held in fee or less-than-fee title and are either inside or outside the approved boundaries of Arctic Refuge.

Off-Refuge facilities include a Refuge office and maintenance annex at the Federal Building in Fairbanks, a Service aircraft hangar at the Fairbanks International Airport, a cooperatively managed Alaska Public Lands function at the Morris Thompson Visitor Center in Fairbanks, a jointly operated Arctic Interagency Visitor Center in Coldfoot on the Dalton Highway, a jointly managed Refuge and community managed Visitor Center in Arctic Village, an administrative building and related facilities at Galbraith Lake, and information kiosks located in Kaktovik, Arctic Village, and at Happy Valley on the Dalton Highway.

The Refuge owns a 16-bed bunkhouse/garage and equipment storage shed located on private lands leased from the City of Kaktovik.

2.4.21.3 Refuge Management Plans

Some management programs are addressed in sufficient detail in the comprehensive conservation plan to be integrated directly into the budgetary process. For other programs, it may be necessary to prepare step-down management plans to implement general strategies identified in this Plan. Information on the step-down planning process can be found in 602 FW 3 of the Service Manual.

A list of Refuge step-down management plans is found in Chapter 6 of this Plan.

2.4.22 Alaska Mineral Resource Assessment Program

Section 1010 of ANILCA requires that all Federal lands be assessed for their oil, gas, and other mineral potential. Mineral assessment techniques that do not have lasting impacts—such as side-scanning radar, trenching, and core drilling—may be allowed throughout the Refuge. Special use permits issued to other government agencies or their contractors for assessment work will include stipulations to ensure that the assessment program is compatible with Refuge purposes. For example, stipulations may limit access during nesting, calving, spawning, or other times when fish and wildlife may be especially vulnerable to disturbance.

2.5 Management Categories Table

2.5.1 Introduction

Table 2-1 summarizes activities, public uses, commercial activities or uses, and facilities by management category. In some cases, it provides very specific guidance, such as for highway vehicles. In other cases, such as for research and management facilities, the direction is general. While facilities may be allowed in all management categories, the types of facilities and how they would be constructed and operated vary by management category. The descriptions of the management categories reflect a clear distinction in the level of action and constraints that may be placed on activities or developments in the management categories. The descriptions of the management categories reflect the desired future condition of the area and shall be used to evaluate site-specific proposals. Activities allowed or authorized in the different categories will be managed differently, depending on the management category in which they occur.

Management categories, activities, public uses, commercial activities or uses, and facilities that generally do not apply to Arctic Refuge are shaded in gray.

2.5.2 Definitions for Management Categories Table

The following are definitions for terms used in Table 2-1.

Allowed: Activity, use, or facility is allowed under existing NEPA analysis, appropriate use findings, Refuge compatibility determinations, and applicable laws and regulations of the Service, other Federal agencies, and the State.

May be allowed: Activity, use, or facility may be allowed subject to site-specific NEPA analysis, an appropriate use finding (when required), a specific Refuge compatibility determination (when required), and compliance with all applicable laws and regulations of the Service, other Federal agencies, and the State.

May be authorized: Activity, use, or facility may only be allowed with a required special use permit or other authorization.

Not allowed: Activity, use, or facility is not allowed.

The following terms are used in the table and throughout this chapter.

NEPA analysis: All activities, uses, and facilities proposed for a refuge that have the potential to affect the environment require an analysis of potential environmental impacts under the National Environmental Policy Act. This analysis may be documented as a categorical exclusion, an environmental assessment (EA), or an environmental impact statement (EIS), depending on the nature of the proposed project.

Appropriate Use: All activities, uses, and facilities over which the Service has jurisdiction must be determined to be appropriate following direction in Service Manual 630 FW 1. Hunting, fishing, wildlife observation and photography, and environmental education and interpretation are considered appropriate by national policy with no further analysis required. See Section 2.4.1 for a description of the criteria used to determine if other activities, uses, or facilities are appropriate.

Compatibility: All activities, uses, and facilities allowed on the Refuge, except management actions undertaken by the Service, must be found to be compatible with the purposes of the Refuge and the mission of the Refuge System. Management activities undertaken by volunteers, cooperators, or contractors working for the Service, with limited exception, are exempt from compatibility review (part 603 of the Service Manual).

Regulations: All activities, uses, and facilities allowed on a refuge must comply with any applicable regulations, as published in the CFR. Regulations are developed by the Service through a public process to implement the legal authorities under which the Service manages the Refuge System. For more information on these regulations, see the Management Policies and Guidelines section of this chapter. For some activities, other Federal agency and/or State regulations may also apply.

Temporary: The term “temporary” means a continuous period of time not to exceed 12 months, except as specifically provided otherwise. Special use permits or other authorizations may prescribe a longer period of time, but the structures or other human-made improvements need to be readily and completely dismantled and removed from the site when the period of authorized use terminates.

The following guidelines apply to all activities, uses, and facilities on a refuge.

Area or time restrictions: All activities, uses, and facilities allowed on a refuge may be restricted in certain areas or at certain times, at the discretion of the refuge manager and with the appropriate level of public involvement, by emergency (short-term) or permanent regulation, if necessary to protect resources on refuge lands or human health and safety.

Human safety and management emergencies: Actions not allowed on a refuge or in specific management categories may be allowed in situations or events that threaten human health or safety, or that make the action necessary to meet legal mandates.

Table 2-1. Activities, public uses, commercial activities, or uses, and facilities by management category.

Note: Those management categories and activities that do not apply to Arctic Refuge are shaded gray.

ACTIVITY or USE	MANAGEMENT of WILDERNESS	MANAGEMENT of WILD RIVERS	MINIMAL MANAGEMENT	MODERATE MANAGEMENT	INTENSIVE MANAGEMENT
ECOSYSTEM, HABITAT, FISH, AND WILDLIFE MANAGEMENT (See Sections 2.4.10, 2.4.11, and 2.4.12)					
Ecosystem and Landscape Management					
Collecting Information on and Monitoring Ecosystem Components Data gathering, monitoring, and maintaining a comprehensive database of selected ecosystem components (e.g., plants, animals, fish, water, air). (See Sections 2.4.12 and 2.4.12.1)	Allowed*; see Section 2.4.20	Allowed	Allowed	Allowed	Allowed
Research and Management Access and collection of data necessary for management decisions or to further science by the Service. (See Section 2.4.12)	Allowed*; see Section 2.4.20	Allowed	Allowed	Allowed	Allowed
Access and collection of data necessary for management decisions or to further science by ADFG.	Allowed*; see Section 2.4.20	Allowed	Allowed	Allowed	Allowed
Access and collection of data necessary for management decisions or to further science by other researchers.	May be authorized*; see Section 2.4.20	May be authorized	May be authorized	May be authorized	May be authorized
Research and Management Facilities May be permanent or temporary structures or camps, including weirs, counting towers, and sonar counters. (See Section 2.4.21.1)	May be allowed*; consistent with Section 2.3.4 and 2.4.21.1	May be allowed	May be allowed	May be allowed	May be allowed

* Subject to minimum requirement analysis

ACTIVITY or USE	MANAGEMENT of WILDERNESS	MANAGEMENT of WILD RIVERS	MINIMAL MANAGEMENT	MODERATE MANAGEMENT	INTENSIVE MANAGEMENT
Fish and Wildlife Habitat Management					
Describing, Locating, and Mapping Habitats Development of quantitative, written, and graphic descriptions of fish and wildlife habitat, including water, food, and shelter components. (See Section 2.4.11.1)	Allowed*; see Section 2.4.20	Allowed	Allowed	Allowed	Allowed
Habitat Management (See Section 2.4.11.1) ***Mechanical Treatment:*** Activities such as cutting, crushing, or mowing of vegetation; water control structures; fencing; artificial nest structures.	Not allowed; with exceptions consistent with Sections 2.3.4. See also Section 2.4.20	Not allowed; with exceptions consistent with Section 2.3.5	Not allowed; with exceptions consistent with Section 2.3.3	May be allowed	May be allowed
Chemical Treatment: Use of chemicals to remove or control non-native species. (See Section 2.4.12.8)	May be allowed*; see Section 2.4.20	May be allowed	May be allowed	May be allowed	May be allowed
Manual Treatment: Use of hand tools to remove, reduce, or modify hazardous plant fuels or exotic plant species, or to modify habitats (e.g., remove beaver dams).	May be allowed*; see Section 2.4.20	May be allowed	May be allowed	May be allowed	May be allowed
Aquatic Habitat Modifications Activities such as stream bank restoration, passage structures, fish barriers, or removal of obstacles that result in physical modification of aquatic habitats to maintain or restore native fish species. (See Section 2.4.11.1)	May be allowed*; consistent with Section 2.3.4. See also Section 2.4.20	May be allowed; consistent with Section 2.3.5	May be allowed	May be allowed	May be allowed

* Subject to minimum requirement analysis

ACTIVITY or USE	MANAGEMENT of WILDERNESS	MANAGEMENT of WILD RIVERS	MINIMAL MANAGEMENT	MODERATE MANAGEMENT	INTENSIVE MANAGEMENT
Fire Management—Prescribed Fires Planned ignitions designed to meet specific management objectives. (See Section 2.4.11.2)	May be allowed*; see Section 2.3.4	May be allowed	May be allowed	May be allowed	May be allowed
Fire Management—Use of Wildland Fire Management of wildfires to meet resource objectives. Wildfires or portions of wildfires may remain unsuppressed to protect and maintain the ecological integrity of Refuge lands. (See Section 2.4.11.2)	May be allowed*	May be allowed	May be allowed	May be allowed	May be allowed
Fire Management—Fire Suppression Management actions intended to extinguish or confine a fire or a portion of a fire, beginning with its discovery, to protect, prevent, or reduce the loss of identified values. (See Section 2.4.11.2)	Allowed	Allowed	Allowed	Allowed	Allowed
Non-native and Pest Plant Control Monitoring, extirpation, control, removal and/or relocation, and other management practices for pest and non-native plant species. (See Section 2.4.12.8)	May be allowed*; see Section 2.4.20	May be allowed	May be allowed	May be allowed	May be allowed
Water Quality and Quantity Management Monitoring of water quality and quantity to identify baseline data and for management purposes; includes installation of gauging stations. (See Section 2.4.10.3)	Allowed*; see Section 2.4.20	Allowed	Allowed	Allowed	Allowed

* Subject to minimum requirement analysis

ACTIVITY or USE	MANAGEMENT of WILDERNESS	MANAGEMENT of WILD RIVERS	MINIMAL MANAGEMENT	MODERATE MANAGEMENT	INTENSIVE MANAGEMENT
Fish and Wildlife Population Management					
Reintroduction of Species The reintroduction of native species to restore diversity of native fish, wildlife, and habitats. (See Section 2.4.12.6)	May be allowed*; see Section 2.4.20	May be allowed	May be allowed	May be allowed	May be allowed
Fish and Wildlife Control The control, relocation, sterilization, removal, or other management of native species, including predators, to maintain diversity of native fish, wildlife, and habitats; favor other fish or wildlife populations; protect reintroduced, threatened, or endangered species or to restore depleted native populations. (See Section 2.4.12.7)	May be allowed*; see Section 2.4.20	May be allowed	May be allowed	May be allowed	May be allowed
Non-native Species Management The removal or control of non-native species (including predators). (See Section 2.4.12.8)	May be allowed*; see Section 2.4.20	May be allowed	May be allowed	May be allowed	May be allowed
Pest Management and Disease Prevention and Control Relocation or removal of organisms that threaten human health or survival of native fish, wildlife, or plant species. Management practices directed at controlling pathogens that threaten fish, wildlife, and people, such as rabies and parasite control. (See Section 2.4.12.9)	May be allowed*; see Section 2.4.20	May be allowed	May be allowed	May be allowed	May be allowed

* Subject to minimum requirement analysis

ACTIVITY or USE	MANAGEMENT of WILDERNESS	MANAGEMENT of WILD RIVERS	MINIMAL MANAGEMENT	MODERATE MANAGEMENT	INTENSIVE MANAGEMENT
Fishery Restoration Actions taken to restore fish access to spawning and rearing habitat, or actions taken to restore populations to historic levels. Includes harvest management, escapement goals, habitat restoration, stocking, egg incubation boxes, and lake fertilization. (See Section 2.4.12.10)	May be allowed*	May be allowed	May be allowed	May be allowed	May be allowed
Fishery Restoration Facilities Fisheries facilities may be permanent or temporary and may include hatcheries, fish ladders, fish passages, fish barriers, and associated structures. (See Sections 2.4.12.1 and 2.4.21.1)	May be authorized*	May be authorized	May be authorized	May be authorized	May be authorized
Fishery Enhancement Activities applied to a fish stock to supplement numbers of harvestable fish to a level beyond what could be naturally produced based upon a determination or reasonable estimate of historic levels. (See Section 2.4.12.10)	Not allowed	Not allowed	Not allowed	May be authorized	May be authorized
Fishery Enhancement Facilities May be permanent or temporary and may include hatcheries, egg incubation boxes, fish ladders, fish passages, fish barriers, and associated structures. (See Sections 2.4.12.10 and 2.4.21.1)	Not allowed	Not allowed	Not allowed	May be authorized	May be authorized
Non-native Species Introductions Introduction of species not naturally occurring in the Refuge. (See Section 2.4.12.6)	Not allowed	Not allowed	Not allowed	Not allowed	Not allowed

* Subject to minimum requirement analysis

ACTIVITY or USE	MANAGEMENT of WILDERNESS	MANAGEMENT of WILD RIVERS	MINIMAL MANAGEMENT	MODERATE MANAGEMENT	INTENSIVE MANAGEMENT
SUBSISTENCE (See Section 2.4.13)					
Subsistence Activities					
Fishing, Hunting, Trapping, and Berry Picking The taking of fish and wildlife and other natural resources for personal consumption, as provided by law.	Allowed	Allowed	Allowed	Allowed	Allowed
Collection of House Logs and Firewood Harvesting live standing timber greater than 6 inches diameter at breast height for personal or extended family use.	May be authorized	May be authorized	May be authorized	May be authorized	May be authorized
Collection of House Logs and Firewood Harvesting live standing timber between 3 and 6 inches diameter at breast height for personal or extended family use.	20 trees or fewer per year allowed; more than 20 trees per year may be authorized; consistent with Section 2.4.13	20 trees or fewer per year allowed; more than 20 trees per year may be authorized; consistent with Section 2.4.13	20 trees or fewer per year allowed; more than 20 trees per year may be authorized; consistent with Section 2.4.13	20 trees or fewer per year allowed; more than 20 trees per year may be authorized; consistent with Section 2.4.13	20 trees or fewer per year allowed; more than 20 trees per year may be authorized; consistent with Section 2.4.13
Collection of Plant Materials Harvesting trees less than 3 inches diameter at breast height, dead standing or downed timber, grass, bark, and other plant materials used for subsistence purposes.	Allowed	Allowed	Allowed	Allowed	Allowed
Temporary Facilities – See Temporary Facilities (Public Use) (See also Section 2.4.16.2)					
Subsistence Cabins – See Cabins (Public Use) (See also Section 2.4.16.1)					

ACTIVITY or USE	MANAGEMENT of WILDERNESS	MANAGEMENT of WILD RIVERS	MINIMAL MANAGEMENT	MODERATE MANAGEMENT	INTENSIVE MANAGEMENT
Subsistence Access – subject to reasonable regulations under provisions of Section 811 of ANILCA (See Section 2.4.13.1)					
Use of snowmobiles, motorboats, and other means of surface transportation traditionally employed for subsistence purposes.	Allowed	Allowed	Allowed	Allowed	Allowed
PUBLIC ACCESS (See Sections 2.4.12.8, 2.4.12.9, 2.4.13.1 and 2.4.14) Restrictions subject to provisions of Section 1110 of ANILCA as applicable; see also Subsistence Access section in this table.					
Foot	Allowed	Allowed	Allowed	Allowed	Allowed
Dogs and Dog Teams (Straw and hay bedding not allowed)	Allowed	Allowed	Allowed	Allowed	Allowed
Domestic Sheep, Goats, and Camelids (e.g., llamas and alpacas)	Not allowed**	Not allowed**	Not allowed**	Not allowed**	Not allowed**
Other Domestic Animals Includes horses (pelletized weed-free feed required)	Allowed	Allowed	Allowed	Allowed	Allowed
Non-Motorized Boats Includes canoes, kayaks, rafts, etc.	Allowed	Allowed	Allowed	Allowed	Allowed
Motorized					
Use of snowmobiles, motorboats, airplanes, and non-motorized surface transportation methods for traditional activities and for travel to and from villages and home sites.	Allowed	Allowed	Allowed	Allowed	Allowed
Highway Vehicles	Not allowed	Not allowed	Not allowed	May be allowed on designated roads	Allowed on all-weather roads

** Requires new regulations for non-commercial uses.

ACTIVITY or USE	MANAGEMENT of WILDERNESS	MANAGEMENT of WILD RIVERS	MINIMAL MANAGEMENT	MODERATE MANAGEMENT	INTENSIVE MANAGEMENT
Off-Road Vehicles (All-Terrain Vehicles) Includes air boats and air-cushion vehicles. (See Sections 2.4.13.1 and 2.4.14.2)	Not allowed; with exceptions consistent with Section 2.4.13.1	Not allowed; with exceptions consistent with Section 2.4.13.1	Not allowed; with exceptions consistent with Section 2.4.13.1	May be authorized	May be authorized
Helicopters Includes all rotary-wing aircraft. (See Section 2.4.14.3)	Not allowed; with exceptions consistent with Section 2.4.14.3	Not allowed; with exceptions consistent with Section 2.4.14.3	Not allowed; with exceptions consistent with Section 2.4.14.3	May be authorized	May be authorized
PUBLIC USE, RECREATION, and OUTREACH ACTIVITIES Also see ACCESS and Commercial Recreation sections.					
Hunting, Fishing, Wildlife Observation, Wildlife Photography, Interpretation, and Environmental Education Note: All activities listed are priority public uses. (See Sections 2.4 and 2.4.15)	Allowed	Allowed	Allowed	Allowed	Allowed
Trapping, Walking, Hiking, Camping at Undeveloped Sites, and Dog Sledding (See Sections 2.4 and 2.4.15)	Allowed	Allowed	Allowed	Allowed	Allowed
General Photography See also COMMERCIAL USES. (See Sections 2.3 and 2.4.15)	Allowed	Allowed	Allowed	Allowed	Allowed
Outreach Activities (See Sections 2.3 and 2.4.17)	Allowed	Allowed	Allowed	Allowed	Allowed
Public Use and Recreation Facilities – level of development is consistent with management intent of the category (See Section 2.4.16)					
All Weather Roads And associated developments, including bridges.	Not allowed	Not allowed	Not allowed	May be allowed	May be allowed

ACTIVITY or USE	MANAGEMENT of WILDERNESS	MANAGEMENT of WILD RIVERS	MINIMAL MANAGEMENT	MODERATE MANAGEMENT	INTENSIVE MANAGEMENT
Unimproved Roads Note: While unimproved roads are not allowed in Minimal, Wilderness, and Wild River Management categories, roads may exist. In these management categories, the roads will not be designated for use or maintained.	Not allowed	Not allowed	Not allowed	May be allowed	May be allowed
Designated Off-Road Vehicle (All-Terrain Vehicle) Routes and Areas	Not allowed	Not allowed	Not allowed	May be authorized	May be authorized
Roadside Exhibits and Waysides	Not applicable	Not applicable	Not applicable	May be allowed	May be allowed
Constructed and Maintained Landing Areas	Not allowed	Not allowed	Not allowed	May be allowed	May be allowed
Cleared Landing Areas Includes unimproved areas where airplanes land. Minor brush cutting or rock removal by hand is allowed for maintenance.	Existing areas allowed to remain*; new areas not allowed; see Section 2.4.20	May be allowed	May be allowed	May be allowed	May be allowed
Constructed Hiking Trails Includes bridges, boardwalks, trailheads, and related facilities. (See Section 2.4.16)	May be allowed*	May be allowed	May be allowed	May be allowed	May be allowed
Designated Hiking Routes Unimproved and unmaintained trails; may be designated by signs, cairns, and/or on maps.	Allowed	Allowed	Allowed	Allowed	Allowed
Boat Launches and Docks (Public) Designated sites for launching and storing watercraft or tying up a float plane. (See Section 2.4.16)	Not allowed*	Not allowed	Not allowed	May be allowed	May be allowed

* Subject to minimum requirement analysis

ACTIVITY or USE	MANAGEMENT of WILDERNESS	MANAGEMENT of WILD RIVERS	MINIMAL MANAGEMENT	MODERATE MANAGEMENT	INTENSIVE MANAGEMENT
Visitor Contact Facilities A variety of staffed and unstaffed facilities providing information on the Refuge and its resources to the public; facilities range from visitor centers to kiosks and signs. (See Section 2.4.16)	Not allowed*; see Sections 2.3.4 and 2.4.20	Not allowed	Not allowed	May be allowed	May be allowed
Campgrounds Developed sites accessible by highway vehicles.	Not applicable	Not applicable	Not applicable	May be allowed	May be allowed
Hardened Campsites Areas where people can camp that are accessible by vehicle or on foot but where the only facilities provided are for public health and safety and/or resource protection; may include gravel pads for tents, hardened trails, and/or primitive toilets. (See Section 2.4.16)	May be allowed*; consistent with Section 2.4.20	May be allowed	May be allowed	Allowed	Allowed
Temporary Facilities Includes tent frames and platforms, caches, and other similar or related facilities used for taking fish and wildlife; does not include cabins. See also COMMERCIAL USES and Administrative Facilities. (See Section 2.4.16.2)	Tent platforms left in place more than 12 months may be authorized; all others may be allowed	Tent platforms left in place more than 12 months may be authorized; all others may be allowed	Tent platforms left in place more than 12 months may be authorized; all others may be allowed	May be allowed	May be allowed

* Subject to minimum requirement analysis

ACTIVITY or USE	MANAGEMENT of WILDERNESS	MANAGEMENT of WILD RIVERS	MINIMAL MANAGEMENT	MODERATE MANAGEMENT	INTENSIVE MANAGEMENT
Cabins – also other related structures such as outdoor toilets, food caches, storage sheds, and fish drying racks (See Section 2.4.16.1)					
Public Use Cabin A cabin administered by the Service and available for use by the public; intended only for short-term public recreational use and occupancy.	Not allowed	Not allowed	Not allowed	May be allowed	May be allowed
Administrative Cabin Any cabin primarily used by Refuge staff or other authorized personnel for the administration of the Refuge. (See Section 2.4.21.1)	May be allowed*; consistent with Section 2.4.20	May be allowed	May be allowed	May be allowed	May be allowed
Subsistence Cabin Any cabin necessary for health and safety and to provide for the continuation of ongoing subsistence activities; not for recreational use.	Existing cabins allowed to remain; new cabins may be authorized; consistent with Section 2.4.20	Existing cabins allowed to remain; new cabins may be authorized	Existing cabins allowed to remain; new cabins may be authorized	Existing cabins allowed to remain; new cabins may be authorized	Existing cabins allowed to remain; new cabins may be authorized
Commercial Cabin Any cabin that is used in association with a commercial operation, including but not limited to commercial fishing activities and recreational guiding services.	Existing cabins allowed to remain; new cabins not allowed consistent with Section 2.4.20	Existing cabins allowed to remain; new cabins may be authorized	Existing cabins allowed to remain; new cabins may be authorized	Existing cabins allowed to remain; new cabins may be authorized	Existing cabins allowed to remain; new cabins may be authorized
Other Cabins Cabins associated with authorized activities or uses by other government agencies.	May be authorized; consistent with Section 2.4.20	May be authorized	May be authorized	May be authorized	May be authorized

* Subject to minimum requirement analysis

ACTIVITY or USE	MANAGEMENT of WILDERNESS	MANAGEMENT of WILD RIVERS	MINIMAL MANAGEMENT	MODERATE MANAGEMENT	INTENSIVE MANAGEMENT
Administrative Facilities (See Section 2.4.21.1)					
Administrative Field Camps Temporary facilities used by Refuge staff and other authorized personnel to support individual (generally) field projects; may include but not limited to tent frames and temporary/portable outhouses, shower facilities, storage/ maintenance facilities, and caches.	May be allowed*	May be allowed	May be allowed	May be allowed	May be allowed
Administrative Field Sites Permanent facilities used by Refuge staff or other authorized personnel for the administration of the Refuge. Includes administrative cabins and related structures (see Cabins) and larger multi-facility administrative sites necessary to support ongoing field projects, research, and other management activities. Temporary facilities, to meet short-term needs, may supplement the permanent facilities at these sites.	Use of existing sites allowed, including replacement of existing facilities as necessary; new sites may be allowed*; consistent with Sections 2.3.4 and 2.4.20	Use of existing sites allowed, including replacement of existing facilities as necessary; new sites may be allowed	Use of existing sites allowed, including replacement of existing facilities as necessary; new sites may be allowed	Use of existing sites allowed, including replacement of existing facilities as necessary; new sites may be allowed	Use of existing sites allowed, including replacement of existing facilities as necessary; new sites may be allowed
Refuge Administrative Office Complex Facilities necessary to house Refuge operations, outreach, and maintenance activities, and associated infrastructure; includes staff offices, storage, maintenance, parking lots, and other similar facilities.	Not allowed	Not allowed	Not allowed	Not allowed	May be allowed

* Subject to minimum requirement analysis

ACTIVITY or USE	MANAGEMENT of WILDERNESS	MANAGEMENT of WILD RIVERS	MINIMAL MANAGEMENT	MODERATE MANAGEMENT	INTENSIVE MANAGEMENT
Hazardous Materials Storage Sites, including appropriate structures and equipment, necessary for the storage and transfer of fuels and other hazardous materials necessary for administrative purposes; must be in compliance with all Federal and State requirements.	May be allowed*	May be allowed	May be allowed	May be allowed	May be allowed
Residences Residential housing for Refuge staff and their families; includes single and multi-family dwellings.	Not allowed	Not allowed	Not allowed	Not allowed	May be allowed
Bunkhouses Quarters to house temporary and similar employees, volunteers, visitors, and other agency personnel.	Not allowed	Not allowed	Not allowed	Not allowed	May be allowed
Aircraft Hangars and Facilities for Storage of Aircraft	Not allowed	Not allowed	Not allowed	Not allowed	May be allowed
Boat Launches and Docks (Administrative) Designated sites for launching and storing watercraft or tying up a float plane.	May be allowed*	May be allowed	May be allowed	May be allowed	May be allowed
Radio Repeater Sites Sites used to maintain radio communications equipment; may include a location for helicopter access.	May be allowed*	May be allowed	May be allowed	May be allowed	May be allowed

* Subject to minimum requirement analysis

ACTIVITY or USE	MANAGEMENT of WILDERNESS	MANAGEMENT of WILD RIVERS	MINIMAL MANAGEMENT	MODERATE MANAGEMENT	INTENSIVE MANAGEMENT
COMMERCIAL ACTIVITIES OR USES Except as noted, a special use permit or other authorization is required for economic use of a refuge.					
Commercial Recreation – includes all forms of guiding, including those operated by nonprofit, educational, and other non-commercial groups (See Section 2.4.18.1)					
Guiding	May be authorized	May be authorized	May be authorized	May be authorized	May be authorized
Transporting	May be authorized	May be authorized	May be authorized	May be authorized	May be authorized
Fixed-Wing Air-Taxis	May be authorized	May be authorized	May be authorized	May be authorized	May be authorized
Helicopter Air-Taxis	Not allowed	Not allowed	Not allowed	Not allowed	Not allowed
Bus and Auto Tours	Not applicable	Not applicable	Not applicable	May be authorized	May be authorized
Mineral Exploration (See Section 2.4.18.2) See Section 2.4.22 for information on the Alaska Mineral Resource Assessment Program.					
Surface Geological Studies Includes surface rock collecting and geological mapping activities (includes helicopter or fixed-wing access).	May be authorized consistent with Section 2.4.18.2	May be authorized consistent with Section 2.4.18.2	May be authorized consistent with Section 2.4.18.2	May be authorized consistent with Section 2.4.18.2	May be authorized consistent with Section 2.4.18.2
Geophysical Exploration and Seismic Studies Examination of subsurface rock formations through devices that set off and record vibrations in the earth. Usually involves mechanized surface transportation but may be helicopter supported; includes studies conducted for DOI.	Not allowed	May be authorized consistent with Section 2.4.18.2	May be authorized consistent with Section 2.4.18.2	May be authorized consistent with Section 2.4.18.2	May be authorized consistent with Section 2.4.18.2
Core Sampling Using helicopter transported motorized drill rig to extract subsurface rock samples; does not include exploratory wells; includes sampling conducted for DOI.	Not allowed with exceptions consistent with Sec. 2.4.22	Not allowed with exceptions consistent with Sec. 2.4.22	May be authorized consistent with Section 2.4.18.2	May be authorized consistent with Section 2.4.18.2	May be authorized consistent with Section 2.4.18.2

ACTIVITY or USE	MANAGEMENT of WILDERNESS	MANAGEMENT of WILD RIVERS	MINIMAL MANAGEMENT	MODERATE MANAGEMENT	INTENSIVE MANAGEMENT
Other Geophysical Studies Helicopter-supported gravity and magnetic surveys and other minimal impact activities that do not require mechanized surface transportation.	Not allowed	May be authorized consistent with Section 2.4.18.2	May be authorized consistent with Section 2.4.18.2	May be authorized consistent with Section 2.4.18.2	May be authorized consistent with Section 2.4.18.2
Mineral Development (see Section 2.4.18.2)					
Oil and Gas Leasing Leasing, drilling, and extraction of oil and gas for commercial purposes. Includes all associated above and below ground facilities.	Not allowed unless authorized by Congress under ANILCA 1003	Not allowed unless authorized by Congress under ANILCA 1003	Not allowed unless authorized by Congress under ANILCA 1003	Not allowed unless authorized by Congress under ANILCA 1003	Not allowed unless authorized by Congress under ANILCA 1003
Sale of Sand, Gravel, and Other Common Variety Minerals Extraction of sand, gravel, and other saleable minerals for commercial purposes; includes commercial use by Federal, State, and local agencies.	Not allowed	Not allowed	Not allowed	May be authorized	May be authorized
Other Mineral Leasing Includes the extraction of coal, geothermal resources, potassium, sodium, phosphate, sulfur, or other leasable minerals for commercial purposes. For cases of national need, see Section 2.4.18.2.	Not allowed	Not allowed	Not allowed	Not allowed	Not allowed
Mining of Hardrock Minerals Development of valid (pre-ANILCA) mining claims (lode, placer, and mill sites) on Refuge lands for the purpose of extracting hardrock minerals. There are no valid claims on the Refuge.	Not allowed	Not allowed	Not allowed	Not allowed	Not allowed

ACTIVITY or USE	MANAGEMENT of WILDERNESS	MANAGEMENT of WILD RIVERS	MINIMAL MANAGEMENT	MODERATE MANAGEMENT	INTENSIVE MANAGEMENT
Other Commercial Activities					
Commercial Filming, Videotaping, and Audio Taping (See Section 2.4.18.6)	May be authorized	May be authorized	May be authorized	May be authorized	May be authorized
Grazing (See Section 2.4.18.7)	Not allowed	Not allowed	Not allowed	Not allowed	Not allowed
Agriculture (Commercial) (See Section 2.4.18.7)	Not allowed	Not allowed	Not allowed	Not allowed	Not allowed
Commercial Fishery Support Facilities At or below 1979 levels. (See Section 2.4.18.3)	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Commercial Fishery Support Facilities Above 1979 levels. (See Section 2.4.18.3)	Not allowed	May be authorized	May be authorized	May be authorized	May be authorized
Seafood Processing (See Section 2.4.18.3)	Not allowed	Not allowed	Not allowed	Not allowed	Not allowed
Aquaculture and Mariculture Support Facilities (See Section 2.4.18.3)	Not allowed	Not allowed	Not allowed	Not allowed	May be authorized
Commercial Timber and Firewood Harvest (See Section 2.4.18.4)	Not allowed	May be authorized	May be authorized	May be authorized	May be authorized
Commercial Gathering of Other Resources (See Section 2.4.18.5)	Not allowed	Not allowed	Not allowed	May be authorized	May be authorized
Transportation and Utility Systems Includes transmission lines, pipelines, telephone and electrical power lines, oil and gas pipelines, communication systems, roads, landing areas, and other necessary related facilities. Does not include facilities associated with on-Refuge oil and gas development. (See Section 2.4.14.7)	May be authorized by Congress	May be authorized	May be authorized	May be authorized	May be authorized

ACTIVITY or USE	MANAGEMENT of WILDERNESS	MANAGEMENT of WILD RIVERS	MINIMAL MANAGEMENT	MODERATE MANAGEMENT	INTENSIVE MANAGEMENT
Navigation Aids and Other Facilities Includes air and water navigation aids and related facilities, communication sites and related facilities, facilities for national defense purposes and related air/water navigation aids, and facilities for weather, climate, and fisheries research and monitoring; includes both private and government facilities. (See Section 2.4.14.11)	May be authorized*	May be authorized	May be authorized	May be authorized	May be authorized
Major Hydroelectric Power Development Hydroelectric dams creating a change in stream flow with an elevation change and reservoir behind the dam. (See Section 2.4.18.7)	Not allowed	Not allowed	Not allowed	Not allowed	Not allowed
Small Hydroelectric Power Development Hydroelectric generation by low-head or instream structures that do not change the flow of the river. (See Section 2.4.18.7)	Not allowed	Not allowed	Not Allowed	May be authorized	May be authorized

* Subject to minimum requirement analysis

3. Issues and Alternatives

This chapter discusses the issues and alternatives considered and analyzed as part of this Comprehensive Conservation Plan (Plan, Revised Plan) and environmental impact statement (EIS). The chapter presents three significant issues and six alternatives for managing Arctic National Wildlife Refuge (Arctic Refuge, Refuge). Included is the "No Action" alternative (Alternative A) which is the continuation of current management, as detailed in the 1988 Plan (Service 1988a).

3.1 Issues

The U.S. Fish and Wildlife Service (Service) defines an issue as any unsettled matter that requires a management decision. Issues were identified internally by Refuge staff as well as through public comments. All issues identified in scoping were reviewed in a series of workshop discussions involving the Refuge Staff, the State of Alaska and other agency planning team partners, the regional planning chief, and the Refuge supervisor. All identified issues outside the scope of the Plan or that could be resolved through existing laws, regulations, or policies were eliminated from further consideration.

3.1.1 Significant Issues

Significant issues are problems, conflicts, or opportunities we will address in the Plan. A significant issue is one component of an alternative. The Refuge's role in identifying and analyzing significant issues is to objectively consider a wide range of approaches that could be taken to address each issue. Three significant planning issues were identified for consideration during revision of the Plan:

1. Should one or more areas of the Refuge be recommended for Wilderness designation?
2. Should additional wild and scenic rivers be recommended for inclusion in the National Wild and Scenic Rivers System?
3. How will the Refuge manage Kongakut River visitor use to protect resources and visitor experience?

Refuge staff developed a range of actions (i.e., different options or strategies) for addressing each issue. The regional planning chief, Refuge manager, Refuge supervisor, and regional chief of the Refuge System reviewed and edited the suite of issues. Lastly, the regional director reviewed and approved the issues for inclusion in the Revised Plan and EIS. This section includes a detailed description of the three significant planning issues. Included are a sample of the comments we received from the public on each issue.

3.1.1.1 Wilderness

Issue 1: Should one or more areas of the Refuge be recommended for Wilderness designation?

Currently about 37 percent of Arctic Refuge (7.16 million acres) is desinated Wilderness. As part of the comprehensive conservation planning process, the Service reviews lands not designated as Wilderness to determine if they are qualified and suitable to be recommend for

Wilderness designation. This review divided the Refuge's non-Wilderness lands into three Wilderness Study Areas (WSAs): Brooks Range, Porcupine Plateau, and Coastal Plain (Appendix H). All three WSAs were determined to meet the minimum criteria for Wilderness designation. This Plan will decide which, if any, of the units will be recommended for Wilderness designation. Only Congress can designate Wilderness.

Summary of Comments

Nearly all commenters addressed this issue. A primary focus was the coastal plain and the effect Wilderness designation would have on potential oil and gas development there. The primary concern of those opposing or supporting Wilderness designation for this area was that the designation would either preclude development or protect the area from it. The Gwich'in people and others generally supported a Wilderness recommendation for the area because they felt it would provide protection for caribou and other wildlife. The Iñupiat people and others generally opposed a Wilderness recommendation for the area because they felt it would limit or preclude economic opportunities and would interfere with subsistence activities.

There were relatively few comments specific to either the Brooks Range or the Porcupine Plateau WSAs. Most wilderness comments not focused on the coastal plain stated that either all or none of the Refuge's non-Wilderness areas should be recommended for designation. Those supporting Wilderness recommendations said Wilderness status would provide needed permanent protection for the Refuge's wildlife, ecological, scientific, recreational, subsistence, and other values. Those opposing Wilderness recommendations said the Refuge or the State currently has enough or too much Wilderness and that Wilderness unnecessarily limits public access and use.

Scoping Comments

"The entire Coastal Plain should be recommended for wilderness designation for its importance to wildlife, symbol of wilderness and subsistence values for future generations."

"The 1002 area of ANWAR should not only continue to be excluded from wilderness designation but it should be open up to responsible on shore oil and gas exploration and development as soon as possible."

"Wilderness status for the 1002 would also deprive the people of Kaktovik, KIC, ASRC, and the North Slope Borough of economic development opportunities there."

"Alaskans firmly believe that we can coexist with nature successfully without any need to lock up the land by imposing no-go designations through wilderness status."

"The only way to guarantee the protection of the Arctic NWR is to permanently protect it with Wilderness designation."

"The CCP plan should recommend the Coastal Plain be proposed wilderness designation to protect the caribou and Gwich'in way of life for future generations."

"Above all, it is my strong conviction that we cannot forgo the chance to protect and keep one of the last places on Earth truly wild"

"Wilderness designation carries with it significant limitations on access and uses that choke off traditional activities."

"The only way to guarantee the protection of Arctic NWR is to permanently protect it with Wilderness designation."

"Additional wilderness will do nothing but add red tape to our subsistence lifestyle."

"I very strongly oppose any wilderness designation for the Coastal Plain of the Arctic National Wildlife Refuge, or for any part of ANWR, period."

3.1.1.2 Wild and Scenic Rivers

Issue 2: Should additional wild and scenic rivers be recommended for inclusion in the National Wild and Scenic Rivers System?

The Wild and Scenic Rivers Act and agency policy (602 FW 1 and 3) require land managers to identify rivers for wild and scenic river review during land management planning. Twenty waters in Arctic Refuge were evaluated for inclusion in the National Wild and Scenic Rivers System (NWSRS), and 10 rivers were determined to be eligible. All 10 rivers are free-flowing and possess at least one of the following outstandingly remarkable values (ORVs): scenic, recreational, geologic, fish, wildlife, historic, or cultural. A suitability study was conducted for the 10 eligible rivers, and four were preliminarily determined to be suitable. According to the Wild and Scenic Rivers Act, values must "be protected for the benefit and enjoyment of future generations." Recommending rivers for inclusion in the NWSRS requires the implementation of management prescriptions intended to protect the rivers' values. Only Congress can designate rivers for inclusion in the NWSRS.

<u>Summary of Comments</u>

Comments that addressed wild and scenic rivers were generally in favor of the Service conducting a review, although we also received comments expressing opposition. Comments ranged from descriptions of specific rivers or areas in rivers, to discussions of the review process and requirements under the Wild and Scenic Rivers Act. We also received comments addressing the relationship of wild and scenic rivers to designated Wilderness.

<u>Scoping Comments</u>

"The Ramparts of the Porcupine River have been recommended as national natural landmarks. This portion of the Porcupine Plateau is thought by many to be one of the state's outstanding scenic features."

"You should, on the wild river side of things, please focus on the rivers within the non-wilderness portions of the refuge…. Wild rivers inside wilderness really don't offer much additional protection and therefore the focus should be on those that may require additional protection."

"The USFWS should conduct a suitability review of the 24 identified rivers, especially for the Hulahula and Kongakut Rivers for wild river designation could aid in protecting river values. In general, the USFWS should recommend to Congress wild river designation for those rivers where user capacities and developments are concerns."
"I also recommend Wild and Scenic River status for the north flowing rivers in the Refuge."

"The Canning, the Hulahula and the Kongakut are pristine, wild rivers that should be recommended for Wild and Scenic River status. I have never seen a river more qualified for wild river status than the Canning and the Marsh Fork of the Canning."

"The Refuge is in the awkward position of having a dream team of all-star rivers. Nearly every river in the Refuge would qualify for W and S status. If you have the time start listing them."

"The Commission is also opposed to studies and/or recommendations for additional wild and scenic rivers within the Arctic Refuge. As we have stated above on the wilderness study issue, existing statutory and regulatory authorities are more than adequate to protect all rivers and water within the refuge. In fact, one of the purposes of the refuge is to ensure 'water quality and necessary water quantity within the refuge.' We see no need to conduct wild and scenic river studies that will divert staff resources from other management issues."

3.1.1.3 Kongakut River Visitor Management

Issue 3: How will the Refuge manage Kongakut River visitor use to protect resources and visitor experience?

The Kongakut River, on the north side of the Brooks Range, offers spectacular views from the mountains to the coastal plain and an opportunity to witness migrating caribou; contains a variety of unique geologic features; and receives nearly one-quarter (24 percent) of the documented visitors to the Refuge. Its entire extent is in designated Wilderness.

Visitor feedback indicates growing concern about Wilderness character of the Kongakut River. Group crowding; user conflicts; excessive over-flights; fire rings, tent rings, and human waste accumulations at concentrated access points and popular camp areas; hardening or impairment of fragile riparian and tundra habitats; and increased footprint of aircraft landing areas are having a negative effect on the Refuge's Wilderness and biological resources.

Internal scoping of Refuge staff resulted in the following list of potential Kongakut River visitor management strategies and actions:

- develop targeted messages to inform visitors about preferred camping and hiking practices
- increase rehabilitation efforts at impaired and impacted sites
- stagger visitor use and reduce the number of groups during peak season
- disperse commuter aircraft overflights in the Kongakut River valley
- initiate an adaptive management framework for monitoring recreation impacts
- develop management strategies through comprehensive, Refuge-wide, visitor use management step-down planning

<u>*Summary of Comments*</u>

The vast majority of public comments specific to the Kongakut River suggested a need for greater management efforts along the river corridor. Requests for increased management efforts for the Kongakut River were focused on retaining—or restoring—the quality of visitor experience. Many comments suggested specific ways to improve visitor experiences, particularly by addressing crowding. Some specific suggestions included modifying group size limits, implementing a lottery system for float trips, and spreading out launch days. Other concerns raised by the public included the need to designate the Kongakut as a wild river and to address potential impacts to river access landing areas.

<u>*Scoping Comments*</u>

"I do have some concerns about the impacts of recreational traffic in some areas, in particular along the Kongakut corridor…you'll see a lot of traffic and there are places that are popular campsites where it's kind of hard to pick up a rock and not find a gift from previous visitors to that campsite. And that's pretty disturbing to come across."

"The Arctic Refuge did a great thing when it introduced regulations for commercial operators on the…Kongakut. It's time to codify these regs and revisit them. I would like to see group size limited to 8, including guides. I'd like to see a limit on the number of trips each company can run on each river, to one trip per river per month, and then have a reservation system that spreads out launch dates so there's a 2-3 day buffer between launch

dates. This would eliminate the large number of trips that tends to launch between June 11 and 21 each summer, creating a large number of groups on the river at the same time."

"I suspect that some of the more popular rivers, such as the Kongakut…are losing their lonely nature. Implement permitting or other controls to prevent overuse and preserve the solitude of those who are there."

"Visitor use has greatly increased from the years when I first visited. This is especially true of the major river valleys such as the Kongakut…I strongly feel that the Conservation Plan should incorporate restrictions on visitor use, particularly in the major river valleys by float trip parties."

3.1.2 Issues Identified During Scoping but Eliminated from Detailed Study

The following discussion briefly describes issues and actions the staff considered but subsequently eliminated from detailed study and National Environmental Policy Act (NEPA) analysis through this Plan. Issues raised by the public and the agency included development, policy, ecological, management, visitor use, and administrative concerns. Many of these issues are important to the management of the Refuge and will be deferred to and incorporated into various step-down plans (see Chapter 6). For a more detailed discussion of the 34 issues considered but eliminated, please refer to Appendix D.

Development Issues – A major issued identified by the public is oil and gas development on the Refuge's coastal plain. Some commenters, including the State of Alaska, asked that the Plan address oil and gas leasing or development scenarios in the range of alternatives. The Service has no administrative authority over oil and gas development. Section 1003 of the Alaska National Interest Lands Conservation Act (ANILCA) specifically prohibits oil and gas leasing, development, and production anywhere on Arctic Refuge until Congress takes action to change this provision.

Policy Issues – Other members of the public expressed concern that the Service is violating ANILCA by conducting wilderness and wild and scenic river reviews. Service policy directs the Refuge to conduct these reviews. They do not violate ANILCA because the reviews do not constitute a withdrawal, nor are they being conducted for the sole purpose of establishing a conservation system unit. The reviews are part of the periodic comprehensive conservation planning process required by ANILCA 304(g)(1), and they are consistent with the requirement in ANILCA 304(g)(2)(B) to consider "the special values of the Refuge as well as any other archeological, cultural, ecological, geological, historical, paleontological, scenic, or wilderness value…." For more on development and policy issues refer to Appendix D, Sections D.1 and D.2.

Ecological Issues – Climate change is expected to continue to affect Refuge resources and the associated human environment for the foreseeable future. There are few actions the Refuge can take to manage the effects of climate change. Rather than incorporate climate change into the alternatives, the Refuge established several objectives to evaluate climate change through scientific research and monitoring and the sharing of traditional knowledge in local communities (see Chapter 2, Section 2.1). Concerns were also expressed about changes in fire behavior, the Service's response (or lack thereof) to fires, and smoke impacts. These concerns are best addressed through a Fire Management Plan (FMP) so as to provide maximum flexibility in Refuge response to wildfires.

The Revised Plan does not provide a range of management alternatives for the Refuge's Public Use Natural Area (PUNA) and two Research Natural Areas (RNAs). We decided existing management, in combination with Refuge purposes, afford a high degree of protection for the features and values in these specially designated areas and that no additional management guidance is needed. Similarly, the Plan does not provide a range of management options for the Refuge's three wild rivers. Their management would instead be addressed through step-down management plans called Comprehensive River Management Plans (see Chapter 2, Section 2.1.3). The Revised Plan provides an opportunity for us to collaboratively study the ecology and natural heritage values of the Refuge's Marine Protected Area (MPA), which was established in 2009, and enhance public recognition of the MPA through environmental education and outreach (Chapter 2, Section 2.1.3).

Visitor Use Issues – Numerous issues were raised about visitor use of the Refuge, the impacts such use is having on Refuge resources and visitor experience, and perceived or real conflicts between different user groups. Identified public use-related issues included crowding; human waste accumulations, different standards for different user groups, how the Refuge interacts with the public, group size, conflicts among and between commercial and private users, preference for guided or non-guided visitors, and aircraft landing impacts and overflight effects. These issues, while relevant and important planning issues, are complex and most effectively addressed through a Visitor Use Management Plan (see Chapter 2, Section 2.1.5, Objective 5.4). For more on visitor use issues refer to Appendix D, Section D.5.

Administrative Issues – Some commenters expressed concern over the administrative facility at Lake Peters and asked the Refuge to remove it. The Refuge may take action to modify or remove the facility's buildings by conducting an environmental analysis separate from the Revised Plan (see Chapter 2, Section 2.1.2, Objective 2.5). Other people wanted the Refuge to establish one or more commercial-free zones and/or an area free from mechanization where solitude and natural quiet are protected. The Refuge gave strong consideration to this issue and developed a range of options for the alternatives. However, the Refuge did not have the necessary data to adequately describe effects on access, private aircraft use, big-game hunting, and scientific research. Further, there were unresolved questions about specific ANILCA requirements for establishment of such an area. The issue was deferred to a Wilderness Stewardship Plan where these questions can be more fully explored (see Chapter 2, Section 2.1.2, Objective 2.4).

3.1.3 Actions Considered for Significant Issues

Actions are different management options or strategies that could be employed to address a planning issue. Each of the three significant planning issues considered in the alternatives presents a range of actions. However, some of the ideas generated by the public and Refuge staff for Wilderness, wild and scenic rivers, and Kongakut River visitor use management were not carried forward. These in effect constitute different alternatives that were eliminated from detailed study. DOI regulations require us to consider those reasonable alternatives that meet the purpose and need of the proposed action and address one or more significant issues (43 CFR 46.415). However, when there are potentially a very large number of alternatives, then we are to disclose those alternatives eliminated from detailed study with a brief discussion of the reasons for eliminating them (40 CFR 1502.14 and 43 CFR 46.420). In this section, we identify the actions considered for the three significant planning issues but not carried into the alternatives. The primary reason for eliminating these options was to keep the number of alternatives at a manageable number.

3.1.3.1 Wilderness Actions not in the Alternatives

The Wilderness Review (Appendix H) established three Wilderness Study Areas (WSAs): Brooks Range, Porcupine Plateau, and Coastal Plain. Five options are presented in Alternatives A through F. To keep the number of alternatives to a manageable number, we considered but did not carry forward the following options:

- The Porcupine Plateau WSA was not recommended by itself, nor was it put forward in combination with the Coastal Plain WSA.
- The Brooks Range WSA was not put forward in combination with the Coastal Plain WSA.
- A different land management category for areas adjacent to Arctic Village and Kaktovik (e.g., Moderate Management) was not introduced.

3.1.3.2 Wild River Actions not in the Alternatives

The wild and scenic river review (Appendix I) identified 10 rivers that are eligible for inclusion in the NWSRS. These rivers were examined for suitability; four were determined suitable for inclusion in the NWSRS. To keep the number of alternatives to a manageable number, we considered but did not carry forward the following options:

- recommend only those suitable rivers and river segments in designated Wilderness
- recommend only those suitable rivers and river segments outside designated Wilderness
- recommend only the Kongakut River
- recommend all suitable rivers except the Kongakut River
- recommend only suitable rivers with a particular value, such as “recreational,” “cultural,” or “fish”
- do not recommend any rivers but develop a river management plan for all rivers in the Refuge, including suitable rivers
- limit access or user numbers on suitable rivers
- limit commercial and/or private recreational activity on suitable rivers

3.1.3.3 Kongakut River Actions not in the Alternatives

The staff considered numerous actions and strategies to address public concerns about the Kongakut River. Some of these actions could be addressed through the Plan. Others are best handled through a Refuge-wide Visitor Use Management Plan (VUMP) or Wilderness Stewardship Plan (WSP) to avoid the displacement of issues from the Kongakut River to other areas of the Refuge. Still others would require rule making. We chose to eliminate the following options from the alternatives in order to keep the number of alternatives to a manageable number and to present only options that would not require the promulgation of regulations:

- restrict use during the two peak use periods
- restrict use during the entire open water season
- restrict the number of commercial trips each company can do on the river
- limit launch dates
- develop a commercial prospectus in which commercial operators tell the Refuge how they will improve conditions on the Kongakut
- require the removal of human waste
- require mandatory, site-specific, trip orientation and certification
- prohibit camping at drop-off and pick-up locations
- limit the number of nights allowed at specific camping areas
- designate camp sites
- establish group size limits for all users

3.2 Alternatives

Multiple elements combine to create each of the alternatives:

- Goals and objectives
- Management categories
- Management policies and guidelines
- Different strategies to respond to issues, public concerns, and opportunities identified during the planning process

The alternatives presented in this Plan were designed to meet the purposes and goals of Arctic Refuge, achieve the mission of the Service, fulfill the purpose and need for the planning document, and respond to key issues and concerns that were identified during public and internal scoping. The alternatives described in this chapter were developed to comply with NEPA, ANILCA and other pertinent laws, and the regulations and directives applied to implement those laws. The alternatives provide a basis for comparing potential impacts and help managers make better decisions regarding the physical, biological, economic, and social effects that could result from proposed actions and activities on Refuge lands.

NEPA directs the Service to develop a range of reasonable alternatives and consider those alternatives in an equal manner. NEPA also requires alternatives considered in an EIS meet the purpose and need for the proposed action. Section 1003 of ANILCA specifically prohibits oil and gas leasing, development, and production anywhere on Arctic Refuge. Until Congress takes action to change this provision, the Service will not permit oil and gas leasing in the Refuge under any of the alternatives in the Plan.

The Service decided that six alternatives would address the three significant planning issues and provide a reasonable range for approaching Refuge management for the next 15 years. The Refuge's goals, objectives, management categories, and management guidelines (Chapter 2) are considered to be the heart of the Plan. They explain the approach the Service would like to take to manage the Refuge.

Alternative A represents the current management situation at Arctic Refuge; it is also called the "No Action" alternative. Alternative A would continue management direction from the 1988 Plan and would not adopt any of the management goals, objectives, policies, or guidelines identified in Chapter 2 of the Revised Plan. Alternative F is similar to Alternative A, but it would adopt all the proposed management objectives (Chapter 2, Section 2.1) and the updated management policies and guidelines identified in Chapter 2, Sections 2.3, 2.4, and 2.5. Alternatives B through E would adopt the Refuge management objectives, management policies, and guidelines but differ in how they would address the three significant planning issues. All six alternatives would maintain three management categories for Refuge lands: Minimal, Wilderness, and Wild River (see Chapter 2, Section 2.3).

3.2.1 Management Actions Common to All Alternatives

This section identifies some of the key components to be included in this Plan regardless of which alternative is selected. These management actions are either already occurring and will continue, or are currently in the process of being implemented and will be carried forward as part of this Plan. These actions address common issues; public concerns; and Refuge purposes, goals, and objectives as described in this Plan.

3.2.1.1 Environmental Conservation and Monitoring

Standard Practice

Arctic Refuge will continue to be managed in accordance with existing laws, Executive orders, regulations, and policies that govern how the Service administers and operates the Refuge System. Accordingly, the Service and the Refuge will:

- monitor and address the effects of accelerating climate change at a landscape level
- monitor, protect, and maintain fish and wildlife populations, habitat values, ecological processes, and biological diversity
- maintain water quality and quantity throughout the Refuge and protect the values of the Wind, Ivishak, and Sheenjek wild river corridors
- provide opportunities to pursue research on wildlife and habitats and conduct inventory and monitoring projects
- protect and monitor cultural and historical sites
- protect designated Wilderness and maintain the wilderness characteristics of the Refuge
- provide and support law enforcement on Refuge lands

Migratory Birds

Arctic Refuge provides vital breeding and staging habitat for large numbers of migratory waterfowl and shorebirds (Chapter 4, Section 4.3.6, and Appendix F). The Migratory Bird Treaty Act was amended in 1996 to legalize subsistence hunting and taking of eggs of migratory birds in Alaska during spring and summer. This amendment led to the establishment of the Alaska Migratory Bird Co-management Council. Regardless of the alternative selected, the Service and the Refuge will continue to work with the Alaska Migratory Bird Co-management Council and other partners to collect accurate and extensive baseline data on species distribution and abundance and subsistence harvests to ensure that healthy populations are maintained, subsistence opportunities provided, and the Service fulfills its international obligation to comply with the Migratory Bird Treaty Act.

Porcupine Caribou Herd

The government of Canada and the government of the United States of America are signatories of the International Porcupine Caribou Herd Conservation Agreement (Department of the Interior 1987).

The 1987 "Agreement between the Government of Canada and the Government of the United States of America on the Conservation of the Porcupine Caribou Herd” gave authority to initiate an eight-member International Porcupine Caribou Board made up of four members from Canada and four from the United States. This board makes recommendations to the regulatory agencies for conservation actions regarding the Porcupine caribou herd. The current board includes the deputy commissioner of the Alaska Department of Fish and Game (ADFG), the Service's Alaska regional director, and representatives from the villages of Venetie and Kaktovik.

Invasive Species

Invasive species are plants and animals that are not native to an area but become established and have adverse effects on native species. In the arctic, invasive species are thought to be a relatively new and growing phenomenon, associated with human activities and climate change. Invasive plants may be introduced to Arctic Refuge from the Dalton Highway corridor and villages. Refuge visitors can spread seeds on their clothing, recreational gear, domestic animals such as dogs or pack stock, and aircraft or watercraft. Non-native wildlife species may expand their ranges to include Refuge lands due to changes in habitats associated with climate change. The Refuge will continue to conduct invasive-species surveillance and may implement means to prevent, control, or eradicate these species if necessary and practicable.

Environmental Contaminants

The Service conducted a study of contaminants in water, sediments, and fish in Arctic Refuge in 1988 and 1989 and recommended that further work be conducted to establish baseline data for concentrations of heavy metals (Snyder-Conn and Lubinski 1993). The baseline data indicated that except for well-used harbor areas around Kaktovik, contaminants concentrations were reflective of a relatively pristine and remote Arctic region (Snyder-Conn and Lubinski 1993).

Current and future planned activities have potential to create sources of contamination, including spills or development activities outside of Refuge boundaries. Under all management alternatives, Arctic Refuge would work with the Service's Environmental Contaminants Program and other appropriate regulatory agencies, such as the U.S. Environmental Protection Agency (EPA) and the State of Alaska Department of Environmental Conservation (ADEC), to document baseline contaminant concentrations and establish a targeted plan for long-term monitoring of contaminant levels.

Yukon River Salmon

On January 28, 1985, the government of Canada and the government of the United States of America signed the Pacific Salmon Treaty. In 2002, the treaty was amended to include the Yukon River Salmon Agreement. Salmon in the Yukon River watershed are a shared resource between Canada and Alaska. Under all management alternatives, the Service and Arctic Refuge would continue to cooperatively manage salmon in the Yukon River watershed (including the Porcupine, Coleen, and Sheenjek Rivers) according to the agreement and any future revisions or amendments to the agreement.

3.2.1.2 *Public Use and Access*

Standard Practice

The Service and Arctic Refuge will continue to:

- allow appropriate and compatible private and commercial uses
- allow methods of public access, including for rural residents engaged in subsistence uses, currently allowed by law and regulation
- provide land status information concerning lands within the Refuge boundary
- provide information about 17(b) easements on Native corporation land that allow public access to public lands
- provide opportunities to pursue social, cultural, and economic research
- provide the opportunity for continued subsistence uses by federally qualified subsistence users

Subsistence

One of the four purposes for which the Refuge was established is to provide the opportunity for continued subsistence uses by federally qualified subsistence users in a manner consistent with (i) the conservation of fish and wildlife populations and habitats in their natural diversity, and (ii) the fulfillment of international treaty obligations with respect to fish and wildlife and their habitats. Under all alternatives, ANILCA Title VIII will apply providing a number of provisions to ensure that, consistent with other Refuge purposes, rural residents can continue to use Refuge lands and resources to meet their physical, economic, traditional, cultural, and social needs. Regardless of the alternative selected, the Service will ensure that rural residents engaged in subsistence uses shall have reasonable access to subsistence resources on Refuge lands and waters subject to reasonable regulations.

The Federal Subsistence Board reserved the Arctic Village Sheep Management Area for federally qualified subsistence users from the villages of Arctic Village, Fort Yukon, Venetie, Kaktovik, and Chalkyitsik to minimize conflicts and competition with general Dall's sheep hunters. The Arctic Village Sheep Management Area is currently closed to general hunting of Dall's sheep but remains open to hunting of other big game in accordance with State game regulations. Big-game guide use area ARC 12, which surrounds Arctic Village and includes the Arctic Village Sheep Management Area, will continue to remain vacant.

Recreation and Outreach

Hunting, fishing, wildlife observation and photography, environmental education, and interpretation are the six priority public uses identified in the National Wildlife Refuge System Improvement Act of 1997. The Service and the Refuge will emphasize these uses where compatible with Refuge purposes. Regardless of the alternative selected, the recreational opportunities that currently exist at Arctic Refuge will continue to be provided.

3.2.1.3 Funding and Personnel Requirements (Alternatives A-F)

All current management programs would continue under all alternatives. The base operational budget ($3,286,000 in fiscal year 2011) would continue, with minor changes based on annual budget allocations from Congress. The Refuge currently has a staff of 34 employees: 22 permanent employees and one full-time term employee; one permanent part-time employee; five temporary intermittent employees; and three to five temporary seasonal employees. This level of staffing would continue should Alternative A be selected.

3.2.1.4 Funding and Personnel Requirements (Alternative B-F)

In addition to the funding requirements listed in Section 3.2.1.3, implementing Refuge management goals and objectives (see Chapter 2, Section 2.1) would require additional staffing and funding under Alternatives B-F. No additional costs would be incurred from the management actions specific to Alternatives B-F. The base Refuge operational budget of $3,286,000 (in fiscal year 2011) would increase to $4,044,000 with additional funds to cover 3.5 full-time permanent employees, one temporary intermittent employee, and additional inventory and management resources required by new programs, as described below. Additional one-time funds of $230,000 would be needed to cover term positions and identified projects.

Staffing Budget Needs beyond Current Level: ($445,000 per year):

1. Public Use Manager/Native Liaison (GS-11/12 permanent): This position would oversee the larger visitor and public use programs of the Refuge. The person in this position would provide oversight and management of: the Refuge's education and outreach programs for a full range of publics (local and national); commercial use permitting of service providers; resource monitoring programs for visitor and public use; liaison, community relations, and formal consultations with villages; and the development of various public and visitor use planning efforts. The position's cost would be $130,000 ($75,000 salary; $25,000 benefits; and $30,000 operational costs).
2. Biological Technician (GS-5/7 permanent): This position would assist with field projects, logistics, data management, report preparation, etc. The position's cost would be $80,000 ($45,000 salary; $15,000 benefits; and $20,000 operational costs).
3. Visitor Services Specialist (GS-5/7 permanent): The position would provide operational support for the commercial visitor use permit program and would provide meaningful information and guidance to commercial services providers, visiting publics, and local communities on appropriate use of the Refuge, its conservation issues and needs, and best visitor and use practices. This position would work within primary hub access communities with high visitor use, such as Kaktovik, Arctic Village, and Coldfoot. The position's cost would be $80,000 ($45,000 salary; $15,000 benefits; and $20,000 operational costs).
4. Law Enforcement Officer/Pilot (GS-12, existing permanent position): The action alternatives would require fully funding the existing Arctic Refuge officer position at its current grade level with an adequate operational budget. The additional operating costs that would be required are $20,000.
5. Law Enforcement Officer/Pilot (GS-11/12 permanent): This position would be a shared resource for three Fairbanks-based Refuges (half time to Arctic Refuge) and would be stationed remotely (i.e., in Coldfoot). The individual would perform a full range of resource protection duties across the three Refuges, including public education and outreach regarding conservation needs and Federal and state regulations. The officer/pilot would be capable of accessing and patrolling by various means, including boat, plane, and snowmachine, and would have the capacity to work effectively in cross cultural environments and with diverse visitor and users. Costs would include all mandatory training for pilots and law enforcement officers. The position's full-time cost is $160,000 ($75,000 salary; $40,000 benefits; and $45,000 operational costs). The position's cost to Arctic Refuge would be $80,000.
6. Refuge Information Technician (GS 5/7 temporary intermittent): An additional Refuge Information Technician for the village of Venetie would be shared with the Yukon Flats National Wildlife Refuge to enhance communications with the village and the tribal government. The position's cost is $13,000 ($12,000 salary and $1,000 benefits).
7. Biological Technicians (GS-5/7 seasonal): Averaged over the life of the Plan, the action alternatives would require four additional temporary seasonal biological technicians per year, each operating under a three-month (field season) appointment. The total annual cost for all four of these positions would be $55,000 ($40,000 total salary; $10,000 total benefits; and $5,000 total operational costs).

Additional Program Driven Funding Requirements ($300,000 per year):

1. To adequately support inventory, monitoring, and research efforts of current staff, including: the study of climate change effects; the acquisition or replacement of equipment and supplies; biometrician support contracts; additional base to support ecological inventory and monitoring (phased in over 10 years); and cooperative monitoring and research programs.

One-Time Term Positions and Project Funding Requirements ($230,000):

One-time costs associated with the goals and objectives listed in Chapter 2, Section 2.1, apply to alternatives B-F and are broken down as follows:

1. Recreational Planner (GS-12, full-time term (3-5 years)): A functional and capable planner is needed to lead several major Refuge planning efforts: a Visitor Use Management Plan, a Wilderness Stewardship Plan, three Comprehensive River Management Plans, an Integrated Cultural Resources Management Plan, a Land Protection Plan, and other step-down plans identified in the Revised Plan. The position would cost $130,000 ($75,000 salary; $25,000 benefits; and $30,000 operational costs). A regional office planner on detail to Arctic Refuge could fill this position.
2. $50,000 estimated to conduct the Visitor Study in 2013.
3. $50,000 estimated to upgrade the Marion Creek residences at Coldfoot for year-round use.

3.2.2 Alternative A – Current Management

Alternative A is the "No Action" Alternative. It describes current management of Arctic Refuge, provides the baseline against which to compare Alternatives B through F, and is required by NEPA. Under Alternative A, general management of Arctic Refuge would continue to follow the 1988 Plan (Service 1988a) and associated record of decision (Service 1988b), as amended by the Fire Management Plan (FMP) for Arctic Refuge (Service 2008b), which was a step-down plan to the 1988 Plan.

With the exceptions of the Refuge land management categories, much of the management direction described in the 1988 Plan for Arctic Refuge is outdated. However, under Alternative A, the updated version of the Refuge management policies and guidelines described in Chapter 2 (Sections 2.3, 2.4, and 2.5) would not take effect. Table 3-2 of this chapter (Section 3.3.2) discusses the major differences between the 1988 management direction and the updated version of the policies and guidelines for Refuge management. Table 3-3 identifies key differences between Minimal and Wilderness management.

3.2.2.1 Alternative A - Objectives

The 1988 Plan did not include any goals or objectives for Refuge management. Under Alternative A, management would continue as detailed in the 1988 Plan, thus objectives would not be adopted if Alternative A is selected.

3.2.2.2 Alternative A - Management Categories

Under Alternative A, the original land management categories, as described in the 1988 Plan, would continue to apply to lands in Arctic Refuge. Lands administered by Arctic Refuge would fall into three categories as follows: Minimal Management (12.3 million acres), Wilderness Management (7.07 million acres)[1], and Wild River Management (536,000 acres)[2] (Map 3-1).

3.2.2.3 Alternative A - Specific Management by Major Issue

The following discussion describes how Alternative A would address the significant issues identified during internal and public scoping.

Wilderness

No new areas would be recommended for Wilderness designation.

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[1] This acreage value excludes wild river corridors. Wild rivers within designated Wilderness are managed under Wild River Management, not Wilderness Management.

[2] Acreages in this Plan are derived from many sources and may not agree with previously published values, including the draft Revised Plan. For more information, please refer to "A Note about Acreages" in the front pages of this volume.

Wild and Scenic Rivers

No new rivers would be recommended for wild river designation. The Refuge would use existing management tools to maintain values on the Atigun, Hulahula, Kongakut, and Marsh Fork Canning Rivers.

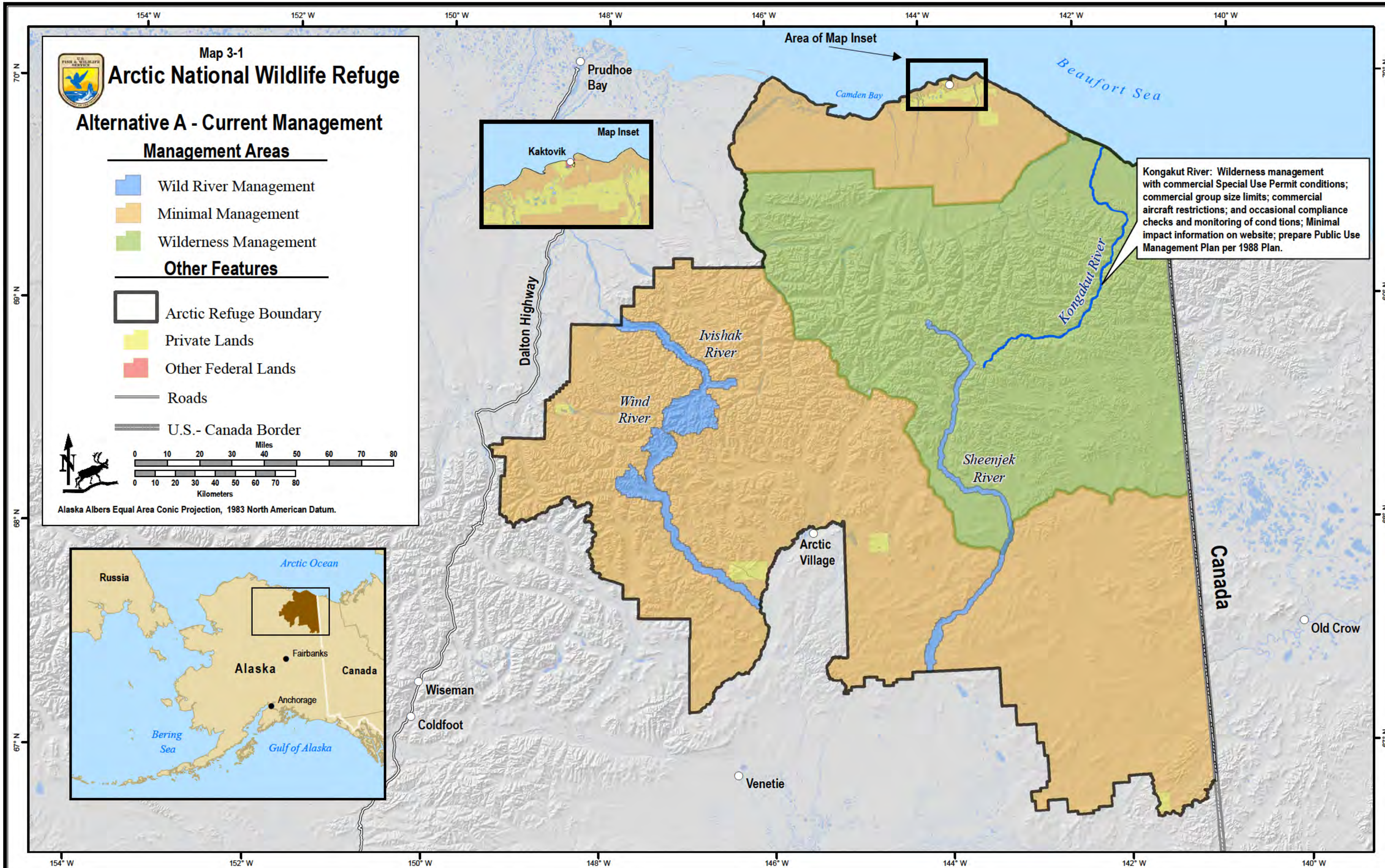
Kongakut River Visitor Management

Under Alternative A, the Service would continue to manage visitor use on the Kongakut River to provide opportunities for adventure and primitive, unconfined recreational experiences in an undeveloped setting, while protecting the area's natural conditions and resources. Current management strategies include:

- Commercial service providers are required to have special use permits and permit compliance checks occur occasionally.
- Under permit conditions, commercial operators are limited to 7 hikers and 10 floaters and one commercial group on the Kongakut River at a time.
- Group size is not regulated for non-guided visitors, but it is recommended that they follow commercial limits.
- In the Kongakut Valley, commercial air operator special use permit holders are required, under permit conditions, to limit airplane landings to non-vegetated surfaces only. Commercial air operators are also requested to follow the Federal Aviation Administration (FAA) advisory to maintain a minimum of 2,000 feet above ground level for flight operations and to refrain from intentionally flying low over camps, people, or wildlife.
- Information on low-impact camping, minimum impact techniques (such as those promoted by the Leave No Trace Center for Outdoor Ethics), and other best practices is available on the Refuge's website.
- Monitoring of physical and social conditions related to visitor use occurs occasionally, and campsite conditions are monitored periodically.
- A Public Use Management Plan would be prepared, as directed by the 1988 Comprehensive Conservation Plan.

3.2.2.4 Alternative A - Funding and Personnel Requirements

All current management programs would continue under Alternative A. The base operational budget $3,286,000 in fiscal year 2011) would continue, with periodic adjustments to balance the offsets of fixed costs and inflation. The Refuge currently has a staff of 34 employees: 23 permanent or term full-time; 1 permanent part-time; 5 temporary intermittent; 3-5 temporary seasonals. This level of staffing would continue should Alternative A be selected.


Map 3-1
Arctic National Wildlife Refuge
Alternative A - Current Management
Management Areas
Wild River Management
Minimal Management
Wilderness Management
Other Features
Arctic Refuge Boundary
Private Lands
Other Federal Lands
Roads
U.S.- Canada Border
Miles
0 10 20 30 40 50 60 70 80
0 10 20 30 40 50 60 70 80
Kilometers
Alaska Albers Equal Area Conic Projection, 1983 North American Datum.
Map Inset
Kaktovik
Area of Map Inset
Prudhoe Bay
Camden Bay
Beaufort Sea
Kongakut River: Wilderness management with commercial Special Use Permit conditions; commercial group size limits; commercial aircraft restrictions; and occasional compliance checks and monitoring of cond tions; Minimal impact information on website; prepare Public Use Management Plan per 1988 Plan.
Kongakut River
Ivishak River
Wind River
Sheenjek River
Dalton Highway
Arctic Village
Canada
Old Crow
Wiseman
Coldfoot
Venetie
Russia
Arctic Ocean
Alaska
Fairbanks
Canada
Anchorage
Bering Sea
Gulf of Alaska
154° W
152° W
150° W
148° W
146° W
144° W
142° W
140° W
70° N
69° N
68° N
67° N

3.2.3 Alternative B

Under Alternative B, the management policies and guidelines for Arctic Refuge (Chapter 2, Sections 2.3, 2.4, and 2.5), would take effect (see Section 3.3.2 for a comparison of the proposed management policies and guidelines to those in the 1988 Plan). The Refuge vision, goals, and objectives, described in Chapter 1, Section 1.6 and Chapter 2, Section 2.1 would also be adopted under Alternative B.

Although most of the general management direction described in Alternative A would continue, some specific directions and actions occurring under Alternative A would change under Alternative B. Management actions under Alternative B are discussed here.

3.2.3.1 Alternative B - Objectives

Alternative B would adopt all the objectives described in Chapter 2, Section 2.1.

3.2.3.2 Alternative B - Management Categories

Under Alternative B, lands in Arctic Refuge would be managed under the Minimal, Wilderness, and Wild River Management categories described in Chapter 2, Section 2.3. The alternative would maintain the same acreages in each of the management categories as Alternative A (current management): Minimal Management (12.3 million acres), Wilderness Management (7.07 million acres)[3], and Wild River Management (536,000 acres). If Congress were to designate the Brooks Range WSA as Wilderness, there would be a reduction of 5.48 million acres of Minimal Management and an increase of the same amount of acres of lands under Wilderness Management. Similarly, if the recommended rivers were designated by Congress for inclusion in the NWSRS, there would be a reduction of approximately 53,000 acres of Minimal Management and 117,000 acres of Wilderness Management. There would be an increase of 170,000 acres of Wild River Management.

3.2.3.3 Alternative B - Specific Management by Major Issue

Wilderness

The Brooks Range WSA would be recommended for Wilderness designation (Map 3-2).

Wild and Scenic Rivers

The Hulahula, Kongakut, and Marsh Fork Canning rivers would be recommended for inclusion in the NWSRS as wild rivers. The Refuge would use existing management tools to maintain values for the Atigun River.

[3] This acreage value excludes wild river corridors. Wild rivers within designated Wilderness are managed under Wild River Management, not Wilderness Management.

Kongakut River Visitor Management

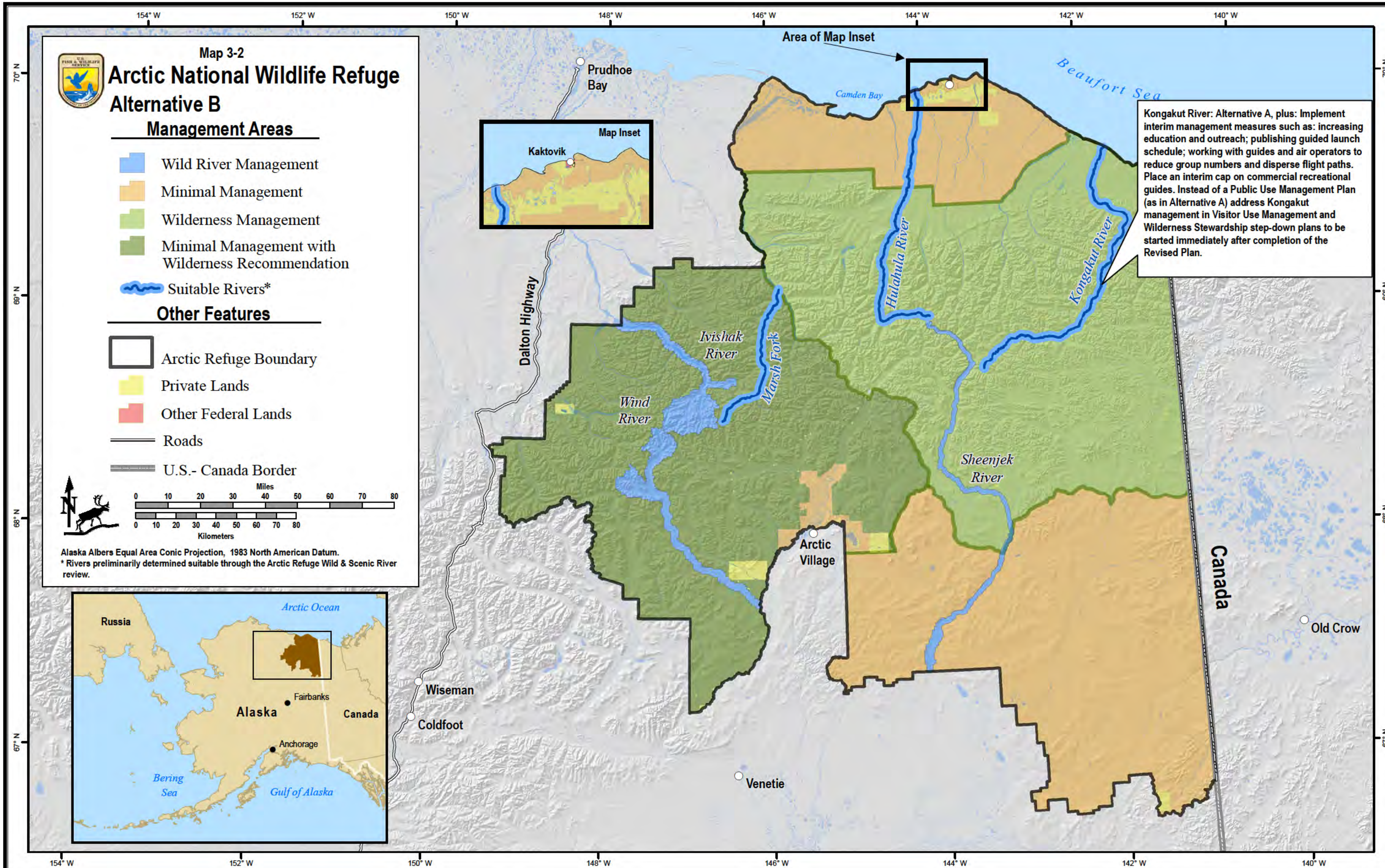
Under Alternative B, the Service would continue to the implement all current management actions described in Alternative A to manage visitor use on the Kongakut River.

In addition to current management, Refuge managers would immediately initiate step-down planning processes following a signed record of decision for this Revised Plan. These step-down planning processes would be compliant with NEPA (including public involvement) and would produce a Visitor Use Management Plan (VUMP) and a Wilderness Stewardship Plan (WSP). These plans would replace the Public Use Plan prescribed in Alternative A.

The VUMP and WSP would address visitor use management issues and concerns for the Kongakut River identified by the Service and the public during this comprehensive conservation planning process and any additional issues identified during the step-down planning processes. Based on what the Service heard from the public during the development of this Revised Plan, managers at Arctic Refuge expect the VUMP and WSP to address crowding, resource degradation, loss of Wilderness character, and other impacts to visitor experience and the Kongakut River valley. Refuge managers anticipate the step-down plans would consider a range of reasonable management actions to address these issues, including (but not limited to): group size limits; limited allocation between commercial and private recreation; a permit system; regulations to control the timing of visits; restrictions on aircraft landings; rules for disposal of human waste; hardening sites for aircraft landings and camping; mandatory use of bear-resistant food containers; site rehabilitation; and increased outreach to and communication with visitors before they begin their trips to the Kongakut River. Managers will use the VUMP to determine tools and schedules for monitoring desired conditions and experiences and to identify actions for restoring conditions where necessary.

Under Alternative B, Refuge managers would implement interim management measures while they complete the VUMP and WSP. Interim measures would be replaced by the new management direction prescribed in the VUMP and WSP. In the interim, Refuge managers would:

- Work with guides to reduce the number of groups on the Kongakut River during heavy use periods (late June and mid-August) by encouraging them to schedule clients voluntarily outside of the heavy use period.
- Work with commercial air operators to disperse commuting flight paths in and out of the Kongakut River valley, subject to safe aircraft operation.
- Publish schedules of proposed guided launch dates and historical patterns of visitor use on the Refuge's website to help guides and visitors plan their trips.
- Develop additional outreach materials for all Kongakut River users (floaters, hikers, hunters, and others) with targeted messages that explain preferred practices and strategies for minimizing impacts, such as proper disposal of human waste, how to avoid disturbing wildlife, and how to alleviate crowding.
- Conduct occasional on-site checks to educate users and ensure their compliance with terms and conditions of special use permits and existing Federal and State regulations.
- Monitoring would continue to be conducted occasionally but would be modified to include criteria that specifically evaluate the effectiveness of management actions.
- Identify, evaluate, and rehabilitate impaired and impacted sites on the Kongakut River.



Map 3-2
Arctic National Wildlife Refuge
Alternative B
Management Areas
Wild River Management
Minimal Management
Wilderness Management
Minimal Management with Wilderness Recommendation
Suitable Rivers*
Other Features
Arctic Refuge Boundary
Private Lands
Other Federal Lands
Roads
U.S.- Canada Border
Miles
Kilometers
Alaska Albers Equal Area Conic Projection, 1983 North American Datum.
* Rivers preliminarily determined suitable through the Arctic Refuge Wild & Scenic River review.
Area of Map Inset
Map Inset
Kaktovik
Prudhoe Bay
Camden Bay
Beaufort Sea
Kongakut River: Alternative A, plus: Implement interim management measures such as: increasing education and outreach; publishing guided launch schedule; working with guides and air operators to reduce group numbers and disperse flight paths. Place an interim cap on commercial recreational guides. Instead of a Public Use Management Plan (as in Alternative A) address Kongakut management in Visitor Use Management and Wilderness Stewardship step-down plans to be started immediately after completion of the Revised Plan.
Dalton Highway
Hulahula River
Kongakut River
Ivishak River
Marsh Fork
Wind River
Sheenjek River
Arctic Village
Canada
Old Crow
Wiseman
Coldfoot
Venetie
Russia
Arctic Ocean
Alaska
Fairbanks
Anchorage
Bering Sea
Gulf of Alaska

Under Alternative B, the Service also would put in place an interim cap on use by commercial recreational guides on the Kongakut River starting in 2013 and expiring at the end of 2016 or when the VUMP is implemented, whichever occurs first. Only those guides who operated on the Kongakut River in at least one year during the period 2007 through 2011 would be allowed to operate on the Kongakut River during this interim period. For each year of the interim period, those guides authorized to operate on the Kongakut River would be restricted to the average number of client use days they reported for the Kongakut River during the period 2007 through 2011. For example, if a guide had trips on the Kongakut River in 2007, 2008, and 2011, that guide's cap would be the number of client use days for those three years added together and divided by three. The result of this calculation is the average client use days reported for that guide's operation on the Kongakut River during this five-year period.

3.2.3.4 Alternative B - Funding and Personnel Requirements

Alternative B would adopt the goals and objectives outlined in Chapter 2, Section 2.1. To accomplish this work, base operational costs would increase to $4,044,000 to cover 3.5 full-time permanent employees, one temporary intermittent employee, four temporary seasonal employees, and associated program driven activities. Additionally, $230,000 would be required for term positions and one-time project costs (see Sections 3.2.1.3 and 3.2.1.4 for details).

3.2.4 Alternative C

Alternative C would adopt the Refuge management policies and guidelines presented in Chapter 2, Sections 2.3, 2.4, and 2.5. The Refuge vision, goals, and objectives, described in Chapter 1, Section 1.6 and Chapter 2, Section 2.1, would go into effect under Alternative C.

Although most of the general management direction described in Alternative A would continue, some specific directions and actions occurring under Alternative A would change under Alternative C. Management actions under Alternative C, are discussed here.

3.2.4.1 Alternative C - Objectives

Alternative C would adopt all the objectives described in Chapter 2, Section 2.1.

3.2.4.2 Alternative C - Management Categories

Under Alternative C, lands in Arctic Refuge would be managed under the Minimal, Wilderness, and Wild River Management categories described in Chapter 2, Section 2.3. The alternative would maintain the same acreages in each of the management categories as Alternative A (current management): Minimal Management (12.3 million acres), Wilderness Management (7.07 million acres)[4], and Wild River Management (536,000 acres). If Congress were to designate the Coastal Plain WSA as Wilderness, there would be a reduction of 1.57 million acres of Minimal Management and an increase of the same amount of acres of lands under Wilderness Management. Similarly, if Congress were to designate the rivers recommended under Alternative C for inclusion in the NWSRS, there would be a further reduction of approximately 7,100 acres of Minimal Management and an increase of 7,100 acres of Wild River Management.

3.2.4.3 Alternative C - Specific Management by Major Issue

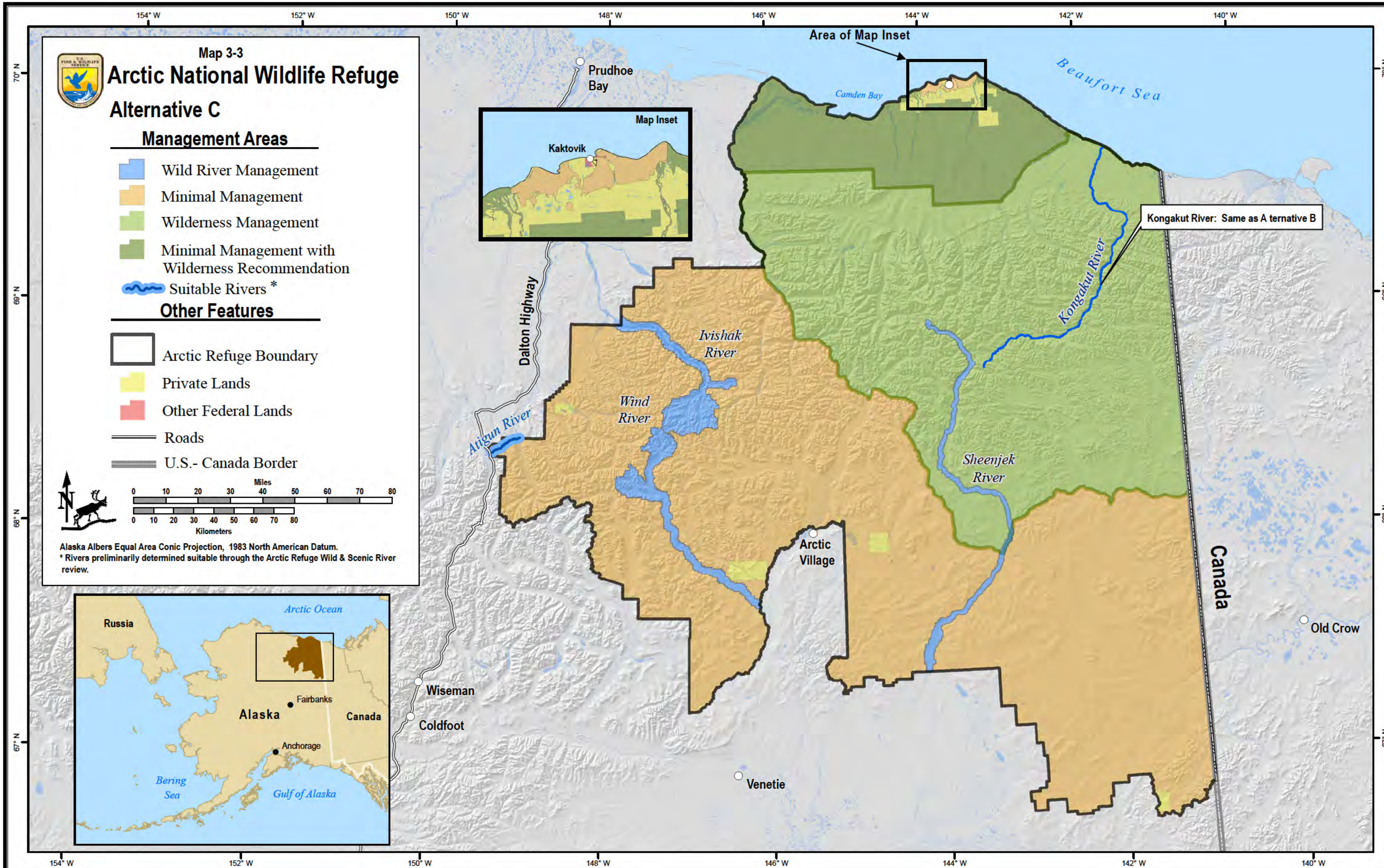
Wilderness

Under this alternative, the Coastal Plain WSA would be recommended for Wilderness designation (Map 3-3).

Wild and Scenic Rivers

The Atigun River would be recommended for inclusion in the NWSRS as a wild river. The Refuge would use existing management tools to maintain values for the Hulahula, Kongakut, and Marsh Fork Canning rivers.

[4] This acreage value excludes wild river corridors. Wild rivers within designated Wilderness are managed under Wild River Management, not Wilderness Management.


Map 3-3
Arctic National Wildlife Refuge
Alternative C
Management Areas
Wild River Management
Minimal Management
Wilderness Management
Minimal Management with Wilderness Recommendation
Suitable Rivers *
Other Features
Arctic Refuge Boundary
Private Lands
Other Federal Lands
Roads
U.S.- Canada Border
Miles
0 10 20 30 40 50 60 70 80
0 10 20 30 40 50 60 70 80
Kilometers
Alaska Albers Equal Area Conic Projection, 1983 North American Datum.
* Rivers preliminarily determined suitable through the Arctic Refuge Wild & Scenic River review.
Map Inset
Kaktovik
Area of Map Inset
Prudhoe Bay
Camden Bay
Beaufort Sea
Kongakut River: Same as A ternative B
Kongakut River
Dalton Highway
Ivishak River
Wind River
Atigun River
Sheenjek River
Arctic Village
Canada
Old Crow
Wiseman
Coldfoot
Venetie
Russia
Arctic Ocean
Alaska
Fairbanks
Canada
Anchorage
Bering Sea
Gulf of Alaska
154° W
152° W
150° W
148° W
146° W
144° W
142° W
140° W
70° N
69° N
68° N
67° N

Kongakut River Visitor Management

Under Alternative C, the Service would implement all the management actions described in Alternative B to manage visitor use on the Kongakut River. These actions include: preparing a Visitor Use Management Plan (VUMP) and a Wilderness Stewardship Plan (WSP) immediately following approval of this Revised Plan; implementing a series of interim management measures until the VUMP and WSP are completed; and placing an interim cap on commercial recreational guides on the Kongakut River starting in 2013 and expiring at the end of 2016 or when the VUMP is implemented, whichever comes first.

3.2.4.4 Alternative C - Funding and Personnel Requirements

Alternative C would adopt the goals and objectives outlined in Chapter 2, Section 2.1. To accomplish this work, base operational costs would increase to $4,044,000 to cover 3.5 full-time permanent employees, one temporary intermittent employee, four temporary seasonal employees, and associated program driven activities. Additionally, $230,000 would be required for term positions and one-time project costs (see Sections 3.2.1.3 and 3.2.1.4 for details).

3.2.5 Alternative D

Alternative D would adopt the Refuge management policies and guidelines presented in Chapter 2, Sections 2.3, 2.4, and 2.5. The Refuge vision, goals, and objectives, described in Chapter 1, Section 1.6 and Chapter 2, Section 2.1, would go in effect under Alternative D.

Although most of the general management direction described in Alternative A would continue, some specific directions and actions occurring under Alternative A would change under Alternative D. Management actions under Alternative D are discussed here.

3.2.5.1 Alternative D - Objectives

Alternative D would adopt all the objectives described in Chapter 2, Section 2.1.

3.2.5.2 Alternative D - Management Categories

Under Alternative D, lands in Arctic Refuge would be managed under the Minimal, Wilderness, and Wild River Management categories described in Chapter 2, Section 2.3. The alternative would maintain the same acreages in each of the management categories as Alternative A (current management): Minimal Management (12.3 million acres), Wilderness Management (7.07 million acres)[5], and Wild River Management (536,000 acres). If Congress were to designate the Brooks Range and Porcupine Plateau WSAs as Wilderness, there would be a reduction of 11.04 million acres of Minimal Management and an increase of the same amount of acres of lands under Wilderness Management. Similarly, if recommended rivers were designated by Congress for inclusion in the NWSRS, there would be a further reduction of approximately 59,000 acres of Minimal Management and 117,000 acres of Wilderness Management. There would be an increase of 176,000 acres of Wild River Management.

3.2.5.3 Alternative D - Specific Management by Major Issue

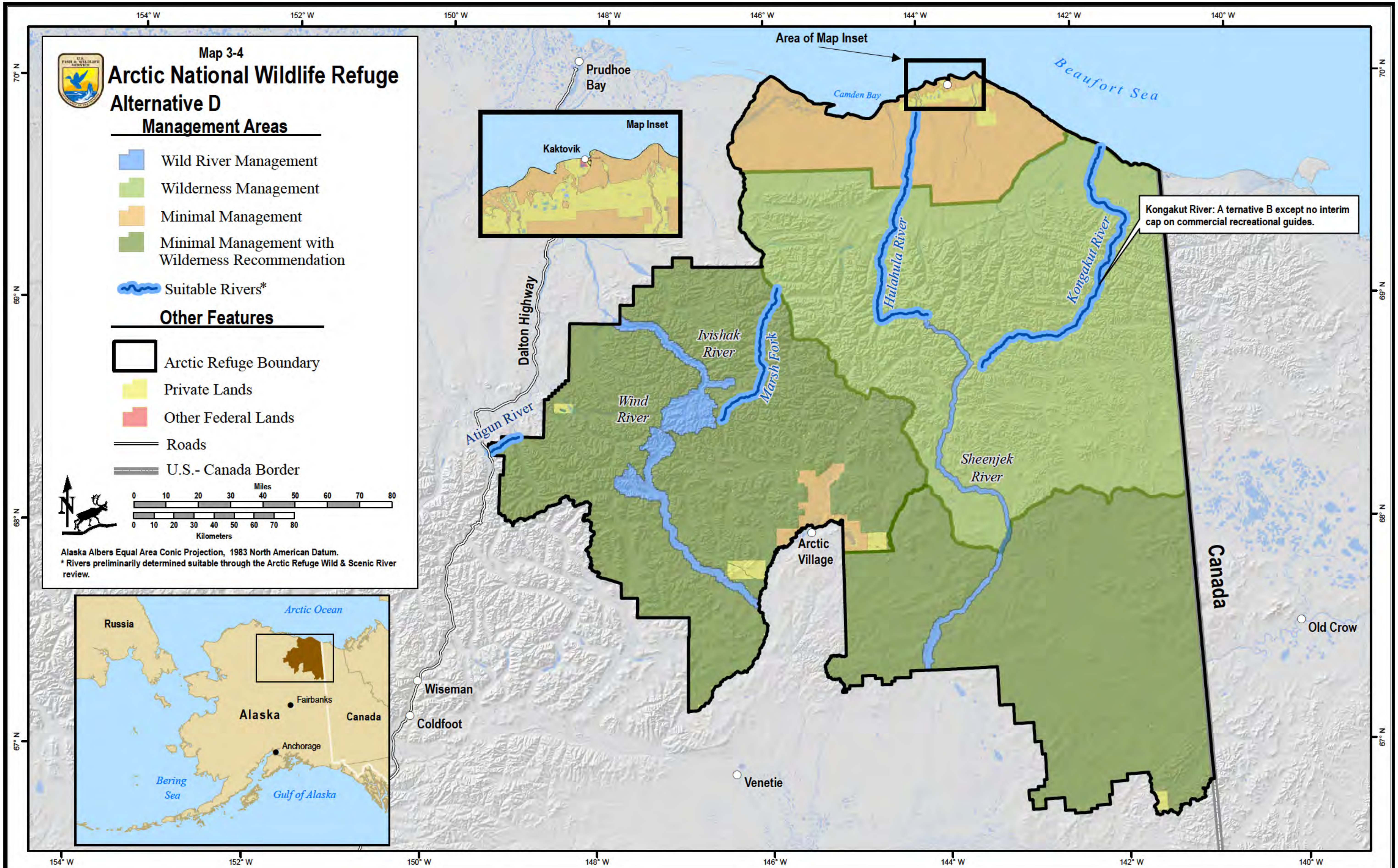
Wilderness

Under this alternative, the Brooks Range and Porcupine Plateau WSAs would be recommended for Wilderness designation (Map 3-4).

Wild and Scenic Rivers

The Atigun, Hulahula, Kongakut, and Marsh Fork Canning rivers would be recommended for inclusion in the NWSRS as wild rivers. Only those portions of the Hulahula River managed by the Refuge would be included in the recommendation.

[5] This acreage value excludes wild river corridors. Wild rivers within designated Wilderness are managed under Wild River Management, not Wilderness Management.



Map 3-4
Arctic National Wildlife Refuge
Alternative D
Management Areas
Wild River Management
Wilderness Management
Minimal Management
Minimal Management with Wilderness Recommendation
Suitable Rivers*
Other Features
Arctic Refuge Boundary
Private Lands
Other Federal Lands
Roads
U.S.- Canada Border
Miles
0 10 20 30 40 50 60 70 80
0 10 20 30 40 50 60 70 80
Kilometers
Alaska Albers Equal Area Conic Projection, 1983 North American Datum.
* Rivers preliminarily determined suitable through the Arctic Refuge Wild & Scenic River review.
Area of Map Inset
Map Inset
Kaktovik
Prudhoe Bay
Camden Bay
Beaufort Sea
Kongakut River: A ternative B except no interim cap on commercial recreational guides.
Dalton Highway
Hulahula River
Kongakut River
Ivishak River
Marsh Fork
Wind River
Atigun River
Sheenjek River
Arctic Village
Canada
Old Crow
Wiseman
Coldfoot
Venetie
Russia
Arctic Ocean
Alaska
Fairbanks
Anchorage
Canada
Bering Sea
Gulf of Alaska
154° W
152° W
150° W
148° W
146° W
144° W
142° W
140° W
70° N
69° N
68° N
67° N

Kongakut River Visitor Management

Under Alternative D, the Service would implement all the management actions described in Alternative B to manage visitor use on the Kongakut River, except the Service would not place an interim cap on commercial recreational guides on the Kongakut River. The actions that would be implemented under this alternative include preparing a Visitor Use Management Plan (VUMP) and a Wilderness Stewardship Plan (WSP) immediately following the record of decision of this Revised Plan, and implementing a series of interim management measures until the VUMP and WSP are completed.

3.2.5.4 Alternative D - Funding and Personnel Requirements

Alternative D would adopt the goals and objectives outlined in Chapter 2, Section 2.1. To accomplish this work, base operational costs would increase to $4,044,000 to cover 3.5 full-time permanent employees, one temporary intermittent employee, four temporary seasonal employees, and associated program driven activities. Additionally, $230,000 would be required for term positions and one-time project costs (see Sections 3.2.1.3 and 3.2.1.4 for details).

3.2.6 Alternative E

Alternative E would adopt the Refuge management policies and guidelines presented in Chapter 2, Sections 2.3, 2.4, and 2.5. The Refuge vision, goals, and objectives, described in Chapter 1, Section 1.6 and Chapter 2, Section 2.1, would also go in effect under Alternative E.

Although most of the general management direction described in Alternative A would continue, some specific directions and actions occurring under Alternative A would change under Alternative E. Management actions under Alternative E are discussed here.

3.2.6.1 Alternative E - Objectives

Alternative E would adopt all the objectives described in Chapter 2, Section 2.1.

3.2.6.2 Alternative E - Management Categories

Under Alternative E, lands in Arctic Refuge would be managed under the Minimal, Wilderness, and Wild River Management categories described in Chapter 2, Section 2.3. The alternative would maintain the same acreages in each of the management categories as Alternative A (current management): Minimal Management (12.3 million acres), Wilderness Management (7.07 million acres)[6], and Wild River Management (536,000acres). If Congress were to designate the Brooks Range, Porcupine Plateau, and Coastal Plain WSAs as Wilderness, there would be a reduction of 11.65 million acres of Minimal Management, and the acres of lands under Wilderness Management would increase by the same amount. If rivers recommended under this alternative were designated as wild rivers by Congress, there would be a further reduction of 64,000 acres of Minimal Management and 117,000 acres of Wilderness Management. There would be an increase of 180,000 acres of Wild River Management.

3.2.6.3 Alternative E - Specific Management by Major Issue

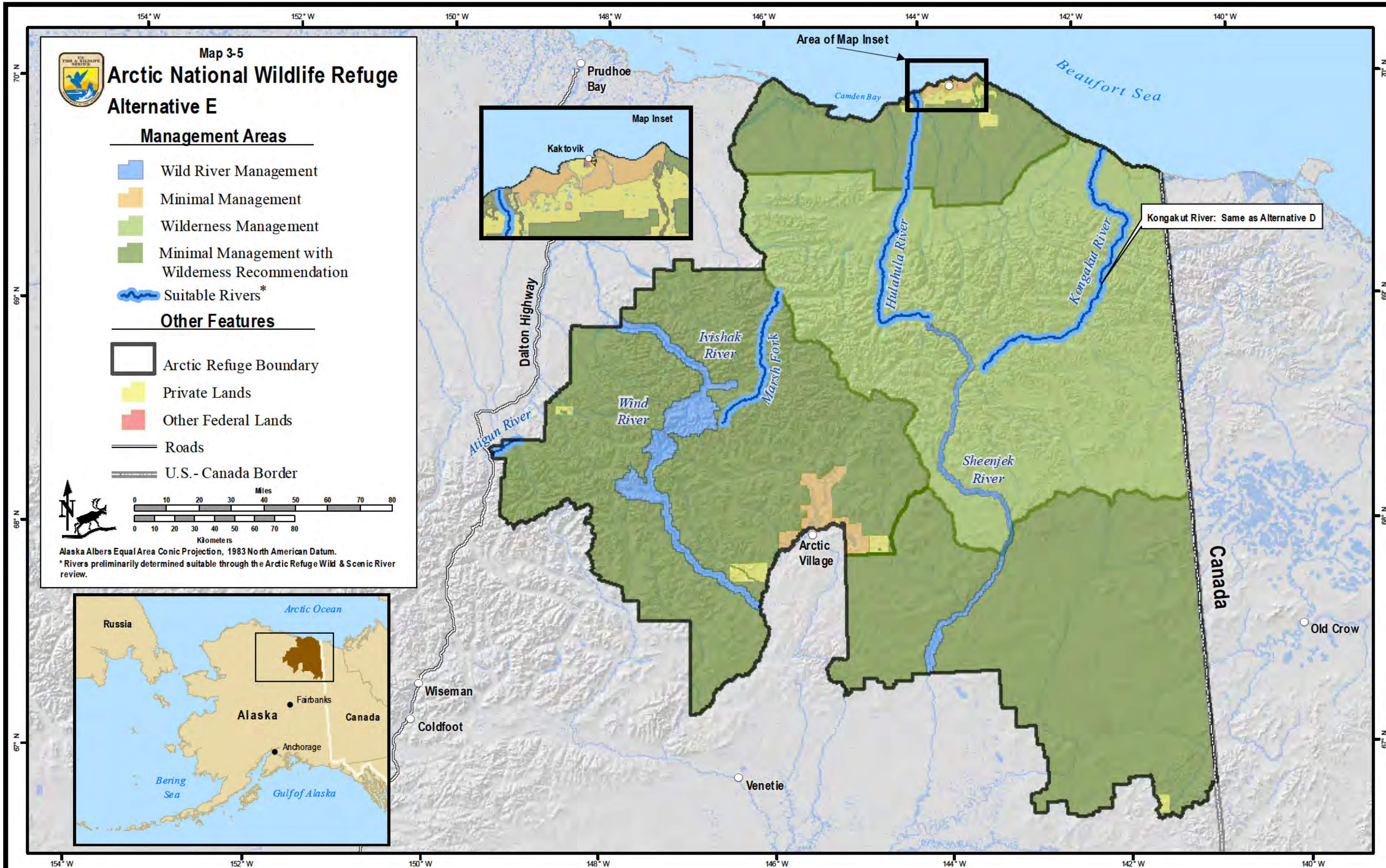
Wilderness

Under this alternative, the Brooks Range, Porcupine Plateau, and Coastal Plain WSAs would be recommended for Wilderness designation (Map 3-5).

Wild and Scenic Rivers

The Atigun, Hulahula, Kongakut, and Marsh Fork Canning rivers would be recommended for inclusion in the NWSRS as wild rivers.

[6] This acreage value excludes wild river corridors. Wild rivers within designated Wilderness are managed under Wild River Management, not Wilderness Management.



Map 3-5
Arctic National Wildlife Refuge
Alternative E
Management Areas
Wild River Management
Minimal Management
Wilderness Management
Minimal Management with Wilderness Recommendation
Suitable Rivers*
Other Features
Arctic Refuge Boundary
Private Lands
Other Federal Lands
Roads
U.S.- Canada Border
Miles
0 10 20 30 40 50 60 70 80
Kilometers
Alaska Albers Equal Area Conic Projection, 1983 North American Datum.
* Rivers preliminarily determined suitable through the Arctic Refuge Wild & Scenic River review.
Map Inset
Kaktovik
Area of Map Inset
Camden Bay
Beaufort Sea
Prudhoe Bay
Dalton Highway
Atigun River
Wind River
Ivishak River
Marsh Fork
Hulahula River
Kongakut River
Kongakut River: Same as Alternative D
Sheenjek River
Arctic Village
Canada
Old Crow
Wiseman
Coldfoot
Venetie
Russia
Arctic Ocean
Alaska
Fairbanks
Canada
Anchorage
Bering Sea
Gulf of Alaska
154° W
152° W
150° W
148° W
146° W
144° W
142° W
140° W
70° N
69° N
68° N
67° N

Kongakut River Visitor Management

Under Alternative E, the Service would implement all management actions described in Alternative D to manage visitor use on the Kongakut River. These actions include preparing a Visitor Use Management Plan (VUMP) and a Wilderness Stewardship Plan (WSP) immediately following approval of this Revised Plan, and implementing a series of interim management measures until the VUMP and WSP are completed.

3.2.6.4 Alternative E - Funding and Personnel Requirements

Alternative E would adopt the goals and objectives outlined in Chapter 2, Section 2.1. To accomplish this work, base operational costs would increase to $4,044,000 to cover 3.5 full-time permanent employees, one temporary intermittent employee, four temporary seasonal employees, and associated program driven activities. Additionally, $230,000 would be required for term positions and one-time project costs (see Sections 3.2.1.3 and 3.2.1.4 for details).

3.2.7 Alternative F

Alternative F would adopt the Refuge management policies and guidelines presented in Chapter 2, Sections 2.3, 2.4, and 2.5, and the Refuge vision, goals, and objectives, described in Chapter 1, Section 1.6 and Chapter 2, Section 2.1. Although most of the general management direction described in Alternative A would continue, some specific directions and actions occurring under Alternative A would change under Alternative F. Management actions under Alternative F are discussed here.

3.2.7.1 Alternative F - Objectives

Alternative F would adopt all the objectives described in Chapter 2, Section 2.1.

3.2.7.2 Alternative F - Management Categories

Under Alternative F (Map 3-6), lands in Arctic Refuge would be managed under the Minimal, Wilderness, and Wild River Management categories described in Chapter 2, Section 2.3. The alternative would maintain the same acreages in each of the management categories as Alternative A (current management): Minimal Management (12.3 million acres), Wilderness Management (7.07 million acres)[7], and Wild River Management (536,000 million acres).

3.2.7.3 Alternative F - Specific Management by Major Issue

Wilderness

As under Alternative A, no new areas would be recommended for Wilderness designation.

Wild and Scenic Rivers

As under Alternative A, no new rivers would be recommended for wild river designation. The Refuge would use existing management tools to maintain values on the Atigun, Hulahula, Kongakut, and Marsh Fork Canning rivers.

Kongakut River Visitor Management

Under Alternative F, the Service would implement all management actions described in Alternative D to manage visitor use on the Kongakut River. These actions include preparing a Visitor Use Management Plan (VUMP) and a Wilderness Stewardship Plan (WSP) immediately following approval of this Revised Plan, and implementing a series of interim management measures until the VUMP and WSP are completed.

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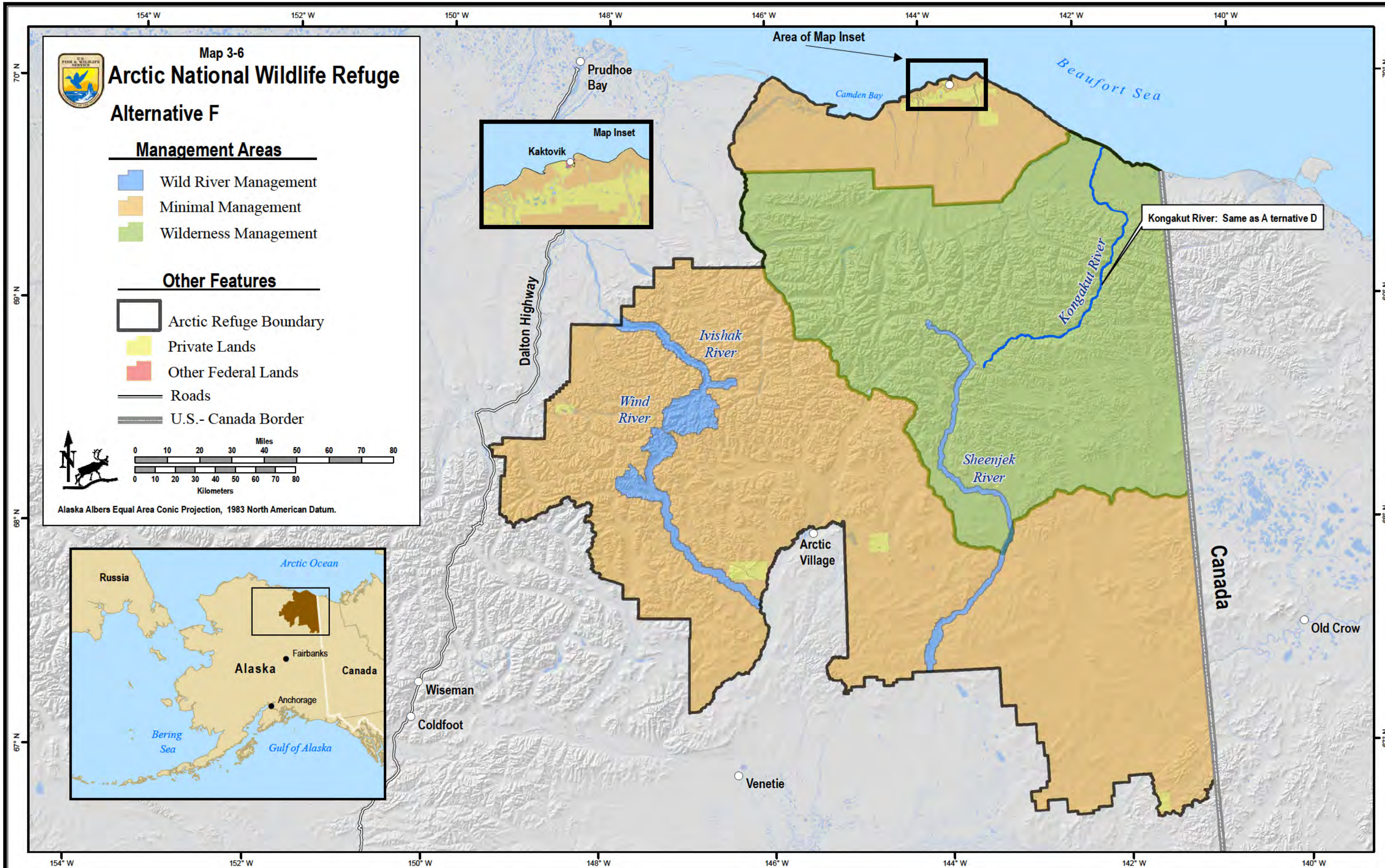
[7] This acreage value excludes wild river corridors. Wild rivers within designated Wilderness are managed under Wild River Management, not Wilderness Management.


Map 3-6
Arctic National Wildlife Refuge
Alternative F
Management Areas
Wild River Management
Minimal Management
Wilderness Management
Other Features
Arctic Refuge Boundary
Private Lands
Other Federal Lands
Roads
U.S.- Canada Border
Miles
Kilometers
Alaska Albers Equal Area Conic Projection, 1983 North American Datum.
Map Inset
Kaktovik
Area of Map Inset
Prudhoe Bay
Camden Bay
Beaufort Sea
Kongakut River: Same as A ternative D
Kongakut River
Ivishak River
Wind River
Sheenjek River
Dalton Highway
Arctic Village
Canada
Old Crow
Wiseman
Coldfoot
Venetie
Russia
Arctic Ocean
Fairbanks
Alaska
Canada
Anchorage
Bering Sea
Gulf of Alaska

Alternative F - Funding and Personnel Requirements

Alternative F would adopt the goals and objectives outlined in Chapter 2, Section 2.1. To accomplish this work, base operational costs would increase to $4,044,000 to cover 3.5 full-time permanent employees, one temporary intermittent employee, four temporary seasonal employees, and associated program driven activities. Additionally, $230,000 would be required for term positions and one-time project costs (see Sections 3.2.1.3 and 3.2.1.4 for details).

3.3 Comparison of the Alternatives

3.3.1 Summary of Alternatives by Major Issues

Table 3-1 compares the six alternatives by the three significant planning issues identified in scoping. The table also compares the alternatives by Refuge budgetary and staffing needs required for implementation.

3.3.2 Comparison of Old and New Management Policies and Guidelines

This discussion compares the Refuge's management policies and guidelines presented in Chapter 2, Table 2-1 (which apply to Alternatives B, C, D, E, and F) and the management directions from the 1988 Plan (that applies to Alternative A). Direct comparison of the management guidelines is difficult because the organization of the management guideline tables and levels of detail provided by various categories of actions differ substantially between the 1988 Plan and Revised Plan. For example, the 1988 Plan had very detailed descriptions of fisheries management activities and facilities, and the proposed management policy and guidelines in this Plan (Chapter 2, Sections 2.3 through 2.5) do not. Table 3-2 provides a side-by-side comparison of the two sets of management guidelines. Wording changes that do not change management intent are not displayed. A detailed comparison of specific wording from the 1988 Plan as modified with the new policies and guidelines in Chapter 2, Table 2-1 is filed in the administrative record for this Plan.

The 1988 Plan for Arctic Refuge describes five management categories: Intensive, Moderate, Minimal, Wild River, and Wilderness. The 1988 Plan adopted three of the management categories for the management of Refuge lands: Minimal, Wild River, and Wilderness. The current Plan describes management policies and guidelines for the same five categories, and lands will be assigned to the same three categories: Minimal, Wild River and Wilderness Management. None of the alternatives in this Revised Plan assign Refuge lands to the Intensive or Moderate Management categories. Lands recommended in this Plan for Wilderness designation will continue to be managed under the Minimal Management category. Rivers recommended for wild river designation will be managed according to the current underlying management category: Minimal Management for the Atigun, Marsh Fork Canning, and lower Hulahula rivers; and Wilderness Management for the Kongakut and upper Hulahula rivers. Only if Congress were to designate recommended lands to the National Wilderness Preservation System (NWPS) or rivers to the National Wild and Scenic Rivers System would management shift to the Wilderness or Wild River Management categories.

Table 3-2 compares major differences—by management category—between the 1988 Plan and the proposed management policies and guidelines in this Revised Plan. If a specific management category is not identified, the new policies and guidelines would apply to all management categories.

Table 3-1. Comparison of alternatives by major planning issue and budget and staff requirements.

Issue	Alternative A (No Action)	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F
Issue 1: Wilderness						
Should additional Wilderness Study Areas be recommended for inclusion in the National Wilderness Preservation System, and if so, which areas?	No new wilderness recommended.	Recommend the Brooks Range Wilderness Study Area.	Recommend the Coastal Plain Wilderness Study Area.	Recommend the Brooks Range and Porcupine Plateau Wilderness Study Areas.	Recommend the Brooks Range, Porcupine Plateau, and Coastal Plain Wilderness Study Areas.	Same as Alternative A
Issue 2: Wild and Scenic Rivers						
Should additional rivers be recommended for inclusion in the National Wild and Scenic Rivers System (NWSRS), and if so, which rivers?	No rivers recommended. Use existing management tools to maintain values on the Atigun, Hulahula, Kongakut, and Marsh Fork Canning rivers.	Recommend the Hulahula, Kongakut, and Marsh Fork Canning rivers. Use existing management tools to maintain values on the Atigun River.	Recommend the Atigun River. Use existing management tools to maintain values on the Hulahula, Kongakut, and Marsh Fork Canning rivers.	Recommend the Atigun, Kongakut, and Marsh Fork Canning rivers, and those portions of the Hulahula River managed by the Refuge.	Recommend the Atigun, Hulahula, Kongakut, and Marsh Fork Canning rivers.	Same as Alternative A
Issue 3: Kongakut River Visitor Use						
How will the Refuge manage Kongakut River visitor use to protect natural resources and visitor experience?	▪ Group size limits exist for guided groups (7 hikers, 10 floaters) ▪ No group size limits for non-guided visitors ▪ Information on minimum impact camping practices is available on the Refuge's web site ▪ Commercial service providers have Special Use Permits (SUPs) with occasional compliance checks ▪ Monitoring of physical and social conditions occurs occasionally ▪ Visitor impacts are monitored periodically ▪ On-site permit compliance checks are done infrequently ▪ In the Kongakut River valley, air operator permit holders are required to limit landings to non-vegetated surfaces and requested to follow all FAA advisories during flight operations ▪ Prepare a Public Use Management Plan (as required by the 1988 Plan)	Same as Alternative A, **and**: ▪ Step-down plans (Visitor Use Management and Wilderness Stewardship) initiated immediately following approval of the Revised Plan ▪ Step-down plans to address Kongakut River management issues identified by the public during the Revised Plan planning process, including: o crowding o resource degradation o impacts to wilderness characteristics o site rehabilitation o communications to visitors about impacts, resource issues, etc. prior to their trips o monitoring tools and schedules ▪ The following additional interim measures would be implemented pending completion of the step-down plans: o Work with guides to reduce number of groups during heavy use periods by using alternative scheduling practices o Work with air operators to disperse commuting flight paths in and out of the Kongakut River valley,	Same as Alternative B	Same as Alternative B, **except**: ▪ No interim cap would be set on commercial recreational guides on the Kongakut River	Same as Alternative D	Same as Alternative D

Issue	Alternative A (No Action)	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F
		subject to safe aircraft operation o Publish schedule of proposed guided launch dates and historical visitor use patterns o Develop additional outreach materials for users, with targeted messages aimed at minimizing impacts such as proper waste disposal, avoiding wildlife impacts, and alleviating crowding o Enforce permit conditions and Refuge regulations by increased occasional on-site checks o Visitor impacts monitored periodically, but focused on management effectiveness o Identify, evaluate, and rehabilitate degraded sites ▪ Set an interim cap on commercial recreational guides on the Kongakut River starting in 2013 and expiring at the end of 2016, or when the Visitor Use Management Plan is implemented, whichever is first ▪ Specifics of the cap: for each year of the interim period, recreational guide businesses authorized to operate on the Kongakut River would be restricted to the average number of client use days they reported for their operation on the Kongakut River for those years they operated on the river from 2007 through 2011.				
Budget and Staffing Needs						
Permanent Full-time Employees	22	25.5	25.5	25.5	25.5	25.5
Permanent Part-time Employees	1	1	1	1	1	1
Full-time Term Employees	1	1	1	1	1	1
Temporary Intermittent	5	6	6	6	6	6
Temporary Seasonal	3-5	7-9	7-9	7-9	7-9	7-9
Base Costs	$3,286,004	$4,044,000	$4,044,000	$4,044,000	$4,044,000	$4,044,000
One-time Costs	n/a	$230,000	$230,000	$230,000	$230,000	$230,000

* The 0.5 represents a full time permanent employee working half-time for Arctic Refuge

Table 3-2. Differences between the new management policies and guidelines proposed in this Revised Plan (Alternatives B, C, D, E, and F), and those in the 1988 Plan (Alternative A).

Management Topic	Alternative A: 1988 Plan	Alternatives B, C, D, E, & F: Revised Plan	Comments
Research and Management Facilities: Administrative facilities	Permitted in Minimal, Moderate and Intensive Management	May be allowed in Minimal, Moderate, and Intensive Management	See section 2.4.21.1
Research and Management Facilities: Fish weirs	Wild River Management: May be permitted on a case-by-case basis subject to NEPA compliance and Refuge compatibility determination, except permanent facilities not normally permitted	May be authorized in Wild River Management	
Habitat Management: Using mechanical means such as cutting, crushing, or mowing of vegetation; water control structures; fencing; artificial nest structures	Compared with Habitat Improvement, Mechanical Manipulation: May be permitted in Minimal Management subject to appropriate Plan revision	Not allowed in Minimal Management with exceptions	For exceptions, see sections 2.3.3, 2.3.4, 2.3.5, and 2.4.20
Habitat Management: Using hand tools to remove, reduce, or modify hazardous plant fuels or exotic plat species, or to modify habitats (e.g., remove beaver dams)	Compared with Minor Habitat Improvements such as: *nest devices and temporary habitat actions* In Wilderness, Wild River, and Minimal Management: may be permitted subject to NEPA compliance, and Refuge compatibility. For Wilderness only, a Wilderness Minimum Requirement Analysis is also required.	May be allowed	see sections 2.3.4, and 2.4.20
Habitat Management: Using chemicals to remove or control non-native species (compared with chemical habitat modification for fishery management)	May be permitted on case-by-case basis subject to NEPA compliance and Refuge compatibility. In Wilderness and Wild River categories, permanent facilities not normally permitted	May be allowed	See sections 2.4.11.1 and 2.4.12.8, Service Manual 620 FW 1

Management Topic	Alternative A: 1988 Plan	Alternatives B, C, D, E, & F: Revised Plan	Comments
Fishery Enhancement Facilities	Minimal Management — May be permitted on a case-by-case basis subject to NEPA compliance and Refuge compatibility	Not allowed in Minimal Management	See section 2.4.12.10
Pest Management and Disease Prevention and Control	Compared with Pest Control: Normally will not occur except to control exotic species; native species may be controlled where severe resource danger is likely or where safety is jeopardized	May be allowed	See section 2.4.12.8
Other Domestic Animals (including horses, certified weed-free feed required)	Permitted for traditional activities, subject to reasonable regulation	Allowed (certified weed-free feed required)	Certified weed-free feed required for all alternatives in this Plan but not required in 1988 Plan
Off-road Vehicle (All-Terrain Vehicles): Includes air boats and air-cushion vehicles	Not permitted for public use in Wilderness, Wild River, and Minimal Management Moderate and Intensive Management: Permitted only on designated routes or areas; air boats and air-cushion boats not permitted	Not allowed, with exceptions, in Wilderness, Wild River, and Minimal Management May be authorized in Moderate and Intensive Management	For exceptions, see section 2.4.13.1
Helicopters	May be permitted but only by special use permit	Not allowed with exceptions	For exceptions, see section 2.4.14.3
All Weather Roads	Not permitted except according to Title XI of ANILCA in Wilderness, Wild River, and Minimal Management Moderate and Intensive Management: Not provided; may be permitted subject to Title XI of ANILCA	Not allowed in Wilderness, Wild River, and Minimal Management May be allowed in Moderate and Intensive Management	

Management Topic	Alternative A: 1988 Plan	Alternatives B, C, D, E, & F: Revised Plan	Comments
Unimproved Roads	Not permitted except according to Title XI of ANILCA in Wilderness, Wild River, and Minimal Management Not provided; may be permitted subject to Title XI of ANILCA in Moderate and Intensive Management	Not allowed in Wilderness, Wild River, and Minimal Management May be allowed in Moderate and Intensive Management	
Constructed and Maintained Landing Areas	Primitive landing areas may be designated; no new construction allowed	Not allowed in Wilderness, Wild River, and Minimal Management May be allowed in Moderate and Intensive Management	See section 2.4.16
Boat Launches and Docks (public use)	Not permitted in Wilderness, Wild Rivers, and Minimal Management	Not allowed	
Visitor Contact Facilities	Not provided in Wilderness, Wild Rivers, Minimal, and Moderate Management	Not allowed in Wilderness, Wild River, and Minimal Management May be allowed in, Moderate and Intensive Management	
Administrative Field Camps: Temporary facilities for habitat/population management	Permitted in Minimal, Moderate, and Intensive Management	May be allowed in Minimal, Moderate, and Intensive Management	
Administrative Field Sites: Permanent facilities for habitat/population management	Permitted in Minimal, Moderate, and Intensive Management	Use of existing sites allowed including replacement of existing facilities as necessary; new sites may be allowed in all categories	For exceptions, see sections 2.3.4 and 2.4.20
Other Geophysical Studies	May be permitted subject to Refuge special use permit conditions in Wilderness	Not allowed in Wilderness	For exceptions, see section 2.4.18.2
Sand and Gravel	Not permitted in Moderate Management	May be authorized in Moderate Management	
Commercial Fishery Support Facilities At or below 1979 levels	May be permitted subject to reasonable regulation and provisions of ANILCA	Not applicable	See section 2.4.18.3

Management Topic	Alternative A: 1988 Plan	Alternatives B, C, D, E, & F: Revised Plan	Comments
Commercial Fishery Support Facilities Above 1979 levels	In Wilderness, may be permitted subject to reasonable regulation and provisions of ANILCA	Not allowed in Wilderness	See section 2.4.18.3
Commercial Timber and Firewood Harvest	Not permitted in Wild River and Minimal Management	May be authorized in Wild River and Minimal Management, but only if necessary to accomplish objectives in approved Fire Management Plan	See section 2.4.18.4

3.3.3 Comparison of Wilderness Management and Minimal Management Categories

Table 3-3 explains key differences between Wilderness Management and Minimal Management according to the management policies and guidelines in Chapter 2. Wilderness designation represents a more permanent commitment to perpetuating natural conditions and processes and wilderness-associated recreational opportunities. The most important difference is that Minimal Management is an administrative management category that can be changed by the Service through a Plan amendment, while lands under Wilderness Management have statutory protection that can only be changed by Congress. The purposes of the Wilderness Act are within and supplemental (i.e., additional) to Refuge purposes in designated Wilderness. A Minimum Requirement Analysis (MRA) is required for Refuge management activities conducted in areas under Wilderness Management; MRAs are not required for Minimal Management. Please refer to the management policies and guidelines in Chapter 2 (Sections 2.2, 2.3, and 2.4), for descriptions of the management categories and for detailed information about allowable uses and activities within each management category.

Table 3-3. Key differences between Minimal and Wilderness Management categories[1]

Topic	Minimal Management	Wilderness Management
Management of Area	Managed under ANILCA and other laws and policies	Managed under the Wilderness Act, the exceptions provided by ANILCA, the Service's Wilderness Stewardship Policy, and other laws and policies
Purposes	Managed to achieve establishing purposes of the Refuge	Managed to achieve establishing purposes of the Refuge and Wilderness Act purposes
Refuge Management Activities	No MRA required	MRA required for all Refuge management activities
	Mechanized and motorized equipment may be allowed when overall impacts are temporary or its use furthers management goals.	Mechanized and motorized equipment would be subject to an MRA or where ANILCA provides exceptions
Public Access	Cleared aircraft landing areas may be allowed [2]	Existing cleared aircraft landing areas allowed to remain, but new cleared areas not allowed
Public Use, Recreation, and Outreach Activities	New commercial cabins may be authorized[3]	New commercial cabins are not allowed
Public Use of Motorized Generators and Water Pumps	May be allowed	Not allowed
Commercial Activities or Uses	Geophysical exploration and seismic studies, core sampling, and other geophysical studies may be authorized outside the coastal plain (1002 Area)	Geophysical exploration and seismic studies, core sampling, and other geophysical studies not allowed
	Transportation and utility systems may be authorized by the Service through a Plan amendment	Transportation and utility systems may be authorized subject to Presidential and Congressional approval

[1] See Chapter 2, Section 2.3.3 Minimal Management, Section 2.3.4 Wilderness Management, and Section 2.4.20 Management of Designated Wilderness

[2] May be allowed: Activity, use, or facility may be allowed subject to site-specific NEPA analysis, an appropriate use finding (when required), a specific Refuge compatibility determination (when required), and compliance with all applicable laws and regulations of the Service, other Federal agencies, and the State.

[3] May be authorized: Activity, use, or facility only allowed with a required special use permit or other authorization.

3.4 Evaluation of Alternatives

3.4.1 Evaluation Criteria

The alternatives described in this chapter were evaluated against six criteria based on existing laws, policies, and guidelines. These criteria were selected as being the most important factors for evaluating the alternatives discussed in this Plan and for selecting the best option for Arctic Refuge.

- How well does the alternative satisfy the purposes of Arctic Refuge and other provisions of ANILCA?
- How well does the alternative satisfy the mission of the Refuge System?
- How well does the alternative contribute to meeting the goals of the Refuge?
- How does the alternative address the issues and concerns identified during scoping?
- How well does the alternative maintain biological integrity, diversity, and environmental health at the Refuge and ecosystem scales and contribute to managing the Refuge as part of an ecosystem?
- How well does the alternative promote relationship building, long-term partnering, and sharing of resources in the region?

The differences among the alternatives are relatively small. With few exceptions, each action alternative (Alternatives B through F) varies only slightly from the current management direction described under Alternative A. Therefore, the differences between Alternatives B through F in meeting the evaluation criteria are minor. Alternatives that would clearly not meet the purposes of the Refuge or the missions of the Refuge System and the Service were not developed. Scoping did not identify any major issues that would result in substantial changes in management direction for Arctic Refuge.

3.4.2 Response to Refuge Purposes

An important criterion used in evaluating the alternatives is the degree to which the alternatives achieve the purposes of Arctic Refuge as mandated by ANILCA, and where applicable PLO 2214 (Chapter 1, Section 1.4), and other mandates found in law and policy (Chapter 1, Sections 1.2.3 and 1.3, and Appendix A).

Alternatives B through F would adopt the goals, objectives, management policies, and guidelines described in Chapter 2, Sections 2.1 through 2.5. These alternatives support the Refuge purposes to: conserve fish and wildlife populations and habitats in their natural diversity; provide for continued subsistence opportunities; preserve water quality and quantity; and meet international treaty obligations. These alternatives also support the preservation of wildlife, wilderness, and recreational values in the lands and waters of the old Arctic Range. Alternatives B, C, D, and E could provide a higher level of habitat conservation by recommending additional lands for Wilderness status. Alternatives C and E could provide more protection of wilderness values in the Refuge's coastal plain. Water quality and other river values could achieve a higher level of protection for those rivers recommended for inclusion in the NWSRS. Alternative E recommends more lands and waters for these special designations than any of the other alternatives.

Under all alternatives, Arctic Refuge would continue to provide hunting, fishing, trapping, wildlife observation and photography, and environmental education and interpretation opportunities to learn about wildlife and habitats on Refuge lands. Alternatives B, C, D, and E have the potential to limit opportunities for commercial use by guides and transporters to a greater degree than the current management situation under Alternative A. Of all the alternatives, Alternatives B and C would be the most restrictive to commercial recreational guides using the Kongakut River.

3.4.3 Response to National Wildlife Refuge System Mission

All alternatives discussed in this Plan were developed to meet the mission of the Refuge System. Arctic Refuge plays a key role in conserving migratory birds, shorebirds, and waterfowl; salmon, Arctic char, grayling, and a variety of other fish species; Western Arctic and Porcupine caribou herds; and polar bears. Many other species such as grizzly bear, black bear, moose, Dall's sheep, muskox, wolf, and wolverine use the Refuge year-round. All the alternatives, in concert with the management direction described in Sections 2.3, 2.4, and 2.5 of this chapter, would continue to protect these species and their habitats in perpetuity.

3.4.4 Response to Refuge Goals

The goals and objectives for Refuge management described in Chapter 2, Section 2.1 reflect the purposes of the Refuge and the missions of the Refuge System and the Service. All the alternatives A through F would achieve the nine Refuge goals, although the alternatives differ in the specific management actions that would be employed to achieve the goals. All six alternatives conform to law and policy. Regardless of which action alternative is selected (B through F), the Service is committed to supporting the Refuge's goals and objectives, and will monitor each of them for achievement. If Alternative A is selected (the No Action alternative), the goals and objectives would not be adopted.

All alternatives promote partnerships and collaborations with the State of Alaska, local communities, and other public and private partners. All alternatives discussed in this Plan support subsistence, recreational, educational, and commercial services and would protect fish and wildlife resources and habitats. All alternatives would protect water resources and cultural resources.

Ecological condition, visitor experience, subsistence opportunities, and the tangible and intangible values of the Refuge would be maintained or improved if any of the Alternatives B through F, including all of their associated objectives and management guidelines, were to be selected.

3.4.5 Response to Issues

This section summarizes how the alternatives address the major planning issues identified during internal and public scoping.

3.4.5.1 Wilderness

The six alternatives explore different ways the Refuge could implement the wilderness review. Alternatives A and F would not recommend any additional lands for Wilderness designation and would rely on current management (Alternative A) or the management policy and guidelines presented in Chapter 2, Sections 2.4 and 2.5 (Alternative F) to maintain wilderness characteristics and values for Refuge lands and waters not currently designated as Wilderness. Alternatives B through E would recommend different combinations of WSAs for inclusion in the NWPS, with Alternative E recommending nearly all currently undesignated lands.

The act of recommending Wilderness would not change the underlying management category, nor would it necessarily result in congressional designation of Wilderness. Should Alternatives B, C, D, or E be selected, any lands recommended for Wilderness designation would continue to be managed according to the Minimal Management category outlined in Chapter 2, Section 2.3.3 and the management objectives presented in Chapter 2, Section 2.1. Only if Congress decides to designate recommended lands for inclusion in the NWPS would the underlying management category change from Minimal Management to Wilderness Management (Chapter 2, Section 2.3.4), at which time the purposes of the Wilderness Act would become within and supplemental to Refuge purposes. The Refuge would then manage these lands in accordance with the Wilderness Act, subject to the exceptions found in ANILCA.

3.4.5.2 Wild and Scenic Rivers

The six alternatives explore different ways the Refuge can manage the waters and values for rivers found suitable for inclusion in the NWSRS. Alternatives A and F would not recommend any rivers for inclusion in the NWSRS and would rely on current management (Alternative A) or the management policy and guidelines presented in Sections 2.4 and 2.5 of Chapter 2 (Alternative F) to maintain each river's values. Under Alternatives B, C, D, and E, different combinations of rivers would be recommended for the NWSRS. Alternative E would recommend the largest number of rivers and the most river corridor acreage of all the alternatives.

Any rivers recommended through the record of decision of the Revised Plan would continue to be managed according to Minimal or Wilderness Management categories (Chapter 2, Sections 2.3.3 and 2.3.4) and the management objectives listed in Chapter 2, Section 2.1. Only if Congress were to designate some or all of the recommended rivers would the underlying management category convert to Wild River Management (Chapter 2, Section 2.3.5). For those wild rivers, or segments of wild rivers, flowing through designated Wilderness, the more restrictive provisions of the Wild and Scenic Rivers Act and the Wilderness Act would apply.

3.4.5.3 Kongakut River Visitor Management

The six alternatives build upon each other to offer different approaches to managing visitor use in the Kongakut River valley. Options included in the alternatives are those that the Refuge could implement without promulgating regulations. Alternative A would maintain current management, which includes special use permit conditions, occasional compliance checks and monitoring of resource conditions and visitor experience, group size limits for commercial groups, and developing a Refuge-wide Public Use Management Plan. Alternatives B and C would retain all current management and add the following activities: increase outreach; publish a schedule of guided launches; conduct site rehabilitation; and address additional Kongakut River visitor management in the context of a Refuge-wide, Visitor Use Management step-down plan. Additionally, Alternatives B and C would set an interim cap on commercial recreation guides; it would run from 2013 until 2016, or until the required Visitor Use Management Plan is completed. Alternatives D, E, and F would include all the management activities identified in Alternatives A, B, and C, except there would be no interim cap on commercial recreation guides.

3.4.6 Response to Biological Integrity and Ecosystem Management

Service policy (601 FW 3) provides refuge managers with direction for assessing biological integrity, as well as maintaining and restoring biological integrity, diversity, and environmental health. Alternatives B through F, in concert with the management direction described in Chapter 2, Sections 2.4 and 2.5, would support the Service's policy on biological integrity. Should Alternative A be selected, the Refuge would have to comply with policy 601 FW 3, but the management direction adopted under this alternative (i.e., the management direction in the 1988 Plan) does not spell out how to achieve the policy.

The National Wildlife Refuge System Improvement Act of 1997 initiated an ecosystem approach to refuge management (Appendix A). Ecosystem management acknowledges that all living organisms (including people and their communities), the physical environment, and the ecological processes that sustain them are interconnected. A given ecosystem can be described as the intersection of natural forces, social relations, and the full range of meanings and values that people assign to the landscape (Williams and Patterson 1999). Ecosystems are not limited by land ownership or the boundaries of conservation units and human communities. Hence, Refuge planning and management should always take into account surrounding public and private lands, strive to maintain existing conservation partnerships, and seek opportunities to work with new partners. All the alternatives proposed in this Plan would support these principles of ecosystem management and contribute to maintaining the health of intact ecosystems in Alaska.

3.5 Selection of Preferred Alternative

After a thorough analysis of environmental, social, and economic considerations, the regional director selected Alternative E as the preferred alternative. Alternative E would: adopt the goals, objectives, management policies, and guidelines described in Chapter 2; recommend an additional 12.28 million acres of the Refuge for inclusion in the National Wilderness Preservation System (NWPS); recommend an additional four rivers for inclusion in the National Wild and Scenic Rivers System (NWSRS); and implement interim management measures to address visitor use of the Kongakut River pending completion of a Refuge-wide Visitor Use Management Plan.

3.5.1 Factors Considered in the Decision

Before selecting Alternative E, the Service reviewed and considered the direct, indirect, and cumulative effects of each of the Plan's six alternatives (see Chapter 5); relevant issues, concerns, and opportunities; input received throughout the planning process, including advice from technical experts and public comments on the draft Plan/EIS; and other factors, including Refuge purposes and relevant laws, regulations, and policies. Alternative E addresses a variety of needs, including protection of fish and wildlife populations and their habitats and providing opportunities for fish and wildlife-dependent recreation, subsistence, and other public uses. Alternative E contributes significantly to achieving the Refuge's purposes and goals, and strengthens the monitoring of fish, wildlife, habitat, and public uses on the Refuge to provide a means to better respond to changing conditions in the surrounding landscape.

3.5.2 Goals and Objectives

The goals and objectives adopted under Alternative E are rooted in the purposes, vision statement, and special values of the Refuge (Chapter 1) and they serve to prioritize Refuge management and the work of the staff for the next 15-20 years. The objectives and strategies outline specific actions the Refuge will take to ensure the lands and waters within the Refuge continue to support fish, wildlife, plants, and their habitats for the benefit of present and future generations while providing for subsistence opportunities and wildlife-dependent recreational opportunities, including opportunities for hunting, fishing, wildlife observation and photography, and environmental education and interpretation. The objectives and strategies promote building relationships and developing long-term partnerships.

3.5.3 Management Policies and Guidelines

Alternative E updates the management direction of the 1988 Plan with the management policies and guidelines detailed in Chapter 2 of the Revised Plan. The revised management policies and guidelines incorporate current laws, regulations, and policies and provide broad management direction for Refuge programs and activities.

3.5.4 Wilderness

The public provided the Service with many opinions about whether to recommend additional Wilderness within the Refuge, and hundreds of thousands of the public comments we received were in support of additional Wilderness in Arctic Refuge. While Minimal Management provides similar management tools as Wilderness Management, Minimal Management is an administrative management category that can be changed by the Service through a Plan amendment. Lands under Wilderness Management have statutory protection that can only be changed by Congress, and only Congress can designate Wilderness. By recommending an additional 12.28 million acres of Refuge land and water for Wilderness designation, Alternative E strives for a more permanent commitment to perpetuating the Refuge's natural conditions and processes and wilderness-associated recreational opportunities. However, until Congress makes a decision, the 12.28 million recommended acres will continue to be managed under Minimal Management.

3.5.4.1 Wilderness and Refuge Purposes

Wildlife – Wilderness designation would provide the greatest long-term assurance that the Refuge's wildlife and natural diversity would be perpetuated. Wilderness designation would generally preclude alterations of habitats to favor one species over another and would best protect the Refuge's free-functioning ecological systems and natural processes, with exceptions for management emergencies (see Chapter 2, Section 2.4.2).

Subsistence – Wilderness designation would provide long-term protection for the lands, wildlife, and other resources on which subsistence users depend and would serve to perpetuate the natural conditions in which the region's Native cultures evolved.

International Treaty Obligations – Wilderness designation would enhance long-term protections for all indigenous wildlife, including treaty species.

Water Resources – Wilderness designation would provide an additional layer of protection for water resources in the Refuge.

3.5.5 Wild and Scenic Rivers

Alternative E would recommend the Atigun, Marsh Fork Canning, Hulahula, and Kongakut rivers for inclusion in the NWSRS. These four rivers all have outstandingly remarkable recreational values, and all four rivers are being impacted by public use (such as emerging trails, hardened campsites, human waste accumulation, etc.). The Wild and Scenic Rivers Act would provide a suite of management tools that would help the Refuge better manage each of these river corridors. If Congress were to include these rivers in the NWSRS, the Refuge would prepare Comprehensive River Management Plans specific to each of the four rivers. These plans would: describe the existing resource conditions in the river corridor; define the goals and desired conditions for protecting river values; address the types and amounts of public use the river area can sustain (i.e., user capacities); address water quality issues and instream flow requirements; and include a monitoring strategy to maintain desired conditions. Until Congress makes a decision, under Alternative E the Refuge will maintain the free-flowing condition, water quality, recommended classification (i.e., wild), and the outstandingly remarkable and other values of the four rivers by implementing the interim management prescriptions described in Appendix I of the Revised Plan. Under these interim measures, the

Refuge could implement administrative management actions to maintain river values within the corridors.

3.5.6 Kongakut River Visitor Management

The public expressed strong interest in the Service taking meaningful steps towards addressing the degradation of resources and visitor experience in select areas of the Refuge, such as within the Kongakut River corridor. Alternative E implements a series of management actions that can be taken now, without promulgating regulations, to improve visitor experience and resource conditions in the Kongakut River valley. These interim measures include: working with guides to reduce visitor volume and to disperse flights; publishing a launch schedule; developing new outreach materials with targeted messages; increasing enforcement of permit conditions and refuge regulations; and identifying and repairing degraded sites. An interim cap on commercial recreational guides is not included in Alternative E. The interim measures will remain in effect until a Refuge-wide Visitor Use Management Plan is completed.

3.5.7 Conclusion

Alternative E addresses the key issues and concerns identified during the planning process and will best achieve the purposes of the Refuge, the mission of the Refuge System, and maintain the Refuge's special values. Arctic Refuge serves a distinctive function in the Refuge System as a landscape that is essentially unaltered and free-functioning, contains outstanding natural diversity, and provides a benchmark for wilderness qualities and for perpetuating biological integrity, diversity, and environmental health. Alternative E provides assurance that the Refuge's special values and distinctive function will be protected and perpetuated for future generations.

4. Affected Environment

This chapter describes the physical, biological, social, cultural, and economic components of the environment of Arctic National Wildlife Refuge (Arctic Refuge, Refuge) that could be affected by the management alternatives described in this Comprehensive Conservation Plan (Plan). The chapter also describes land status, special designations, and infrastructure for and staffing of the Refuge. Appendix F lists the scientific names of the plants and animals of the Refuge.

4.1 Geographic Setting

4.1.1 Refuge History

The Refuge has a long history. During World War II, a public land order (PLO 82; January 22, 1943) withdrew much of the land in northern Alaska for "use in connection with the prosecution of the war." This 49-million-acre[1] withdrawal included the entire Arctic coastal plain, including lands previously reserved as the National Petroleum Reserve No. 4 (Executive Order 3797-A; February 23, 1923). When land is "withdrawn," it is closed to some or all of the public land laws and/or mineral laws and reserved for a particular purpose or program administered by a Federal agency.

During the 1950s, the wilderness movement was gaining momentum. Two National Park Service (NPS) employees, George Collins and Lowell Sumner, were convinced that the northeastern corner of Alaska was one of the best remaining examples of true wilderness. Together with the help of nationally prominent conservationists, they sought its protection. While there was considerable support for the idea, there was also strong opposition from those concerned about future industrial development of the Alaska territory. The political struggle ended on December 6, 1960, when Secretary of the Interior Fred A. Seaton signed PLO 2214, creating the Arctic National Wildlife Range (Range, Arctic Range), and PLO 2215, revoking the existing withdrawal (PLO 82). The 8.83-million-acre Arctic Range was established for the "purpose of preserving unique wildlife, wilderness and recreational values" and was withdrawn from all forms of appropriation under the public land laws, including mining but not mineral leasing laws.

The action represented both a victory and a compromise for conservationists. In exchange for designating the Arctic Range, the national conservation community quietly withdrew its opposition to the revocation of PLO 82, which had effectively protected most of Arctic Alaska from State and corporate appropriation. Interior Secretary Seaton signed PLO 2215 immediately after signing PLO 2214, enabling the State to acquire and develop lands beyond the Range's western boundary, including what became the Prudhoe Bay oil field.

PLO 2214 had two clauses. The first outlined the purposes for the Arctic Range ("preserving unique wildlife, wilderness and recreational values"). The second stated that the Secretary of the Interior was authorized to permit "the hunting, and the taking of game animals, birds, and

[1] Acreages in this Plan are derived from many sources and may not agree with previously published values, including the draft Revised Plan. For more information, please refer to "A Note about Acreages" in the front pages of this volume.

fish in the wildlife range…as well as the trapping of fur animals.” The clause went on to say, “State law shall govern all hunting and taking of wildlife which the Secretary of the Interior permits under the terms of this order.”

On December 2, 1980, the Alaska National Interests Lands Conservation Act (ANILCA, Public Law 96-487) established the Arctic National Wildlife Refuge. Section 303(2) of ANILCA specified the Refuge include the existing Arctic National Wildlife Range[2], including “lands, waters, interests, and whatever submerged lands, if any, were retained in Federal ownership at the time of statehood,” plus an additional 11.04 million acres of public lands.

ANILCA Section 303(2)(B), identified four purposes for managing the Refuge. Chapter 1 (Section 1.4.2.1) of this Plan describes these purposes (ANILCA purposes). Under the provisions of ANILCA Section 305, the three 1960 purposes are to remain in force and effect on the original Range lands to the extent they are consistent with ANILCA; however, the ANILCA purposes apply to the entire Refuge. ANILCA also designated the Ivishak, Sheenjek, and Wind rivers within the Refuge boundary as national wild rivers (Section 603) and about 7.16 million acres as the Arctic Wildlife Refuge Wilderness (Section 702(3)).

The newly created Wilderness included most of the original Range, except for approximately 1.57 million acres of the Arctic coastal plain. This area of the coastal plain (the “1002 Area”), was opened to limited oil and gas exploratory activity pursuant to ANILCA Section 1002. Section 1002 also directed the Secretary of the Interior to prepare a report to Congress on biological resources, the oil and gas potential of the coastal plain, and the impacts of development, and provide recommendations as to whether further oil and gas exploration and development should be permitted. In 1987, the Department of the Interior (DOI) published the Arctic National Wildlife Refuge, Alaska, Coastal Plain Resource Assessment report, which found that the coastal plain met criteria of the Wilderness Act for designation. While the Secretary of the Interior recommended to Congress that the entire 1002 Area should be open to oil and gas leasing programs at such a pace and in such circumstances so as to avoid unnecessary adverse effects on the environment, Congress has not acted on this recommendation.

ANILCA Section 1003 prohibits production of oil and gas on Arctic Refuge and requires congressional authorization before undertaking any leasing or other development leading to production of oil and gas from the original Range. In 1988, Congress amended ANILCA Section 1302 through Public Law 100-395, which requires congressional authorization before the Secretary can exchange or otherwise convey lands or interests in lands in the coastal plain of Arctic Refuge. The amendment addressed congressional concerns that exchanges could ultimately preempt the authority of Congress to make the decision whether to lease and develop oil and gas resources of the coastal plain.

The last major additions to the Refuge occurred in the mid-1980s. About 1.3 million acres of land, originally selected by the State of Alaska under the Alaska Statehood Act (Public Law 85-508) but later relinquished, was added to the Refuge in two actions occurring in 1983 and 1985. This State selected land was located 40 miles east of Arctic Village on the southern slopes of the Brooks Range and was surrounded on three sides by Refuge land. On August 16, 1988, the President signed the Alaska Submerged Lands Act (Public Law 100-395), which

[2] On February 29, 1980, about nine months before passage of ANILCA, the Arctic National Wildlife Range was renamed the William O. Douglas Arctic Wildlife Range by Presidential Proclamation 4729.

amended ANILCA. Section 301 of the Submerged Lands Act added 325,000 acres to Arctic Refuge. These acres were a former proposed utility and transportation corridor managed by the Bureau of Land Management (BLM). Both these additions were of lands already within the boundaries of the Refuge as established by ANILCA.

In 1996, Public Law 104-167 officially renamed the "Arctic National Wildlife Refuge Wilderness" the "Mollie Beattie Wilderness." The name change posthumously honors conservationist Mollie Beattie, the first female director of the U.S. Fish and Wildlife Service (Service).

4.1.2 Land Status

The exterior boundary of Arctic Refuge encompasses nearly 19.86 million acres, of which about 19.64 acres (99 percent) are administered by the Refuge. Table 4-1 shows, by general ownership, the approximate area of non-Refuge lands within the Refuge boundary.

The Alaska Native Claims Settlement Act of 1971 (ANCSA) and ANILCA determined the current land ownership patterns in and surrounding Arctic Refuge. ANCSA authorized the formation of Alaska Native village and regional corporations, enabling northeast Alaska's Native Iñupiat and Athabascan peoples to select and gain title to Federal lands that were originally part of their ancestral homelands.

Nine years later, ANILCA established the current Refuge boundaries. For the most part, boundary lines roughly followed major ecological features, such as rivers or watersheds, regardless of existing land ownership. Consequently, the Refuge surrounds non-Refuge land in a variety of ownerships, including Alaska Native allotments, Alaska Native corporation lands (regional and village), a town site, and other Federal agency withdrawals (Table 4-1, Map 4-1).

Complete conveyances of Native corporation land selections, and thus changes in land ownership, were scheduled to be finished in 2009 under the provisions of the Alaska Land Transfer Acceleration Act of 2004 (Public Law 108-452). However, it is likely that there will be continued but minor land ownership changes as selected lands are conveyed, relinquished, or rejected, and land conveyed by interim conveyances is surveyed prior to patent.

Table 4-1. Surface land status as of March 21, 2012

Land Status	**Arctic Refuge (acres)** [a]		
Federal (U. S. Fish and Wildlife Service)	19,660,000		
	Selected [b]	**Conveyed** [b, c]	**Other**
Arctic Slope Regional Corporation	0	11,088.00	
Doyon Limited	1,200	85,994.61	
Kaktovik Iñupiat Corporation	4,400	90,108.20	
Native Allotments	319.97	11,470.25	
Town Site (Canyon Village)	0	29.86	
Other Federal Agency	0	0	669
Total	5,919.97	198,690.92	669

[a] Official Service acreage from the "Annual Report of Lands Under Control of the U.S. Fish and Wildlife Service as of September 30, 2009" states Arctic Refuge is 19,286,722 acres, which includes 5,822 acres of Native selected land. Official Service acreage differs from the GIS-derived acreage of 19,660,000 acres cited in Table 4-1. The GIS-derived acreage includes the Refuge's coastal lagoons. For more information about acreage values, see "A Note about Acreages" in the front matter of this volume.

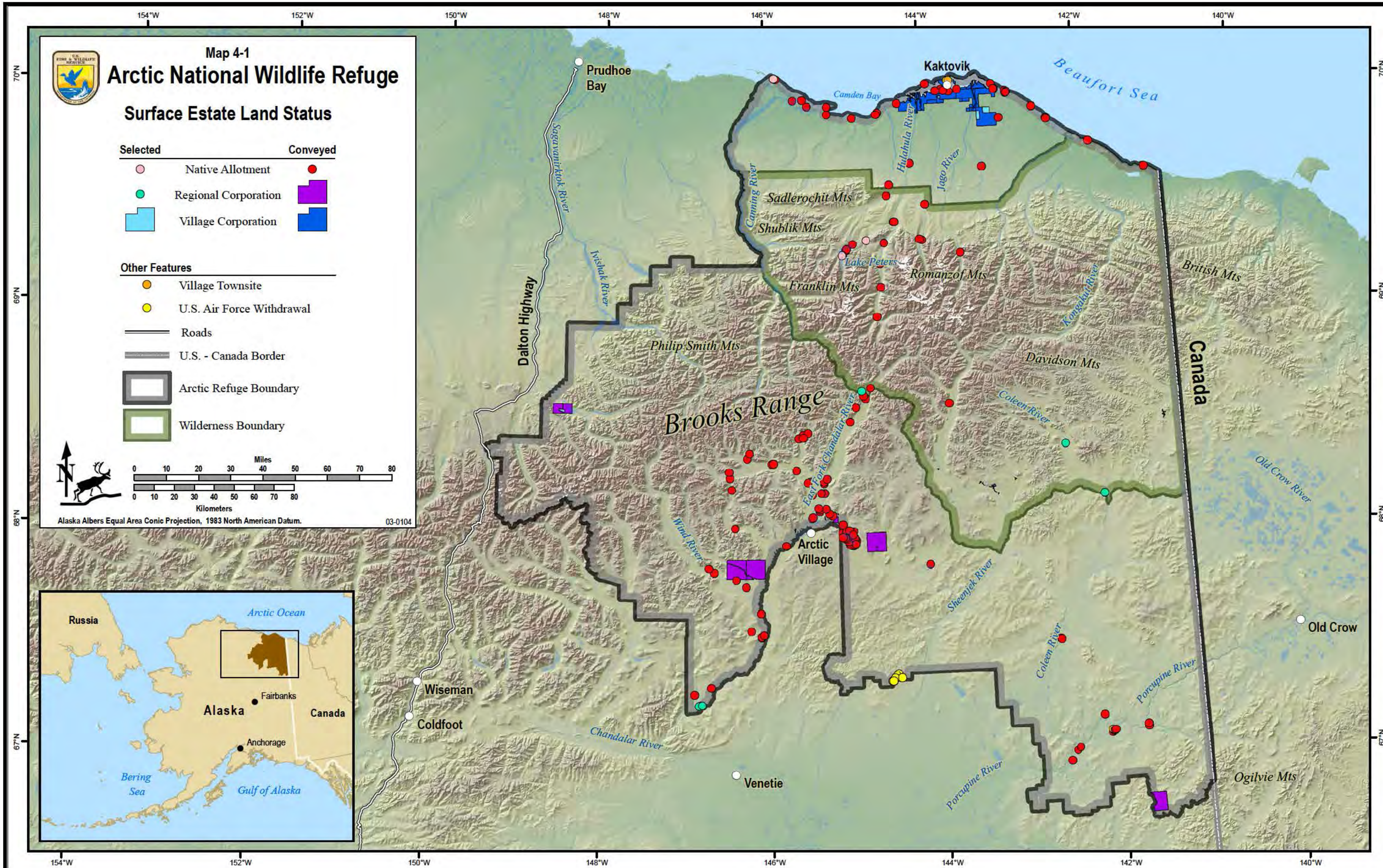
[b] Acreages of Native conveyed lands are from legal documents (deeds, patents, interim conveyance documents). Acreages of selected lands are GIS-calculated approximations and may differ from acreage figures reported elsewhere. The source for the GIS data is the Master Title Plats maintained by the Bureau of Land Management. Acreage figures exclude submerged beds of meandered water bodies (rivers of 198 feet or more in width and lakes of 50 acres or more), within interim conveyed and patented Native corporation lands. Ownership of the submerged lands beneath water bodies outside of Native corporation ownership depends on the navigability status and is yet to be determined for most water bodies. No ownership of the land beneath these water bodies is implied in this table.

[c] Includes patented and interim conveyed lands. Only land claims within the Refuge boundary are reported.

4.1.2.1 Regional Native Corporation Lands

Section 7 of ANCSA authorized the Secretary of the Interior to divide the State into 12 geographic regions, each composed of Alaska Natives sharing a common heritage. The regions were to be based upon existing Native associations. Arctic Refuge spans portions of two geographic regions represented by the Arctic Slope Regional Corporation (ASRC) and Doyon Limited (Doyon). The provisions of ANCSA Sections 12 and 14 determined the land entitlements for each regional corporation. Regional corporations were prevented from selecting the subsurface estate in refuges (such as the former Arctic Range) but were authorized to select an equivalent acreage elsewhere.

Doyon owns 123,204.47 acres of land in the southern part of the Refuge and ASRC owns 11,088.00 acres surrounding Elusive Lake in the western Brooks Range. ANCSA conveyance rules prevented ASRC from obtaining subsurface estate in the former Arctic Range; however, the corporation received a large tract of subsurface through a land exchange. In the Chandler Lake Land Exchange, ASRC exchanged 101,272 acres of surface lands in Gates of the Arctic National Park for the subsurface estate beneath the Kaktovik Iñupiat Corporation (KIC) lands on the coastal plain (more than 90,000 acres). The acquired subsurface estate is in an area considered to have oil and gas potential; however, the commercial development of oil and



Map 4-1
Arctic National Wildlife Refuge
Surface Estate Land Status
Selected
Conveyed
Native Allotment
Regional Corporation
Village Corporation
Other Features
Village Townsite
U.S. Air Force Withdrawal
Roads
U.S. - Canada Border
Arctic Refuge Boundary
Wilderness Boundary
Miles
Kilometers
Alaska Albers Equal Area Conic Projection, 1983 North American Datum.
03-0104
Prudhoe Bay
Kaktovik
Beaufort Sea
Camden Bay
Sagavanirktok River
Ivishak River
Canning River
Hulahula River
Jago River
Sadlerochit Mts
Shublik Mts
Lake Peters
Romanzof Mts
Franklin Mts
Kongakut River
British Mts
Philip Smith Mts
Davidson Mts
Canada
Dalton Highway
Brooks Range
East Fork Chandalar River
Coleen River
Old Crow River
Wind River
Arctic Village
Sheenjek River
Old Crow
Porcupine River
Wiseman
Coldfoot
Chandalar River
Venetie
Ogilvie Mts
Russia
Arctic Ocean
Alaska
Fairbanks
Anchorage
Bering Sea
Gulf of Alaska

gas from ASRC's acquired subsurface in the Refuge is contingent upon an act of Congress, as provided in ANILCA Section 1002 and 1003. ASRC may remove sand and gravel from these lands, provided they follow provisions in the Chandler Lake Exchange agreement that specify how and where sand and gravel pits are located and developed. The exchange included land use stipulations to ensure the conveyance of the subsurface to ASRC would not "undermine the essential integrity of the Arctic National Wildlife Refuge and will not frustrate the purposes of the Refuge." The stipulations remain with the land even if it is sold or exchanged.

In the late 1980s, a review by the General Accounting Office concluded that the Chandler Lake Land Exchange and other proposed exchanges in Arctic Refuge were not in the public interest. In 1988, Congress legislated to prevent more land exchanges within the Arctic coastal plain without congressional approval (P.L. 100-395, amending ANILCA 1302(h)(2).

4.1.2.2 Village Native Corporation Lands

Section 8 of ANCSA provided that the Native residents of each Native village entitled to receive lands under ANCSA "shall organize as a business for profit or nonprofit corporation under the laws of the State of Alaska…." Section 11 of ANCSA created the framework and made certain public lands available for selection by village corporations. Section 11(B)(b)(1) lists the villages subject to ANCSA, including those in the ASRC and Doyon regions. Of these, only unoccupied Canyon Village is within the boundaries of the Refuge. The communities of Venetie and Arctic Village in the Doyon region and Kaktovik in the ASRC region are outside the Refuge boundary but in close proximity.

ANCSA Section 12(a) established rules guiding village corporation land selections. Selections were to include all of the townships in which the village was located. Any additional selections necessary to meet the village's entitlement were to be made from adjacent townships. However, selections of a village corporation located in a national wildlife refuge were limited to 69,120 acres within the refuge boundaries; any remaining land entitlement had to be selected from land outside refuge boundaries.

Because of its location in the former Arctic Range, KIC was subject to this stipulation. However, a provision included in a subsequent land exchange agreement, ratified by ANILCA Section 1431, authorized KIC to acquire its full ANCSA land entitlement in the Refuge. The village site itself is located just outside of the Refuge boundary (as established by ANILCA).

The communities of Venetie and Arctic Village own land adjacent to the Refuge. These villages chose to opt out of the ANCSA land claims settlement. In 1943, the Secretary of the Interior had created the Venetie Indian Reservation for the Neets'aii Gwich'in on approximately 1.8 million acres of their traditional lands. Among other things, ANCSA revoked the Venetie Reservation and all but one other reservation in Alaska. The two Native corporations established for the Neets'aii Gwich'in elected to make use of an ANCSA provision allowing them to take title to former reservation lands in return for giving up the cash and land settlement provided by ANCSA. The United States conveyed fee simple title to the former reservation lands to the Native corporations as "tenants in common." The two corporations then transferred the title for all of the land to the Native Village of Venetie Tribal Government.

Canyon Village's situation is also unusual. At the passage of ANCSA, its population was below the minimum requirement for an ANCSA village. In such cases, Section 14(h)(2) authorized conveyance of up to 23,040 acres to a Native group not qualifying as a Native village, provided that it is incorporated under the laws of the State of Alaska. In 1976, Canyon Village filed a land selection for 5,760 acres of land under this ANCSA provision. At the time of this application, the area in which this selection was made was designated by PLO 3520 as a powersite withdrawal and was therefore unavailable for selection. Although PLO 3520 was later revoked (1990), the application to select the land remained invalid, as the selected land had been designated part of the Refuge by ANILCA in 1980. Canyon Village currently owns no ANCSA-conveyed land but does hold title to a Native town site (see Section 4.1.2.4) in the Refuge. The town site is currently unoccupied.

4.1.2.3 Native Allotments

Until its repeal in 1971, the Native Allotment Act of 1906 authorized individual Alaska Natives to claim up to 160 acres of land. In addition, a 1998 amendment to ANCSA (Section 432 of Public Law 105-276 [43 U.S.C. 1629g]) authorized qualified Alaska Native Vietnam veterans to apply for an allotment if they had not previously done so. The 1998 law addressed the concern that military service may have prevented some Native veterans from applying for an allotment under the 1906 act. The application period for these new allotments closed on January 31, 2002. To date, 123 allotments have been patented in Arctic Refuge.

4.1.2.4 Town Sites

Three Federal laws created the opportunity for Alaska Native villages to establish town sites and convey title to Alaska Native adults:

- The act of March 3, 1891 (26 Stat. 1095), opened Federal land in Alaska for the establishment of town sites.
- The Alaska Native Town Site Act of May 25, 1926 (44 Stat. 629), created the opportunity for Native villages to establish town sites, to survey lots and streets, and to convey lots by restricted deed to Alaska Natives.
- The act of February 26, 1948 (62 Stat. 35), included a provision that allowed the conveyance of town site lots to Alaska Natives by unrestricted deeds.

Kaktovik in 1967 and Canyon Village in 1981 received patent to Federal land (280.92 acres and 29.86 acres, respectively) for the establishment of town sites. Only the Canyon Village town site is within the Refuge boundary, as the Kaktovik site was excluded.

4.1.2.5 ANCSA 22(g)

All lands (including surface and subsurface estates) conveyed under ANCSA in pre-ANCSA national wildlife refuges are subject to section 22(g) of ANCSA. Under section 22(g), refuge lands conveyed under ANCSA remain subject to the laws and regulations governing use and development of the refuge. This means that the refuge manager evaluates the uses proposed by 22(g) landowners to determine whether they are compatible with refuge purposes. The evaluation considers only the effects of the use on the adjacent refuge lands and the ability of the refuge to meet its mandated purposes. The refuge manager can impose special conditions to ensure the compatibility of a proposed use. The evaluation does not consider the effects of the use on the 22(g) lands. Section 22(g) also reserves the right of first refusal to the United States if the lands are offered for sale.

4.1.2.6 ANCSA 14(h)(1)

Under the provisions of ANCSA Section 14(h)(1), regional corporations could apply for and receive conveyance to cemetery sites and historical places. A covenant in the conveyance document states that the corporation shall not authorize any use that is incompatible with or in "derogation of the values as a cemetery site/historical place," including mining or mineral activities of any type. The covenant remains with the land, and the United States reserves the right to seek enforcement of the covenant. Furthermore, 14(h)(1) sites in refuges are subject to the provisions of ANCSA Section 22(g).

Currently, 27 parcels totaling 3,284.34 acres have been conveyed as cemetery sites or historical places. Another five parcels (totaling 1,144.31 acres) are selected but not yet conveyed.

4.1.2.7 State of Alaska

The Alaska Statehood Act (Public Law 85-508) entitled the State to select 102,550,000 acres of vacant or unreserved lands, or lands not appropriated under the general grant, and to select an additional 400,000 acres to promote development and expansion of communities. The State was also granted title to most of the existing roads, airfields, and associated facilities under the Alaska Omnibus Act (Public Law 86-70) enacted on June 25, 1959. The Arctic Refuge boundary established by ANILCA was drawn to exclude a large tract of land east of Arctic Village that had been selected by the State of Alaska. However, the State later relinquished these lands and about 1,300,000 acres were added to the Refuge in 1983 and 1985. There are no other State conveyed or selected lands in the Refuge.

4.1.2.8 Submerged Lands

In general, the Equal Footing Doctrine, the Submerged Lands Act of 1953, and the Statehood Act of 1958 granted the lands beneath tidelands and inland navigable waters to the State of Alaska. Lands beneath water bodies that were reserved or withdrawn by the Federal government prior to statehood on January 3, 1959, may have been retained by the United States. If the United States did not reserve or withdraw submerged lands, then the ownership of inland submerged lands is determined on the basis of navigability. If an inland water body is navigable, the underlying bed of the river or lake belongs to the State; if non-navigable, the bed belongs to the adjacent upland landowner(s). The term navigable has a legal definition and does not simply refer to whether a boat can navigate the body of water.

After statehood, the ownership of coastal submerged lands within the original Arctic Range boundary was disputed by the State and Federal governments. The dispute was settled in 1997 when the Supreme Court ruled that submerged lands (including tidally influenced lands) within the Arctic Range boundary did not transfer to the State of Alaska at statehood (United States v. Alaska, No. 84 Original). The Court's decision recognized that the application to create the Arctic Range (which pre-dated statehood) clearly intended these submerged lands to be included as part of the Range. Arctic Refuge, therefore, contains navigable and non-navigable waters. Submerged lands within the boundaries of the original Arctic Range, including river beds, were retained in Federal ownership on the date Alaska was granted statehood. However, the status of many water bodies outside the former Arctic Range has not yet been determined. Any disagreements between the State and the Federal government over what waters are navigable or non-navigable that cannot be resolved, can only be finally resolved through the Federal courts.

4.1.2.9 Refuge Boundary Issues

In 2000, a court-ordered decree was jointly prepared by the State and Federal governments to address the location of the Refuge boundary bordering the Beaufort Sea. The decree defined the coastal boundary as following the line of extreme low water for offshore bars, reefs, and islands and lagoons. As such, the boundary is considered to be "ambulatory" and prone to migrate if relevant physical features change. The Supreme Court accepted the decree but retained jurisdiction to consider and accept future joint proposals from the State and the United States regarding the coastal boundary of the Refuge. Efforts to jointly define a non-ambulatory administrative boundary have thus far been unsuccessful.

The eastern boundary of Arctic Refuge abuts Canada. Lands adjacent to the boundary have been continuously reserved for 100 years. In 1912, President Taft reserved all public land "lying within sixty feet of the Boundary Line between the United States and the Dominion of Canada" from entry, settlement, or other forms of appropriation under the public land laws.

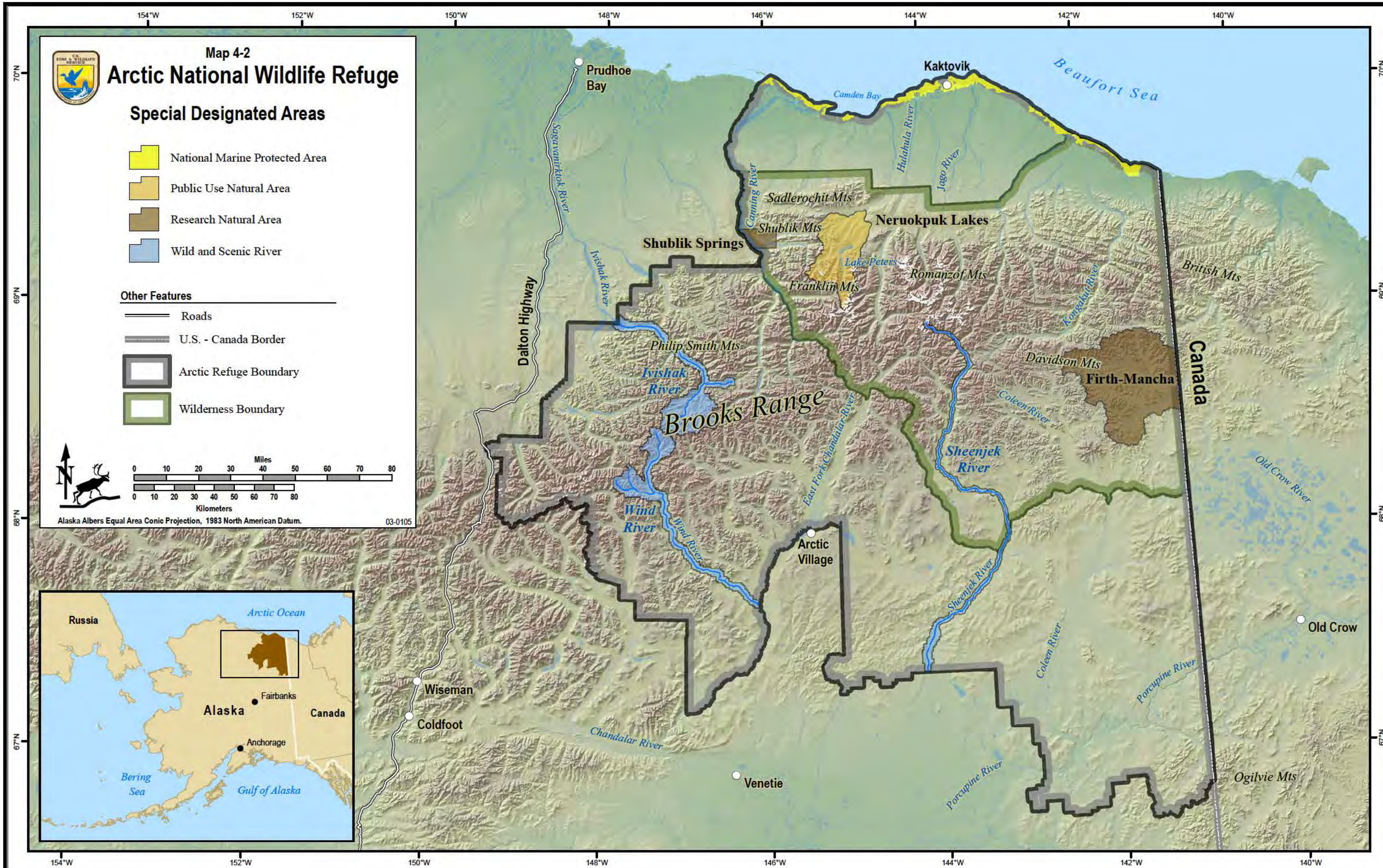
4.1.3 Special Designations

In addition to refuge status, the special status of lands in individual refuges may be recognized by additional designations, either legislatively or administratively. Special designation may also occur through the actions of other agencies or organizations. The influence that special designations have on the management of lands and waters in refuges may vary considerably. Arctic Refuge contains a number of special designated areas (Map 4-2).

4.1.3.1 Research Natural Areas

Two Research Natural Areas (RNAs), the Firth River-Mancha Creek (also known as Firth-Mancha) RNA and the Shublik Springs RNA, were established in the Refuge on August 5, 1975, as part of a national system of RNAs. This designation differs from other classifications, such as Wilderness, refuge, or preserve, in that the latter designations often have broader use and management objectives than the preservation and scientific applications of the RNA system (Federal Committee on Ecological Reserves 1977). RNAs receive no special legislative protection; additional protections, if any, are derived only from the individual agencies that manage them. Both of the Refuge's RNAs occur entirely in designated Wilderness. The Firth-Mancha RNA is approximately 520,000 acres and is located in the northeastern portion of the Refuge. The Shublik Springs RNA is approximately 34,000 acres and is located in the northwestern portion of the Refuge.

The purpose of RNAs is to preserve examples of all major ecosystem types in the country, to provide opportunities for research and education, and to preserve a full range of genetic and behavioral diversity in native plants and animals (Service 1988a). The original RNA system received no special legislative protection; it was left to the administering agencies to provide additional protective measures. However, with the passing of ANILCA in 1980, Arctic Refuge's two RNAs became a part of the Refuge's designated Wilderness, granting additional protection.



Map 4-2
Arctic National Wildlife Refuge
Special Designated Areas
National Marine Protected Area
Public Use Natural Area
Research Natural Area
Wild and Scenic River
Other Features
Roads
U.S. - Canada Border
Arctic Refuge Boundary
Wilderness Boundary
Miles
Kilometers
Alaska Albers Equal Area Conic Projection, 1983 North American Datum.
03-0105
Prudhoe Bay
Kaktovik
Beaufort Sea
Camden Bay
Sadlerochit Mts
Shublik Mts
Neruokpuk Lakes
Shublik Springs
Lake Peters
Romanzof Mts
Franklin Mts
British Mts
Philip Smith Mts
Davidson Mts
Firth-Mancha
Canada
Ivishak River
Brooks Range
Sheenjek River
Wind River
Arctic Village
Old Crow
Wiseman
Coldfoot
Venetie
Ogilvie Mts
Dalton Highway
Russia
Arctic Ocean
Alaska
Fairbanks
Anchorage
Bering Sea
Gulf of Alaska

Although no management plan or objectives have been developed for these RNAs, the description on which the Firth-Mancha RNA designation was based stated that "the area will be maintained in a natural condition permitting succession to advance to a climax without interference" (Service 1988a). A similar goal was stated for the Shublik Springs RNA in its area description: the area was to be dominated by natural processes of succession, with no improvement or disturbance of the habitat (Service 1988a). Both RNAs are managed as Wilderness, which ensures the integrity of these areas.

4.1.3.2 Public Use Natural Areas

The Neruokpuk Lakes Public Use Natural Area was established on May 2, 1977. It is approximately 212,000 acres and is the only Public Use Natural Area (PUNA) in the Refuge. It is located in the Brooks Range, entirely in the designated Wilderness area. It was chosen as a PUNA because of its relative ease of access, scenic beauty, and abundant wildlife.

The purposes of PUNAs are to preserve important natural areas for public use and to preserve these areas essentially unmodified by human activity for future use (Service 1988a). No management plan or objectives have been established for the Neruokpuk Lakes PUNA. However, it is managed as Wilderness, which ensures the integrity of this area.

4.1.3.3 Marine Protected Area

In 2005, all marine waters located within Refuge boundaries were nominated as part of the National Marine Protected Area System. Currently, approximately 91,000 acres of marine waters and lagoons located off the northern coast of the Refuge are a designated marine protected area (MPA). Given the uncertainty of shifting shorelines and the point at which to differentiate between freshwater and saltwater at river mouths, the acreage estimate for the MPA is plus or minus several hundred acres.

Executive Order 13158, issued in 2000, strengthened and expanded the nation's system of MPAs and defined them 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."

There are no special conditions for managing the MPA. Some parts of the MPA fall in designated Wilderness, while others are outside of the Wilderness boundary. The current management approach ensures the integrity of this area.

4.1.3.4 Wild Rivers

In 1980, ANILCA designated those portions of the Ivishak, Sheenjek, and Wind rivers within the boundaries of Arctic Refuge as wild rivers under the Wild and Scenic Rivers Act. The Service established corridor boundaries for each of the rivers through the 1988 Plan. All three rivers are part of the National Wild and Scenic Rivers System (NWSRS), and the Refuge manages the rivers under the Wild River Management category (see Chapter 2, Section 2.3.5). In this management category, water bodies are maintained in natural, free-flowing, and undisturbed conditions, where the evidence of human activities is minimized.

Each river in the NWSRS has particular values for which it was designated, and management of a wild river must protect those specific values. Congress did not specify values for the Ivishak, Sheenjek, and Wind rivers. The Refuge will use legislative records, historic reports, and current information to determine the values for each river through individual Comprehensive River Management Plans (see Chapter 2, Section 2.1.3, Objective 3.5).

The Ivishak River flows north through the Philip Smith Mountains and the northern foothills of Arctic Refuge to join the Sagavanirktok River on the Arctic coastal plain south of Prudhoe Bay. From its headwaters, the Ivishak develops an increasingly wide, braided floodplain typical of northern Alaska rivers. Bird life on the river likely exceeds 100 species. Sixty-one miles of the 95-mile-long Ivishak River lie in Arctic Refuge. The wild river corridor encompasses 200,000 acres and includes all of the river's headwaters.

The Sheenjek River originates from glaciers in the Romanzof Mountains. This river travels south 200 miles to join the Porcupine River near its junction with the Yukon River. The Sheenjek flows through a wide variety of Arctic habitats and scenery. Portions of the Porcupine caribou herd occasionally winter in the Sheenjek valley. The segment of the Sheenjek River classified as wild totals 191 miles. The river management corridor encompasses 150,000 acres.

The Wind River, also classified as wild, flows for 102 miles and is entirely within the boundary of Arctic Refuge. Beginning in the Philip Smith Mountains, this river offers a wide variety of vegetation, scenery, and wildlife characteristic of tundra-taiga transition on the South Slope of the Refuge. All of the river's headwaters are included in the river's corridor, which is 200,000 acres in size.

4.1.3.5 Wilderness Qualities

Section 304(g) of ANILCA requires the Service to identify and describe the special values of the Refuge, including wilderness values. Congressionally designated Wilderness is subject to the provisions of the Wilderness Act of 1964 and to the modifying provisions of ANILCA. Areas not designated as Wilderness may possess wilderness-associated values but may or may not have the same degree of natural and other qualities as designated Wilderness. In Arctic Refuge, 7.16 million acres were designated as Wilderness by ANILCA in 1980. The lands that were part of the original Range retain the 1960 establishing purpose to preserve the unique wilderness values of the area to the extent the establishing purpose is not inconsistent with ANILCA (see Chapter 1, Section 1.4.2). With only a few exceptions, the designated Wilderness and the non-designated areas (Minimal Management category) of the Refuge have been managed in the same manner.

The Wilderness Act describes four primary qualities of Wilderness. The following are descriptive of the Refuge's designated Wilderness and much of the non-designated areas of the Refuge, with the exception of certain tracts in the vicinity of Kaktovik and Arctic Village (see Appendix H).

Undeveloped

The undeveloped quality of Wilderness is defined as free from roads, structures, and other evidence of modern human occupation or improvements, where the land essentially retains its original character and ecological function (Landres et al. 2008). The undeveloped quality can influence opportunities to experience solitude and unconfined recreation.

Untrammeled

The Wilderness Act states that Wilderness is an area where the land and its biological communities are untrammeled by humans. In other words, Wilderness is essentially unrestricted and free from modern human control or manipulation (Landres et al. 2008). The untrammeled quality of the Wilderness resource can be diminished when ecological events or processes are constrained or manipulated.

Natural

In designated Wilderness, ecological systems are substantially free from the effects of modern civilization (Landres et al. 2008). Natural condition is the degree to which an area remains substantially free from the effects of modern civilization; it is affected primarily by the forces of nature and looks natural to the average visitor.

Opportunities for Solitude or Primitive and Unconfined Recreation

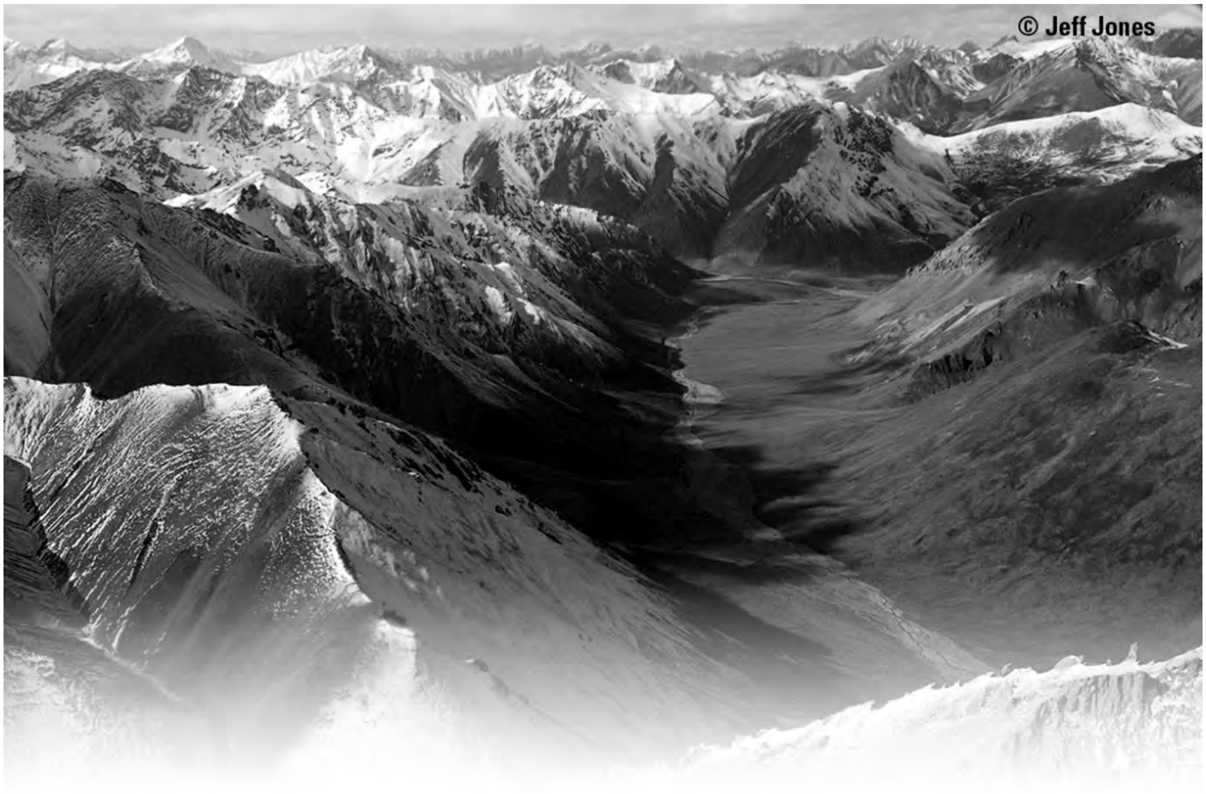
Primitive or unconfined recreation in wilderness settings is characterized by non-motorized methods of travel, no or minimal facilities, self-reliance, and a minimum of restrictions on the visitor's travel and behavior. Privacy and isolation are important components, but solitude also is enhanced by the absence of distractions, such as large groups, mechanization, unnatural noise and light, unnecessary managerial presence (such as signs), and other modern artifacts.

Primitive or unconfined recreation in wilderness settings is characterized by freedom from management restrictions on visitor behavior (Landres et al. 2008). Travel in Wilderness usually is by non-motorized and non-mechanical means (e.g., walking or paddling). Wilderness recreation may often include the experiences of challenge, risk, self-reliance, and/or freedom. Facilities in Wilderness can decrease the challenges of self-reliant recreation. Dispersed travel and camping patterns, in an area with little or no facilities, can enhance opportunities for unconfined recreation.

4.1.3.6 Designated Wilderness

At 7.16 million acres, the Refuge's designated Wilderness area is the largest, wildest, and most diverse Wilderness in the National Wildlife Refuge System (Refuge System). It includes five ecoregions, spanning 132 miles (mi) or 213 kilometers (km) north to south. The coastal marine system along the Beaufort Sea in the eastern quarter of the Refuge along the Canadian border is characterized by bays, inlets, and lagoons sheltered by barrier islands, and the Kongakut River delta. The coastal plain consists of a narrow band of relatively flat, wet, and moist tundra. The Brooks Range Foothills consists of a narrow swath of gently rolling hills and plateaus that ascend from the coastal plain to the mountains. The Brooks Range Mountains, reaching to 9,000 feet, dominate the unit, which contains the highest peaks and most glaciers in the Brooks Range. Rugged crags, deep-cleft valleys, knife-like ridges, and expansive vistas combine to make it dramatically scenic. The Davidson Mountains flank the southern Brooks Range. Dissected by broad, spruce-lined valleys, some of these lower-level mountains are steep and rugged, while others are rounded and gradual.

The variety of unaltered habitats supports a great diversity of high-interest arctic and subarctic wildlife, including whales, seals, polar and brown bears, wolves, wolverines,



muskoxen, moose, Dall's sheep, and wide-ranging caribou. Most species of birds, mammals, and fish in the Refuge use this Wilderness for at least some portion of their life cycles. The many animal and plant species that live there are integral components of the area's ecology.

The purposes of the Wilderness Act are additional purposes of the designated Wilderness portion of the Refuge, specifically:

> *"Secure an enduring resource of wilderness; protect and preserve the wilderness character of areas within the National Wilderness Preservation System (NWPS); administer the NWPS for the use and enjoyment of the American people in a way that will leave these areas unimpaired for future use and enjoyment as wilderness; and gather and disseminate information regarding the use and enjoyment of wilderness areas."*

The designated Wilderness is administered in accordance with the Wilderness Act, the special provisions of ANILCA, and other laws and regulations governing management of the Refuge System. A primary purpose is to maintain the area's Wilderness character: the natural and scenic condition of the land, natural numbers and interactions of wildlife, and the integrity and freedom of ecological processes. Consistent with protection of Wilderness character, the area provides for a wide range of uses. It is regularly used for subsistence hunting and fishing by residents of Kaktovik and occasionally by Arctic Villagers. Scientists conduct investigations related to biology, ecology, geology, and climate change. In 2010, an estimated 720 visitors came seeking adventure and solitude through a variety of activities—river floating, backpacking, camping, mountain climbing, wildlife observation, hunting, and fishing.

4.2 Physical Environment

4.2.1 Landforms and Geology

Arctic Refuge lies across the spine of the Brooks Range Mountains in the northeast corner of Alaska. It spans roughly 200 mi north to south from the Beaufort Sea coast of the Arctic Ocean to the Porcupine and Chandalar River tributaries of the Yukon River. From east to west, the Refuge is 180 mi across at its maximum width between the U.S.–Canada border and the Sagavanirktok River drainage near the Dalton Highway (Map 4-2). Five ecoregions (Nowacki et al. 2001) encompass the Refuge in a roughly north-south direction (Map 4-3). Those ecoregions include the Beaufort Sea coastal plain, the Brooks Range Foothills, the Brooks Range Mountains, the Davidson Mountains, the Yukon–Old Crow Basin, and the North Ogilvie Mountains. The following descriptions of these ecoregions are taken primarily from Gallant et.al. (1995), Nowacki et.al. (2001), and the Alaska Division of Geological and Geophysical Surveys (1987).

4.2.1.1 Beaufort Sea Coastal Plain

This ecoregion is a smooth tree-less plain rising very gradually (slope gradients generally less than 1°) from the Arctic Ocean to the foothills of the Brooks Range, 590 feet/foot (ft) (180 meters [m]) above sea level. Locally, permafrost-related features mark the terrain surface-ice related features, such as extensive networks of ice-wedge polygons, oriented lakes, peat ridges, frost boils, and pingos (ice-cored hills) are common. The coastal plain in Arctic Refuge is relatively narrow, ranging from 2.5–25 mi (4–40 km) in width. In contrast, this ecoregion is over 100 mi (160 km) wide south of Barrow.

The coastal plain sediments are late-Quaternary deposits of marine, glacial-fluvial, alluvial, and aeolian origin. Siltstone and sandstone underlay the unconsolidated materials at depths of several to tens of meters. Much of the coastal plain is dominated by a series of large alluvial fans.

4.2.1.2 Brooks Range Foothills

In Arctic Refuge, the Brooks Range Foothills ecoregion consists of a narrow swath of rolling hills and plateaus that rises from the coastal plain on the north to the Brooks Range on the south. The hills and valleys of the ecoregion have better defined drainage patterns than those found in the coastal plain to the north, and have fewer lakes. This ecoregion is underlain by thick permafrost, and many ice-related surface features are present. Like the coastal plain, the northern portion of the Brooks Range Foothills are built from unconsolidated Quaternary materials of glacial, alluvial, and aeolian origin with several small exposures of sandstone, siltstone, and shale (Imm et al. 1993). Elevations are generally less than 2,000 ft (600 m) above sea level.

This ecoregion was free from Pleistocene glaciation (except for some areas directly north of the Brooks Range) but is underlain by thick permafrost. Many ice-related features are present, such as gelifluction lobes, ice-wedge polygons, stone stripes, and beaded stream drainages. Regional slope gradients generally vary from 0° to 5°, but may be steeper in some areas.

4.2.1.3 Brooks Range Mountains

The Brooks Range ecoregion represents the northernmost extension of the Rocky Mountains. The Brooks Range consists of a wide belt of mountain ranges that arc gently east to west across the Refuge. The long, central, northeast-trending crest of the Philip Smith Mountains forms the continental drainage divide where the range enters the Refuge from the southwest. In the north central portion of the Refuge, where the range bends east and southeast, the highest peaks of the Franklin, Romanzof, and British Mountains project up abruptly at the north front of the range (Alaska Division of Geological and Geophysical Surveys 1987). North of the Franklin Mountains are the Shublik Mountains, lying between the Canning and Sadlerochit rivers. The isolated Sadlerochit Mountains lie to the north of the Shublik Mountains.

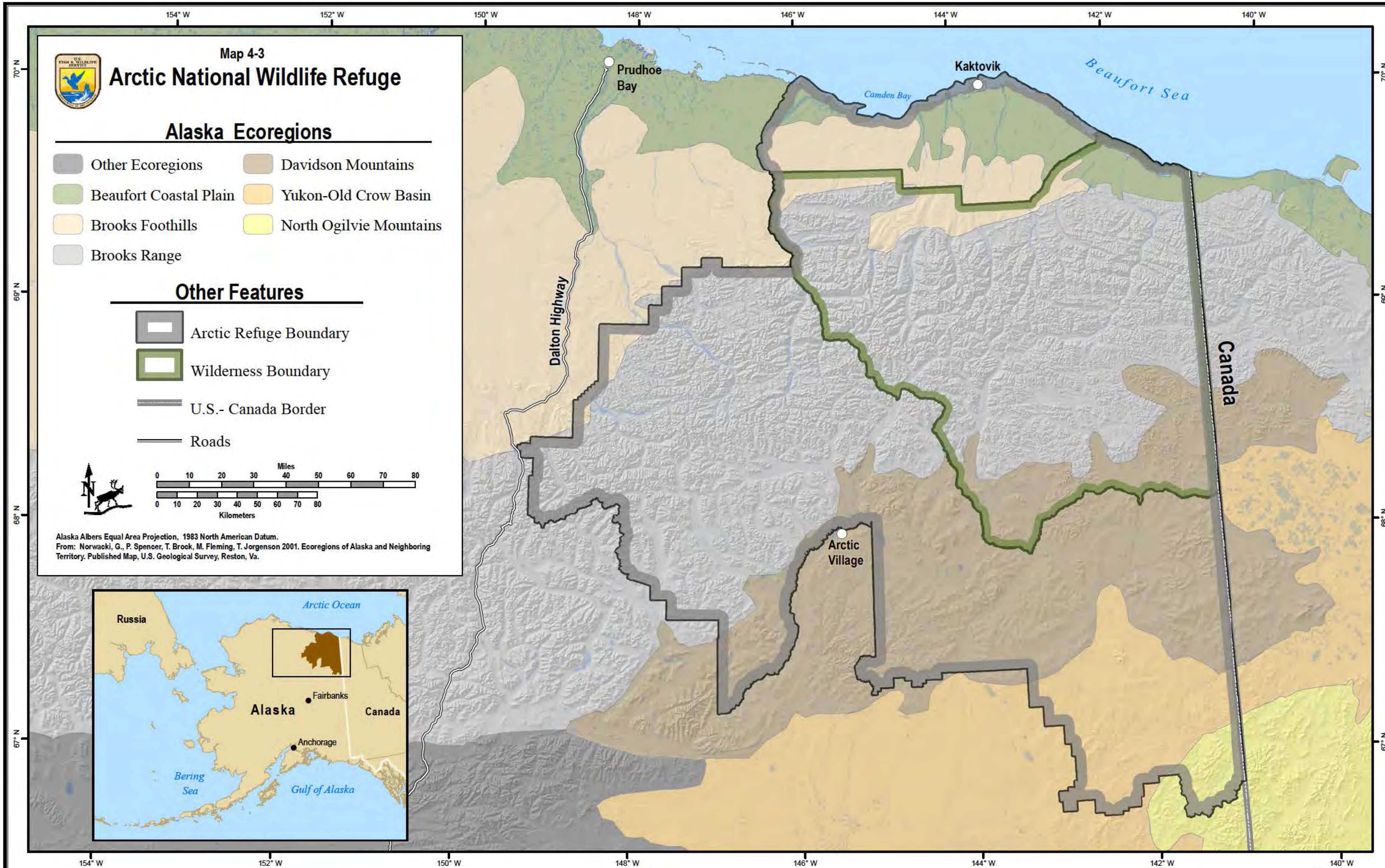
Topography throughout the Brooks Range is rugged, reflecting glaciation and differential erosion of tilted, folded, and faulted rock layers. Valleys are wide, steep sided and flat floored, cut by glaciers and then filled with alluvium. Mountain summits are generally from 4,000 to 6,000 ft (1,200 to 1,800 m) in the Philip Smith Mountains; 7,000 to 8,000 ft (2,100 to 2,400 m) in the Franklin Mountains; and 8,000 to 9,000 ft (2,400 to 2,700 m) in the Romanzof Mountains. The four highest peaks in the Brooks Range are in the Refuge in the Romanzof Mountains, the highest being 9,020-ft (2,760-m) Mount Chamberlin.

The bedrock underlying the Brooks Range consists of folded and faulted stratified Paleozoic and Mesozoic sedimentary deposits (including sandstone, shale, and limestone marine and nonmarine deposits, and some metamorphic rocks) that were uplifted during the Cretaceous period. Rubble and exposed bedrock cover the mountain slopes. The Sadlerochit and Shublik Mountains are mostly limestone, quartz, sandstone, dolomite, and a shale-quartz-chert sandstone conglomerate. In the Franklin and Romanzof Mountains, an east to west formation of schist lies to the north adjacent to a latitudinal chert and phillite formation. The oval Okpilak batholith spanning the Okpilak River on the north edge of the range is composed of course-grained granite. To the east, the British Mountains are latitudinal strips (north to south) of volcanic rock, calcareous siltstone and sandstone, and schist. Bathtub Ridge, south of British Mountains, is capped by lithic graywacke, and ringed with marine deposits of shale, siltstone, and sandstone. The remainder of the Brooks Range in the Refuge, including the Philip Smith Mountains, is primarily limestone with surface inclusions of quartzite, schist, sandstone, and shale (Imm et al. 1993).

This ecoregion was extensively glaciated during the Pleistocene epoch, but only small, scattered alpine glaciers persist above 6,000 ft (1,800 m) in the Franklin and Romanzof Mountains. Continuous, thick permafrost underlies the region.

4.2.1.4 Davidson Mountains

This ecoregion along the south flank of the Brooks Range consists of rugged mountains and steep, rounded ridges, dissected by broad floodplains of glacial origin. Elevations range from 1,600 ft (500 m) in the valleys to greater than 5,000 ft (1,500 m) on the peaks—with some peaks rising above 5,900 ft (1,800 m). Slope gradients are commonly within the range of 5° to 15°. Most of the ecoregion is overlain with unconsolidated (Quaternary) alluvial, colluvial, glacial and lacustrine deposits. Other geologic formations consists of volcanic rock (basalt), Lisburne Group Alapah limestone, Skagit limestone, a Kayak shale/Kanyut conglomerate/Noatak sandstone, Beaucoup formation of heterogeneous marine-deposited calcareous shale and


Map 4-3
Arctic National Wildlife Refuge
Alaska Ecoregions
Other Ecoregions
Beaufort Coastal Plain
Brooks Foothills
Brooks Range
Davidson Mountains
Yukon-Old Crow Basin
North Ogilvie Mountains
Other Features
Arctic Refuge Boundary
Wilderness Boundary
U.S.- Canada Border
Roads
Miles
0 10 20 30 40 50 60 70 80
Kilometers
0 10 20 30 40 50 60 70 80
Alaska Albers Equal Area Projection, 1983 North American Datum.
From: Norwacki, G., P. Spencer, T. Brock, M. Fleming, T. Jorgenson 2001. Ecoregions of Alaska and Neighboring Territory. Published Map, U.S. Geological Survey, Reston, Va.
Prudhoe Bay
Kaktovik
Camden Bay
Beaufort Sea
Dalton Highway
Canada
Arctic Village
Russia
Arctic Ocean
Alaska
Fairbanks
Anchorage
Canada
Bering Sea
Gulf of Alaska
154° W
152° W
150° W
148° W
146° W
144° W
142° W
140° W
70° N
69° N
68° N
67° N

sandstone, and exposed chert formations (Imm et al. 1993). Also in this ecoregion, close to the U.S.–Canada border, is the large Old Crow batholith composed of Balotite granite.

This ecoregion is underlain by continuous permafrost. Permafrost and frost-related ground features are evident, including low mounds, gelifluction lobes, frost boils, and stone stripes. Many of the peaks were glaciated during the Pleistocene epoch.

4.2.1.5 Yukon–Old Crow Basin

The Yukon–Old Crow Basin ecoregion abuts the Davidson Mountains in the southeast corner of the Refuge. This gently sloping basin along the Porcupine River is comprised of depositional fans, terraces, pediments, and mountain toeslopes that ring the Yukon and Old Crow Flats. The surfaces surrounding the flats are largely unglaciated and products of millions of years of weathering of the surrounding mountains. Here, deep deposits of colluvial, alluvial, and aeolian origin are underlain by continuous masses of permafrost. Active fluvial processes are etched throughout the topography featuring deltaic fans, terraces, and floodplains (Nowacki et al. 2001). Along with the unconsolidated deposits are inclusions of igneous rock (basalt and breccia) and formations of limestone, dolomite, and clay sedimentary and metamorphic rock (Imm et al. 1993).

4.2.1.6 North Ogilvie Mountains

The North Ogilvie Mountains primarily lie in the Yukon Territory but extend into the Southeast corner of the Refuge. This terrain consists of flat-topped hills and eroded remnants of a former plain (Nowacki et al. 2001). Sedimentary rocks of limestone and dolomite underlie most of the area along with small inclusions of basalt and quartzite sandstone (Imm et al. 1993). Unconsolidated deposits are only found in the narrow floodplains. Ridge tops and upper slopes are often barren with angular, frost-shattered rock outcrops surrounded by long scree slopes. These are characteristic of an unglaciated area that has undergone long periods of erosion (Nowacki et al. 2001).

4.2.1.7 Coastal Marine System

Although the coastal marine system was not designated separately by Nowacki et al. (2001), it deserves recognition here as a unique, functioning ecosystem because it holds important biological values for the Refuge. The coastal boundary of Arctic Refuge, defined as the line of extreme low water running along the coast and barrier islands from the U.S.–Canada border to Brownlow Point (Reed 2000), is 154 mi (247 km) in length and at a scale of 1:1000, there is approximately 593 mi (368 km) of inner shoreline (Brackney 2008). Sixteen bays and lagoons line Arctic Refuge coast and cover approximately 90,100 acres (ac) (365 km2) (Brackney 2008).

The Beaufort Sea coast is characterized by bays and inlets, lagoons with barrier islands, exposed peat bluffs, drained basins, and deltas. Jorgenson and Brown (2005) subdivided the Beaufort Sea coastline into segments by type and classified 266 mi (428 km) of Arctic Refuge shoreline, including spits and barrier islands, as follows:

- delta–72 mi (116 km), 27 percent
- exposed bluff–40 mi (64 km), 15 percent
- lagoon–154 mi (248 km), 58 percent

The lagoons are generally shallow with a maximum depth of 6.5–13 ft (2–4 m) and are wholly or partially sheltered by barrier islands. Bays and inlets may have spits across a portion of the mouth. Hachmeister and Vinelli (1984) classified eastern Beaufort Sea lagoons and bays as either open and exposed, limited exchange, or pulsing. Open and exposed habitats are bays or lagoons with little or no spit or barrier island protection from ocean wave action or nearshore water exchange. Limited exchange lagoons have partial barrier island protection, which restricts the flow of nearshore water. Pulsing lagoons have extensive barrier island protection with small narrow outlets and exhibit pulsing effects in water level due to tidal pumping. Traveling east from Barter Island, the coastline has a northeastern aspect, and the lagoons are all pulsing or limited exchange until you reach Demarcation Bay near the U.S.–Canada border. West of Barter Island, the coast has a primarily northwestern aspect, and the barrier islands are more fragmented across open and exposed lagoons and bays. With the exception of Kaktovik Lagoon, most lagoons are long and narrow with their long axis parallel to the shoreline.

Three modes of formation have likely generated the barrier islands: shoreward migration of existing beaches and barriers during the last sea level rise, lateral growth of spits and barriers, and stranding of the islands seaward of the coast as tundra is eroded (Morack and Rogers 1981, Naidu and Kelly 2002, Ruz et al. 1992, Short 1979). The islands are dynamic and migrating westward and landward due to wave action, currents, winds, and ice sediment deposition (Morack and Rogers 1981, Reimnitz et al. 1990). Major rivers may also be a primary source of sand and gravel to the islands with the sands deposited by westward littoral drift (Naidu and Kelly 2002). With the exception of Barter Island, remnant tundra islands are rare, and the majority of barrier islands along Arctic Refuge coast are composed of sand and gravel.

Shoreward of the barrier islands, the shoreline consists of eroding bluffs and complex embayments formed by the breaching of lakes and thermokarst basins through shoreline erosion (Ruz et al. 1992). Mean annual rates for the Beaufort Sea coast of Arctic Refuge estimated by Jorgenson and Brown (2005) varied from 3 feet of erosion per year to nearly 40 feet of accretion per year and depended on coastline type and lithology. The highest accretion rates were associated with deltas at the mouth of glacier-fed rivers.

4.2.1.8 Glaciers

The glaciations of the Pleistocene Epoch had large impacts on the landscapes of Alaska through the construction of outwash terraces, moraines, loess deposition, and erosion (Hamilton 1994, Hamilton and Porter 1975). The maximum extent of Pleistocene glaciations on Arctic Refuge covered the Philip Smith, Franklin, Romanzof, and British Mountains on both the north and south sides of the Brooks Range (Balascio et al. 2005a, Balascio et al. 2005b). Glaciers extended only short distances out into the foothills in some river valleys.

Today, glaciers are a small but important component of the Refuge landscape and have an important influence on downstream terrestrial and estuarine ecosystems (Nolan et al. 2011). Research on glaciers in the Refuge began with the International Polar Year in 1956. McCall Glacier, near Mt. Hubley, has the longest history of research of any U.S. Arctic glacier (Weller et al. 2007). The present day extent of the approximately 400 glaciers in Arctic Refuge is limited to several small areas in the Philip Smith Mountains and cirques and valley glaciers in the Romanzof Mountains. These glaciers covered over 140 mi^2 (360 km^2) in 1956 but have been losing mass at an increasing rate since the late 19th century (Nolan et al. 2005). Most will

likely vanish within the next 50 years (Nolan et al. 2011). McCall Glacier has retreated more than 2,600 ft (800 m) since the late 1800s (Nolan et al. 2005).

Currently, glacier melt water contributes considerably to the mid-late summer flow of several North Slope rivers, particularly the Hulahula, Jago, and Okpilak. This consistent flow benefits stream habitat for anadromous Dolly Varden (*Salvelinus malma*) fish populations and enhances the marine food web by increasing organic matter transport to estuarine ecosystems (Nolan et al. 2011). The freshwater and silts transported to the deltas from glacial melt maintains freshwater invertebrate populations that shorebirds rely on as a post-breeding food source. Reliable food sources are critical for these birds during the post-breeding period when they must put on sufficient fat reserves for long distance migration.

4.2.2 Climate

The climatic conditions of the Refuge mirror its diverse geographic features and latitudes. The mean annual temperature is below freezing in all parts of the Refuge and decreases to the north. The amounts of rain and snowfall are directly related to topography; high mountains receive the greatest amounts of precipitation, and lowland areas receive the least. There is a trend toward increasing continental and diminishing maritime influence with distance from the coast. Thus, temperature ranges and extremes tend to be greater inland.

Table 4-2 shows climate summaries for weather stations near Arctic Refuge. Stations are listed in order from the north coast across the Brooks Range to the interior boreal forest.

Table 4-2. Average temperature, precipitation, snowfall, and snow depth. These data are from long-term climate stations near Arctic Refuge, in order from north to south[a].

	Barter Island	Kuparuk	Toolik Lake	Atigun Pass	Arctic Village	Old Crow	Bettles	Fort Yukon
Temperatures (°Fahrenheit) at Weather Stations								
January	-14	-17	-10	-5	-23	-24	-12	-19
February	-20	-18	-6	0	-18	-18	-8	-14
March	-16	-15	-5	-2	-2	-7	3	2
April	-1	1	9	13	14	12	21	22
May	21	23	30	30	38	37	43	44
June	34	40	48	41	54	54	58	59
July	40	47	53	44	58	58	59	62
August	39	44	46	38	49	52	53	56
September	32	34	32	26	32	38	41	41
October	15	16	11	10	11	15	19	20
November	-1	-3	-2	2	-11	-10	-1	-6
December	-12	-11	-8	-1	-12	-17	-9	-17
Avg. Annual Temp.	10	12	24	16	16	16	22	21
Annual Precipitation (inches)								
Total[b]	6	4	-[c]	24	9	11	14	7
Snowfall	42	32	-	-	49	51	83	42
Snow Depth	7	5	-	26	9	-	13	9
Station Information								
Station Elevation	30 ft	67 ft	2,362 ft	4,643 ft	2,085 ft	824 ft	630 ft	427 ft
Dates	1949-1988	1983-2009	1989-2007	1992-2009 [d]	1962-1996	1971-2000	1951-2009	1938-1990

[a] Data from Western Climate Data Center, Natural Resource Conservation Service, Toolik Lake Research Station, and Canadian Weather Service.

[b] Total precipitation per year is sum of rain and snow water equivalent.

[c] - = missing

[d] 2008-2010 for snow depth at Atigun Pass

No long-term weather stations exist in the Refuge, but temperatures for different ecoregions of the Refuge can be estimated using the PRISM climate model for Alaska (Table 4-3). This model uses data from weather stations (1961–1990) and a topographic model to estimate temperatures in areas with no weather stations (PRISM Climate Group 2008). Temperatures decrease in the northward direction. South of the Brooks Range the mean annual air temperature averages 20-23 °F. It decreases to 13 °F in the Brooks Range, 12 °F in the northern foothills, and 10 °F on the coastal plain.

Table 4-3. Average temperatures in Arctic Refuge ecoregions. Average temperatures (°F) in six ecoregions of Arctic Refuge, based on data from weather stations near the Refuge and a model that included topographic data (PRISM Climate Group 2008).

Area	Average Temperatures (°Fahrenheit)		
	Annual	February	July
Arctic Refuge	15	-11	50
Beaufort Coastal Plain	10	-19	45
Brooks Range Foothills	12	-17	48
Brooks Range	13	-16	48
Davidson Mountains	20	-10	55
Yukon–Old Crow Basin	21	-8	60
North Ogilvie Mountains	23	-3	57

4.2.2.1 North Slope

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

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

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

Therefore, available soil moisture is considerably greater than the low annual precipitation would produce in a more temperate climate, and soils are usually saturated during summer.

Surface winds along the Arctic coast average 9 to 15 miles per hour (mph), with occasional intense storms generating winds exceeding 70 mph. Winds are predominantly from the northeast, although the strongest winds come from the west. September and October are the windiest months on the coast, probably due to maximum amounts of open water (Wendler et al. 2010).

4.2.2.2 Brooks Range

The climate of the Brooks Range is classified as continental subarctic: a climate dominated by a long, bitterly cold winter season with short, clear days, relatively low humidity, and relatively little precipitation. In the large mountain valleys, the growing season is longer than north of Brooks Range, and summer temperatures are warmer. Based on weather stations near the Refuge, mean July temperatures in the valleys range from 50° to 58 °F. January is the coldest month, with mean temperatures mainly between -12° and -15 °F, similar to the coastal plain. Annual precipitation, snowfall, and snow depth exceed that of the coastal plain and are greater in the south-side valleys than in the north-side valleys. Steep slopes with enhanced drainage and higher evapotranspiration from warmer summers combine to create much drier habitats for plants than those found on the coastal plain.

4.2.2.3 South of Brooks Range

South of the Brooks Range, the Refuge climate is continental subarctic, with extreme temperatures during winter and summer. The distance of the eastern Brooks Range from the open ocean tends to prevent the inland movement of moist maritime air masses, causing the south side of the Refuge to be drier and warmer than similar topography further west towards the Bering Sea. Fort Yukon, about 60 mi south of the Refuge (with the closest official weather station) holds the State record high temperature of 100 °F and comes close to the record low of -75 °F. Because the southern part of the Refuge is at higher elevations than Fort Yukon, weather records from Bettles, approximately 120 miles west of the Refuge, are more representative of the interior Alaska part of the Refuge than Fort Yukon records. July temperatures in Bettles average 59 °F but can be very warm, with highs reaching above 80 °F. January temperatures average -12 °F, with lows periodically reaching -50 °F. Annual precipitation averages 14 in, half of which falls as summer rain; winter snow depths average 13 in.

4.2.3 Climate Change

4.2.3.1 Observed Temperature and Precipitation Trends

Climate analyses suggest that warming in the 20th century was greater than warming during any other century in the past 1,000 years, and the 1990s were likely the warmest decade in 1,000 years (Mann et al. 1999, Folland et al. 2001). The arctic climate has warmed rapidly during the past 50 years, with annual average temperatures increasing nearly twice as fast as the rest of the world (Arctic Climate Impact Assessment 2005). This polar amplification of warming is attributed to: (1) positive feedback effects of greater heat absorption, due to reduced snow and ice cover on land and sea, (2) larger fraction of energy going to warming rather than evaporation compared to the tropics, (3) shallower troposphere (lower atmosphere) and frequent temperature inversions, and (4) atmospheric and oceanic circulation. Compared to the rest of the circumpolar Arctic, northern Alaska, western Canada, and central Russia have experienced the most rapid warming.

Warming in Alaska rose sharply beginning in 1977, concurrent with large scale arctic atmosphere and ocean regime shifts (Parson et al. 2000). Despite considerable annual variation, the 50-year trend in mean annual temperature is positive, rising an average of 3.5 °F statewide between 1949 and 2005. Mean annual temperatures rose 3.6 °F at Barrow, on the arctic coast, and 4.1 °F at Bettles, in the interior boreal forest (Shulski and Wendler 2007). The greatest warming has occurred during winter and spring. Higher temperatures have caused earlier spring snow melt, reduced sea ice, widespread glacier retreat, insect outbreaks, and permafrost warming.

Annual precipitation in interior Alaska increased 30 percent between 1968 and 1990, with high year-to-year variability (Parson et al. 2000). Precipitation trends are not clear on the North Slope, in part because the difficulty of collecting rain and snow in windy sites makes historical precipitation data less reliable than temperature data. Based on the two best long-term time series on the North Slope (Barrow 1949–1996 and Barter Island 1949–1988), precipitation on the coastal plain declined slightly in the latter decades of the 20th century (Curtis et al. 1998). In contrast, a more recent time series from Kuparuk (near Prudhoe Bay, 1983–2009) shows slightly increasing precipitation over that period, again with great year-to-year variability (Western Climate Data Center). Two thirds of the summers between 1995 and 2006 had higher than average amounts of rain. Snow depth data are scant, but LANDSAT satellite images available since 1972 show a decreasing trend in mid-spring snow cover.

4.2.3.2 Projected Climate Change

Projections for future climate in Arctic Refuge are available from the Scenarios Network for Alaska Planning (SNAP) at the University of Alaska, Fairbanks (SNAP 2010). Projections are based on current and past climate data from weather stations near the Refuge, observed trends over the past 50 years at those stations, and models that extrapolate trends into the future based on atmospheric circulation models and topography.

SNAP climate change modeling projects a continued increase in temperature and precipitation for all regions of Arctic Refuge (Figure 4-1 and Table 4-4). Mean annual temperature is expected to increase at an average rate of about 1 °F per decade, to about 6 °F warmer than historical temperatures by 2040, and to 10 °F warmer by 2080. Most of this warming is expected to occur during winter (October–May) and will affect coastal areas more than inland areas, due to the influence of a longer marine ice-free period (Martin et al. 2009). Projected summer temperature increases are of a lesser magnitude and are more pronounced in inland areas.

Precipitation is expected to increase approximately 26 percent by 2040 and 40 percent by 2080. Most of this increase is expected to occur in winter, thereby contributing to a deeper snow pack. In summer and winter, precipitation will increase more on the coast and in the inland boreal forest than in the Brooks Range.

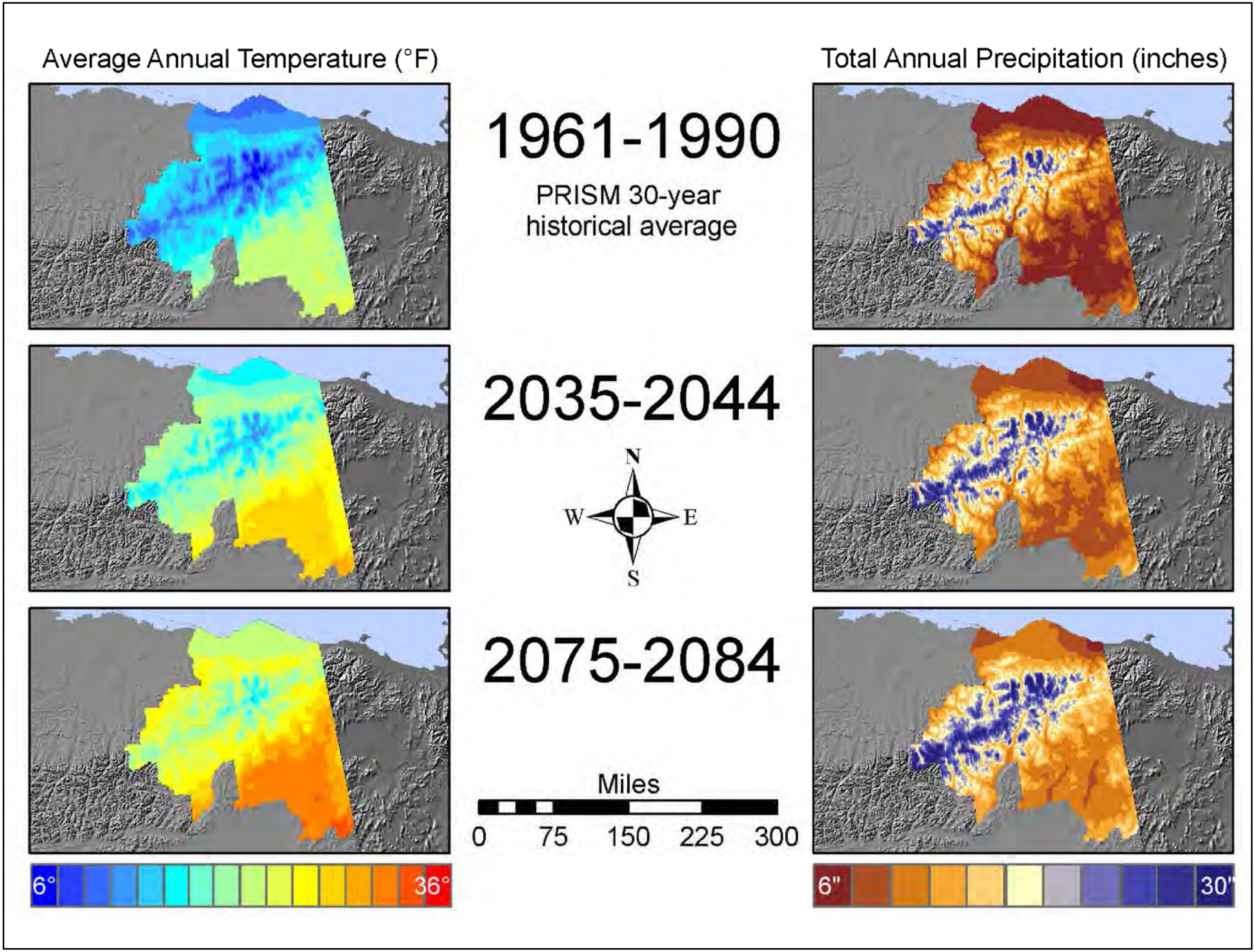
Table 4-4. Projected temperature and precipitation changes in the Refuge

Year	Season	Temperature (ºF)		Precipitation (inches)		
		Average	Change	Total	Change	% Increase over Historical
Historical	Annual	15.0		13.3		
2040		20.5	5.5	15.4	2.1	16%
2080		24.8	9.8	16.8	3.5	26%
Historical	Summer	41.6		8.4		
2040		44.1	2.5	9.4	1.0	12%
2080		46.8	5.2	9.9	1.5	18%
Historical	Winter	-4.0		4.9		
2040		3.6	7.6	6.0	1.1	23%
2080		9.0	13.0	6.9	2.0	40%

Based on climate modeling by Scenarios Network for Alaska Planning (2010). Table is from Loya et al. (2009).

Figure 4-1. Projected increases in temperature and precipitation in Arctic Refuge.

Projected future increases in temperature and precipitation in Arctic Refuge, based on climate models from Scenarios Network for Alaska Planning (2010). Figure is from Loya et al. 2009. This figure presents projections based on ‘moderate’ estimates of human-caused carbon dioxide emissions, including no increase of worldwide emissions over current levels.


Average Annual Temperature (°F)
Total Annual Precipitation (inches)
1961-1990
PRISM 30-year historical average
2035-2044
2075-2084
N
W
E
S
Miles
0
75
150
225
300
6°
36°
6"
30"

4.2.4 Air Quality

Currently, Arctic Refuge does not monitor or collect air quality data. Historically, because of minimal human-caused inputs, air pollution in the Refuge was thought to be low. Current known sources of air pollution in or near the Refuge include industrial developments (such as oil and gas development), villages, motorized traffic (snowmachines, automobiles, aircraft, motorboats, all-terrain vehicles), fires, and arctic haze. The Service is aware of increasing industrial activity in airsheds affecting the Refuge. Specifically, the Service is involved in National Environmental Policy Act (NEPA) reviews for onshore oil and gas exploration and production at the National Petroleum Reserve-Alaska, overseen by BLM, in reviews of offshore development now managed by the Bureau of Ocean Energy Management, and nearby air permitting activities that are under State of Alaska Department of Environmental Conservation's jurisdiction. Increasing off-Refuge industrial development is anticipated to generate more air pollution in the future, which may impact resources in Arctic Refuge. Preliminary modeling of air pollution emissions projected for new industrial development on Alaska's North Slope indicates it could impact the Refuge in sufficient concentrations to present an anthropogenic threat to fish, wildlife, and plants, and to the habitats and ecosystems in Arctic Refuge (M. Bond, Deputy Chief, Service's Branch of Air Quality, pers. comm.). For example, air pollution transported and deposited into Refuge watersheds may be a large factor affecting water quality and contaminant levels. Air pollution impacts can be intensified during temperature inversions: times when stagnant air masses reduce air mixing and trap pollutants near the ground. Poor visibility is an effect of air pollution during these periods. Air pollutants deposited in the Refuge through atmospheric deposition, primarily sulfur and nitrogen, can affect many ecosystem characteristics, including nutrient cycling and biological diversity.

Arctic haze has been defined as the occurrence each winter and spring of increased air pollution and decreased visibility over arctic regions arising primarily from human-derived emissions (Warneke et al. 2009). Chemical composition of the particles in haze has been used to identify that the primary sources of haze are emissions from Eurasia (Shaw 1982). Arctic haze has been linked to the same sources in Eurasia over the last 30 years. It has been observed that in recent years that there has been a reduced concentration of primary pollutants (Quinn et al. 2009). In 2008, several haze plumes were studied over northern Alaska (including Arctic Refuge). These plumes were determined to have originated from wildland fires in southern Siberia and agricultural fires in northern Kazakhstan. The plumes were transported to the Arctic and trapped in air masses ranging from ground level to more than four miles in altitude (Warneke et al. 2009). In addition to reduced air quality, these plumes deposited black carbon on the surface of snow and ice, which could potentially reduce surface albedo and increase melting events (Warneke et al. 2009).

4.2.5 Soils

Due to the cold, dry climate, the soils in Arctic Refuge are generally not well developed. Soil development is dependent upon underlying materials (such as bedrock, glacial moraine, sand) temperature, water regime, topography, and vegetation. Soil types have been generally described for the ecoregions of the Refuge (Rieger et al. 1979).

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

Soils in the rolling foothills area form on a variety of parent materials, ranging from very gravelly deposits on ridges and upper slopes to medium- and fine-grained materials in lower areas. Most soils of the long slopes and broad valleys of the foothills are poorly drained and form from silty and clayey materials. Well-drained, very gravelly soils with dark, non-acidic to slightly acidic upper layers occur locally. Peaty soils are found in valley bottoms; sandy soils, including windblown silt, occur in isolated dunes bordering major streams. Near-surface permafrost in the foothills is evidenced by widespread ice-related surface features. The highly erodible soils above the permafrost layer are stabilized by vegetation.

The Brooks Range consists mainly of very steep, exposed bedrock and coarse rubble surrounding alpine valleys and more gently sloping areas with shallow, very gravelly and stony soils. Steeper terrain has fewer, isolated bodies of gravelly and stony soils. Gravelly glacial till underlies large valleys, while glacial outwash deposits extend from the mouths of these valleys down into the foothills.

Soil types south of the Brooks Range vary considerably. Wet, loamy soils with a thick, overlying peat layer and a shallow permafrost table occur in lowlands along rivers. Peat deposits are found locally in these soils. Upland sites have better-drained soils. Hills and ridges of the southern slopes of the Brooks Range, Davidson Mountains, and Porcupine Plateau are underlain by well-drained, brown loams. Hillsides, slopes, and ridges bordering the Yukon Flats are underlain by moderately well-drained gravelly and stony loams.

4.2.6 Permafrost

Permafrost underlies most of Arctic Refuge. Permafrost is frozen earth material (soil, rock, ice, and organic material) that does not thaw in the summer and remains continuously frozen for at least two years. In areas with a mean annual air temperature at or below -21° to -18 °F, permafrost is continuous (Smith and Riseborough 2002), except in areas below the largest rivers and lakes, which do not freeze to the bottom in winter. Shallow lakes and rivers in this zone freeze to the bottom and are directly underlain by permafrost.

Most of Arctic Refuge falls in the zone of continuous permafrost. On the North Slope, permafrost thickness is generally in the range of 650–1,300 ft (Gold and Lachenbruch 1973). In the lowlands in the Porcupine River drainage in the southeastern part of the Refuge , flat areas are usually underlain by thick permafrost, the base of which may be over 1,000 ft deep (Ferrians 1965). In upland areas, permafrost is of variable thickness, up to depths of 600 ft.

In areas underlain by permafrost, the surface layer of soil that thaws during the summer and freezes again in winter is termed the active layer. Plant roots and burrowing animals can be found in this layer of soil. Soil texture and moisture are important in determining active layer depth. Gravelly soils tend to be well drained with deep active layers; organic-rich soils tend to be poorly drained with shallow active layers. The deepest active layers on the North Slope are in riverine tall willow shrublands with sandy soils.

The active layer is shallow north of the Brooks Range, ranging from less than 1 to 4 ft thick. Permafrost close to the ground surface maintains high soil moisture in the active layer. Without permafrost, which impedes water percolation into deeper layers, soil in the rooting zone of plants would be much drier. Thawing of permafrost would consequently have large effects on at least this portion of Arctic Refuge. South of the Brooks Range, the active layer may be more than 5 ft deep.

4.2.6.1 Observed and Projected Permafrost Trends

Permafrost provides a stable platform upon which arctic ecosystems have evolved. Disruption of this surface stability by thawing of ground ice is a threat to vegetation and human-built infrastructure, and aquatic and terrestrial ecosystems. Long-term monitoring of permafrost temperature profiles across northern Alaska shows a warming trend over the past 25 years (Osterkamp 2005). The greatest warming, 1.67 to 2.22 °F (3 to 4 °C), was detected near the coast; and warming decreased inland. Permafrost temperatures are also increasing in the northern portions of Arctic Refuge, warming 4 to 5 °F (2 to 3 °C) near Kaktovik between 1985 and 2004, and 3 to 4 °F (1.5 to 2 °C) between 1985 and 1998 on the coastal plain of Arctic Refuge (Osterkamp and Jorgenson 2006). Permafrost temperatures have been measured at a network of stations across the North Slope since the late 1970s; 2011 set new record high permafrost temperatures at all stations (Richter-Menge 2011).

Using climate projections, SNAP predicts that permafrost distribution in arctic Alaska will remain stable through the end of the century, as evidenced by a projected mean annual soil temperature below freezing. In contrast, permafrost south of the Brooks Range is at risk of melting. With increased temperatures, mean annual temperatures in the southern part of the Refuge will approach 32 °F, causing permafrost to warm and eventually disappear in this area of the Refuge (Osterkamp 2005). Given the warming permafrost already documented on the coastal plain of Arctic Refuge, permafrost could even disappear on some parts of the coastal plain in the next century (Osterkamp and Jorgenson 2006).

Thawing of ice-rich permafrost soils creates characteristic surface landforms, termed thermokarst features. Processes associated with thermokarst include thawing, ponding, surface and subsurface drainage, surface subsidence, and erosion (Lachenbruch 1962). Despite the relative stability projected for permafrost in arctic Alaska, recent observations suggest that warming summer air temperatures can accelerate thermokarst processes at mean annual ground temperatures well below freezing. Increased thawing of buried ice wedges has already been documented in study areas west of the Refuge (Jorgenson et al. 2006) and in the Refuge (Jorgenson unpublished data). This is probably associated with warm air temperature, which causes a deepening network of water-filled troughs and pits above the ice wedges and drying of adjacent areas. Based on the general distribution of ice-rich soils, surface changes of this type could potentially affect 10–30 percent of arctic lowland landscapes. In the near term, thermokarst processes, such as the degradation of ice wedges (affecting soil stability, local drainage, and vegetation), are the likely agents of habitat change rather than widespread deepening of the soil active layer or a shift to discontinuous permafrost (Martin et al. 2009).

Sensitivity of a permafrost-dominated landscapes to climate warming is greatly influenced by the quantity of ground ice contained in the soil. Hillsides are likely to be very sensitive to climate warming. The soils on mid- to lower slopes tend to be highly organic and saturated, with abundant ice wedges and segregated ice near the permafrost table. Thaw slumps are likely to become abundant on the sloping surfaces (Gooseff et al. 2009). Slumping will create new thaw lakes, expose new soil to plant colonization, and increase sediment transport in runoff. Gullies are likely to become common where water flows through ice wedge networks, causing the ground surface to collapse. The gullies then contribute to channelization of flow and drying of lakes and intervening ridges.

Landscapes underlain by extremely ice-rich silt (yedoma) are highly sensitive to warming and have the potential for drastic change. Yedoma along the lower Colville River, west of the Refuge, consists of only 3.3 ft (1 m) or less of soil, covering 33 to 82 ft (10 to 25 m) of ice. Yedoma is abundant across the lower Brooks Range foothills and may occupy roughly 20 percent of the overall foothills landscape on the North Slope (Carter 1988). It is also present south of the Brooks Range in unknown quantities.

As permafrost warms, its ability to support structures diminishes; this could affect potential industrial development on the Refuge, as well as infrastructure in nearby villages (Esch and Osterkamp 1990). Thicker gravel pads may be needed to support structures, and increased quantities of gravel may be needed to maintain roads above thawing ice wedges. If the climate continues to warm, there may be a shorter period each winter during which snow cover and frozen ground are adequate to support seismic and other exploration activities, and the potential for these activities to disturb vegetation and soil would increase (Jorgenson et al. 2010).

In addition to thawing caused by warming air temperatures, permafrost may also be impacted by wildland fires. After a fire, the change in surface conditions (e.g., removal of vegetation and organic soil) results in soil warming and increased active layer depths. The soil may no longer have a water table perched on top of permafrost and may become well-drained (Brabets et al. 2000).

4.2.7 Oil and Gas Occurrences and Potential

The U.S. Geological Survey's (USGS) most recent comprehensive assessment of undiscovered oil and gas resources in Arctic Refuge was published in 1999. The assessment encompassed the federally managed 1002 Area, Native corporation lands of the coastal plain, and the adjacent Beaufort Sea State waters. Other parts of the Refuge are already permanently off-limits to oil and gas exploration and were not assessed. Like all modern resource assessments, the USGS study dealt with the uncertainty of predicting undiscovered resources by adopting a probabilistic approach, using statistical distributions to capture the range of possible outcomes. USGS estimated that the entire assessment area contains between 5.7 and 16 billion barrels of technically recoverable oil, with a mean (expected value) of 10.4 billion barrels (Bird 1999, Schuenemeyer 1999). Technically recoverable non-associated natural gas (gas in reservoirs containing little or no oil) was estimated to range from 0 to 10.9 trillion cubic feet, with a mean of 3.8 trillion cubic feet. Most of this volume was ascribed to the Federal 1002 lands, with mean recoverable oil and gas estimated at 7.7 billion barrels and 3.5 trillion cubic feet (Bird 1999). Although these estimates were developed using all the available data and standardized assessment methods, they are inherently speculative in nature, since the resources remain undiscovered. Their accuracy can only be determined by systematic exploration of the subsurface—in other words, by drilling test wells.

4.2.7.1 Distribution of Oil and Gas

Undiscovered resources are expected to be distributed unevenly beneath the coastal plain. Of the expected-case recoverable oil volume of 10.4 billion barrels in the assessment area, 74 percent (7.7 billion barrels) is thought to lie beneath Federal lands of the 1002 Area (See Section 4.1.1; Map 4-1). Within the 1002 Area, 83 percent of the expected oil (6.4 billion barrels) is assessed in the northwestern one-third of the coastal plain, where the sedimentary rocks that are likely to host petroleum systems have remained nearly undeformed since their deposition (Schuenemeyer 1999). Several intervals of the stratigraphic succession are prospective as exploration plays, but about two-thirds of the oil resource is predicted to occur in just one of them—the topset play (Schuenemeyer 1999). Topset reservoirs would consist of sandstones and conglomerates deposited in river channels and deltaic settings on the ancient coastal plain and shoreline north of the growing Brooks Range.

The remaining two-thirds of the 1002 Area to the southeast is expected to contain a much smaller share of the recoverable oil (1.3 billion barrels, or 17 percent of the 1002 Area's mean estimate) (Schuenemeyer 1999). There, sedimentary formations were strongly deformed by the folding and faulting that uplifted the mountain ranges just to the south. The more recent episodes of this deformation occurred after the initial stages of hydrocarbon generation and migration in the area, and much of the early-generated oil may have migrated through the area without encountering traps. Furthermore, some may have been detained in early-formed structures and stratigraphic traps, perhaps to be spilled as those traps were disrupted by younger deformation. In any case, the thermal history of the rocks in the deformed part of the coastal plain makes it more prospective for natural gas than for oil. Most of the resources in the deformed area are thought to be structurally trapped in reservoir rocks deposited from erosion of the ancestral Brooks Range.

4.2.7.2 Number and Size of Expected Fields

The USGS assessment provides statistics regarding the size and distribution of oil and gas fields (Bird 1999, Schuenemeyer 1999). It estimates as many as 30 technically producible oil accumulations in the undeformed area, ranging in size from 10 or 20 million barrels up to one or two billion barrel “giant fields.” Most are thought to be in the 50- to 250-million-barrel range, and most of the resource is likely to be in fields larger than about 100 million barrels. The deformed area is likely to contain only three to five oil fields, with most of the recoverable resource in reservoirs between 250 million and 2 billion barrels in size (Bird 1999). The statistical distributions for number and size of gas fields are more difficult to translate into plain language but indicate that most of the assessed recoverable non-associated gas is likely to occur in as few as one or two major fields (Schuenemeyer 1999).

4.2.7.3 Economically Recoverable Volumes

The fraction of technically recoverable oil and gas that would be economic to produce depends on numerous factors, including market prices, the sizes of the fields, their locations relative to infrastructure, and environmental restrictions. According to USGS predictions of accumulation sizes, at least 80 percent of the anticipated technically recoverable oil would exist in fields larger than about 100 million barrels. More than 60 percent of the recoverable oil resource may lie in accumulations larger than about 260 million barrels. Most discoveries of this magnitude have now been developed in other areas of the onshore North Slope. Depending on the economic factors cited previously, many of them, particularly those greater than 500 million barrels, would likely be viable for near-term development in Arctic Refuge.

In a 2005 economic update to the 1998 resource assessment, the USGS developed full-cycle cost functions that predict the volume of oil that is economically recoverable at a given market price (Attanasi 2005). The functions are based on a host of assumptions, the uncertainties of which are not readily quantified. Some assumptions seem to be common sense and easily justified; for example, development would use highly efficient horizontal production wells and large fields would shoulder the economic burden during initial stages of development, with clusters of smaller nearby accumulations (satellites) becoming economical to develop later. Other assumptions pose greater uncertainty. For example, due to the current absence of a gas pipeline, gas resources were assigned zero value in the 2005 analysis. It is widely considered that North Slope gas will eventually be brought to market, and the economic impacts of developing gas fields along with the oil could be significant. In any case, among the economic assessment’s key findings were that at $30 per barrel, 73 to 82 percent of the technically recoverable oil in the study area could be economically discovered, developed, produced, and transported to market. This fraction was estimated to increase to more than 92 percent at prices of $55 per barrel. Based on the mean estimate of 7.7 billion barrels of technically recoverable oil in the federally-administered 1002 Area, these percentages translate to approximately 5.6 to 7.1 billion barrels of economically recoverable oil. Although potentially distributed in dozens of accumulations, these volumes are the equivalents of 1.5 to 2.0 times the total oil recoverable from the Kuparuk River field, or about 30–50 percent that of the greater Prudhoe Bay Unit.

4.2.8 Minerals

Geologically, the Refuge is part of the Arctic composite terrain that extends across the Alaska-Canada border into the Yukon Territory. Portions of the areas represented by the following USGS topographic maps, with mineral information, are located in the Refuge: Arctic, Christian, Chandalar, Coleen, and Philip Smith Mountains. Prior to ANILCA, the USGS and previous U.S. Bureau of Mines conducted limited reconnaissance geological and mineral investigations in the 1970s in northeast Alaska. Limited mineral industry work was also conducted in the 1970s.

The following text includes: (1) summary descriptions of mineral prospects in the areas of the topographic maps, summarized by the USGS and U.S. Bureau of Mines in the Alaska Resource Data File records; and (2) summary descriptions of mineral deposit model types, of which the prospects may be indicative.

Arctic: Numerous prospects consist of stratiform copper and iron sulfide minerals situated in sedimentary shale units, as well as a volcanic tuff unit, that are indicative of sedimentary hydrothermal deposits such as the Zambian Copper Belt in Africa.

Christian: Several prospects consisting of stratiform chromite associated with ultramafic rocks that are indicative of stratigraphic deposition of iron and magnesium in the basal melt of ultramafic magmatic rocks such as the Stillwater Complex in Montana and the Muskox Complex in Nunavut (northern Canada). One copper prospect that is indicative of sedimentary hydrothermal deposits is also present.

Chandalar: A considerable prospect consisting of strata bound copper and zinc associated with sedimentary shale and meta-clastic rocks overlain by limestone. Several hundred mining claims were located on this prospect in the late 1970s, in which three years of mineral exploration were conducted. The claims were dropped upon creation of Arctic Refuge.

Coleen: Numerous prospects containing uranium, as well as lead, tin, and molybdenum, in association with felsic intrusive vein systems of the Old Crow batholith. Several prospects consisting of barite beds or lenses. Several prospects consisting of poly metallic vein deposits and hornfelsed zones containing copper, lead, and zinc derived from felsic volcanic dikes intruding meta-sedimentary host rocks such as argillite and phyllite. The Old Crow plutonic batholith in this quadrangle is unique in that differentiation has produced uranium, tin, tungsten, silver, and gold mineralization in the form of skarn, replacement and vein mineralization as well as porphyry copper and gold mineralization in the pluton.

Philip Smith: Numerous prospects of veins containing copper sulfides cutting carbonate host rocks. Numerous prospects of quartz veins containing highly anomalous amounts of lead, zinc and copper sulfides in chert breccia caps overlying limestone. Prior to creation of Arctic Refuge, mining industry claims covered many of these prospects. These deposits are classified as Mississippi Valley Type deposits and are the sites of several mines in the world. Numerous fluorite prospects are prevalent in the quadrangle in thick veins and replacement crystals associated with volcanic rocks and underlying carbonates. The Philip Smith Mountains also contain numerous phosphate deposits. These deposits are contained in black, calcareous siltstones and shale’s. Some uranium is associated with the phosphate.

4.2.9 Water Resources

The Continental Divide, which arcs along the crest of the Brooks Range, partitions the Refuge hydrologically. All waters on the North Slope of the range flow to the Beaufort Sea. Waters on the South Slope of the divide flow into tributaries of the Yukon River drainage and eventually to the Bering Sea. Nearly the entire Refuge is underlain by continuous permafrost, which limits infiltration of surface water and maintains a high ratio of water storage at the surface relative to that in soils. The distribution of permafrost and depth of the active layer have a strong influence on surface water balance. Potential threats to water resources on Arctic Refuge include climate change, local and global contaminants, and invasive species, as well as off-Refuge threats such as oil and gas development, transportation system impacts, and gravel and mineral extraction.

Data on the Refuge's water resources are temporally and spatially limited. Long-term (greater than five years) data do not exist, and most short-term data were collected on the North Slope in the 1002 Area over two decades ago. Data from mountain headwater streams are particularly rare. Collection of critical ancillary data, such as air temperature, precipitation, radiation, loss of glaciers, and characteristics of vegetation and permafrost, has also been limited and for the most part has not been coordinated with water resource data collection efforts. This lack of coordination limits the interpretation and applicability of existing water resource data. Extending the period of record for existing water resource datasets, collecting data at additional sites, such as headwater streams in contributing watersheds, and coordinating efforts with other physical, chemical, and biological monitoring will improve our understanding of the functioning of aquatic ecosystems and our ability to detect, predict, and prepare for impacts of local and global stressors in the Refuge (Zhang et al. 2000, Vörösmarty et al. 2001, Martin et al. 2009, North Slope Science Initiative 2009).

4.2.9.1 North Slope

Relative to the rest of the North Slope of Alaska, the Refuge has a high density (20,600 mi) of streams and rivers (Brackney 2008). Most major rivers originate in the Brooks Range, flow almost directly north into the Arctic Ocean, and have relatively few tributaries, while smaller streams and rivers contribute substantial volumes of water and sediment to coastal ecosystems.

Based on origin, hydrologic regimes, and chemical and biological characteristics, Craig and McCart (1975) classified North Slope streams and rivers into three categories: mountain, spring-fed, and tundra. Mountain streams are typically fast flowing and fed by varying proportions of snowmelt, glacier meltwater, and spring-fed tributaries. Waters are cold (usually less than 50 °F), occasionally turbid, moderately hard, and support low invertebrate densities. The most common species of fish in mountain streams is Dolly Varden. Spring-fed streams are often tributaries of mountain streams and have relatively stable flows and temperatures throughout the year. Spring-fed waters are characterized by low levels of dissolved solids and very high densities of macroinvertebrates. Many spring-fed streams provide critical spawning and overwintering habitat for Dolly Varden. Tundra streams originate in the Brooks Range Foothills and coastal plain ecoregions, are fed by surface runoff, tend to be meandering systems, and have low to moderate invertebrate densities. Waters are typically warmer and exhibit lower pH and conductivity relative to mountain and spring-fed streams. Huryn et al. (2004) found that gradients in freezing probability, nutrient concentrations, and substratum instability control invertebrate communities in these systems.

Most streams and rivers freeze in October or November and remain frozen until temperatures warm and break-up occurs in late May or early June (Lyons and Trawicki 1994). During late winter, unfrozen water provides critical habitat for fish in the Refuge (Craig 1989) and only exists downstream from springs (Childers et al. 1977, Craig 1989a), in deep pools or lakes (Trawicki et al. 1991, Lyons and Trawicki 1994), and below ice hummocks (Elliot and Lyons 1990, Lyons and Trawicki 1994). Downstream from spring-fed areas, overflow water freezes and forms aufeis which melts later than snow and can be a large temporary reservoir of freshwater (Kane and Slaughter 1973). Childers et al. (1977) reported that nearly contiguous fields of aufeis covered over one hundred miles from the upper reaches of the Canning River down to its delta.

Break-up in the Refuge typically begins in the Brooks Range and foothills and progresses toward the coast, causing snowmelt to flow over land and down ice-covered stream channels in the coastal plain (Lyons and Trawicki 1994). As much as 50 percent of the annual flow may occur during break-up (Clough et al. 1987, Lyons and Trawicki 1994). After break-up, streams and rivers are fed by a variety of sources, including precipitation, springs, and meltwater from aufeis and glaciers (Lyons and Trawicki 1994, Childers et al. 1997). Later in the summer season, infrequent precipitation events can lead to loss of instream connectivity, which can have negative impacts on fish migrating to critical overwintering habitat (Lyons and Trawicki 1994). Relative to the rest of the North Slope, glaciers (Nolan et al. 2011) and springs (Yoshikawa et al. 2007) contribute large volumes of water to a number of streams and rivers in the Refuge. In some systems, these more reliable sources of flow may help sustain flows during dry summers when precipitation events are infrequent.

The physiography of the Refuge and hydrologic and thermal regimes of this region have played an important role in shaping the Refuge's stream and riverine ecosystems and will continue to play an important role in determining their response to a changing climate. Most springs in Arctic Refuge have survived since the last glacial maximum (Yoshikawa et al. 2007), suggesting that they will continue to flow and be refugia for aquatic biota in a changing climate. In contrast, contributions from glaciers may disappear completely in the next 50 years (Nolan et al. 2011). In the Jago, Hulahula, and Okpilak watersheds, discharge from glacial sources is the dominant source of flow when precipitation is low and air temperatures are high.

When glacial discharge is high, runoff is turbid and transports large volumes of water, sediment, and nutrients to downstream ecosystems. Loss of glacial meltwater may alter downstream ecosystems and reduce instream connectivity, especially during dry summers. Deepening of the active layer, the extended duration of the summer season, and increased evapotranspiration rates will also influence surface water availability and instream connectivity. In the foothills, deepening of the active layer may lead to increased base flow at mid to lower elevation slopes (Martin et al. 2009). In the coastal plain, however, increased active layer depth will likely lower water tables and lead to an overall loss of water availability and instream connectivity at the surface. These effects may be exacerbated by increased evapotranspiration rates and the extended duration of the summer season.

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

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

Long-term data on water resources on the North Slope of the Refuge are limited. There are currently three gaging stations, all of which are along rivers in the 1002 Area. In the past, discharge data have been collected sporadically at several springs and major tributaries (Childers et al. 1973) and continuously over short time periods (less than five years) at a smaller number of sites in the 1002 Area (Lyons and Trawicki 1994) and at mountain headwaters streams.

4.2.9.2 The Refuge South of the Brooks Range

There are approximately 36,500 mi (58,000 km) of streams and 9,735 lakes covering more than 67,500 ac (27,315 ha) on the South Slope of Artic Refuge (Brackney 2008). The Chandalar and Porcupine rivers drain the entire South Slope and interior portion of the Refuge. The Porcupine River Basin is a major tributary of the Yukon, accounting for 20 percent of the drainage area and contributing nearly 10 percent of the flow to the Yukon River (Brabets et al. 2000). The headwaters of the Porcupine River flow from Old Crow Flats in Canada. Within the Refuge, the Salmon Trout River flows north from the Ogilvie Mountains, and the Sheenjek and Coleen rivers flow south from the Brooks Range and Davidson Mountains before draining into the Porcupine River. The east and middle forks of the Chandalar River drain the western reaches of the South Slope and the Davidson Mountains before joining to form the Chandalar River south of the Refuge and to the west of the Porcupine River. Prominent lakes on the South Slope include Big Fish Lake at 1,402 ac (560 ha), Vettekwi Lake at 846 ac (342 ha), and Grayling Lake at 565 ac (228 ha).

Spring snow melt typically progresses from the south to the north in late April through May on the South Slope. Due to differences in wind and snow pack, the highest mountain valleys on the South Slope may actually retain snow longer than the north-facing valleys on the North Slope. Very few stream gage or water quality data are available for South Slope streams or lakes. There are no continuous discharge records for headwater streams, but there are data for two large rivers. A long-term gaging station has been maintained by the Water Survey of Canada on the Porcupine River at the U.S.–Canada border, and a short-term station was run by the Service on the Sheenjek River just south of Arctic Refuge in 1993–1998 (Trawicki 2000).

Degradation of permafrost can have a large influence on water flow paths and export of sediment, organic matter, inorganic nutrients, and major ions to downstream ecosystems. The influence of permafrost degradation on these processes will depend largely on the type of permafrost degradation (deepening of the active layer, decrease in permafrost extent, or thermokarst failure). Permafrost in the Yukon River Basin is currently thawing (Hinzman et al. 2005, Jorgenson et al. 2006). With the exception of areas that lack an upper soil organic layer or are underlain by discontinuous permafrost (e.g., the Ogilvie Mountains), the depth of the active layer limits subsurface flow paths to the organic rich soil in the shallow active layer. As permafrost thaws and the active layer deepens, deeper flow paths through mineralized soils will form. As the potential for groundwater storage in the active layer increases, a shift from surface-water dominated flows to ground-water dominated flows may occur (Frey and McClelland 2009). The relative proportion of groundwater flow to the Porcupine River above Fort Yukon is less than 10 percent of mean annual surface flow (Walvoord and Striegl 2007). From 1968 to 2004, groundwater contributions to the Porcupine River increased by 56 percent while mean annual flow decreased by 18 percent. Increases in the relative contribution of groundwater may have resulted from active layer deepening. Deeper flow paths will likely result in changes in retention, processing, and export of organic matter, inorganic nutrients, and major ions. Concentrations of dissolved silica, phosphate, and nitrate may increase (Frey and McClelland 2009); however, the availability of dissolved organic matter may decrease due to adsorption to deep mineral soils (Frey and McClelland 2009, Walvoord and Striegl 2007).

In the future, a decrease in the overall extent of permafrost in the Refuge will likely occur. A decrease in the extent of permafrost may increase the relative importance of subpermafrost groundwater discharge and alter surface water chemistry (Frey and McCelland 2009, Walvoord and Striegl 2007). Increased groundwater flow may result in increased concentrations of dissolved inorganic carbon and decreased concentrations of dissolved organic carbon and dissolved organic nitrogen (Walvoord and Striegl 2007). The rate of thermokarst failures may be increasing in the Refuge. Thermokarst failures are more localized than active layer deepening and declines in permafrost extent, but can have large impacts on downstream sediment and nutrient loads.

Few physical and chemical data are available for streams and rivers in the Refuge, especially headwater streams. More intensive sampling has occurred outside Arctic Refuge in the lower basin of the Chandalar, Sheenjek, Porcupine, and Christian rivers (Dornblaser and Halm 2006). Water chemistry in these rivers is related to surficial geology, physiography, permafrost extent, and discharge. There is a linear relationship between flow and hydrologic yields of total nitrogen and total phosphorus in the Porcupine River, with half the annual export occurring during spring (Dornblaser and Striegl 2007). The Sheenjek River originates in the mountains, is underlain by continuous permafrost, and the lower basin has low concentrations of dissolved organic carbon and sediments (Dornblaser and Halm 2006). In contrast, the lower Christian River has higher dissolved organic matter concentrations. This river originates in the foothills of the Brooks Range where permafrost is continuous and then flows through the Yukon Flats where permafrost is discontinuous. Dornblaser and Halm (2006) reported higher alkalinity in the Sheenjek (123 mg/L as calcium carbonate) and Chandalar River (119 mg/L as calcium carbonate) compared to the Porcupine River above Fort Yukon (65 mg/L as calcium carbonate) or the nearby Yukon River at Circle (67 mg/L as calcium carbonate). This may reflect the predominance of limestone bedrock at the source of the Sheenjek and Chandalar. Total particulate mercury concentrations were generally lower in the Sheenjek, Christian, and Chandalar rivers in comparison to the Porcupine and Yukon River levels (Dornblaser and Halm 2006).

4.2.9.3 Coastal Marine System

Seasonal processes play a major role in the functioning of coastal ecosystems. With the coming of winter on the North Slope in late September or early October, lagoon waters begin to freeze over. Brackish lagoons begin freezing earlier than coastal waters, which tend to be more saline (Wiseman and Short 1976). Lagoon ice may be 6 ft (2 m) or more thick by April or May (Barry 1979). As the ice thickens, sub-ice water circulation is reduced, and waters may become highly saline (Truett 1980), pooling in the deeper portions of the lagoons and embayments. These brine pools remain until they are flushed out by the large influx of fresh water at break-up in late May or early June (Pollard and Segar 1994), or they may remain on the bottom and create stratified conditions (Hale 1991). Fresh water overflows the shore-fast ice and initiates the break-up of ice at river mouths and in lagoons as ice melt proceeds outward from the shore and river mouths (Truett 1980). On barrier-island protected coasts, flooding is confined to the lagoons (Short and Wiseman 1975), whereas in open coastal areas, the fresh water may flow many kilometers over and underneath the ice (Reimnitz and Bruder 1972). Coastal sea ice breaks up four to eight weeks after the initial melt (Short and Wiseman 1975).

The large spring discharge of relatively warm fresh water from rivers creates warm brackish water conditions near the coast (Hale 1991). Depending on the prevailing wind, magnitude of freshwater influx, coastal geometry, and exchange with marine waters, lagoons and bays can stratify in salinity and temperature with warm brackish water overlaying cold dense saline waters. In protected lagoons, surface temperatures may be as high as 50 °F (10 °C), and surface salinities may be as low as five parts per thousand. Offshore, ocean conditions are much colder and more saline at this time. As the open water season progresses, freshwater discharge from the rivers decreases, and combined with wind-driven mixing and upwelling of deep water, the strength of stratification of nearshore waters gradually erodes as salinities increase and temperatures decline (Pollard and Segar 1994, Hale 1991).

Tidal variations along the Beaufort Sea coast are small, with a diurnal range of 4–12 in (10-30 cm), and contribute little to the nearshore circulation. Circulation in the nearshore regions is driven primarily by winds, with currents responding quickly to changes in wind direction. Along the Arctic Refuge coastline, the prevailing summer winds are from the east, causing a general westward nearshore circulation and offshore movement of water and ice seaward of the barrier islands. Strong west winds occur periodically and tend to cause onshore movement. Summer and fall storms may cause upwelling and movement of marine waters into the nearshore environment and can lead to considerable changes in local sea level (Kowalik 1984). Surges of cold, saline marine water associated with these upwellings can contribute to destratification of nearshore waters, increasing salinity and decreasing temperature in the nearshore environment (Hale 1991). Open bays tend to take on ocean conditions and, if stratified, pulsing lagoons may become mixed during ocean upwelling events. Bays and lagoons may become more estuarine in nature if nearshore currents and influx of freshwater are sufficient to restore the warm brackish nearshore band. Large ocean upwelling events can affect terrestrial environments as well. In 1970, a storm surge caused by gale-force westerly winds inundated low-lying tundra on the coastal plain as far as 3.1 mi (5,000 m) inland and 11 ft (3.4 m) above sea level (Reimnitz and Mauer 1979). The driftwood line from that event is still noticeable.

Substantial increases in air temperature and storm frequency, combined with decreases in summer sea ice in recent decades, have increased erosion along the southern Beaufort Sea coastline in recent decades (Wendler et al. 2010). Recent concern about alterations to the carbon cycle brought about by climate warming (McGuire et al. 2009) has brought attention to increased shoreline erosion and the input of carbon into the Arctic Ocean. Estimates of soil organic carbon inputs from the Arctic Refuge shoreline average 6,254 metric tons annually, about 3.5 percent of the total input along the Beaufort Sea coastline (Jorgenson and Brown 2005).

4.2.10 Soundscape

A soundscape refers to the entire acoustic environment of an area, including natural quiet, natural sounds, and human-caused sounds. Natural quiet and natural sounds are intrinsic elements of the Wilderness character of designated Wilderness and the wilderness characteristics of the entire Refuge. As such, their perpetuation is important for meeting the Refuge's purposes, goals, objectives, and special values. Human-caused sounds may mask or obscure natural sounds and disrupt wildlife behavior. They may interfere with locating prey or detecting predators, or with the complex communication systems many species have evolved to assist in mating or other behaviors. As well, human-caused sound interferes with the sense of solitude that is important to many visitors. Currently, aircraft used to transport visitors and Service personnel and cooperators are the most frequent source of human-caused sound on the Refuge.

The Refuge's soundscape was documented in a single study in 2010. This study was conducted in conjunction with the proposed Point Thomson Development Project (U.S. Army Corps of Engineers 2011). The study used basic acoustical concepts and methodologies developed through coordination with the Army Corps of engineers, the National Marine Fisheries Service, North Slope Borough, NPS, and the Service to measure existing sound levels and establish baseline conditions at six locations adjacent to the northwestern border of the Refuge during winter and summer 2010. It also included an analysis of potential project-related noise levels for five alternative development scenarios. The ambient soundscape in the project area was influenced by both human and natural sound sources. The four soundscapes in the noise study area (upland coastal plain, upland coastal plain near surface water features, offshore island, and coastal shoreline) varied in overall noise level, distribution of noise throughout the day, range of noise levels dependent on local fauna, and frequency of human-created noise events.

Natural ambient sound levels along the northwestern boundary of the Refuge are low, and natural sounds dominate the environment during both winter and summer. These sounds include atmospheric/meteorological phenomena, water features, and insects and other animals. Noise from human activities is largely absent from the Refuge's ambient soundscape. Non-natural audible events included infrequent aircraft overflights. Generally, natural noise levels were greater in the summer season due to the influence of water features such as the Canning River. Natural ambient noise levels at the Canning River (upland coastal plain near surface water features), upland coastal plain, and coastal shoreline monitoring locations were reported to be "lower than typical residential noise environments and comparable to an unoccupied building."

During the study, industrial activities were present and quantified at sites 2.5 to 8 mi west of the Refuge (Mary Sacks and Flaxman Islands) and 2.5 to 8 mi from existing developments. Human-caused noises included aircraft overflights and other industrial noises associated with oil- production. Sound intensity ranged from 20 to 50 dBA (A-weighted decibel). During selective audio review, these human-caused noises were audible "between 0 and 100 percent of any particular hour"; however, at these distances ambient conditions were still quiet by most standards, equal to "an unoccupied room or a very quiet room at night."

These data are thought to be representative of the range of natural conditions found in the northwest corner of the Refuge. Other areas of the Refuge (away from water features and the windy coastline) would be expected to be even quieter, with a predominance of natural sounds coming from wildlife and insects. Human caused noise from aircraft would be highest along well-used river corridors, for example along the Kongakut River, and in areas used as flight paths to common landing areas.

4.3 Biological Environment

4.3.1 Land Cover and Vegetation

Arctic Refuge contains a unique juxtaposition of ecosystems compared to the rest of northern Alaska. The southern portions of the Refuge border the Yukon Flats, which have the highest summer temperatures in Alaska. In contrast, the northern portion of the Refuge, along the Beaufort Sea, experiences some of the coldest summer temperatures. Because of the northeasterly sweep of the Brooks Range, the coastal plain in the Refuge is much narrower than it is further west. The highest summits of the range are in close proximity to the coast.

North of the Brooks Range, the coastal plain and Brooks Range Foothills ecoregions are treeless tundra, composed mainly of hardy dwarf shrubs, sedges, and mosses. Habitats on the North Slope can be grouped into four broad categories: coastal lagoons, lowland wet tundra and lakes, upland moist tundra, and river floodplains with willow shrub thickets.

In the Brooks Range Mountains ecoregion, barren rock and sparse, dry alpine tundra predominate. Mountain valleys contain moist tundra and areas of shrub willow thickets. Along rivers south of the mountains, the biological environment is more complex. Spruce forests predominate in the lowlands of the Yukon–Old Crow Basin ecoregion, and spruce woodlands extend far into valleys of the Davidson Mountains ecoregion. Open tundra is present throughout the area and covers vast expanses of uplands in the Davidson Mountains. Dense shrub thickets occur on floodplains, near tree line, and on glacial moraines. Treeless bogs are found mostly along major river floodplains.

There is a strong contrast between vegetation on north- and south-facing slopes due to effects of the sun's low angle at these latitudes. Vegetation also varies depending on soil characteristics, such as texture, moisture content, and bedrock type (particularly whether or not the parent material of the bedrock is acidic).

Broad land cover classes (i.e., vegetation types) can be mapped using satellite images. Map 4-4 provides a map of land cover classes in the Refuge, as mapped by the National Land Cover Database (Homer et al. 2004). This map was developed from classifications of Landsat-7 satellite images.

Table 4-5 provides estimates of the area of the Refuge covered by each land cover class. These estimates are based on the National Land Cover Database map for the Brooks Range and interior ecoregions (Homer et al. 2004) and on systematic field sampling of vegetation types for the coastal plain and northern foothills ecoregions (Jorgenson et al. 1994).

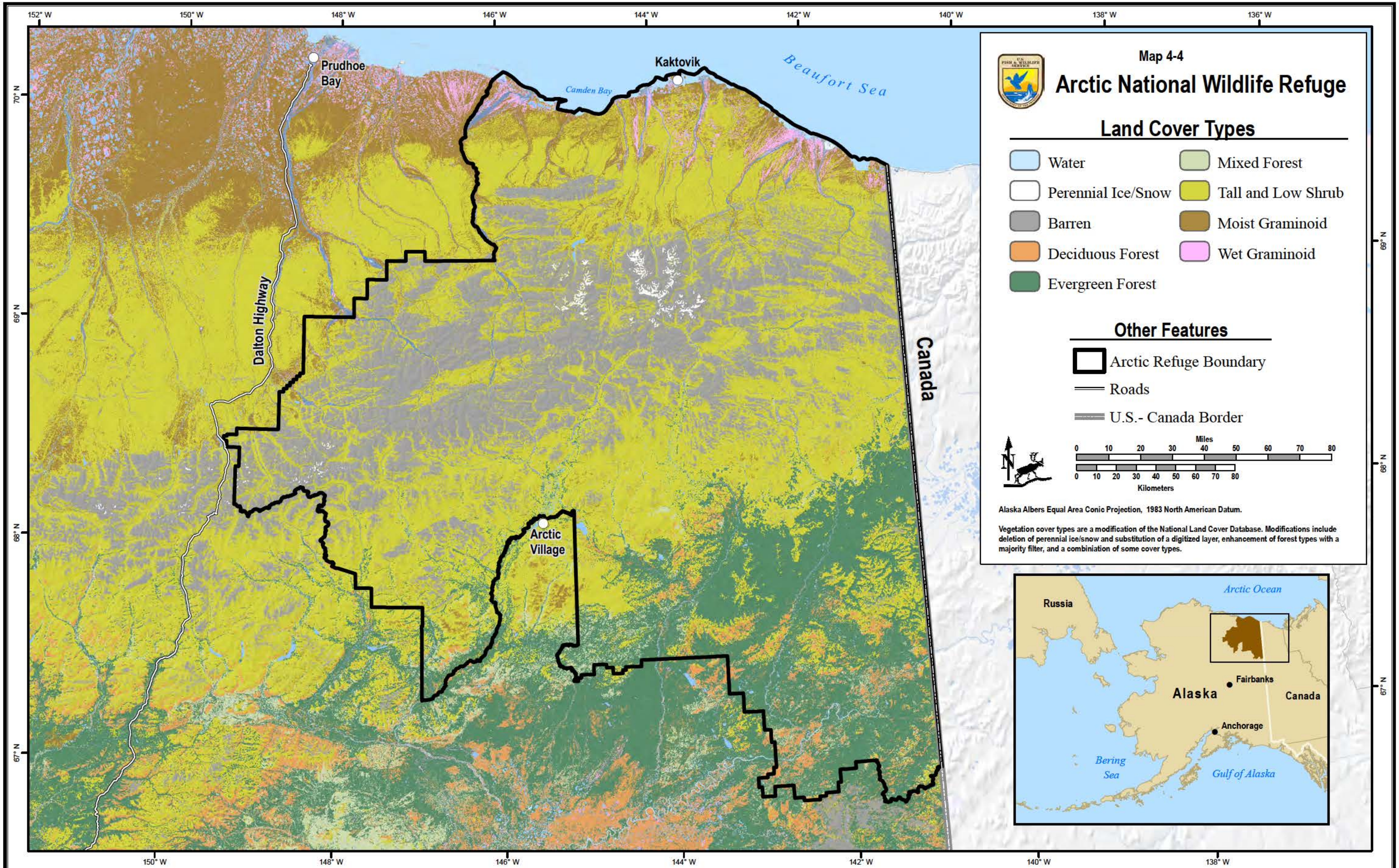
Table 4-5. Land cover classes of Arctic Refuge. Land cover types of Arctic Refuge are based on the National Land Cover Database for most of the Refuge (Homer et al. 2004) and systematic sampling of vegetation types on the North Slope of the Refuge (Jorgenson et al. 1994).

Land Cover Class	% of Refuge	Acres
Forest:		
Evergreen Forest	12	2,376,901
Deciduous Forest	1	242,070
Mixed Forest	1	219,270
Shrub:		
Tall and Low Shrub	22	4,435,104
Dwarf Shrub	25	4,762,434
Herbaceous:		
Moist Graminoid	9	1,487,782
Wet Graminoid	2	494,410
Other:		
Barren or Sparsely Vegetated	26	5,138,892
Ice	1	250,134
Water	1	244,372

The vegetation types listed in the following text can be nested in the mapped land cover classes listed in Table 4-5 and provide more detailed information than can be mapped accurately with Landsat images. Vegetation types are based on the Alaska Vegetation Classification (Viereck et al. 1992), which is a hierarchical classification system that divides vegetation first into three broad categories (forest, shrub, and herbaceous) and then into finer subdivisions to arrive at the vegetation type. The following paragraphs describe the main vegetation types that apply to Arctic Refuge vegetation and list some of the dominant plant species in each. Species are listed in the approximate order of dominance in each class.

4.3.1.1 Forests

Spruce, deciduous, or mixed spruce/deciduous forests cover about 14 percent of the Refuge. The majority of these are white and black spruce forests (*Picea glauca* and *P. mariana*). These spruce forests occur only on the south side of the Brooks Range, though a northward extension along the Canadian border exists on tributaries of the north-flowing Firth River. Though much less common than spruce, deciduous forests comprised of balsam poplar (*P. balsamifera*) occur farther north in the Brooks Range than spruce.



Map 4-4
Arctic National Wildlife Refuge
Land Cover Types
Water
Perennial Ice/Snow
Barren
Deciduous Forest
Evergreen Forest
Mixed Forest
Tall and Low Shrub
Moist Graminoid
Wet Graminoid
Other Features
Arctic Refuge Boundary
Roads
U.S.- Canada Border
Miles
0 10 20 30 40 50 60 70 80
0 10 20 30 40 50 60 70 80
Kilometers
Alaska Albers Equal Area Conic Projection, 1983 North American Datum.
Vegetation cover types are a modification of the National Land Cover Database. Modifications include deletion of perennial ice/snow and substitution of a digitized layer, enhancement of forest types with a majority filter, and a combination of some cover types.
Prudhoe Bay
Kaktovik
Camden Bay
Beaufort Sea
Dalton Highway
Arctic Village
Canada
152° W
150° W
148° W
146° W
144° W
142° W
140° W
138° W
136° W
70° N
69° N
68° N
67° N
Russia
Arctic Ocean
Alaska
Fairbanks
Anchorage
Canada
Bering Sea
Gulf of Alaska

Spruce Forest (12 Percent of Refuge)

White spruce forests are typically found on well-drained soils, south-facing slopes, and along rivers and streams where permafrost is lacking. White spruce is the only tree growing at altitudinal tree line in the Brooks Range. Black spruce forests occur on north-facing slopes and in areas where soil drainage is moderate to poor, but they do not extend as far north in the Refuge as white spruce.

In closed spruce forests, the tree canopy is dense, covering greater than 60 percent of the area. This type is comprised mainly of white spruce on moist to well-drained sites in the boreal forest of the Yukon–Old Crow basin ecoregion. Species commonly found in the understory include *Rosa acicularis, Shepherdia canadensis, Salix* spp., *Pyrola* spp., *Betula nana, Vaccinium uliginosum, V. vitis-idaea, Carex* spp., *Eriophorum* spp., and *Hylocomium splendens.*

Open spruce forests consists of open stands (30–60 percent tree cover), with crowns not usually touching. This type is primarily dominated by black spruce on low, poorly-drained sites or upland sites with permafrost. Open stands of white spruce on alluvial sites and in the uplands and subalpine zone are also included in this type. Dwarf shrubs are the most common understory vegetation, usually consisting of *Ledum decumbens* or *L. groenlandicum, Vaccinium uliginosum, Betula nana, or Empetrum nigrum*. Non-woody plants common in the understory include *Eriophorum vaginatum, Cladonia* spp., and *Cladina* spp. Other species may include *Arctostaphylos rubra, A. arctica, Dryas integrifolia, Rhododendron lapponicum, Salix reticulata, S. lanata, Carex bigelowii, Festuca altaica, Equisetum arvense,* and *Hylocomium splendens.* On alluvial and well-drained sites, the shrub layer usually consists of *Salix glauca* and *Alnus crispa.*

Spruce woodlands have widely spaced spruce trees (less than 30 percent cover), usually with a dense understory of shrubs. Major shrub species include *Betula nana, Ledum groenlandicum, L. decumbens, Vaccinium uliginosum, V. vitis-idaea, Salix reticulata, S. glauca, S. lanata, Alnus crispa, and Dryas integrifolia*. Non-woody species may include *Lupinus arcticus, Equisetum arvense, E. scirpoides, Eriophorum vaginatum, Carex bigelowii, C. scirpoides, Festuca* spp., *Cetraria* spp., *Cladina* spp., *Polytrichum* spp., *Hylocomium splendens*, and *Dicranum* spp.

Deciduous Forest (One Percent of Refuge)

Deciduous forests are typically found on well-drained to moist soils on hills and river terraces south of the Continental Divide. Deciduous trees grow quickly after disturbances, such as fires, but do not live as long as spruce. This vegetation type is often an early successional stage that will develop into a mixed forest and eventually a spruce forest. Balsam poplar, paper birch (*Betula papyrifera*), and aspen (*Populus tremuloides*) are the dominant tree species. Understory species include *Alnus crispa, Salix* spp., *Rosa acicularis, Shepherdia canadensis*, and *Calamagrostis canadensis*. Small stands of balsam poplar occur in northern valleys of the Brooks Range on sites with year-round subsurface flowing water, especially along the Canning and Kongakut rivers.

Mixed Forest (One Percent of Refuge)

This type is comprised of a mix of deciduous and evergreen trees, with neither clearly dominant, and occurs on well-drained to moist sites in the boreal forest uplands. The primary evergreen is white spruce, while the primary deciduous species are paper birch with occasional balsam poplar and aspen. Understory species common to the spruce and deciduous vegetation types listed in the following text may also be found in mixed forests, along with *Ribes* spp., *Lupinus arcticus*, and *Juniperus communis* on drier sites.

4.3.1.2 Shrub

This vegetation category covers approximately 46 percent of the Refuge and is dominated by shrubs (greater than 25 percent cover) with an understory of herbaceous plants. The taller shrubs are mainly deciduous and shed their leaves simultaneously in the fall, while many of the dwarf shrubs are evergreen.

Dwarf Shrub (25 Percent of Refuge)

Dry prostrate dwarf shrub occupies upper slopes in the mountains and foothills and also occurs on dry areas of coastal plain tundra and on dry, infrequently-flooded river terraces or alluvial fans throughout the Refuge. Moist habitats on slightly elevated microsites of the coastal plain and alluvial terraces in the foothills and mountains are often drier as a result of greater exposure to wind and lack of water from surrounding terrain. Lichens are more common than mosses in these drier habitats. Bare soil as a result of frost action is common in this habitat type. Low snow cover exposes plants to abrasion and desiccation by winter winds, so they do not generally grow more than 4 in tall. Mountain avens (*Dryas* spp.) is the most common shrub in this vegetation type. Other common shrubs are *Arctostaphylos rubra, Salix reticulata, S. rotundifolia*, and *Cassiopia tetragona*. Herbaceous plants include *Saxifraga hircula, Polygonum bistorta, Petasites frigida, Polemonium boreale, Equisetum arvense, Carex* spp., *Festuca* spp., *Hierochloe* spp., *Epilobium latifolium,* and *Geum glaciale*. The *Cetraria* species of lichen are also common.

Moist prostrate dwarf shrub contains similar shrub species as dry prostrate dwarf shrub, but greater winter snow cover and summer soil moisture allows grasses, sedges, and mosses to thrive in the understory. This type occurs on moist habitats on the coastal plain and in foothills tundra on gentle to moderately steep slopes. It grades into moist sedge-Dryas tundra when sedges dominate. In the mountains, this type is frequently found on mid- to lower slopes that receive subsurface drainage from adjacent terrain. *Dryas integrifolia* is often the dominant species. *Carex bigelowii* is usually the main sedge, producing a hummocky surface. Horsetails (*Equisetem arvense*) and the moss *Tomenthypnum nitens* are characteristic species in this type. Other species include *Salix lanata, S. arctica, S. pulchra, Rubus chamaemorus, Saxifraga hirculus, S. punctata, Petasites frigidus, Eriophorum vaginatum*, and *Carex aquatilis*.

Tall and Low Shrub (22 Percent of Refuge)

The riparian shrub type develops on gravels along rivers and is dominated by the willows *Salix planifolia* and *S. alaxensis*. On the North Slope, this is the tallest vegetation type. Species composition and density is controlled by frequency of flooding, water velocity, and the size of particles deposited during flooding. Many other species occur as co-dominants or in the understory, including *Salix lanata, S. richardsonii, S. glauca, S. brachycarpa, S. hastata, S. reticulata, Arctostaphylos rubra, Populus balsamifera, Shepherdia canadensis, Potentilla palustris, Dryas integrifolia, D. drummondii, Equisetum arvense, E. variegatum, E scirpoides, Carex* spp., *Festuca* spp., *Juncus castaneus, Petasites frigida, Hedysarum* spp., and *Hylocomium splendens*.

The non-riparian shrub type is comprised of upright-growing shrubs with interlocking branches, primarily willows (*Salix* spp.), shrub birch (*Betula nana*), and bog blueberry (*Vaccinium uliginosum*). These shrubs are typically 4 in to 1.5 ft tall, although willows in the boreal forest can reach 16 ft. The erect shrub class is common on lower mountain slopes, low rolling hills, and re-growing burned areas. On mountain bases with gentle slopes (less than 15 percent) or on hillsides at lower elevations, tussocks of the sedge *Eriophorum vaginatum* often occur with shrubs, so this class grades into moist sedge-tussock tundra. Other shrub species include *Alnus viridus, Ledum decumbens, Vaccinium vitis-idaea, Cassiope tetragona, and Empetrum nigrum*. Other species present may include *Carex lugens, Carex scirpoidea, Equisetum arvense, E. scirpoidea, Hylocomium splendens, Tomenthypnum nitens*, and *Sphagnum* spp.

4.3.1.3 Herbaceous

This vegetation category covers approximately 10 percent of the Refuge. Herbaceous plants do not have much woody tissue and generally die back to the ground surface each year. There are two major growth forms: graminoids and forbs. Graminoids include grasses and grass-like plants, such as sedges and rushes. Forbs are broad-leaved plants, such as fireweed and lupine.

Herbaceous vegetation types in Arctic Refuge are graminoid-dominated and are divided into wet and moist types. Shrubs and forbs are present but provide less than 25 percent cover.

Wet Herbaceous (Two Percent of Refuge)

The very wet graminoid vegetation type occurs on aquatic habitats surrounding large, open bodies of fresh water; very wet habitats that contain numerous small bodies of open water; and coastal marshes frequently inundated with salt water. Surface forms include low-centered polygons with abundant standing water, thaw lake basins, edges of lakes, and low-bank coastline. The grass *Arctophila fulva* is the primary species in deeper fresh water (to 3 ft deep), with sedges *Carex aquatilis, Eriophorum scheuchzeri*, and *Eriophorum angustifolium* dominating areas where the water is less than 1 ft deep. *Puccinellia phryganodes, Carex subspathacea*, and *Dupontia fisheri* are the most common salt-tolerant species in coastal salt marshes.

The wet graminoid type is found in habitats that generally have standing water throughout the summer, receiving water by surface and subsurface flow from surrounding terrain. This type is most common on low-lying flats and drainages on the coastal plain. Surface forms can be low-centered polygons and strangmoor (string-patterned bog). Graminoids dominate and include many sedge species, with *Carex aquatilis* and *Eriophorum angustifolium* being the most common. Other plant species found in this vegetation type include willows, rushes, *Pedicularis* spp., *Valeriana capitata*, and *Polygonum* spp. There is usually little shrub, forb, or moss cover, except on drier microsites such as polygon rims.

Moist Herbaceous (Nine Percent of Refuge)

Moist herbaceous tundra occurs on flat or gently sloping terrain and is the most common vegetation type in the coastal plain ecoregion. Dwarf shrubs and sedges occur together in habitats intermediate in moisture regime between the wet graminoid and moist dwarf shrub types. Polygonized patterned ground is common, with wet and moist areas often intermixed in a complex pattern.

Moist sedge-willow tundra is found on low-lying flats and gentle slopes, with the sedges *Eriophorum angustifolium* and *Carex aquatilis* and the willows *Salix pulchra* and *S. reticulata* dominating. Other common species include *Dryas integrifolia, Salix lanata, Carex bigelowii, C. membranacea, Polygonum* spp., and *Senecio* spp. Mosses include *Tomenthypnum nitens, Hylocomium splendens, Aulacomnium* spp., *Sphagnum* spp., and *Campylium stellatum*.

The moist sedge-Dryas tundra type occupies moderately well-drained sites on moist calcareous slopes and pebbly glacial and marine sediments. The dwarf shrub *Dryas integrifolia* and the sedge *Carex bigelowii* are dominant species, often occurring with the willows *Salix richardsonii, S. phlebophylla*, and *S. reticulata*, and mosses such as *Tomenthypnum nitens, Hylocomium splendens, Distichium capillaceum,* and *Ditrichum flexicaule*. Forbs (e.g., *Lupinus arcticus*), lichens (e.g., *Cetraria* spp.), and horsetails (e.g., *Equisetum variegatum*) are common. There is often a hummocky surface topography, with patches of exposed mineral soil and extremely variable organic horizons, resulting from active and stabilized frost boils.

The moist sedge-tussock tundra type occurs on moderately well-drained slopes and is dominated by the tussock-forming sedge *Eriophorum vaginatum*. Other common plants include the shrubs *Salix pulchra, S. reticulata, Betula nana, Dryas integrifolia, Vaccinium uliginosum, V. vitis-idaea*, and *Ledum decumbens*. Mosses and liverworts include *Hylocomium splendens, Sphagnum* spp., *Aulacomnium turgidum, Ptilidium ciliare*, and *Tomenthypnum nitens.*

4.3.1.4 Barren and Sparsely Vegetated Areas

Approximately 26 percent of the Refuge is bare of vegetation or sparsely vegetated. In this category, plants are scattered or absent, and bare mineral soil or rock dominates the landscape.

Barren floodplains consist of river deposits, including silt, sand, and rocks. Plant cover is less than five percent and includes the same species described here for scarcely vegetated floodplain, if any vegetation is present.

The scarcely vegetated floodplain type is a result of the initial invasion of plants on recently exposed river gravels. Plant cover is 5 to 20 percent. Some common species include *Epilobium latifolium* and willows. With infrequent river flooding, this type develops into riparian shrublands.

The ground surface in the barren rock and scree type is dominated by bedrock and rocky slopes, usually with less than five percent plant cover. A type of lichen tundra may form, dominated by blackish lichens on rocks, mainly of the genera *Umbilicaria, Cetraria, Cornicularia, and Pseudophebe*. These sites may be devoid of flowering plants.

The sparsely vegetated scree type has 5 to 20 percent plant cover on more or less unstable, steep, rocky slopes. With greater stability of the scree, it develops into dry prostrate dwarf shrub. Some shrubs commonly found in this type include *Betula nana, Dryas integrifolia, D. octopetala, Vaccinium uliginosum, Cassiope tetragona*, and *Salix phlebophylla*. Other plant species include *Lupinus arcticus, Carex* spp., *Umbilicaria* spp., *Crystopteris* spp., *Diapensia lapponica*, and *Cetraria* spp.

4.3.1.5 Other Areas

Water comprises one percent of the Refuge area and includes lakes, ponds, and rivers.

The perennial ice and snow type includes glaciers on the highest mountains and ice patches on river bars below year-round springs (aufeis). It comprises one percent of the Refuge area.

4.3.2 Wildfire

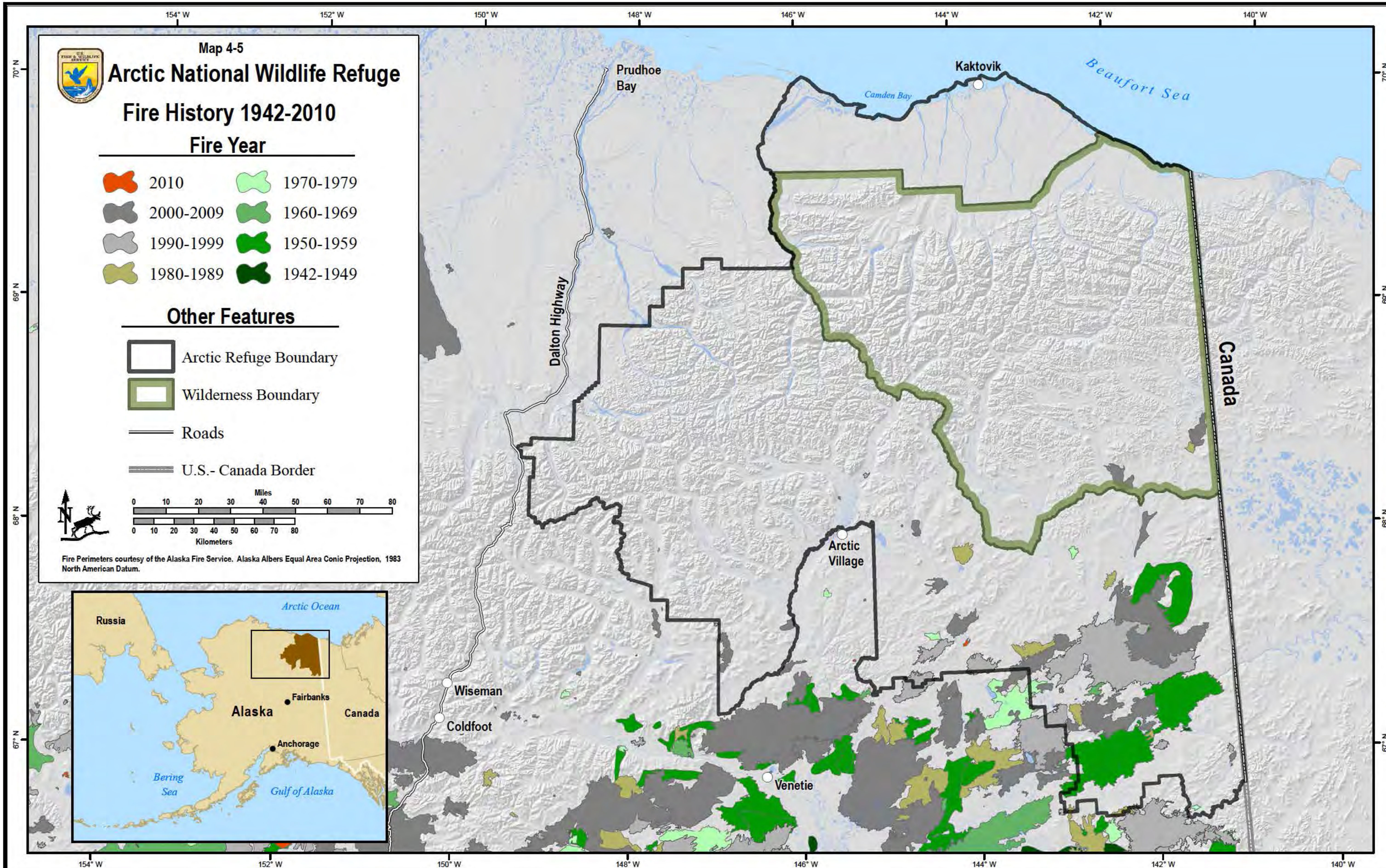
Almost all wildfires in the Refuge have occurred south of the Brooks Range, in the Yukon-Old Crow Basin, Olgavie Mountains, and Davidson Mountains ecoregions (Map 4-5). Only a few small fires are known to have occurred in the Brooks Range region of the Refuge. Fires in the mountains remain small due to a moister climate, less lightning, sparse tree cover, and rugged terrain with many natural fire breaks. Historic fire records document no fires in the Refuge north of the Brooks Range, although a small lightning-caused tundra fire burned less than one mile outside the Refuge's western boundary in 2004.

Wildfires are common in the forested parts of the Refuge. Fire defines the disturbance-driven natural system of the southern Refuge and plays a crucial role in the maintenance of the ecosystem, as in all of interior Alaska. It affects plant and animal species distribution and abundance, diversity of landscapes, and hydrology, carbon, and nutrient cycles. Frequent small fires produce patchy environments with varied habitats that are of value to many wildlife species during the natural fire recovery process. Patchy fires also break up contiguous fire fuel loading and make future large-scale fires less intense. Large intense fires can burn in hot, dry weather and cover hundreds of thousands of acres. Vegetation and changing weather patterns during the fire (e.g., changes in relative humidity and wind) can result in a mosaic of different burn severities, with inclusions of unburned vegetation often due to fire breaks provided by wet areas. Under extreme conditions, these fires can result in large homogeneous areas of high burn severity that may recover slowly due to removal of the entire soil organic layer and long distances to seed sources for spruce and shrubs. The largest recorded fires in Arctic Refuge burned in 1950, 1990, 2004, and 2005.

4.3.3 Climate Change Impacts to Vegetation

4.3.3.1 Potential Changes to the Natural Fire Regime

Concern has been expressed about increasing wildfire frequency in Alaska. The Bureau of Land Management, Alaska Fire Service (BLM-AFS) maintains records of fire occurrences back to about 1950, with incomplete records to about 1942. These records show that total area burned in the boreal forest of Alaska was higher in the 1980s and 1990s than in the 1960s and 1970s (Kasischke and Turetsky 2006). The first decade of this century has had some extreme fire years, with 2004 being the most extreme fire year on record in Alaska. The number and area of wildfires in the Refuge vary greatly from year to year, with 1950 burning more area than any subsequent year, so there is insufficient data to ascertain whether the current fire frequency on the Refuge is greater than historic levels.


Map 4-5
Arctic National Wildlife Refuge
Fire History 1942-2010
Fire Year
2010
2000-2009
1990-1999
1980-1989
1970-1979
1960-1969
1950-1959
1942-1949
Other Features
Arctic Refuge Boundary
Wilderness Boundary
Roads
U.S.- Canada Border
Miles
0 10 20 30 40 50 60 70 80
0 10 20 30 40 50 60 70 80
Kilometers
Fire Perimeters courtesy of the Alaska Fire Service. Alaska Albers Equal Area Conic Projection, 1983 North American Datum.
Prudhoe Bay
Kaktovik
Camden Bay
Beaufort Sea
Dalton Highway
Canada
Arctic Village
Wiseman
Coldfoot
Venetie
Russia
Arctic Ocean
Alaska
Fairbanks
Canada
Anchorage
Bering Sea
Gulf of Alaska
154° W
152° W
150° W
148° W
146° W
144° W
142° W
140° W
70° N
69° N
68° N
67° N

Climate changes, which result in longer, hotter, and drier summers, sustained high winds, low relative humidity and low moisture in fire fuels could cause a change in the natural fire regime on the Refuge. Insect damage to vegetation also increases with drought conditions and weakens trees and shrubs, making them more flammable. These conditions would increase the frequency, intensity, and duration of wildland fire and the amount of acreage burned each year.

In the boreal forest, more frequent and intense wildland fires could burn large areas of spruce and convert forests to a less flammable, deciduous vegetation type (Rupp et al. 2002). If the climate became warmer and drier than current conditions, spruce trees would be weakened by drought stress and insect damage. This could eventually transform the boreal forest portion of the Refuge to a landscape dominated by deciduous forests. Moose habitat would likely be improved, but area and quality of caribou winter habitat would be diminished.

Tundra fires have been rare in northern Alaska, with only eight known occurrences on the whole North Slope from 1955 to 2006 (Jones et al. 2009). In the fall of 2007, coinciding with an unusually warm and dry summer, a 386-square-mile area burned in the central Arctic Foothills (Hu et al. 2010). This is the largest North Slope fire on record and underscores the potential for more frequent, larger tundra fires with warmer summers. The North Slope fire regime may change and become similar to that of the Seward Peninsula in western Alaska. The Seward Peninsula has a tundra landscape but has a warmer climate than the North Slope, with periodic high-fire years, shrubbier tundra, and encroaching spruce trees (Racine et al. 2004).

4.3.3.2 Treeline

It is predicted that the limits of treeline will move north in latitude and upward in elevation with a warmer climate (Hinzman et al. 2005). Modeling studies focused on the Alaska forest-tundra ecotone project that a shift from tundra to spruce forest could occur in about 150 years (Rupp et al. 2000). Migration of spruce trees to higher latitudes or higher elevations has been documented in the western Brooks Range and at lower latitudes in Alaska and the adjacent Yukon Territory. There is no clear evidence for advancing treeline in the central or eastern Brooks Range (Barber et al. 2009). This could be due to the topographic barrier created by the highest peaks in the Brooks Range and perhaps to the drier summers of the eastern Brooks Range, where drought stress may hinder spruce growth on marginal sites (Wilmking et al. 2004).

Patches of balsam poplar trees currently occur north of treeline in scattered locations across the northern Brooks Range and foothills and in floodplain settings with year-round groundwater flow (Bockheim et al. 2003). Some groves of stunted poplar grow within 16 miles of the Beaufort Sea. Because these trees have wind-dispersed seeds and are adapted to growing in early successional habitats, balsam poplar should be able to advance northward on floodplains across arctic Alaska in response to warming temperatures.

4.3.3.3 Plant Phenology

The growing season in Alaska has lengthened by 13 days since 1950 (Keyser et al. 2000), and climate model projections indicate that by 2080, the growing season will be about a month longer than it is at present in all parts of the Refuge (SNAP 2010). Despite projections of an increase in precipitation, increased temperatures and an extended growing season would increase evapotranspiration rates enough that landscape-scale drying is predicted across the entire Refuge. Near mid-century, the landscape may be 10 to 12 percent drier in the north and south ecoregions of the Refuge and 16 percent drier in the Brooks Range; near the end of the century, it may be 23 to 25 percent drier in the north and south and 37 percent drier in the Brooks Range. Warming and drying would likely change vegetation phenology, such as timing of leaf bud out, seed set, and leaf senescence.

Remote sensing methods using satellite images, most notably the normalized difference vegetation index, have been used to assess vegetation trends in the Arctic and Sub-Arctic. Index values are a measure of vegetation “greenness” (i.e., photosynthetic activity) and correlate well with green plant biomass. Index data from northeast Alaska show that green-up occurs earlier in warmer years, with a longer growing season and greater peak summer biomass, and that the date of vegetation green-up has advanced in recent years (Martin et al. 2009).

4.3.3.4 Plant Distribution

A warming environment will change distributions of plants. Some species will adapt to climate change, while others will be unable to adapt and will be lost. Many species will adapt to changing conditions by moving, since the climate is changing too rapidly to adapt in place by natural evolution. Many recent species distribution shifts have been documented elsewhere in the world (Parmesan and Yohe 2003), but a lack of baseline data makes this more difficult in a remote area like Arctic Refuge.

The geographic ranges of North American flora and fauna are expected to shift upwards in elevation and northward in response to projected temperature and precipitation changes in the next 100 years (IPCC 2001, Payette et al. 2001). Shifting species ranges could increase the chances of invasion by non-native plant species. These projected changes would likely affect the biological integrity and environmental health of Refuge ecosystems. The long-term effects to biological diversity would be complex.

4.3.3.5 Non-native Plants

Non-native plants are currently uncommon on the North Slope (McKendrick 2000). Cool summer temperatures and a short growing season may presently impede their invasion in arctic Alaska, but this will change if the climate continues to warm. Warming may create a more suitable environment for some plants, enabling native and non-native plant species to extend their current ranges northward.

The main determinants of non-native plant invasion in northern Alaska are human traffic and disturbance to the ground. Non-native plants are common on disturbed ground in cities of interior Alaska, where extreme winter temperatures are just as cold as most of Arctic Refuge. The Fairbanks area is an excellent point source for infestations in interior and northern Alaska because of extensive disturbed ground and a road connection to the Arctic. Although the vast majority of non-native plant infestations in Alaska are on human-disturbed ground, Carlson and Shephard (2007) observed that non-native plants are spreading into natural ecosystems at an accelerating rate.

Arctic Refuge has few documented non-native plants, but this is likely to change in the near future. Motorized and foot traffic and extent of disturbed ground, associated with recreational or industrial activity, in and near the Refuge are expected to increase. This increase in activity, combined with a warmer climate, will likely lead to an increase in problems with non-native plants in the future. MacFarlane (2003) documented the presence of non-native plants on oil exploration seismic lines in Alberta that were not present in the adjacent forest. Revegetation projects on disturbed sites, specifically the application of commercial seed, could introduce non-native plant species.

4.3.3.6 Vegetation composition changes

Vegetation of Arctic Refuge may be changing under current climate conditions, especially on the North Slope. A 22-year satellite normalized difference vegetation index record analyzed by Verbyla (2008) showed an increasing trend in greenness on the arctic coastal plain and arctic foothills, no major trend in the Brooks Range, and some decrease in index values in the boreal forest. The observed increase on the North Slope could reflect increased shrub cover and stature or more robust growth of sedges and grasses. Decrease in greenness in the boreal forest could be due to increasing summer drought stress in recent warm years, which limits tree growth (Wilmking et al. 2004).

An increase in the amount of shrubs in tundra during the past 50 years has been documented for areas of the south-central North Slope, using repeat aerial photography (Tape et al. 2006). Normalized difference vegetation index increases across the North Slope suggest that shrubbiness has likely increased at a landscape scale, although few long-term field data are available to verify this. In the only long-term vegetation data set from the coastal plain of Arctic Refuge, Jorgenson and Buchholtz (2003, unpublished data) found no significant increase in shrub cover during the period 1984–2009. However, under projections for a warmer and drier climate, shrubs are expected to become more dominant in the tundra. An increase in shrubby tundra would cause a decrease in sedge-dominated vegetation, which would profoundly affect wildlife habitat. Such a change could adversely affect species that feed on sedges, such as geese.

4.3.3.7 Plant disease and pathogens

Plant photosynthetic activity in boreal forests of Alaska, as measured by the normalized difference vegetation index, decreased from 1982 to 2003 (Verbyla 2008). This decrease is attributed to wildland fire activity and tree stress caused by drought and insect infestations (Mattson and Hack 1987, Malmström and Raffa 2000). Stress caused by temperature-induced drought could make trees and shrubs more susceptible to disease and pathogens.

Large areas of the Alaskan boreal forest have been impacted by insect infestations during the past two decades (U.S. Department of Agriculture 2010). The spruce beetle outbreak in south-central Alaska, one of the largest recorded insect outbreaks in North America (Werner 1996, U.S. Forest Service 2010), is attributed to the climate regime shift in Alaska (Juday et al. 1998). Temperature-induced drought stress in interior Alaska may have caused the first-recorded spruce budworm outbreak near Fairbanks and could also be responsible for the vast areas of willow shrubs that were damaged and killed as a result of 19 continuous years of willow blotch miner infestation on the Yukon Flats (U.S. Department of Agriculture 2010).

4.3.4 Climate Change and Refuge Habitats

A habitat is an area with a combination of resources (e.g., food, water, cover) and environmental conditions (e.g., temperature, precipitation, presence or absence of predators and competitors) that allows animals and plants to survive and reproduce (Morrison et al. 2006a). Projected environmental changes have the potential to affect the quality of habitats on the Refuge.

Habitats are not static but change naturally through time. Habitat changes in response to either rapid climate changes or human disturbance are of more concern than those that occur from variation in natural processes over time. Long term, we can expect climate change to cause profound habitat changes in Arctic Refuge, which will result in species shifting their distributions northward and to higher elevations. Local extirpations of some populations may result, while range expansions of others will occur.

4.3.4.1 Drying of Lake and Wetland Habitats

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

Increased temperatures and an extended growing season could increase the evapotranspiration rate, increasing the water deficit (defined as the amount by which evapotranspiration exceeds precipitation) and potentially affecting the annual water balance. The annual water balance represents the water available for plants and animals, stream flow, and groundwater recharge. Shallow water systems, including lakes and wetlands, would decrease in number and extent as the annual water balance experiences an ongoing deficit. Permafrost loss on the Refuge could also result in draining of many shallow water systems on the Refuge; the thawing of ice wedges and ice lenses could create more connections between surface water and groundwater systems.

If wetlands and lakes continue to dry, an increase in vegetative cover can be expected; and they could eventually transition to dry meadows and shrublands. This would reduce the amount of habitat available for wetland-dependent species, such as waterfowl.

4.3.4.2 Changing Coastal Habitats

The coastline is a dynamic environment, subject to continual change. Climate change may affect the equilibrium among various coastal processes, however, and result in a net change in habitat availability. Signs of climate change are already apparent in coastal habitats in the arctic. For example, rapid shoreline erosion is occurring, enhanced by the retreat of summer sea ice. Erosion rates of 3–6 ft (1–2 m) per year are typical for many sections of the Beaufort Sea coast.

Coastal erosion is affected by permafrost thawing as well as mechanical, wave-related processes. The combined effect of increased water temperatures, sea level rise, and increased frequency of wind-driven storm surges has resulted in a substantial increase in coastal erosion rates (Jorgenson and Brown 2005). A pronounced sea-surface warming trend since 1995 has been observed for the Arctic Ocean, especially in the Beaufort and Chukchi Seas. Global sea level rise is estimated to have occurred at a rate of 0.12 in (3 mm) per year since 1993, and projections for cumulative global sea level rise by the end of this century range from 0.59 to 1.94 ft (0.18 to 0.59 m) (IPCC 2007c). Wind-driven storm surges can result in very rapid coastal erosion, raising water levels in the Beaufort Sea by more than 6 ft (2 m) (Reimnitz and Maurer 1979). Wind speeds and the number of stormy days, defined by wind speed, have been increasing in the Beaufort Sea (Wendler et al. 2010). The presence of sea ice inhibits wave formation; but in the past few decades, the length of the ice-free period along Alaska's north coast has increased by an average of 50 to 95 days (Rodrigues 2008). Sea ice extent in the Arctic Ocean has also decreased markedly: the peak summer sea ice extent has decreased by 9.2 percent per decade from 1979 to 2005, with a record low extent of polar sea ice in 2007 (Walsh 2010). An increase in open water conditions increases the probability that strong winds will result in a storm surge.

In addition to its effects on coastal erosion rates, reduced sea ice alters habitat conditions for some species. For example, it may change the timing and location of plankton blooms and critically threaten ice-dwelling species such as polar bears and certain seals. Some marine species are shifting northward in response to changing water temperatures and open water conditions.

Increasing ocean temperatures, sea level rise, permafrost degradation, decreased sea ice, increased storm surges, and changes to river discharge and sediment transport will continue to affect coastal habitats, including the barrier island-lagoon system. In Arctic Refuge, this system provides important summer feeding habitat and migration corridors for shorebirds, waterfowl, and anadromous fish. Preliminary evidence suggests that the Beaufort Sea barrier island system may be disintegrating. Total surface area of barrier islands in the central Beaufort Sea (from the Colville River to Point Thomson) has decreased approximately four percent from the 1940s to the 2000s, and the rate of change is steeper since 1980 (Gibbs et al. 2008). A longer period of open water and increased occurrence of larger waves is at least partially responsible for the accelerated decrease in barrier island surface area: barrier islands are typically less than 3.3 ft in elevation and are subject to overwash during storm events. These trends suggest that the deterioration or disappearance of the existing system of barrier islands is possible over a relatively short period of time.

4.3.4.3 Soil Warming, Nutrients, Carbon

The boreal forest and tundra biomes are widely recognized as important in stabilizing global climate by immobilizing carbon in the cold soils. If warming is accompanied by increased soil moisture, there could be a long-term loss of carbon and nitrogen from the system. Experimental studies have shown that a warming of the soil can lead to increased turnover of soil organic matter and redistribution of nitrogen from soils to vegetation (Nadelhoffer et al. 1992).

Predicted changes in vegetation will also affect carbon and nutrient cycles. Increased shrub extent and height will trap more winter snow, insulating the soil and allowing the soil to remain warmer in winter and allowing microbial activity to continue during the winter, which could cause large changes in carbon and nitrogen pools, releasing large amounts of stored carbon to the atmosphere and thus exacerbating warming (Sturm et al. 2001).

4.3.4.4 Contaminants

Interactions between climate change and physical processes may increase availability and uptake of contaminants for fish, wildlife, and their habitats. Contaminants currently stored in glacial ice, multi-year sea ice, and permafrost, including persistent organic pollutants and mercury, will likely be released to aquatic ecosystems as the temperature rises (Schiedek et al. 2007).

4.3.5 Fish

There have been 42 species of fish recorded in the rivers, lakes, and coastal waters of the Refuge (Appendix F, species list). Of these, 14 display freshwater resident life histories in the Refuge, 11 have anadromous life histories, and 17 are marine species. Five of the species classified as anadromous also display freshwater resident life history traits in the Refuge. Some fish species with notable ecological and/or subsistence value in the Refuge are discussed in the following text.

4.3.5.1 Freshwater Species

Sheefish

Sheefish (*Stenodus leucichthys*), also known as inconnu, are large, piscivorous whitefish found in many arctic and subarctic waters of Asia and North America (Alt 1969, McPhail and Lindsey 1970, Morrow 1980). Sheefish populations may exhibit either anadromous or freshwater resident life histories (Howland et al. 2001).

In the Refuge, sheefish are found only on the south side of the Brooks Range, in the Porcupine River (Alt 1974). Sheefish captured in the upper reaches of the Porcupine River in Alaska are freshwater residents (Brown et al. 2007a). Sheefish spawn in flowing water over gravel (Alt 1969, Gerken 2009), but spawning locations in the Porcupine River drainage have not been identified.

Sheefish are considered a good food fish and are routinely eaten wherever they are captured (McPhail and Lindsey 1970, Morrow 1980).

Round Whitefish

Round whitefish (*Prosopium cylindraceum*) are a relatively small, primarily benthic-feeding whitefish common in northern North America and northeastern Asia (McPhail and Lindsey 1970). While anadromous populations of round whitefish exist in certain coastal drainages (Morin et al. 1982), most round whitefish populations are freshwater resident forms, occupying clearwater rivers and lakes (Morrow 1980, Stewart et al. 2007). Round whitefish are generally thought to be less migratory than other whitefish species (Morrow 1980), and large migrations along main-stem rivers are not commonly observed (Brown et al. 2007a). They presumably spawn in tributary rivers and lakes where they are found. Riverine round whitefish spawn in flowing water over gravel (Craig and Wells 1975, Zyus'ko et al. 1993), while lake resident populations spawn over a mixed substrate composed of rocks, gravel, and mud (Normandeau 1969, Bryan and Kato 1975, Haymes and Kolenosky 1984).

Round whitefish are present in the Sagavanirktok (McCart et al. 1972, Alt 1976) and Canning (Ward and Craig 1974, Craig 1977c, Smith and Glesne 1982) River drainages in the northern part of the Refuge but have not been identified in other North Slope Refuge drainages. In the southern part of the Refuge, round whitefish are present in most stream reaches and some lakes in the Chandalar, Sheenjek, and Coleen River drainages (Alt 1974, Ward and Craig 1974, Craig and Wells 1975). Round whitefish have been identified in the main-stem Porcupine River in the Canadian portion of the drainage (Bryan 1973), and it is likely that they occur at times along the Alaska portion of the river.

Round whitefish are occasionally harvested in subsistence fisheries in Alaska but are usually a minor component of the catch (Andersen et al. 2004, Adams et al. 2005, Pedersen and Linn 2005).

Lake Trout

Lake trout (*Salvelinus namaycush*) are long-lived, piscivorous fish that inhabit deep, coldwater lakes and are widely distributed throughout northern North America, from the Alaska Peninsula east across Canada to Nova Scotia and south to northern New York (Scott and Crossman 1973). In general, lake trout spawn in large boulder or rubble substrate at depths less than 13 m (Scott and Crossman 1973).

In the Refuge, lake trout are likely common in coastal and headwater lakes where suitable overwintering habitat (deep water) exists (Scott and Crossman 1973). On the North Slope, lake trout have been documented in Elusive Lake in the Sagavanirktok River drainage, unnamed coastal lakes in the Canning River drainage, Okpilak Lake, Wahoo Lake, Lake Peters, and Lake Schrader (Ward and Craig 1974, Wilson et al. 1977, Glesne 1983, Bendock and Burr 1985, West and Fruge 1989). In South Slope waters, lake trout have been documented in Old John, Blackfish, and Vettatrin Lakes (Craig and Wells 1975, ADFG 1984).

Lake trout are harvested in subsistence fisheries in Old John Lake by the residents of Arctic Village and in Lakes Peters and Schrader by the residents of Kaktovik (Craig 1989b, Adams et al. 2005). Elusive Lake, located in the Ribdon River drainage, supports a small lake trout sport fishery; however, no specific sport harvest data could be found for Refuge waters (Bendock and Burr 1985, Jennings et al. 2010).

Arctic Char

Arctic char (*Salvelinus alpinus*) inhabit freshwater and marine habitats and exhibit a circumpolar distribution in the Holarctic (Johnson 1980, Reist et al. 1997). While anadromous and freshwater-resident forms are present in Alaska, only lake-resident populations exist in the Refuge (Reist et al. 1997). Arctic char feed non-selectively on insect larvae, amphipods, plankton, and fish (Craig 1977c, Armstrong and Morrow 1980). Spawning is thought to occur during fall in deeper portions of lacustrine habitats to avoid ice scouring (Armstrong and Morrow 1980).

In North Slope waters of the Refuge, populations have been documented in numerous lakes in the upper Canning and Sagavanirktok River drainages (McCart et al. 1972, Craig 1977c), Lake Peters and Lake Schrader in the upper Sadlerochit River drainage, and Porcupine Lake (Ward and Craig 1974, Craig 1977c). In South Slope waters, Arctic char have only been documented in Redfish Lake (Ward and Craig 1974, Craig and Wells 1975). No data regarding abundance or harvest of arctic char are currently available.

Northern Pike

Northern pike (*Esox lucius*) inhabit lakes and rivers of the circumpolar north, ranging as far south as southern New England in North America and Spain in Europe (Scott and Crossman 1973). Northern pike are primarily piscivorous but are ambush predators that have been known to opportunistically consume aquatic and terrestrial invertebrates, birds, frogs, and small mammals (Raat 1988). In spring, adults move from overwintering areas in lakes and deeper areas of rivers to spawn in shallow, calm areas containing emergent vegetation and mud bottoms. Adults disperse to summer feeding areas in lakes, rivers, and slough areas.

In the Refuge, northern pike are found in the Chandalar and Sheenjek River drainages on the South Slope (Craig and Wells 1975) but have yet to be captured in a scientific survey on the North Slope, despite documented occurrences to the west and east of the Refuge, in the Colville and Mackenzie rivers (Percy 1975, Bendock and Burr 1985). In South Slope waters of the Refuge, northern pike are harvested in subsistence fisheries by residents of Arctic Village in Old John, Mud, and Loon Lakes (Adams et al. 2005). Recreational harvest is also likely elsewhere; however, no Refuge-specific data could be found (Jennings et al. 2010). In North Slope waters of the Refuge, Jacobson and Wentworth (1982) and Pedersen and Linn (2005) report that northern pike are infrequently harvested in subsistence fisheries in the Hulahula River by residents of Kaktovik. However, the presence of northern pike in North Slope Refuge waters has not been scientifically verified; thus, these data should be viewed with caution.

Longnose Sucker

Longnose suckers (*Catostomus catostomus*) inhabit stream, river, and lake environments of northern North America and Eastern Siberia (Scott and Crossman 1973, Morrow 1980). They are bottom feeders that consume algae, aquatic and terrestrial macroinvertebrates, plants, and fish eggs (Stenton 1951). Spawning occurs in shallow stream habitats over gravel substrate. Besides annual movements to and from spawning grounds, longnose suckers are thought to be relatively sedentary (Scott and Crossman 1973).

In the Refuge, longnose suckers are common in lakes and streams in the Sheenjek, Chandalar, and Coleen rivers on the South Slope (Craig and Wells 1975). In North Slope waters, no documented accounts could be found, despite occurrences in the Colville and Mackenzie rivers to the west and east of the Refuge (Tripp and McCart 1974, Bendock and Burr 1985). Biological data pertaining to longnose suckers in the Refuge are extremely scarce and largely limited to distributional information (Craig and Wells 1975, Ward and Craig 1974). Craig and Wells (1975) located one suspected spawning area in the East Fork of the Chandalar River in the vicinity of the Junjik River. The authors also speculate that, while longnose suckers are present in the Sheenjek, Chandalar, and Coleen rivers, abundances are likely greater in downstream areas.

Longnose suckers are taken in low numbers in subsistence fisheries on the Chandalar River and in Old John Lake by the residents of Arctic Village (Adams et al. 2005).

Burbot

Burbot (*Lota lota*) inhabit deep areas of rivers and lakes of the circumpolar north, extending south into some temperate areas of Europe, Asia, and North America (Morrow 1980). Where burbot and lake trout co-occur, they likely compete for resources, as they have similar habitat and prey requirements (Scott and Crossman 1973). Burbot spawning generally takes place over gravel and sand substrate, in relatively shallow areas of rivers and lakes, but may also occur in river channels (Chen 1969, Breeser et al. 1988). Seasonal movements ranging from a few kilometers to over 250 kilometers have been reported in riverine populations, most likely associated with the connection of spawning and foraging habitats (Percy 1975, Breeser et al. 1988, Evenson 1993).

In North Slope waters of the Refuge, burbot have been documented in lakes and main-stem areas of the Canning (Ward and Craig 1974, Craig 1977c, Smith and Glesne 1982) and Sagavanirktok rivers (Bendock 1980, Bendock and Burr 1985). On the South Slope, burbot have been recorded north of Arctic Village in the Coleen and Chandalar rivers and in three lakes in the Sheenjek River drainage, including Old John Lake (Ward and Craig 1974, Craig and Wells 1975).

Burbot are infrequently harvested in subsistence fisheries by residents of Kaktovik in waters surrounding Barter Island and by residents of Arctic Village in the Chandalar River and Old John Lake (Adams et al. 2005, Pedersen and Linn 2005).

Ninespine Stickleback

Ninespine stickleback (*Pungitius pungitius*) are distributed in North America from Cook Inlet, Alaska, north to the Arctic Ocean and southeast through Canada, terminating on the Atlantic coast of New England (Scott and Crossman 1973, Morrow 1980). Ninespine stickleback prey on aquatic insects and small crustaceans and are an important prey item of lake trout, Dolly Varden char, Arctic char, Arctic grayling, northern pike, burbot, and avian predators, such as loons, terns, and gulls (Palmer 1962, Morrow 1980). They are tolerant of salinities less than 20 parts per thousand (ppt) and may move between fresh and saltwater throughout the year, as access and conditions permit (Wooton 1984). Spawning occurs in freshwater in shallow areas containing aquatic vegetation (Wooton 1984), which are also used as nursery areas. Little is known regarding seasonal movements; however, spawning individuals likely move from shallow areas (littoral, tributary, or slough habitat) to deep areas (river deltas, coastal areas, lake bottoms) (Wooton 1984).

In North Slope waters of the Refuge, ninespine stickleback are widely distributed and abundant in lakes, rivers, and streams of most of the major drainages (Ward and Craig 1974, Craig 1977a, Wilson et al. 1977, Bendock and Burr 1985). Furthermore, ninespine stickleback are commonly found in coastal brackish water lagoons (Griffiths et al. 1977, West and Wiswar 1985, Wiswar et al. 1995, Brown 2008) and coastal lakes, where they are often the only species present (West and Fruge 1989, Trawicki et al. 1991, Wiswar 1994). South Slope waters of the Refuge do not support populations of ninespine stickleback (Scott and Crossman 1973). In the Refuge, biological data regarding ninespine stickleback are presented in numerous publications (Yoshihara 1972, Ward and Craig 1974, Craig 1977a, Griffiths et al. 1977, Wilson et al. 1977, Bendock and Burr 1985, West and Wiswar 1985, West and Fruge 1989, Trawicki et al. 1991, Wiswar et al. 1995, Jarvela and Thorsteinson 1999, Brown 2008). While they are commonly found in most North Slope coastal habitats of the Refuge, catch rates vary dramatically among areas and years.

Slimy Sculpin

Slimy sculpin (*Cottus cognatus*) inhabit lakes and streams throughout northern North America, from as far south as Virginia to the North Slope of Alaska (Bendock 1980, Morrow 1980). Slimy sculpin feed almost exclusively on aquatic and terrestrial macroinvertebrates and are an important prey item in the diet of burbot, lake trout, northern pike, Arctic char, humpback whitefish, and piscivorous birds (Palmer 1962, Craig and Wells 1975, Morrow 1980). Spawning occurs in small tributary and ephemeral habitats (Craig and Wells 1975). Males select and defend nest sites under rocks or logs where females deposit eggs.

In North Slope waters of the Refuge, slimy sculpin have been found in coastal rivers and lakes of the Sagavanirktok, Canning, and Kongakut River drainages (Yoshihara 1972, Bendock 1980, Bendock and Burr 1985). On the South Slope, slimy sculpin are present in the headwaters of the Chandalar, Sheenjek, and Coleen rivers (Craig and Wells 1975).

Biological data pertaining to slimy sculpin in the Refuge are scarce and limited to distributional information in North Slope waters (Yoshihara 1972, Bendock 1980, Bendock and Burr 1985). On the South Slope, Craig and Wells (1975) found slimy sculpin to rank third in abundance behind grayling and round whitefish. Currently, no harvest data are available.

Arctic Grayling

Arctic grayling (*Thymallus arcticus*) reside in lakes and rivers of northern North America, from Hudson Bay to the western shores of Alaska, and in Asia, from Siberia to North Korea (Scott and Crossman 1973). Spawning occurs in small river and lake tributaries over areas of sandy gravel (Bishop 1971). When stream habitat is not available, spawning may also occur in larger substrates in rivers and lakes (Scott and Crossman 1973). Adults feed on aquatic and terrestrial invertebrates and may undertake extensive inter- and intra-drainage movements between overwintering sites (deep pools, lakes, spring-fed areas) and summer feeding habitats

following reproduction (Craig and Poulin 1975, West et al. 1992). Arctic grayling are, at least for short periods, tolerant of saline conditions, as individuals are sometimes captured in estuarine waters during inter-drainage movements in coastal systems (West et al. 1992).

In the Refuge, Arctic grayling are widespread and abundant on the North and South Slopes (Garner and Reynolds 1987, Craig and Wells 1975). Biological information regarding Arctic grayling inhabiting North Slope rivers and lakes of the Refuge are present in numerous publications (Furniss 1975, Garner and Reynolds 1986, Deschermeier et al. 1987, Wiswar 1991, Wiswar 1992, Wiswar 1994, West et al. 1992). Research in South Slope waters of the Refuge is less abundant and largely limited to information on distribution (Ward and Craig 1974, Craig and Wells 1975).

Arctic grayling are harvested in subsistence fisheries by residents of Kaktovik in nearby waters and by residents of Arctic Village in the Chandalar River, Mud Lake Creek, and Old John Lake (Craig 1989b, Adams et al. 2005). Recreational harvest is also likely to occur throughout the Refuge; however, no specific data are available (Jennings et al. 2010).

4.3.5.2 Anadromous Species

Broad Whitefish

Broad whitefish (*Coregonus nasus*) are large, primarily benthic-feeding whitefish found in many arctic and subarctic waters of Asia and North America (McPhail and Lindsey 1970, Morrow 1980). Broad whitefish populations may exhibit either anadromous or freshwater resident life histories (Reist and Bond 1988, Chudobiak 1995, Brown et al. 2007a).

They are present but uncommon in the nearshore waters of the Beaufort Sea in the northern part of the Refuge (Craig 1984, Brown 2008) and are relatively common in the upper Chandalar and Porcupine River drainages in the southern part of the Refuge (Bryan 1973, Craig and Wells 1975, Alt 1976, Brown et al. 2007a). Because Refuge rivers north of the Brooks Range do not support spawning or overwintering habitats for broad whitefish, they spawn and overwinter in aquatic habitats in the lower Sagavanirktok River and farther west or in the Mackenzie River and farther east (Craig 1984, Craig 1989a, Reist and Bond 1988). Therefore, all broad whitefish encountered in the northern part of the Refuge are anadromous fish, foraging in nearshore and estuarine habitats of the Beaufort Sea and occasionally in the lower reaches of the larger rivers (Ward and Craig 1974, Craig 1984, Brown 2008). By contrast, broad whitefish found in the upper Chandalar and Porcupine River drainages in the southern part of the Refuge are freshwater residents and do not migrate to sea (Brown et al. 2007a). Broad whitefish spawn in flowing water over gravel (Chang-Kue and Jessop 1997, Shestakov 2001, Carter 2010); however, the spawning origins and migratory ranges of broad whitefish populations in the southern part of the Refuge are unknown.

Broad whitefish are a very good food fish (McPhail and Lindsey 1970, Morrow 1980) and are harvested in the northern and southern parts of the Refuge (Adams et al. 2005, Pedersen and Linn 2005).

Humpback Whitefish

Humpback whitefish (*Coregonus clupeaformis*) are medium size, primarily benthic-feeding whitefish that are widely distributed in rivers, lakes, and estuaries of northern North America (McPhail and Lindsey 1970). Lake resident populations spawn over rock, gravel, and sand substrates (Bidgood 1974, Bryan and Kato 1975, Anras et al. 1999). River spawning humpback whitefish spawn in flowing water over gravel (Stein et al. 1973, Alt 1979, Brown 2006, Harper et al. 2009).

They are present in the northern and southern parts of the Refuge. They are very rare in the nearshore waters of the Beaufort Sea, in the northern part of the Refuge (Craig 1984, Brown 2008). Humpback whitefish encountered in the northern part of the Refuge are anadromous fish, foraging in nearshore and estuarine habitats of the Beaufort Sea. Similar to broad whitefish, spawning and overwintering habitats of humpback whitefish are in the lower Sagavanirktok River and farther west and in the Mackenzie River and farther east. In the southern part of the Refuge, humpback whitefish are present in several lakes in the upper Sheenjek River drainage (Craig and Wells 1975) and in the main stem Porcupine River (Bryan 1973, Craig and Wells 1975, Alt 1976, Brown et al. 2007a). Humpback whitefish in the Sheenjek River drainage lakes are most likely lake resident populations, living entirely in their home lakes (Ward and Craig 1974, Craig and Wells 1975). It is likely that additional lake resident populations exist in unsurveyed Refuge lakes in the upper Chandalar River drainage. Humpback whitefish populations in the main stem Porcupine River are freshwater residents and do not migrate to sea (Brown et al. 2007a), although their spawning origins and migratory ranges in the freshwater system are unknown.

Humpback whitefish are considered to be a good food fish. They have been exploited in commercial food fisheries in North America more than any other whitefish species (Bodaly 1986, Ebener 1997, Tallman and Friesen 2007) and are routinely harvested in subsistence fisheries in Alaska and northwestern Canada (Corkum and McCart 1981, Adams et al. 2005, Georgette and Shiedt 2005).

Least Cisco

Least cisco (*Coregonus sardinella*) are relatively small, pelagic-feeding whitefish found in many Arctic and subarctic waters of Asia and North America (McPhail and Lindsey 1970, Morrow 1980). They have been documented in estuaries, rivers, and lakes from various locations in Alaska and northwest Canada (Alt 1980, Mann and McCart 1981, Reist and Bond 1988, Moulton et al. 1997, Seigle 2003). Least cisco are known to undertake extensive spawning migrations from lower drainage or estuarine rearing habitats to spawning habitats that may be several hundred kilometers upstream (Reist and Bond 1988, Brown et al. 2007a).

Least cisco distribution in the northern part of the Refuge is limited to summer foraging migrations into nearshore and estuarine habitats of the Beaufort Sea (Craig 1984, Brown 2008). Bendock (1977) found that they were more common on the mainland side of the barrier islands than seaward of these islands in Beaufort Sea coastal waters. Because Refuge rivers north of the Brooks Range do not support spawning or overwintering habitats for least cisco, they spawn and overwinter in aquatic habitats in the Sagavanirktok River and farther west or in the Mackenzie River and farther east (Craig 1984, Craig 1989a, Reist and Bond 1988). The occurrence of least cisco in the southern part of the Refuge appears to be limited to the main stem of the Porcupine River (Bryan 1973, Alt 1974, Brown et al. 2007a), which probably serves as a migration corridor from downstream rearing habitats in the Yukon Flats (Brown and Fleener 2001) or upstream spawning and feeding areas in the Canadian portion of the drainage. Isolated populations in lakes are evidently capable of spawning in the absence of flowing water (Doxey 1991); however, actual spawning habitats in Refuge lakes have not been identified.

Least cisco are harvested in subsistence fisheries as human or dog food, but they are generally captured incidentally to other larger whitefish species (Andersen et al. 2004, Georgette and Shiedt 2005, Moulton and Seavey 2005).

Arctic Cisco

Arctic cisco (*Coregonus autumnalis*) are relatively small, pelagic-feeding whitefish, with a near circumpolar distribution in Arctic waters (McPhail and Lindsey 1970, Moskalenko 1971). Populations have been documented in several large rivers in northern Europe and Asia and in the Mackenzie River in northwestern Canada. All evidence indicates that Arctic cisco observed in Alaskan waters originate in the Mackenzie River drainage (Gallaway et al. 1983, Fechhelm et al. 2007), where several spawning populations have been identified (McLeod and O'Neil 1983, Dillinger et al. 1992).

Arctic cisco are fully anadromous and are not known to exist as freshwater residents (Reist and Bond 1988). Arctic cisco distribution in the Refuge is limited to summer foraging migrations in nearshore habitats of the Beaufort Sea and spawning migrations from overwintering habitats in the Colville River delta, back to the Mackenzie River once they mature (Craig 1989a, Fechhelm et al. 2007, Brown 2008). They are not found in freshwater habitats of the Refuge.

During summer, Arctic cisco are one of the most abundant species in nearshore waters of the Beaufort Sea, including Refuge waters (Craig 1984, Brown 2008) and one of the primary species taken in the Kaktovik subsistence fishery (Griffiths et al. 1977, Pedersen and Linn 2005).

Dolly Varden Char

Dolly Varden char (*Salvelinus malma*) are a coldwater species, distributed on the Arctic coast of North America, from the Mackenzie River west and south through Alaska to British Columbia, and on the western side of the Pacific, from the Chukotsk Peninsula of Russia south to Japan and Korea (Scott and Crossman 1973, Reist et al. 1997, DeCicco 1997). It is important to mention the history of taxonomic confusion surrounding Dolly Varden and Arctic char, in the genus Salvelinus (as reviewed by Reist et al. 1997). In past literature, riverine char inhabiting the Arctic were often described as Arctic char. However, as a result of recent research, anadromous and stream-resident char west of the Mackenzie River have been reclassified as Dolly Varden (Reist et al. 1997).

Stream-resident and anadromous forms of Dolly Varden are present in the Refuge, the latter confined to North Slope waters (Ward and Craig 1974). Resident fish, with few exceptions, utilize spring-fed habitat exclusively for all life history stages (Craig 1977b, McCart 1980). Alternatively, anadromous Dolly Varden migrate to brackish, nearshore coastal areas of the Beaufort Sea from overwintering habitats in deep pools and spring-fed areas in coastal rivers (Craig 1989a, Fechhelm et al. 1997, Jarvela and Thorsteinson 1997). While at sea, individuals move extensively along the Arctic coast in mixed-stock aggregates (West and Wiswar 1985, Craig 1989a, Krueger et al. 1999). Anadromous Dolly Varden return to freshwater to spawn and overwinter (Craig 1984, Craig 1989a).

Dolly Varden are widespread in the Refuge, particularly on the North Slope, with most large coastal rivers supporting populations (Ward and Craig 1974, Bendock and Burr 1985, DeCicco 1997). However, one lake-dwelling population has been documented in the upper Canning River drainage (Craig 1977c). On the South Slope of the Refuge, stream-resident Dolly

Varden are present in the headwaters of major rivers, including documented occurrences in the Sheenjek and Chandalar rivers (Craig and Wells 1975).

Abundance estimates of overwintering aggregations of anadromous Dolly Varden have been conducted in numerous drainages throughout the North Slope of the Refuge since the 1970s (Yoshihara 1973, Craig and McCart 1974, Furniss 1975, Bendock 1980, Bendock 1982, Bendock 1984, Smith and Glesne 1982, Fruge 1987, Arvey 1991, Kristofferson et al. 1991, Viavant 2005, Viavant 2009). The Ivishak River, located in the Sagavanirktok River drainage, has received considerable attention, as it is believed to contain the largest overwintering aggregation of Dolly Varden on the North Slope (Viavant 2005). However, it is unlikely that these fish utilize habitats in the Refuge in any large numbers, as the majority of spawning and overwintering sites are located in lower sections of the drainage, outside Refuge boundaries (Viavant 2005). Similarly, numerous studies have identified spawning and overwintering habitats in drainages in the Refuge (McCart et al. 1972, Yoshihara 1972, Craig 1973, Craig 1977a, Craig and McCart 1974, Glova and McCart 1974, Furniss 1975, Bendock 1982, Bendock 1984, Smith and Glesne 1982, Daum et al. 1984, West and Wiswar 1985, Kristofferson et al. 1991, Viavant 2001, Viavant 2005, Viavant 2009). The abundance and distribution of anadromous Dolly Varden in coastal rivers is likely restricted by the presence of spring-fed areas and deep, oxygenated pools suitable for spawning and overwintering (Craig 1989a). In some small drainages that contain few of these areas, Craig (1978) notes that, “it is conceivable that a single spring-fed site might harbor virtually all members of a particular population, from eggs in the gravel to adult fish, during the eight to nine month winter period.”

Anadromous Dolly Varden are one of the primary species caught in subsistence fisheries by residents of Kaktovik, in a winter fishery at Fish Hole 2 on the Hulahula River and in coastal areas during the summer (Craig 1989b, Pedersen and Linn 2005). There is also evidence of recreational use and harvest on the Hulahula and Kongakut rivers and likely elsewhere (Arvey 1991, Jennings et al. 2010)

Chinook Salmon

Chinook salmon (*Oncorhynchus tshawytscha*) are distributed on the western coast of North America, from southern California to Point Hope, Alaska, and in Asia, from Northern Siberia to Japan (Scott and Crossman 1973). Chinook salmon are anadromous, semelparous, and the largest of the Pacific salmon species. Fry emerge in spring and usually spend the first year of life in freshwater habitats (Wipfli 2009). Smolts migrate to sea in spring (Bradford et al. 2009). In the ocean, the majority of Chinook salmon occupy habitats in the Bering Sea, where they will spend between one and five years before returning to natal freshwater streams to spawn (Healey 1991). On the spawning grounds, females construct gravel nests in clearwater streams and rivers where eggs are deposited and covered with substrate (Healey 1991).

In the Refuge, Chinook salmon are common in South Slope waters; however, they have not been captured in North Slope waters, despite occasional catches in the Colville and Mackenzie rivers to the west and east (Craig and Haldorson 1986, Irvine et al. 2009a). In South Slope rivers, Chinook salmon are common in the Chandalar, Christian, and Sheenjek rivers (Barton 1984). However, spawning is primarily observed in lower portions of these drainages, in areas south of the Refuge border. Thus it is likely that only a small proportion of these fish utilize Refuge waters (Buklis and Barton 1984). In the Refuge, tagging data and aerial observations indicate Chinook salmon are present in the East Fork of the Chandalar and Upper Sheenjek rivers (Barton 1984, Eiler et al. 2004, Eiler et al. 2006a, Eiler et al. 2006b) and in the Coleen

River (Barton 1984). Chinook salmon also pass through the Refuge via the Porcupine River, en route to spawning areas in Canada.

Chinook salmon are harvested in commercial, sport, and subsistence fisheries throughout the Yukon River drainage; however, no harvest data exist for Refuge waters (Hayes et al. 2008).

Chum Salmon

Chum salmon (*Oncorhynchus keta*) are distributed on the western coast of North America, from southern California to the Arctic, and in adjacent waters of Asia, from Korea to Japan (Scott and Crossman 1973). Chum salmon are semelparous and anadromous (Horne-Brine et al. 2009). Fry emerge from gravel nests in early spring and shortly thereafter begin to disperse to the marine environment. Individuals return to freshwater to spawn in natal tributaries beginning in summer and fall (Gilk et al. 2009, Horne-Brine 2009). On the spawning grounds, females construct gravel nests where eggs are deposited and subsequently covered with gravel (Morrow 1980).

In the Refuge, chum salmon are found in rivers on the north and south sides of the Brooks Range. In North Slope waters of the Refuge, chum salmon have been captured in low numbers in the Sadlerochit, Sagavanirktok, and Canning rivers, as well as nearshore coastal areas (Smith and Glesne 1982, Craig and Haldorson 1986, Brown 2008). Currently it is unknown if these fish are members of established, reproducing populations in North Slope rivers or strays originating from more southerly drainages (Bendock and Burr 1984, Craig and Haldorson 1986, Irvine et al. 2009b). In South Slope rivers, chum salmon are more common; it is the most abundant salmon species in the Yukon River drainage (Barton 1984). Sonar-derived population estimates between 1995 and 2006 in the Chandalar and Sheejek rivers ranged from 65,000 to 496,000 and 14,000 to 438,000 fall chum, respectively (Melegari and Osborne 2007). However, the proportion of these fish that move into Refuge waters is likely small, as the primary spawning grounds for these fish are located downstream of Refuge borders (Buklis and Barton 1984). Within Refuge borders, chum salmon have been found in the East Fork of the Chandalar River and an unnamed tributary of the East Fork near Big and Little Rock Mountain (ADFG 2009). An aerial survey by Rost (1986) estimated 400 chum salmon in the Coleen River, with some fish located upstream as far as Pass Creek (ADFG 2009). Chum salmon have also been found in the Salmon Trout River and Sheenjek River north of White Snow Mountain (Barton 1984, ADFG 2009). Furthermore, between 1995 and 2006, an average of 35,000 fall chum migrated through the Refuge via the Porcupine River to spawning areas in the Fishing Branch River and other tributaries in Canada (Melegari and Osborne 2007).

The residents of Kaktovik report infrequently harvesting chum salmon in subsistence fisheries in nearshore areas surrounding Barter Island on the North Slope (Pedersen and Linn 2005). South slope populations are harvested in commercial, sport, and subsistence fisheries throughout the Yukon River drainage; however, no harvest data specific to Refuge waters could be found (Hayes et al. 2008).

4.3.5.3 Marine Species

Arctic Cod

Arctic cod (*Boreogadus saida*) are a marine species distributed throughout the entire northern polar basin, around Greenland and Iceland, into Hudson Bay, and in the North Bering Sea (Cohen et al. 1990). Arctic cod prefer cold (0-6 °C), saline (20-30 ppt) habitats but are at least temporarily tolerant of fluctuating temperatures, salinities, and turbidities, as they are found in both inshore and offshore marine areas, estuaries, and occasionally in coastal rivers (Lowry and Frost 1981, Craig et al. 1982, Cohen et al. 1990). During late summer and fall, Arctic cod may aggregate into large schools and move into nearshore coastal areas that are transitioning from estuarine to marine conditions (Craig et al. 1982, Hop et al. 1997). Seasonal movements and schooling behavior may be associated with spawning, foraging, predator avoidance, or habitat availability, as Arctic cod are often found associated with the edges of pack ice (Welch et al. 1993, Hop et al. 1997). Spawning occurs under ice between November and March, presumably close to shore (Lowry and Frost 1981, Craig et al. 1982).

In the Refuge, Arctic cod are widely distributed throughout nearshore coastal areas of the Beaufort Sea (Craig et al. 1982, Underwood et al. 1995) and may be the most abundant and widely distributed fish species in the Beaufort Sea (Lowry and Frost 1981, Craig et al. 1982, Craig 1984). Catch data suggest Arctic cod are more abundant in coastal areas west of the Refuge, with one estimate during the summer of 1978 in Simpson lagoon numbering in the millions (Craig et al. 1982, Jarvela and Thorsteinson 1999). In the Refuge, catch rates of Arctic cod are variable in and among years and areas but tend to increase during late summer and fall (Griffiths et al. 1977, Fruge et al. 1989, West and Fruge 1989, Underwood et al. 1995, Wiswar et al. 1995, Jarvela and Thorsteinson 1999, Brown 2008).

There is some evidence that Arctic cod are harvested in subsistence fisheries in Kaktovik and Jago lagoons by residents of Kaktovik (Griffiths et al. 1977).

Saffron Cod

Saffron cod (*Eleginus gracilis*) are a marine species distributed throughout the North Pacific, from the Yellow Sea in Asia to southeast Alaska and north in the Arctic Ocean, from eastern Siberia to northwestern Canada (Morrow 1980, Cohen et al. 1990). Saffron cod inhabit both in- and offshore marine and estuarine areas and are occasionally found in coastal rivers (Morrow 1980). Fish tend to move inshore in fall and winter to spawn, then move offshore in spring and summer to feed in deeper habitats (Morrow 1980).

In the Refuge, saffron cod are widely distributed in nearshore coastal areas of the Beaufort Sea (Wiswar and West 1987, Fruge et al. 1989, Wiswar et al. 1995, Brown 2008). Biological data pertaining to saffron cod are largely limited to catch data and are available for nearshore areas in the Refuge (Griffiths 1984, Wiswar and West 1987, Fruge et al. 1989, Wiswar et al. 1995, Brown 2008) and outside (Bendock 1977, Craig et al. 1985, Fechhelm et al. 2006) the Refuge. Catch rates vary substantially among years and areas.

Fourhorn Sculpin

Fourhorn sculpin (*Myoxocephalus quadricornis*) are a marine species distributed throughout the circumpolar north, from the Baltic Sea east across northern Siberia, to the Arctic coast of Canada, and south to Norton Sound, Alaska (Andriyashev 1954, Morrow 1980). Fourhorn sculpin rarely descend below 15-20 m and inhabit cold nearshore marine and estuarine coastal areas year-round, occasionally moving into coastal streams and rivers (Griffiths et al. 1977, Morrow 1980).

In the Refuge, fourhorn sculpin are widely distributed in nearshore coastal areas of the Beaufort Sea (Griffiths et al. 1977, West and Wiswar 1985, Wiswar and West 1987, Underwood et al. 1995, Wiswar et al. 1995, Jarvela and Thorsteinson 1999, Brown 2008). Biological data pertaining to fourhorn sculpin are largely limited to catch data and are available for nearshore areas in the Refuge (Griffiths et al. 1977, West and Wiswar 1985, Wiswar and West 1987, Underwood et al. 1995, Wiswar et al. 1995, Jarvela and Thorsteinson 1999, Brown 2008) and outside (Percy et al. 1974, Griffiths et al. 1975, Craig and Haldorson 1981, Jarvela and Thorsteinson 1999) the Refuge. While catches vary among years and areas, fourhorn sculpin are typically one of the most frequently, if not the most frequently, captured species in nearshore areas of the Refuge.

Arctic Flounder

Arctic flounder (*Liopsetta glacialis*) are a marine species that is distributed from Queen Maude Gulf in Arctic Canada, west along the coast of North America to Siberia, and south to Bristol Bay, Alaska (Andriyashev 1954, Morrow 1980). Arctic flounder typically remain close to shore, inhabiting shallow brackish water habitats and river deltas, occasionally entering rivers and delta lakes (Craig 1977c, Wilson et al. 1977). Spawning occurs in coastal areas (Andriyashev 1954, Morrow 1980).

In the Refuge, Arctic flounder are found throughout nearshore coastal areas of the Beaufort Sea (Griffiths et al. 1977, Wiswar 1986, Jarvela and Thorsteinson 1999, Brown 2008). Relative to Arctic cod and fourhorn sculpin, Arctic flounder are less frequently captured but still common in nearshore areas of the Beaufort Sea coast (Percy et al. 1974, Griffiths et al. 1975, Craig and Haldorson 1981, Jarvela and Thorsteinson 1999, Fechhelm et al. 2006), including areas in the Refuge (Griffiths et al. 1977, Wiswar 1986, Underwood et al. 1995, Jarvela and Thorsteinson 1999, Brown 2008). Arctic flounder are infrequently captured in subsistence fisheries by the residents of Kaktovik, in waters surrounding Barter Island (Pedersen and Linn 2005).

4.3.5.4 Climate Change Impacts on Fish

As the Arctic climate continues to warm, biological, chemical, and physical changes to aquatic ecosystems are occurring (Martin et al. 2009). These changes will alter the structure and function of aquatic ecosystems and have direct and indirect effects on fish, especially in Arctic Refuge where species are at the northern limit of their range.

Adequate water quality, food availability, winter water volume, and flow timing and magnitude limit fish habitat use (Craig 1989a). Adequate water quality is important to fish at all life history stages and varies relative to the species and life history stage considered. In freshwater systems, poor water quality conditions are more likely to occur during winter when habitats are ice-covered and summer when temperatures are warm, productivity is high, and habitats are thermally stratified. Food availability in summer feeding habitats must be adequate to meet energetic demands and allow fish to build overwintering reserves. Adequate volumes of water in overwintering habitats are critical during winter and only exist in deep lakes (Trawicki et al. 1991), spring-fed streams (Childers et al. 1977, Craig 1989a), and deep pools in the lower reaches of large rivers (Ward and Craig 1974). Adequate flow between habitats is crucial to the survival of resident and anadromous fish traveling from summer feeding areas to these limited overwintering habitats. During spring, peak flows aid in the downstream dispersal of juvenile fish to rearing habitats and migration of adult fish to summer feeding habitats in lakes, streams, and estuaries. Collectively changes in water quality, food availability, water storage, and the magnitude and timing of flow will likely alter habitats, leading to local extirpations and changes in abundance, distribution, and the prominence of various life history forms. A lack of biological information and an incomplete understanding of the effects of climate change on aquatic ecosystems will make it difficult to predict and quantify the subsequent effects on fish (Arctic Climate Impact Assessment 2005).

Freshwater and anadromous fish use a wide range of Refuge habitats, including small ponds, lakes, streams, rivers, and estuaries. Lakes and small ponds are important to resident and anadromous species at various stages in their life history. Mountain and Foothill lakes tend to be deeper than coastal plain lakes and may support large populations of resident and anadromous fish. Many depression and thaw lakes on the coastal plain are isolated from deeper waters, are too shallow to support overwintering populations, and do not support fish, even seasonally. Other lakes, such as riverine and delta lakes, may be connected seasonally during flooding events and provide spawning, rearing, and feeding habitat for resident and anadromous species.

Refuge streams and rivers provide important habitat and migratory pathways for anadromous and resident species. Craig and McCart (1975) classified North Slope lentic habitats into three broad categories: mountain, spring-fed, and tundra streams. Mountain streams are typically steep, fast flowing, have gravel substrates, and are fed by varying proportions of snowmelt, glacial meltwater, and spring-fed tributaries. These gravel-bottomed streams are often braided, subject to scour during flooding events, and have low invertebrate densities. Flow in small mountain streams is often intermittent. Waters are typically cold relative to streams at lower elevations. Mountain streams may support feeding, rearing, and overwintering of resident and anadromous species in lower reaches and, when contributions from springs are present, in mid to upper reaches. Spring-fed streams are often tributaries of mountain streams, have relatively stable flows and temperatures throughout the year, and tend to have high invertebrate densities. Spring-fed streams provide critical spawning and overwintering habitat for anadromous and resident species. Tundra streams fed by surface runoff originate in the Foothills and coastal plain ecoregions. They are typically meandering or beaded systems with low to moderate invertebrate densities and substrate composed of silt, sand, and organic matter. These systems may be important spawning, rearing, and feeding habitats for resident and anadromous species, but are too shallow to provide overwintering habitat.

During the spring and summer, North Slope streams and rivers deliver water, nutrients, and sediments to shallow coastal habitats. These flows help fuel lower trophic levels and maintain waters that are warm and brackish relative to cold, saline ocean waters. Compared to streams and rivers, lagoons support much higher densities of invertebrates, making anadromy an advantageous life history strategy for species tied to overwintering or spawning in freshwater habitats (Craig 1989).

On the South Slope of the Refuge, streams originate in the mountains and in Old Crow Basin. The upper reaches of large mountain tributaries are often fed by springs. The lower reaches of large mountain tributaries tend to be deeper, have larger volumes of water available in deep pools during winter, and may have more reliable connections to floodplain lakes during the ice-free season when compared to the large mountain streams on the North Slope.

Various climate conditions and hydrologic and geomorphic processes are essential for maintaining water quality, food availability, winter water volumes, and adequate timing and magnitude of flows. By mid-century dramatic changes to the arctic climate, hydrologic cycle, and landforms will likely occur (Martin et al. 2009). The relative importance of and interactions between these changes will likely vary seasonally, between ecoregions and with waterbody type. Warmer temperatures will lead to earlier snowmelt and an extension in the duration of the ice-free season. During the summer, warmer air temperatures, changes in reflected light, and the extended duration of the summer season will lead to increased water temperatures in freshwater systems. Shallow lakes and streams will be more sensitive to warming than deeper waterbodies, especially those fed by springs. The strength and occurrence of thermal stratification in deeper lakes may increase, leading to a decrease in the susceptibility to wind-driven mixing and an increase in the potential for oxygen deficits. Erosion associated with the degradation of permafrost may affect sedimentation rates, turbidity, and productivity. Increased productivity in the summer could lead to shifts in the relative importance of benthic and pelagic productivity, which could result in changes in prey availability and reduce feeding efficiency. Increased productivity could also lead to increased decomposition rates and oxygen demand in overwintering habitats. Increased winter precipitation may limit light availability and primary productivity below ice-cover, which could exacerbate oxygen deficits in overwintering habitat. Changes in precipitation, water storage capacity, freeze-thaw cycles, and rain on snow events will alter the magnitude and duration of peak flows, which will undoubtedly occur earlier. Changes in the timing of snowmelt will vary between ecoregions, which could lead to changes in ice-dam flooding and interrupt dispersal and migratory movement during spring. Increased evapotranspiration rates, loss of glaciers, a deeper active layer, and the extended duration of the summer season could lead to lower surface water levels, drying of streams and rivers, and fragmentation of habitats during the summer. Degradation of permafrost could lead to formation of pits, troughs, and slumps that could intercept subsurface flows or create new drainage networks, resulting in drying of existing migratory corridors. Loss of relatively warm fresh water flows to estuarine habitats coupled with increased frequency and severity of storm events and degradation of barrier islands could cause the physical and chemical environment in lagoons to transition from warm brackish estuarine conditions to cold saline oceanic conditions earlier in the season.

These changes in climate, hydrology, and landforms will have a wide range of effects on fish and their habitat. Water temperature is an important factor determining the survival, growth, and reproductive success of aquatic organisms. In freshwater habitats of Arctic Refuge, many fish species may initially benefit from warmer water temperatures (Craig 1989a, Reist et al. 2006) and the extended duration of the summer season. As water temperatures rise past optima for cold-water adapted species, especially those with a narrow range of thermal tolerance, physiological stress and increasing metabolic demands may lead to declines in productivity (Tonn 1990), genetic change through natural selection (Reist et al. 2006), or local extirpations (Arctic Climate Impact Assessment 2005). Warmer water temperatures will likely increase the incidence of disease and parasites (Reist et al. 2006) and benefit fish species expanding their range northward, giving these species a competitive advantage over native cold-water tolerant species.

As the duration of the summer season increases, the relationship between photoperiod and thermal regimes will change and phenological mismatches between migration, water levels, peak flows, egg hatching, food availability, water quality, and presence of predators may occur. For example, increased water temperature and the extended duration of the summer season could lead to asynchrony in the timing of temperature-dependent egg hatching and juvenile fish dispersal relative to the availability of their prey resources or presence of predators. Unless temperature increases beyond their physiological tolerance limits, however, the extended duration of the ice-free season will likely benefit most juvenile fish species by extending the time available for building reserves prior to a shorter overwintering season.

During the summer, some aquatic habitats may provide thermal refugia and/or be important migratory corridors linking habitats. Changes in temperature and connectivity between habitats may alter habitat quality, influence behavior, and prohibit migration of some species (Martin et al. 2009). The negative effects of increased temperature on some species may be offset by proportional increases in food availability as a result of additional nutrient inputs and the extended summer season (Reist et al. 2006). Increased water temperature and changes in nutrient inputs associated with deepening of groundwater flow paths or increased terrestrial inputs associated with changes in riparian vegetation could lead to increased rates of primary and secondary productivity. Initially fish may benefit from increases in productivity; however, increased ecosystem respiration rates may decrease dissolved oxygen concentrations in ice-covered overwintering habitats and the deepest, coldest layer of thermally stratified lakes (Reist et al. 2006). Reduced oxygen concentrations will have a negative impact on sensitive fish species using these habitats, especially during winter when habitat availability is drastically reduced (Craig 1989a). Additionally, shifts in the relative importance of benthic and pelagic primary productivity associated with increased nutrients could have a negative impact on fish production if feeding efficiencies decrease.

Other changes in water quality may occur as rates of permafrost degradation and glacier melt increase. Rates of erosion, thermokarst failure, and occurrence of thaw slumps will likely increase along moderate elevation gradients with ice-rich soils. The occurrence of thaw slumps could have a negative impact on water quality and lead to local extirpation of populations (Brown et al. 2011). Bioavailability of mercury is also expected to increase with deepening of the active layer, increased rates of glacier melt, and increased fire frequency and intensity. Changes in riparian vegetation, canopy cover, shifts to deciduous species could lead to changes in snow distribution, channel morphology, terrestrial inputs, invertebrate community composition and food availability for fish.

Large-scale changes in hydrologic regimes that lead to a change in the timing or magnitude of peak flow or decreased connectivity in streams and between lakes could have a negative impact on fish. These changes could alter timing and extent of juvenile dispersal, decrease genetic flow between populations, and prevent seasonal migrations, stranding adults traveling to overwintering areas.

In areas of discontinuous permafrost on the south side of the Refuge, degradation of permafrost has led to an increase in the relative contribution of cool sub-permafrost groundwater relative to surface flow in some locations (Walvoord and Striegl 2007). If these trends continue, an increase in the contribution of cool groundwater inflows may mitigate the effects of surface water warming in areas of discontinuous permafrost. While cooler groundwater inflows may buffer increases in temperature, decreased oxygen concentrations may increase physiological stress to some fish species (Brown et al. 2011).

On the coastal plain, deepening of the active layer, a downward shift to subsurface flows, and increased evapotranspiration rates will likely to lead to shallower nutrient-enriched waters that are more susceptible to solar warming and in some cases drying. Extended periods of drying and prolonged high temperatures could prevent migration to overwintering habitats and could have a negative impact on some anadromous and freshwater resident species that use shallow coastal plain lakes for summer feeding and overwintering (Deegan and Peterson 1992). This loss of late summer connectivity between habitats could also keep fish from benefitting from the extension of the summer feeding season.

On mid to low elevation slopes of the foothills and Davidson Mountains, increased storage associated with deepening of the active layer and groundwater flow paths could lead to an increase in late summer and winter base flows and changes in water chemistry. An increase in summer base flows could buffer effects of increased warming, help maintain access to summer feeding and overwintering habitats, and have a positive effect on most species.

Collectively, these losses in surface water discharge from rivers fed by glacial meltwater, and mountain, foothills, and coastal plain streams on the North Slope could have a negative impact on coastal ecosystems where relatively warm freshwater inputs help maintain warm brackish conditions in lagoons and nearshore coastal habitats. Ocean water conditions tend to be extremely cold (below 32 °F), saline (30 ppt), and outside the long term thermal and salinity tolerance limits of most freshwater and anadromous species inhabiting Arctic Refuge. Loss of freshwater input coupled with loss of sea-ice and protective barrier islands, and an increase in the frequency and severity of storm surges will contribute to the deterioration of the nearshore band and lead to earlier mixing of cold saline ocean waters into lagoons and other nearshore areas. Colder, more saline conditions in these productive nearshore marine environments would have a negative impact on anadromous species, but would likely increase habitat quality for cold-water tolerant marine species. Freshwater resident species, such as Arctic grayling, using nearshore environments as a corridor for interdrainage exchange (Wiswar et al. 1986, West et al. 1992) would also be negatively affected. In addition to changes in salinity and temperature, acidification of ocean ecosystems may affect multiple food web components and have cascading effects on both marine and anadromous fish.

Predicting responses of anadromous fish that integrate changes in marine and freshwater environments will be difficult, particularly for species such as Dolly Varden that have facultative life history strategies (Reist et al. 2006). Loss of glacial meltwater will have important implications for adult Dolly Varden during two critical life history stages: summer feeding in estuarine areas and late summer migration to spawning and overwintering habitat. Loss of instream connectivity and fragmentation of habitat could occur any time following break-up, but will likely increase in frequency and extent as the summer progresses and Dolly Varden are undergoing critical migrations to upstream spawning and overwintering habitat. During the summer feeding season, loss of glacial meltwater could have a negative impact on Dolly Varden feeding in lagoons where relatively warm freshwater inputs help maintain warm brackish conditions. Without substantial freshwater input, the thermal stratification that formed early in the summer season may not be maintained, causing coastal lagoons to take on cold, saline ocean conditions that are far outside the optimal thermal and salinity conditions for Dolly Varden. If their estuarine summer feeding habitat becomes inhospitable and/or late summer connections between summer feeding and overwintering habitat become unreliable, Dolly Varden may spend less time feeding in coastal waters and more time feeding in rivers. Since coastal waters have relatively high densities of prey compared to glacial rivers, this change would have a negative effect on individual growth rates and population size. Cooler, more saline conditions in these productive nearshore marine environments may increase habitat quality for cold-water tolerant marine species, such as saffron cod.

To better understand and predict the effects of climate change on future distributions, health, and biodiversity of fishes in Arctic Refuge, we need a better understanding of physical, chemical, and biological processes that drive the functioning of aquatic ecosystems. To document the effects of climate change on fish in Arctic Refuge, long-term monitoring of climate, phenology, hydrology, and geomorphic processes should be conducted in concert with aquatic ecosystem studies. Studies on fish in Arctic Refuge have been scarce over the past few decades, and baseline data on distributions, lower trophic levels, productivity, diets, life history strategies, genetic diversity, and phenotypic plasticity are needed to assess future changes and help guide future studies and long-term monitoring. A more detailed assessment of potential threats relative to biological thresholds will help guide these efforts. The potential for synergistic interactions between climate change and other threats such as development, introduction of invasive species, contaminants, and consumptive use should be considered as well. Freshwater habitats along the coast will become more vulnerable to salinization and drainage as sea level rises, the severity and frequency of storm surges increase, and rates of coastal erosion increase.

4.3.6 Birds

Common and scientific names of birds follow American Ornithologists' Union (1983) and subsequent supplements. There have been 201 species of birds recorded on the Refuge (see Appendix F). Of these, 109 are confirmed as breeding on the Refuge, and another 35 species likely breed there, although breeding has not been confirmed. Twenty-two species use the Refuge during migration only or are regular visitors, and 35 species are rare visitors or vagrants that do not regularly occur on the Refuge. In the northern foothills of the Brooks Range, Arctic coastal plain and adjacent marine waters, 158 species have been recorded, including 79 breeding species and 79 species that are migrants, visitors, or vagrants. In the Brooks Range, 107 species have been recorded, of which 68 are breeders and 39 are migrants, visitors, or vagrants. On the south side of the Brooks Range and in the adjacent boreal forest areas, 136 species have been recorded, of which 105 are breeders, and 20 are migrants, visitors, or vagrants.

Birds that use the Refuge have ranges that include all 50 U.S. states and six continents. Birds that breed and are reared in northern Alaska likely migrate as far as Antarctica (Arctic terns), New Zealand (bar-tailed godwits) and sub- Saharan Africa (northern wheatear). There are also 25 species that are year-around residents on the Refuge, mostly in boreal forest areas. Residents include two species of ptarmigan (rock and willow), three grouse species (ruffed, spruce, and sharp-tailed), gyrfalcon, five species of owls (great-horned, snowy, northern hawk-owl, great grey, and boreal), four species of woodpeckers (downy, hairy, American three-toed, and black-backed), gray jay, common raven, three species of chickadees (black-capped, boreal, and gray-headed), American dipper, pine grosbeak, white-winged crossbill, and common and hoary redpolls.

Although some Refuge bird species have been well studied, e.g., golden eagles and snow geese (Douglas et al. 2002), distribution and abundance data are lacking for many. In the following sections, we describe what is known about the various species and species groups found on the Refuge.

4.3.6.1 Waterfowl

Thirty-five species of waterfowl have been observed on the Refuge. Of these, 24 species occur as breeders or migrants (Appendix F), including 2, 5, and 17 species of swans, geese, and ducks, respectively. The ducks include 5 species of dabblers, 2 species of bay or diving duck, and 10 species of sea ducks. The geese primarily breed on the coastal plain, but one species, the Canada goose, is only found on the south side of the Refuge. Tundra swans mostly breed on the coastal plain and trumpeter swans breed in wetlands in boreal forest areas.

Most of the dabbling ducks breed on the south side of the Refuge, although green-winged teal and northern pintail also breed on the coastal plain. The sea ducks can be further broken down in to several sub-groups: eiders, harlequin ducks, scoters, long-tailed ducks, goldeneyes, and mergansers. Eiders and long-tailed ducks breed on the coastal plain and utilize adjacent coastal areas. Scoters are most abundant as migrants in the Beaufort Sea but also breed on the inland coastal plain, in the Brooks Range, and on the south side of the Refuge. Harlequin ducks are primarily associated with fast moving streams in the Brooks Range during the breeding season. Buffleheads and goldeneyes are primarily associated with the boreal forest. Red-breasted mergansers, the more common of the two merganser species, breed throughout the Refuge and spend post-breeding molting periods in coastal areas.

Waterfowl are an important subsistence resource for local rural residents (P. Willams, local resident, pers. comm., Jacobson and Wentworth 1982, Naves 2010). Kaktovik residents hunt brant, snow geese, cackling geese, northern pintails, long-tailed ducks, common eiders, and king eiders (Jacobson and Wentworth 1982). Eider and long-tailed duck eggs are occasionally harvested as well. In the following sections, we summarize results from surveys and research conducted on specific waterfowl species on the Refuge.

Swans

Tundra Swan—In 1986, the U. S. Fish and Wildlife Service, Division of Migratory Bird Management, initiated annual surveys for breeding birds on the Arctic coastal plain, including a portion of Arctic Refuge (Larned et al. 2009). Arctic Refuge stratum covers less than two percent of the entire survey area. During the period 1992–2008, Tundra swan populations increased across the Arctic coastal plain of Alaska (Larned et al. 2009).

Trumpeter Swan—Every five years since 1968, U.S. Fish and Wildlife Service, Division of Migratory Bird Management, has conducted summer surveys of trumpeter swans in interior Alaska, including the south side of Arctic Refuge (Conant et al. 2007). Numbers of swans observed in the Yukon Flats survey region, which includes southern portions of Arctic Refuge, have increased dramatically over this period. Ground-based surveys are needed to verify whether these birds are trumpeter swans or tundra swans (A. Brackney, wildlife biologist at Arctic Refuge, pers. comm.).

Geese

Snow Geese—During fall, snow geese and other geese concentrate on the coastal plain. Snow geese in particular occur in great numbers during late August and September; at times more than 300,000 snow geese stage on the coastal plain prior to fall migration (Table 4-6) (Garner and Reynolds 1986, Kendall 2006). These geese nest on Banks Island and other areas in the Canadian Arctic. After breeding, they move westward to the coastal plain of northwest Canada and northeast Alaska. Numbers of snow geese using Arctic Refuge vary inversely with the numbers staging in Canada. These birds remain on the coastal plain for several weeks, foraging on cotton grass and equisetum in upland and coastal tundra habitats (Hupp et al. 2002). When the first persisting snowfall occurs, they fly back east for their southward migration through the MacKenzie River valley.

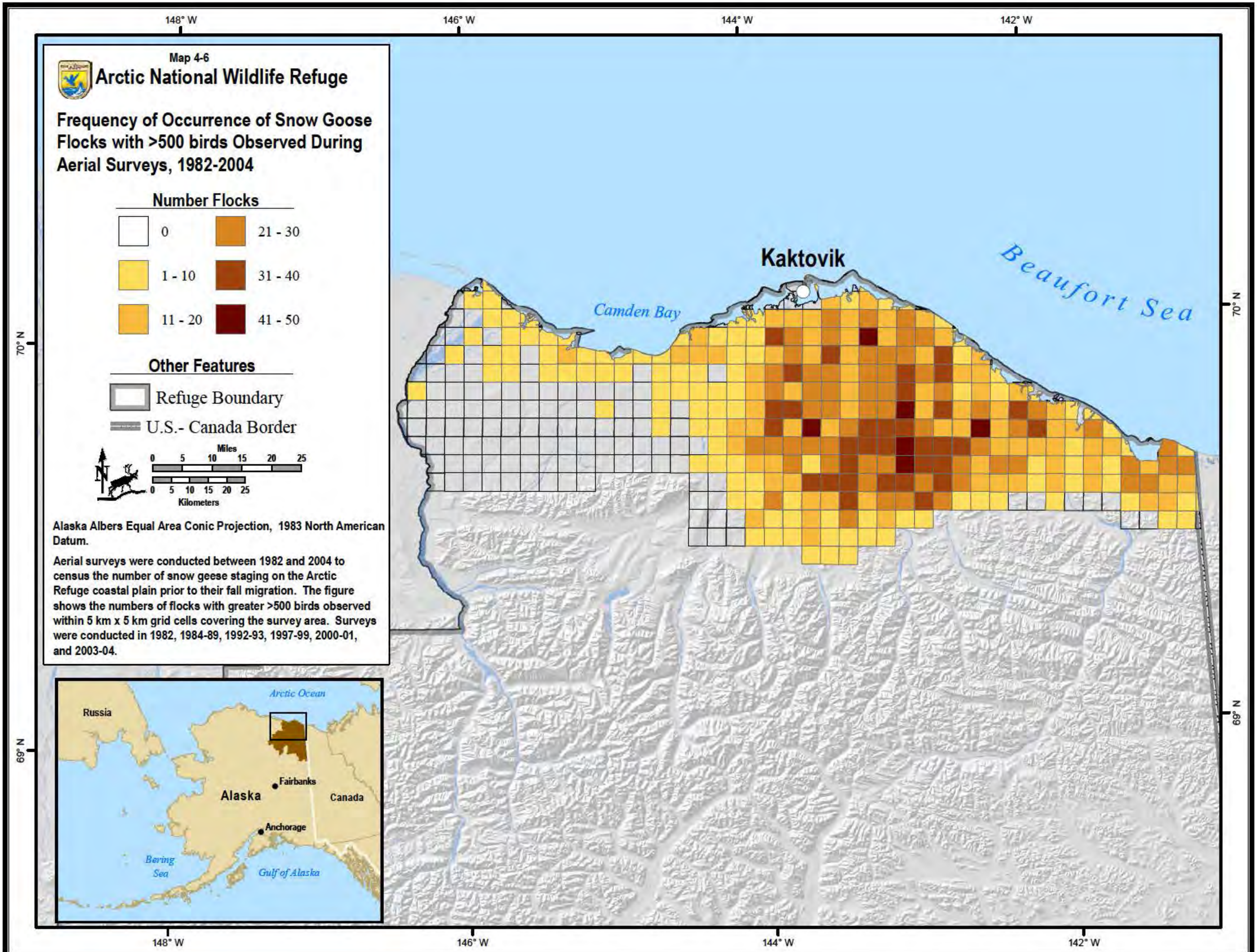
Map 4-6 shows frequency of observations of snow goose flocks on Arctic Refuge coastal plain during surveys from 1982–2004. Snow geese depend on this staging period to build energy reserves needed for their southward migration (Brackney and Hupp 1993). They are easily disturbed by aircraft or other human intrusions during the staging period, making them vulnerable to displacement from important foraging areas.

Table 4-6. Maximum post-breeding snow goose counts on the Refuge

Year	Peak Count
1973[1]	44,037
1974[1]	48,591
1975[1]	0
1976[1]	228,793
1978[1]	325,760[4]
1979[2]	195,000
1980[2]	8,996
1981[2]	20,000
1982[3]	107,072[4]
1983[3]	19,787[4]
1984[3]	94,528[4]
1985[3]	309,225
1986[3]	217,435[4]
1987[3]	107,000[4]
1988[3]	50,800[4]
1989[3]	72,000[4]
1992[3]	60,700
1993[3]	89,500
1997[3]	104,626
1998[3]	28,365
1999[3]	108,000
2000[3]	164,562
2001[3]	93,905
2003[3]	76,422 (186,715[5])
2004[3]	189,636[4]
Mean	106,109
Std Dev	87,933
Median	89,500

[1] Populations extrapolated from transect counts.
[2] Combination of total flock counts and photographic counts
[3] Total flock counts.
[4] Adjusted for observer error.
[5] Adjusted for observer error using the correction factor from 2004.

Notes: Maximum post-breeding snow goose counts on the Arctic National Wildlife Refuge, Alaska: 1973–1981 (Spindler 1982a), 1982 (Spindler 1982b), 1983 (Spindler 1983), 1984 (Oates et al. 1985), 1985 (Roberstson et al. 1997), 1986–1987 (Brackney 1988), 1988 (Brackney 1989), 1989 (Brackney 1990), 1992–1993 (Robertson et al. 1997), 1997–2001 (Boyle et al. 2002), and 2003–2004 (Kendall 2006).



Map 4-6
Arctic National Wildlife Refuge
Frequency of Occurrence of Snow Goose Flocks with >500 birds Observed During Aerial Surveys, 1982-2004
Number Flocks
0
1 - 10
11 - 20
21 - 30
31 - 40
41 - 50
Other Features
Refuge Boundary
U.S.- Canada Border
Miles
0 5 10 15 20 25
0 5 10 15 20 25
Kilometers
N
Alaska Albers Equal Area Conic Projection, 1983 North American Datum.
Aerial surveys were conducted between 1982 and 2004 to census the number of snow geese staging on the Arctic Refuge coastal plain prior to their fall migration. The figure shows the numbers of flocks with greater >500 birds observed within 5 km x 5 km grid cells covering the survey area. Surveys were conducted in 1982, 1984-89, 1992-93, 1997-99, 2000-01, and 2003-04.
Kaktovik
Camden Bay
Beaufort Sea
148° W
146° W
144° W
142° W
70° N
69° N
Arctic Ocean
Russia
Alaska
Fairbanks
Anchorage
Canada
Bering Sea
Gulf of Alaska

Ducks

Common Eider—Common eiders are an important subsistence resource for residents of Beaufort Sea coast villages (Jacobson and Wentworth 1982). U.S. Fish and Wildlife Service, Division of Migratory Bird Management, conducts annual aerial surveys to estimate the number, population trend, and distribution of breeding common eiders in coastal habitats of the Alaskan Arctic coastal plain, including Arctic Refuge (Dau and Taylor 2000, Dau and Anderson 2001, Dau and Anderson 2002, Dau and Hodges 2003, Dau and Larned 2004, Dau and Larned 2005, Dau and Larned 2006, Dau and Larned 2007, Dau and Larned 2008, Dau and Bollinger 2009). The number of common eider pairs observed on the Refuge has ranged from 75 to 445, with considerable annual variation (Dau and Bollinger 2009). A ground based survey was conducted in 2003 and 2004 to estimate numbers of birds, common eiders in particular, that were nesting on Refuge barrier islands (Kendall 2005). A total of 341 eider nests were found during this survey. This was considerably higher than the number of nests (n=14) found during earlier surveys (Divoky 1978), in spite of decline in their population in northern Alaska during the intervening time period (Suydam et al. 2000). The increased nesting population on Refuge barrier islands maybe due to habitat changes. For example, warmer springs may have caused earlier melt of ice in lagoons, making barrier islands less accessible to nest predators such as Arctic foxes. However, these islands and the nesting habitat they provide, primarily driftwood, may be vulnerable to changes in sea conditions such as increased erosion and flooding associated with climate change.

Long-tailed Duck—Coastal lagoons formed by barrier islands provide molting and migratory staging areas for tens of thousands of long-tailed ducks (Brackney et al. 1987). Aerial survey conducted in 2002 and 2003 found up to 28,000 long-tailed ducks staging in lagoons on Arctic Refuge (Lysne et al. 2004). Long-tailed ducks nest on the Arctic coastal plain, but the number of birds found in Arctic Refuge lagoons likely far exceed the number breeding on adjacent tundra. This suggests that birds are migrating from a larger geographic area to use these habitats. There were large declines in numbers of long-tailed ducks breeding on the Arctic coastal plain from 1977 to 1998 (Hodges et al. 1996, Conant and Groves 1998), but in recent years, populations have been fairly stable at lower levels (Larned et al. 2009).

4.3.6.2 Upland Birds

Three grouse and two ptarmigan species occur on the Refuge (Appendix F). Ruffed, spruce and sharp-tailed grouse are found only on the south side of the Refuge. Rock and willow ptarmigan are found in all regions of the Refuge. All of these species are harvested by residents of villages adjacent to the Refuge (P. Willams, local resident, pers. comm., Jacobson and Wentworth 1982, Naves 2010). Ptarmigan are an important food source, especially in the spring, for Kaktovik residents (Jacobson and Wentworth 1982).

4.3.6.3 Loons and Grebes

Four species of loons are found on the Refuge (Appendix F). Red-throated and Pacific loons breed in all regions, whereas common loons breed only on the south side and occasionally visit coastal areas. Yellow-billed loons breed in low numbers on larger lakes in the Brooks Range, but also are fairly common migrants in marine areas.

Two species of grebe, red-necked and horned, occur on the Refuge. Both likely breed on the south side and visit other regions. Horned grebes have been identified as a species of Conservation Concern by the Service (2008a).

Yellow-billed Loon—In 2009, the Service determined that listing the yellow-billed loon as a threatened or endangered species was warranted under the Endangered Species Act, but listing was precluded by other higher priority listing actions. Listing a species as "warranted, but precluded" means the proposal to list is delayed while the Service works on listing proposals for other higher priority species.

Yellow-billed loon populations are vulnerable because of small population size, low reproductive rate, and very specific breeding habitat requirements. The species is also identified as a species with conservation concerns by the Service (2008a), Audubon Alaska (Stenhouse and Senner 2005), and Alaska Department of Fish and Game (ADFG 2006). Subsistence harvest surveys indicate a substantial number of yellow-billed loons are harvested in some years on the North Slope (Naves 2010). While they are not harvested in Kaktovik (Jacobson and Wentworth 1982), they may be occasionally taken in fish nets (Magoun and Robus 1977). In 2006, the Service worked cooperatively with a variety of Native, State and Federal partners to develop a conservation agreement to protect yellow-billed loons and their habitats in northern Alaska.

Yellow-billed loons breed in low numbers on Arctic Refuge, primarily in the northern foothills of the Brooks Range (Bee 1958). They are uncommon migrants and summer residents in the marine areas of the Refuge.

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

4.3.6.4 Seabirds and Alcids

Northern fulmars, short-tailed shearwaters, thick-billed murres, and horned puffins are rare coastal visitors in the summer. Black guillemots are summer residents in coastal areas and breed in low numbers on barrier islands.

4.3.6.5 Raptors

Birds of prey, or raptors, including hawks, eagles, falcons, and owls, are found in all regions of the Refuge. Most hawks breed on the south side or in the Brooks Range. Sharp-shinned hawks, northern goshawks, Swainson's hawks, and red-tailed hawks are all thought to breed on the south side. Northern harriers and rough-legged hawks occur in all regions of the Refuge and likely breed on the inland coastal plain, in the Brooks Range, and on the south side. Ospreys have been observed occasionally in all regions of the Refuge but are most often seen on the south side. Bald eagles visit the Brooks Range and coastal plain, but likely only breed on the south side. Golden eagles breed on the inland coastal plain, in the Brooks Range, and on the south side of the Refuge. Golden eagles are commonly observed on the coastal plain in late June and early July during years when calving and post-calving caribou herds are present (Garner and Reynolds 1986). These are primarily subadult birds (Mauer 1985a, Mauer 1987, Young et al. 2002) that are preying on or scavenging caribou calves. In a 1983–1985 study, golden eagles were the main predators on caribou calves on the calving grounds (Whitten et al. 1992, Griffith et al. 2002). It also appears that northern Alaska, including the Brooks Range and coastal plain of Arctic Refuge, is utilized by birds from other regions in the State. Eagles that were hatched in the Alaska Range were found in the Refuge during at least during two subsequent summers (McIntyre et al. 2008, C. McIntyre, wildlife biologist, National Park Service, pers. comm.).

Four species of falcons are found on the Refuge. Gyrfalcons breed throughout the Brooks Range, though not in high numbers. Merlins and American kestrels visit the coastal plain and breed in the Brooks Range and on the south side. Peregrine falcons also nest throughout the Brooks Range and foothills but are more abundant along south-side rivers with bluffs, particularly the Porcupine River. Two subspecies of peregrine falcons nest on the Refuge: the Arctic peregrine falcon north of the Continental Divide, and the American peregrine falcon to the south. These subspecies had been listed for protection under the Endangered Species Act, but both have been delisted.

Surveys have been conducted on several rivers in the Refuge to monitor cliff-nesting raptors, including the Canning, Hulahula, Kongakut, Porcupine, and Coleen rivers. Species nesting on cliffs along north-flowing rivers include golden eagles, peregrine falcons (*tundrius* subspecies), gyrfalcons, and rough-legged hawks. The primary cliff-nesting species along rivers draining into the Yukon River are peregrine falcons (*americanus* subspecies) and golden eagles (Payer and Kendall 2005, Ritchie and Maguire 2007).

4.3.6.6 Shorebirds

Twenty-six species of shorebirds breed on Arctic Refuge, 22 of which breed on the coastal plain. Another species, the red knot, occurs as a migrant only (Appendix F). Of these 27 species, 21 are identified as species of Moderate or High Conservation Concern by the U.S. Shorebird Conservation Plan (Brown et al. 2001), Alaska Shorebird Conservation Plan (Alaska Shorebird

Group 2008), the Service (2008a), and/or Audubon Alaska (Stenhouse and Senner 2005) because of small or declining populations. Information about critical breeding and migration stopover sites is needed to guide and support conservation activities for these species (Brown et al. 2001, International Wader Study Group 2003, Bart et al. 2007). Baseline data on shorebird population sizes, distributions, habitat requirements, and demographic parameters are needed to evaluate effects of climate change, which is projected to impact shorebird habitats through northward expansion of shrubs into tundra habitats and inundation and erosion of coastal habitats (Sturm et al. 2001, Arctic Climate Impact Assessment 2004). Shorebirds are also vulnerable to direct and indirect impacts from any development of oil and gas reserves in the vicinity of the Refuge (Meehan 1986, Troy 2000, National Research Council 2003).

The Program for Regional and International Shorebird Monitoring (PRISM) was developed as a method to monitor shorebirds in Canada and the United States (Harrington et al. 2002, Skagen et al. 2003, Bart et al. 2005). Using PRISM protocols, we conducted a study to provide baseline data on shorebird abundance and habitat use on the coastal plain of the Refuge (Brown et al. 2007b). We found the five most abundant shorebird species had estimated population sizes of 16,000–53,000, and the total estimated number of shorebirds of all species was approximately 230,000 (95 percent CI: 104,100–363,000, Table 4-7). This was approximately 1.7 percent (95 percent CI: 0.8 percent–2.6 percent) of the combined total estimated North American population for these species (Morrison et al. 2001, Morrison et al. 2006b) and higher than the biological criterion for designation as a site of International Importance under the Western Hemisphere Shorebird Reserve Network (WHSRN); 100,000 birds; (Western Hemisphere Shorebird Reserve Network 2006) and the Ramsar Convention (20,000 birds) (Ramsar 1999). The population size estimated for the pectoral sandpiper was greater than 10 percent of the estimated total population size for the species, which meets the criterion for a WHSRN site of International Importance for a particular species (Western Hemisphere Shorebird Reserve Network 2006). Population estimates were greater than one percent of the estimated total North American population for eight species (Table 4-7), the WHRSN criterion for designation of a site as a site of Regional Importance. Two of these species, American golden-plover and dunlin, are listed as species of Conservation Concern in the Alaska Shorebird Conservation Plan because of small or declining populations (Alaska Shorebird Group 2008).

Estimated densities, population sizes, and percentage of each shorebird species' total estimated population size in the 1002 Area of Arctic Refuge are displayed in Table 4-7. Estimates are grouped according to the number of intensive survey plot detections for each species. From Brown et al. (2007b).

Table 4-7. Estimated densities, population, and percentage of estimated shorebird populations in the 1002 Area

Species	Population size		Percent of population estimate (95% CI)[a]
	Estimate ± SE	(95% CI)	
American Golden-Plover	15,686 ± 3,340	9,142–22,232	7.8 (4.6–11.1)
Semipalmated Sandpiper	49,698 ± 12,300	25,590–73,804	1.4 (0.7–2.1)
Pectoral Sandpiper	52,978 ± 9,176	34,992–70 962	13.2 (8.7–17.7)
Dunlin	10,506 ± 4,112	2,448–18,564	1.4 (0.3–2.5)
Red-necked Phalarope	42,762 ± 8,814	25,488–60,038	1.7 (1.0–2.4)
Red Phalarope	23,226 ± 9,874	3,872–42,580	1.9 (0.3–3.4)
Ruddy Turnstone	2,984 ± 1,484	76–5,892	5.4 (0.1–10.7)
Western Sandpiper	252 ± 252	0–748	0.01 (0.00–0.02)
Stilt Sandpiper	6,218 ± 2,194	1,920–10,518	0.8 (0.2–1.3)
Long-billed Dowitcher	6,848 ± 3,190	594–13,102	1.7 (0.1–3.3)
All species	229,960 ± 22,487	104,122–362,938	1.7 (0.8–2.6)

[a] Percent of population estimate compares the number of birds of each species estimated to occur in the 1002 Area of Arctic National Wildlife Refuge coastal plain and the estimated total population size reported in Morrison et al. (2001), as revised (R. Morrison et al. 2006).

Brown et al. (2007b) found that wetland and riparian habitats, particularly in coastal areas and river deltas, are of particularly high value to many shorebird species. The importance of these habitats for breeding shorebirds should be considered when making management decisions. Shorebird density appears to be highest in wetland areas in the Canning River Delta region (Map 4-7) (Brown et al. 2007b). This is the portion of the Refuge closest to existing and proposed oil development on contiguous State-managed lands. Future research should address the importance of the Canning Delta wetlands for shorebirds and potential effects and mitigation of anthropogenic activities in the region.

Human development in Alaska's Arctic coastal plain, primarily associated with exploration and extraction of petroleum, may directly influence breeding bird populations through habitat loss, disturbance, and presence of contaminants (National Research Council 2003). There may also be indirect consequences, such as the availability of human food sources and man-made structures benefiting predator populations. Changes in predator populations could be an important factor affecting birds breeding on the Arctic coastal plain (National Research Council 2003). However, the dynamic of this predator prey relationship is not well understood.

A multi-year, multi-site study (including Arctic Refuge) that investigated the relationship between human development, nest predator populations, and nest survival of tundra-nesting birds found a negative effect on nest survival for passerines (lapland longspurs) but not shorebirds (Liebezeit et al. 2009). As with other studies conducted in the Arctic, Liebezeit et al. (2009) found substantial temporal and spatial variability in nest survival (Summers and Underhill 1987, Troy 2000).

A development (infrastructure) effect, if present, may be small relative to natural variability in the Arctic, rendering such effects difficult to detect. However, the higher predation risk detected for passerine nests near oil field facilities, along with evidence of the predator effects from elsewhere in the Arctic (Restani et al. 2001, R. Lanctot, unpublished data), is sufficient to warrant continued efforts to minimize benefits for predators. Any developments near the Refuge should be designed to reduce artificial nesting, perching, and denning sites and managed to limit access to food wastes.

Several species of shorebirds aggregate in coastal habitats of the northern Alaska after their breeding season (Connors 1984, Taylor et al. 2010). Staging in these habitats is thought to be necessary for building energy reserves for migration. Coastal areas of Arctic Refuge are vulnerable to climate change and offshore oil development in the eastern Beaufort Sea. Possible impacts include reduced sea ice cover and changing sea conditions causing flooding and increased coastal erosion, which threatens mudflats and other littoral areas used by shorebirds. In addition, large areas of the eastern Beaufort Sea north of Arctic Refuge have recently been leased for oil exploration and development. An oil spill in this region could have direct effects by oiling birds aggregated in coastal areas and indirect effects by impacting the food resources used by birds. Furthermore, onshore activities associated with offshore development may disturb and displace shorebirds from preferred staging areas.

Starting in 2005, Arctic Refuge worked with multiple partners to investigate shorebird use of coastal areas of the Refuge. We identified several high-use areas, but also found considerable inter-annual and within-season variability (Figure 4-2). It may be that there are no particular areas that are most important but rather birds depend on the conglomeration of all coastal habitats and move among sites depending on environmental conditions and food availability. Timing of use of coastal areas varied by species, but generally peak abundance was during the last week of July and the first week of August. However, shorebirds continue to use coastal habitats into September. Our observations suggested that habitat use is influenced by weather and water conditions, which likely determine food availability.

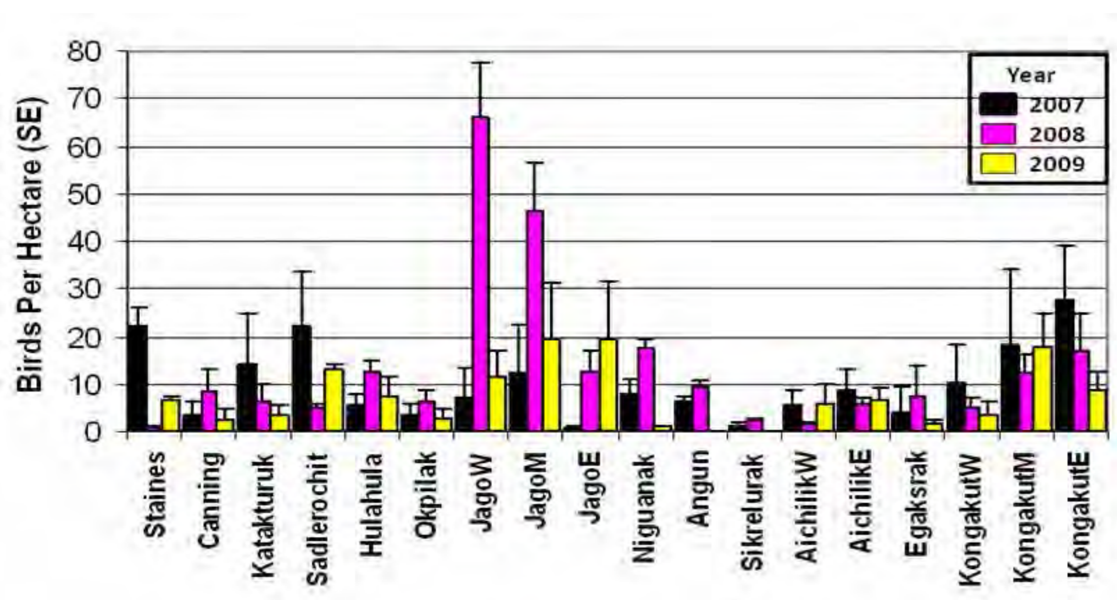
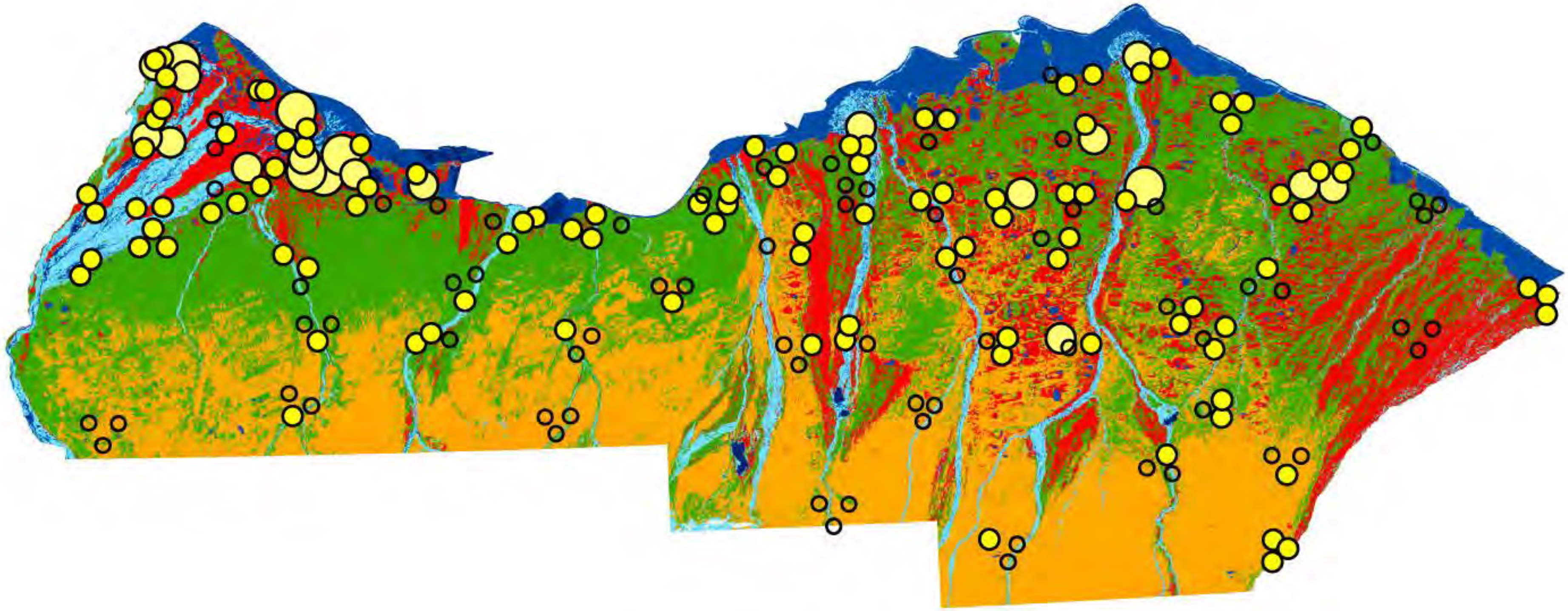


Figure 4-2. Shorebird density on Arctic Refuge delta mudflats observed during surveys, 2007–2009.



Map 4-7

Arctic National Wildlife Refuge

Habitat and Numbers of Shorebirds Detected on Plots during Surveys, 2002 and 2004

Habitat Types

- Riparian
- Wetland
- Upland
- Water
- Moist

No. Shorebirds

- 0
- 1 - 5
- 6 - 10
- 11- 19

N

Miles: 0 4 8 12 16 20

Kilometers: 0 4 8 12 16 20

Alaska Albers Equal Area Conic Projection, 1983 North American Datum.

Relative numbers of shorebirds detected during surveys of plots on the Arctic National Wildlife Refuge Coastal Plain, 2002 and 2004. Plots were randomly distributed in clusters of three throughout the 1002 Area of the Refuge. The study area was stratified by the 4 habitat classes shown (water was not included) and the number of plots in each strata was determined by relative abundance of shorebirds in each habitat as reported in Garner and Reynolds (1986). Fourteen habitat classes reported in Jorgensen el al. (1994) were combined to form the 4 habitat classes used as stratum.

Brown, S., J. Bart, R. B. Lanctot, J. Johnson, S. Kendall, D. Payer, and J, Johnson. 2007. Shorebird abundance and distribution on the coastal plain of the Arctic National Wildlife Refuge. Condor. 109:1-14.

4.3.6.7 Larids

Three jaegers species occur on the Refuge (Appendix F): parasitic jaegers, which breed in all regions of the Refuge; long-tailed jaegers, which breed on the coastal plain and in the Brooks Range; and Pomarine Jaegers, which breed on the coastal plain only in years of high microtine abundance (Wiley and Lee 2000, Kendall et al. 2007). Eleven gull species have been found on the Refuge. The most common are mew, glaucous, herring, and Sabine's gull. Sabine's gulls breed only on the coastal plain, glaucous gulls breed on the coastal plain and in the Brooks Range, herring gulls breed only on the south side, and mew gulls breed in all regions of the Refuge. Other gull species occur as migrants or vagrants.

Local residents report that glaucous gull populations on the coastal plain have been increasing. There is some evidence of increases in gull populations in the Arctic generally (National Research Council 2003), which could be due to global changes in their populations and/or increased human development in the area (Weiser and Powell 2010). Results of aerial surveys have shown glaucous gull populations across the Arctic coastal plain were stable from 1992 to 2008 (Larned et al. 2009), but increases could have occurred prior to this period or birds may have shifted their distribution. Distribution maps from these surveys indicate that gulls tended to be concentrated in the vicinity of human development on the coastal plain, including Kaktovik on Arctic Refuge (Mallek et al. 2002, Noel et al. 2006). Glaucous gull populations are likely regulated by the availability of nesting areas that are free of mammalian predators and close to abundant food sources (Gilchrist 2001). There are numerous accounts of glaucous gulls foraging in North Slope landfills (Day 1998, Weiser and Powell 2010), and they do nest on small islands in lakes and barrier islands (Kendall 2005). The combination of these conditions may benefit gull populations.

Sabine's gulls nest in single pairs or small colonies on the shores or islands of tundra lakes on the coastal plain (Johnson and Herter 1989). There are several small colonies at the Canning River Delta (Martin and Moitoret 1981, Kendall et al. 2007). Sabine's gull populations have increased in the past 10 years (Larned et al. 2009). Arctic terns breed on barrier islands, the coast plain, and in the Brooks Range. Arctic terns are listed as species of Conservation Concern by the Service (2008a) and as a species of High Conservation Concern in the North American Waterbird Conservation Plan (Kushlan et al. 2002). Herring gull, Long-tailed jaeger, parasitic jaeger, pomarine jaeger, and Sabine's gull are listed as species of Moderate Conservation Concern in the North American Waterbird Conservation Plan (Kushlan et al. 2002).

4.3.6.8 Owls

Six species of owls breed on the Refuge. Most are permanent residents in boreal forest areas. Snowy owls are intermittent visitors on the coastal plain, where they breed in years with high microtine populations. Short-eared owls breed in all regions of the Refuge and migrate south during the non-breeding season. Snowy, great grey, and boreal owls are identified as Priority Species for Conservation by Boreal Partners in Flight (Boreal Partners in Flight Working Group 1999), and short-eared owls are identified as a species of Conservation Concern by Audubon Alaska (Stenhouse and Senner 2005).

4.3.6.9 Woodpeckers

Five species of woodpeckers occur on the Refuge, four of which are rare or uncommon year-round residents in the boreal forest. A fifth species, northern flicker, nests in the Brooks Range and on the south side and migrates during the breeding season. Black-backed woodpeckers are identified as a Priority Species for Conservation by Boreal Partners in Flight (Boreal Partners in Flight Working Group 1999).

4.3.6.10 Landbirds

Sixty-seven species of passerines have been recorded on the Refuge: 53 of these species breed on the Refuge, two visit but are not known to breed, and 12 are vagrants. Most of the breeding birds (23 species) occur only in the boreal forest, but landbirds are well represented throughout the Refuge. The majority of landbirds migrate during the non-breeding season, but nine species are year-round residents. The following landbird species have been identified as species of Conservation Concern by Boreal Partners in Flight (Boreal Partners in Flight Working Group 1999), the Service (2008a) or Audubon Alaska (Stenhouse and Senner 2005): olive-sided flycatcher, Hammond's flycatcher, northern shrike, American dipper, gray-checked thrush, varied thrush, bohemian waxwing, blackpoll warbler, Smith's longspur, rusty blackbird, white-winged crossbill, and hoary redpoll. However, reviews of avian monitoring programs for landbirds found that populations of most species breeding in Alaska were not adequately monitored (Rich et al. 2004, Dunn et al. 2005).

Arctic Refuge is likely the only refuge in the United States with a notable breeding population of Smith's longspur, which is listed as a species of Conservation Concern due to low populations and potential vulnerability on their wintering grounds. The breeding range of Smith's longspurs in Alaska is not well known (Boreal Partners in Flight Working Group 1999) but thought to be primarily located in the foothills of the Brooks Range east of Anaktuvuk Pass (Sage 1976). In order to develop effective conservation measures for this species, it is necessary to understand population abundance and distribution, demographic parameters, habitat requirements, basic biology, and threats throughout their annual cycle. To meet those goals the Service, the NPS, and the University of Alaska initiated studies in 2006 to investigate breeding Smith's longspurs in northern Alaska. The objectives of this study included: 1) to estimate Smith's longspur abundance, 2) to evaluate survey methods for estimating abundance, 3) to identify habitat preferences and environmental factors that influence the distribution and abundance, and 4) to develop a species distribution model to predict the distribution of breeding Smith's longspurs in the Brooks Range. In this study, we found Smith's longspurs prefer the forest-tundra transition at the northern edge of the boreal treeline on the south side of the Brooks Range and mixed tundra and dwarf shrub in the Brooks Range foothills on the north side (Kendall 2007, T. Wild unpublished, data). The amount of woody vegetation in these transitional habitats may increase as a result of climate change with unknown impacts to breeding Smith's longspurs, underscoring the importance of continued monitoring and development of effective conservation measures for this species.

4.3.6.11 Climate Change Impacts on Birds

North Side of the Brooks Range

Martin et al. (2009) summarized the possible impacts of climate change on bird species on the North Slope. These effects stem primarily from changes to the abundance and distribution of surface water, changes to vegetation communities, and impacts on coastal processes and habitats. Although precipitation is predicted to increase on the North Slope, increased evaporation and evapotranspiration are predicted to decrease the overall abundance of surface water.

A decrease in the abundance of surface water would cause drying of saturated soils and shallow wetlands, with negative impacts to invertebrate productivity and availability. This in turn would decrease productivity and abundance of some shorebirds and waterfowl. The local redistribution of water through the drying of polygon centers and the formation of thermokarst pits and troughs would also result in a decrease in invertebrate availability for shorebirds and waterfowl using polygon habitat. Concurrently, it would increase invertebrate availability for open water and shoreline-feeding species such as the red phalarope, geese, and dabbling ducks that utilize thermokarst features. Lake drainage and drying resulting from the reduction in surface water would decrease the number of open water bodies, negatively impacting loons, terns and diving ducks. However, these newly formed drained-lake basin-complex wetlands would have positive effects on shorebirds and other waterfowl.

Vegetation community changes associated with a drier soils and loss of shallow wetlands may include increased shrub abundance, changes in plant phenology (e.g., earlier green up), and increased plant productivity and biomass. Increased shrub abundance would favor shrub-associated bird species including many passerines and ptarmigan, while decreasing habitat for wetland species such as waterfowl and shorebirds. Changes in plant phenology may decrease forage quality for post-hatch herbivores, affecting survival of juveniles, and may lower the body condition of molting, post-molt, and pre-migratory herbivores such as geese and ptarmigan.

Coastal processes and habitats are vulnerable to sea level rise and increased shoreline erosion caused by intensified storm surges due to the loss of sea ice. The loss of barrier islands and the lagoons they protect would negatively affect nesting common eider habitat and the foraging and molting habitat of waterfowl, loons, gulls, terns, and shorebirds. Terrestrial habitat losses along shorelines would impact foraging, nesting, and brood-rearing by waterfowl and shorebirds.

South Side of the Brooks Range

Impacts to bird communities from climate change on the south side of the continental divide would occur primarily from the drying of lakes and wetlands (Riordan et al. 2006) and from increased frequency, severity, and extent of natural fires (Rupp et al. 2002). Nearly 14 percent of the Refuge is forested, with about 12 percent in evergreen forest composed of black spruce and white spruce. Increased fire frequency is expected to convert much of this evergreen forest into early successional deciduous forest over the next 80 years (Rupp et al. 2002). Moreover, landscape drying and loss of vegetation productivity may already be occurring in the Alaskan interior (Verbyla 2008).

Bird communities at northern latitudes of the boreal forest may be highly adapted to severe fires regimes (Hutto et al. 2008). A post fire deciduous forest supports a higher abundance of birds along with an altered community of species adapted to early successional forest (Drapeau et al. 2000, Morissette 2000, Smucker et al. 2005). However, densities of Neotropical migrants are higher in old boreal forest (Kirk et al. 1996) and these species may be negatively impacted by the conversion to an early successional deciduous forest.

Although lakes and wetlands are uncommon in the Refuge south of the Brooks Range, the Wind, East Fork of the Chandalar, Sheenjek and Porcupine River valleys have important lake and wetland complexes. Lake and wetland loss from drying would have negative impacts on waterfowl, loons and shorebirds in this area. Climate induced increases in the growing season may allow birds species that are limited by the length of the nesting season, such as the Trumpeter Swan, to colonize these valleys.

4.3.7 Mammals

4.3.7.1 Introduction

Mammals are essential elements of northern ecosystems and contribute to the biodiversity of Arctic Refuge. The ecological role of many northern mammals is not completely understood, but all species shape the dynamics of tundra, alpine, and taiga environments in the Refuge.

Mammals played an important role in the establishment of Arctic Refuge. Advocates for creation of a conservation area in northern Alaska, in testimony before Congress, emphasized the importance of wildlife in the region, including caribou, polar bears, and habitat for reestablishing muskoxen. The proposed region was often seen as “a sanctuary for charismatic mammals” (Kaye 2005). A purpose of Arctic Refuge identified by ANILCA was to conserve mammal populations and their habitats, “including (but not limited to) caribou, polar bears, grizzly bears, muskoxen, Dall sheep, wolves, and wolverines.”

People come to Arctic Refuge from all over the United States and the world to experience northern wilderness and to see or hunt large mammals in undisturbed habitats. Mammals are hunted and trapped by local residents living in and near Arctic Refuge and are used for food and clothing or sold as furs and handicrafts.

4.3.7.2 Description

Attributes of life history, status, and distribution of mammals described in this section are based on locations where mammal species have been observed or collected in northern Alaska and on general descriptions of habitat use by species (Bee and Hall 1956, Wilson and Ruff 1999, MacDonald and Cook 2009). Common and scientific names follow (MacDonald and Cook 2009). Common names of mammals vary among sources. For example, all brown/grizzly bears (*Ursus arctos*) in Alaska are the same species, *Ursus arctos,* but the name "grizzly bear" is often used to distinquish smaller brown bears north of the Alaska Range from larger brown bears in southern Alaska. Dall's sheep (*Ovis dalli*) versus Dall sheep is a similar situation. In this document, except in direct quotes from other documents such as ANILCA, the common names "brown bear" and "Dall's sheep" are used (MacDonald and Cook 2009). Forty-eight species of mammals (including humans and marine mammals) have been observed in Arctic Refuge or in adjacent waters (MacDonald and Cook 2009) (Appendix F). With the exception of humans and some large herbivores, few details are known about trends in abundance, distribution, and habitat use of most of the 41 terrestrial mammal species living in the Refuge.

The vast Arctic Refuge has a broad diversity of ecoregions and subarctic and arctic terrestrial and aquatic habitats (Nowacki et al. 2001, Gallant et al. 1995). Some mammals in the Refuge occupy all ecoregions and/or a broad array of habitats, while others have limited distributions and use few habitats.

Mammal diversity (defined as the number of species occupying an area) is generally less in northern regions than in more southern latitudes (Gaston 2000). Only 20 percent of 412 mammal species in North America also occur in Alaska, and only 11 percent of these North American species are found in Arctic Refuge. Forty-five percent of Alaskan mammals occur in Arctic Refuge.

Arctic Refuge encompasses latitudes ranging from 67.5° to 70.2° north, contains a variety of terrain and habitats, and supports several species such as polar bears, muskoxen, and Alaska marmots found in few other conservations units. Carnivores (Order Carnivora) and hoofed mammals (Order Ungulata) are particularly well represented in Arctic Refuge with 35 percent and 33 percent of North American species, respectively (Figure 4-3). All three species of North American bears and six of 10 North American weasels occur in the Refuge. Thirty-eight percent of all mammal species in the Refuge are carnivores, compared to 12 percent throughout all of North America.

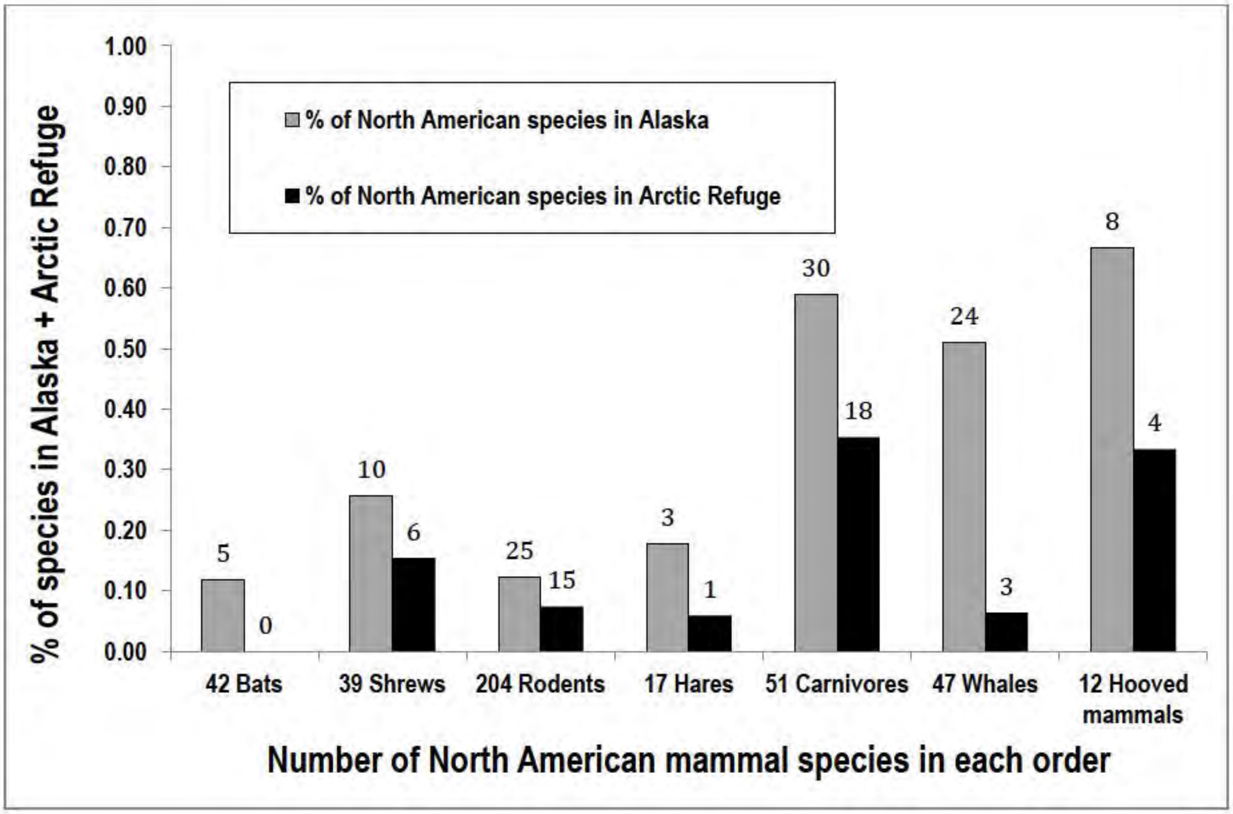


Figure 4-3. Diversity of mammals in Alaska and Arctic Refuge (including adjacent marine waters), shown as a percentage of North American mammal species. Numbers over columns are numbers of North American species also in Alaska and in Arctic Refuge. Data sources: Wilson and Ruff 1999, MacDonald and Cook 2009.

Winter is a defining characteristic of Arctic Refuge. In arctic Alaska, winter conditions exist for 8–9 months of the year. Terrestrial mammals are generally year-round residents of the Refuge and use a diversity of strategies for living in cold and severe weather. Some—such as bears and squirrels—are dormant in winter dens for 6–8 months. Others, such as wolves and foxes, are active all winter. Muskoxen reduce their activity and movements in winter to conserve energy (Reynolds 1998a). Lemmings and voles live beneath the insulating snow. Caribou move to winter ranges in the Refuge or in Canada. The diversity of habitats in the Refuge provides seasonal ranges that accommodate strategies used by mammals during the long winter and short growing season.

Most terrestrial mammals in Arctic Refuge are at the northern limits of their distributions. But some arctic-adapted species, e.g., collared lemmings, muskoxen, arctic foxes, and polar bears, are circumpolar and are found at even higher latitudes in Canada and Greenland. The Alaska marmot lives only in north of the Yukon River and the Alaska tiny shrew is likely found only in Alaska (MacDonald and Cook 2009).

4.3.7.3 Species of Special Interest and Concern

Terrestrial mammal species or groups of species used by humans or known to be important to ecosystem function are of special interest (Table 4-8). Hoofed mammals (ungulates) are hunted for food, and carnivores and herbivores are trapped for their fur. Visitors to Arctic Refuge often want to see mammals as part of their arctic wilderness experience. Several species of mammals, including lemmings and voles, foxes, hares, and lynx vary widely in number from year to year and have pronounced effects on local ecological systems when they are at peak numbers.

Table 4-8. Terrestrial mammals of Arctic National Wildlife Refuge are of special interest because they are used by humans and/or are known to be important components of northern ecosystems. An X indicates that species are of special interest but do not imply that one use is more important than another is. Common names are from MacDonald and Cook (2009).

Mammal Species (by common name)	Human Use		Ecological Component		
	Hunting/ Trapping	Viewing	Grazer/ Browser	Prey Base	Predator
Brown and collared lemmings, singing, root (tundra) and northern red-backed voles.			X	X	
Muskrat	X		X	X	
American beaver[1]	X		X		
Arctic ground squirrel	X	X	X	X	
Alaska marmot	X	X	X		
Snowshoe hare	X		X	X	
American marten, American mink, ermine	X	X			X
North American river otter	X	X			X
Wolverine	X	X			X
Canada lynx	X	X			X
Arctic fox	X	X			X
Red fox	X	X			X
Wolf	X	X			X
American black bear	X	X			X
Brown (grizzly) bear	X	X			X
Polar bear	X	X			X
Caribou	X	X	X	X	
Dall's sheep	X	X	X	X	
Muskox	X	X	X	X	
Moose	X	X	X	X	

[1]Beavers can affect wetlands through dam building

Marine mammals like whales and seals are important subsistence species for Kaktovik residents, and they are of particular concern with respect to changes in sea ice related to a warming climate. However, because they generally live outside the Refuge boundary and are not directly managed by the Refuge, they are not included in the following discussions of species of special interest.

Caribou

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

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

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

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

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

Until recently, caribou throughout the circumpolar Arctic were experiencing population declines (Vors and Boyce 2009), but a more recent assessment in November 2011 found that many arctic caribou and reindeer herds in North America are now increasing or are stable (Russell and Gunn 2011).

Effects of climate change on caribou in northern Alaska are likely to differ by season (Martin et al. 2009). Delach and Matson (2011) found that caribou were "highly vulnerable" to possible changes in climate. Conditions during the snow season that could affect caribou include deep snow or icing events that affect spring migration. Warmer temperatures and longer growing seasons could increase the availability of summer forage (Lenart et al. 2002). This could positively affect female body condition and increase rates of conception, calf production and survival. But mismatches between the emergence of nutritious forage and the arrival of caribou on calving grounds could also occur (Post et al. 2008). Plant species tend to have higher nutrient concentrations and less fiber and lignin in earlier phonological stages (Jorgenson et al. 2002). If tussock sedges emerge and flower before the arrival of caribou on calving grounds, lactating females may miss the highest quality forage of the season. Warmer, longer summers may also increase numbers of parasites and biting insects such as warble flies and nose bots that attack caribou (Witter et al. 2012).

Four caribou herds live in northern Alaska. Two of these, the Porcupine and Central Arctic herds, consistently use Arctic Refuge seasonally or throughout the year. Some caribou from the Teshekpuk caribou herd occasionally overwinter in Arctic Refuge.

Porcupine Caribou Herd

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

During the 1960s and 1970s, the Porcupine caribou herd was relatively stable at about 100,000 animals. Numbers steadily increased after 1978, peaked at 178,000 in 1989, and declined to 123,000 caribou in 2001 (Lenart 2007a) (Figure 4-4). Between 2002 and 2009, no estimates of abundance were available. During this period, caribou left the coastal plain and northern foothills of Arctic Refuge earlier and did not form large post-calving aggregations, or weather conditions precluded flights to photograph groups (E. Lenart, wildlife biologist, ADFG, pers. comm.). In 2010, 169,000 caribou were counted in a photocensus of the Porcupine caribou herd. Between 2001 and 2010 the herd increased to levels not seen since the early 1990s (Figure 4-4). The Teshekpuk and Central Arctic caribou herds also increased between 2002 and 2009 (Figure 4-4).

Birth rates of radio-collared adult females and calf survival by late June were high in the Porcupine herd in most years from 1987 to 2009 (Lenart 2007b, Caikoski 2009). Griffith et al. (2002) found that these measures did not differ between the period of population increase (1983–1989) and the period of decline (1990–2001). These studies suggest that the decline in numbers of Porcupine caribou from 1989 and 2001 likely was not caused by low calf production or low calf survival.

Reduced survival of caribou during late summer, fall, or winter may be a more important factor (Griffith et al. 2002). Non-hunting related mortality for adult females averaged 15 percent in 1975–1988 and 17 percent in 1989–2001 (Wertz et al. 2006). Small changes in adult cow survival could have large effects on growth of the Porcupine caribou herd (Fancy et al. 1994, Walsh et al. 1995, Arthur et al. 2003). The increase in abundance between 2001 and 2010 suggests that the Porcupine caribou had high rates of survival and recruitment of calves during part or all of this period. Population trends of Porcupine caribou herd were associated with phases of the Arctic Oscillation (shifts in sea level pressure over the Arctic Ocean) that influenced winter snowfall and summer growing conditions (Joly et al. 2011).

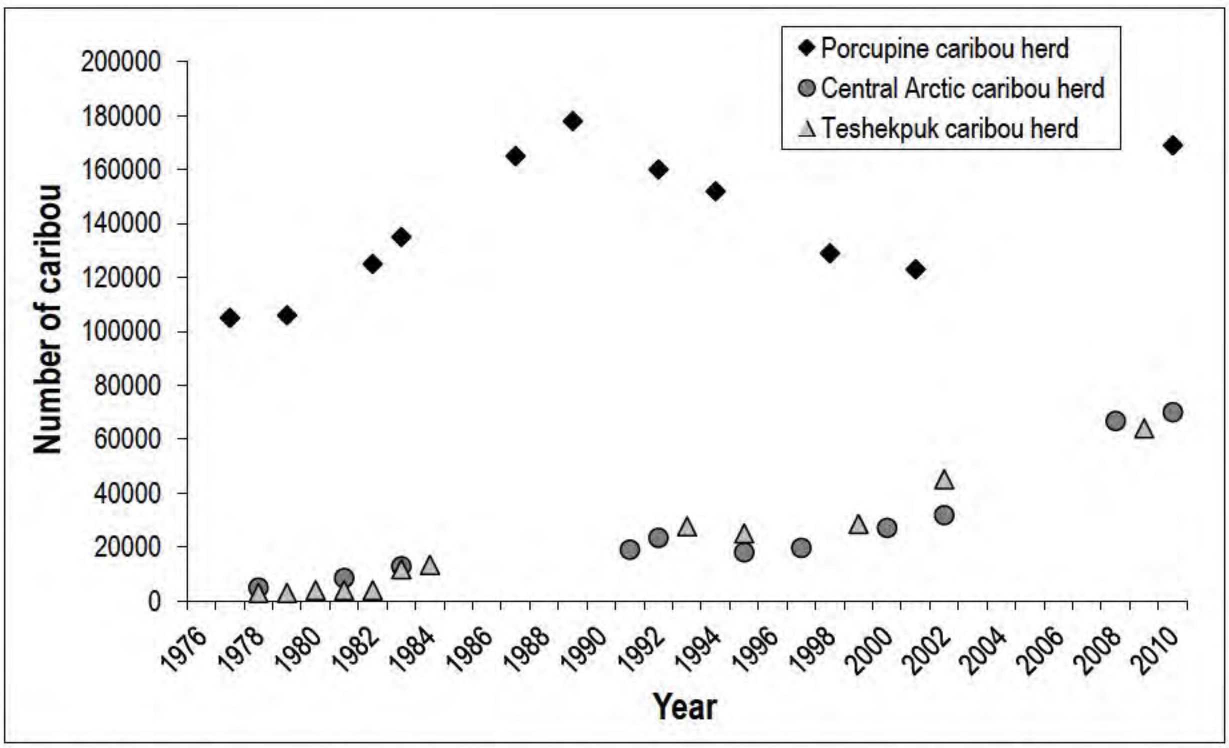


Figure 4-4. Population trends (estimates from photocensuses) of the Porcupine, Central Arctic, and Teshepuk caribou herds in northern Alaska. Data sources: Lenart 2007a, Lenart 2007b, Carroll 2007, Arthur and Del Vecchio 2009, J. Caikoski, wildlife biologist, ADFG, Fairbanks, Alaska, pers. comm., E. Lenart, area biologist, ADFG, Fairbanks, Alaska, pers. comm.

The Porcupine caribou herd ranges over 130,000 square mi (337,000 square km) of wild lands in northeastern Alaska and northwestern Canada (Lenart 2007a) (Map 4-8). The entire Arctic Refuge coastal plain is key calving and post-calving habitat for Porcupine caribou (Griffith et al. 2002). Foothills and mountains of Arctic Refuge are also important summer, fall, and winter habitats, as well as spring and fall migration routes. As the summer progresses and willows (Salix sp.) emerge, caribou also use riparian habitats. The Porcupine caribou herd generally overwinters south of the Brooks Range in Arctic Refuge and in the Richardson and Ogilvie mountains of the Yukon Territory, Canada. Winter distribution varies by year (Griffith et al. 2002, Wertz et al. 2006).

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

For the past few decades, the Porcupine caribou herd has calved in a region encompassed the arctic foot hills and the coastal plain from the Canning River in Arctic Refuge to the Babbage River in Canada, an area of nearly 8.9 million ac (3.6 million ha) (Griffith et al. 2002). The distribution of calving caribou varied from year to year (Map 4-9). From 1983-1999, concentrated calving areas were in Arctic Refuge in all years and also occurred in the Yukon in 3 of 17 years. By contrast, during 2000-2010, concentrated calving areas were in the Yukon or near the USA-Canada border in 7 of 11 years. In 2011, the Porcupine caribou herd calved primarily in the northern Yukon, Canada (E. Wald, wildlife biologist, Arctic Refuge, Fairbanks, Alaska). This variability indicates that the Porcupine caribou herd needs a large region from which the best conditions for calving can be selected in a in a given year.

During the calving season in early June, Porcupine caribou selected areas of wet sedge, herbaceous tussock tundra and riparian vegetation types (Griffith et al. 2002). Emerging tussock cotton grass (*Eriophorum vaginatum*) flowers were an important source of high quality forage in areas used by calving caribou (Jorgenson et al. 2002). This plant species had greater biomass and forage quality in tussock tundra compared with other vegetation types. The distribution of tussock tundra and moist sedge-willow tundra was greater in calving areas in the Arctic Refuge 1002 Area than in areas further south and east (Jorgenson et al. 2002).

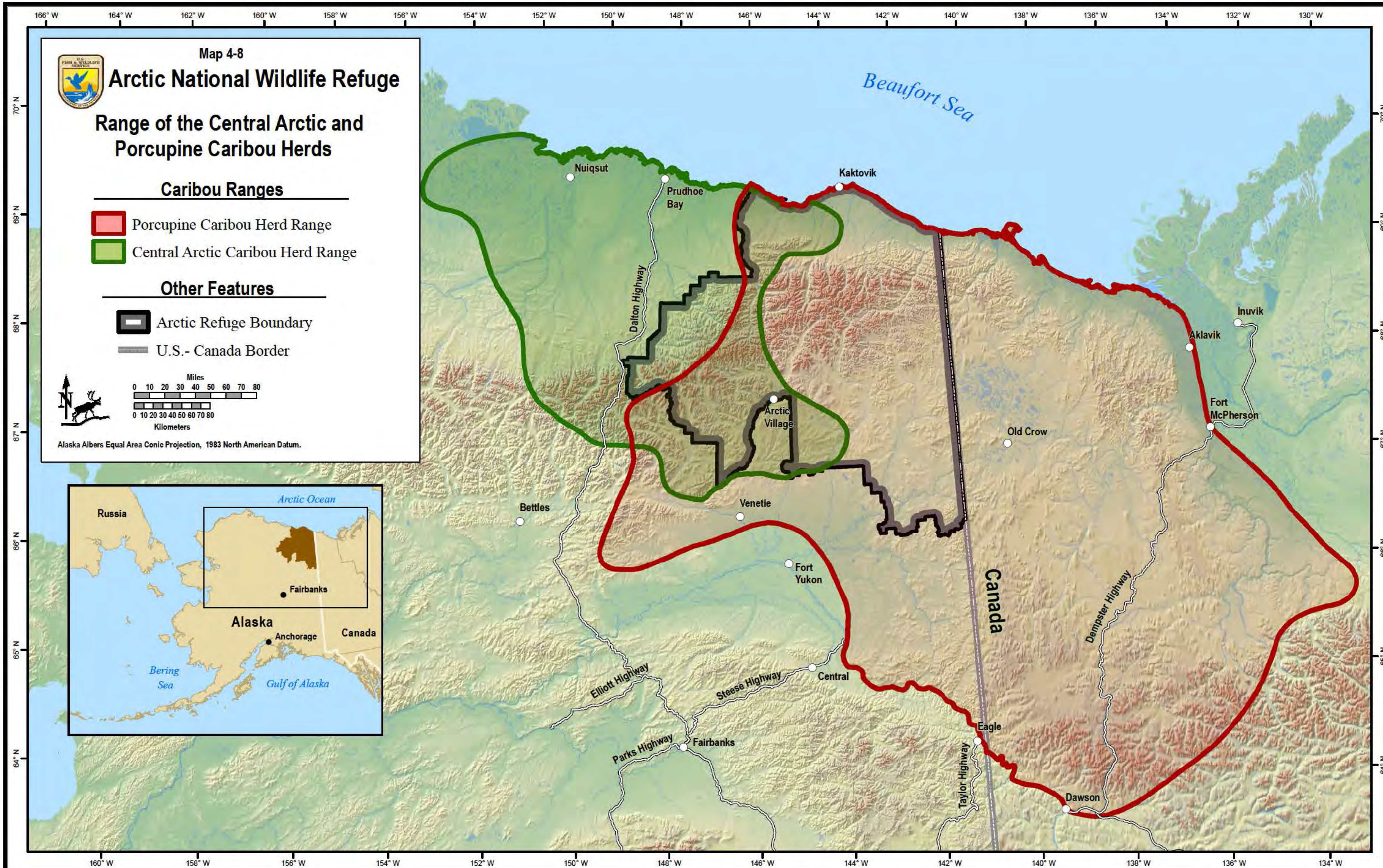
As cotton grass flowers matured, caribou shifted their diet to include a mix of newly emerged willows and herbaceous plants, which they continued to eat until they left the calving grounds at the end of June. In calving areas east of the US-Canada border, habitat quality was poorer and calf survival in June was lower (Griffith et al. 2002).

During the post-calving period (about three weeks after calving), the Porcupine caribou herd tends to move westward. Animals that calve in northwestern Canada move into Arctic Refuge after calving, where the presence of newly emerging sedges provides forage needed by females to quickly regain body reserves used during pregnancy and lactation (Griffith et al. 2002).

By mid- to late June, females with calves are joined by males and non-reproducing females arriving from the wintering grounds. The emergence of biting insects causes caribou to form large post-calving aggregations that frequently move north to the coast or south into the mountains, where winds and cooler temperatures reduce insect harassment.

In the 1980s and 1990s, caribou left Arctic Refuge coastal plain and foothills in early July and moved southward or eastward into Canada. After 2000, caribou generally departed the coastal plain before the end of June (E. Lenart, wildlife biologist, ADFG, pers. comm.).

Caribou from the Porcupine herd are hunted in Alaska and Canada. The Harvest Management Plan for Yukon, Canada (Porcupine Caribou Management Board 2010) outlines different harvests levels to be implemented when numbers of caribou reach targeted levels. For example, if numbers decline below 115,000 animals, harvest levels are reduced. Because numbers from 1989 and 2001 indicated a declining trend and no new information was available after 2001, a reduction in the Canadian caribou harvest was scheduled to take place. But in 2010, Porcupine caribou were well above the target of 115,000. At this level, Canadian subsistence hunters can take an unlimited number of caribou and general licensed hunters in Canada can take two males. All hunters taking Porcupine caribou in Canada are required to report their harvest (First Nation of NaCho Nyak Dun et al. 2010). People from the community of Kaktovik also hunt caribou from the Porcupine herd.


Map 4-8
Arctic National Wildlife Refuge
Range of the Central Arctic and Porcupine Caribou Herds
Caribou Ranges
Porcupine Caribou Herd Range
Central Arctic Caribou Herd Range
Other Features
Arctic Refuge Boundary
U.S.- Canada Border
Miles
0 10 20 30 40 50 60 70 80
0 10 20 30 40 50 60 70 80
Kilometers
Alaska Albers Equal Area Conic Projection, 1983 North American Datum.
Beaufort Sea
Nuiqsut
Prudhoe Bay
Kaktovik
Dalton Highway
Arctic Village
Old Crow
Inuvik
Aklavik
Fort McPherson
Bettles
Venetie
Fort Yukon
Canada
Dempster Highway
Elliott Highway
Steese Highway
Central
Eagle
Parks Highway
Fairbanks
Taylor Highway
Dawson
Russia
Arctic Ocean
Fairbanks
Alaska
Anchorage
Canada
Bering Sea
Gulf of Alaska

Central Arctic Caribou Herd

This herd had about 5,000 caribou in the mid-1970s when it was first identified as a distinct herd (Cameron and Whitten 1979). By the early 1980s, it had grown to almost 13,000 and by the late 1990s, when net calf production was greater than 70 percent calves per female, it increased to over 25000 (Cameron et al. 2002). A photocensus in 2010 counted more than 70000 caribou in the Central Arctic herd (J. Caikoski, wildlife biologists, ADFG), (Figure 4-4).

The average birth rate for adult females of the Central Arctic herd was 89 percent during 1997–2006. During this same period, an average of 80 percent of adult females from the Porcupine caribou herd gave birth annually (Lenart 2007a), Arthur and Del Vecchio 2009). Rapid growth of the Central Arctic caribou herd was due to high birth rates, high calf survival rates, and low adult mortality (Lenart 2007b).

The annual range of the Central Arctic caribou herd overlaps that of the Porcupine caribou herd (Map 4-8). Two main calving concentration areas have been identified for the Central Arctic caribou herd: a western area between the Kuparuk and Colville rivers, and an eastern area between the Sagavanirktok and Canning rivers. The eastern area includes the Canning River delta region in northwest Arctic Refuge.

Arthur and Del Vecchio (2009) studied rates of survival, changes in body mass, and skeletal growth of calves in both areas from June 2001 through May 2007. Survival rates during the early post-calving period did not differ between calving areas in most seasons and years. However, calves born in the eastern area, which includes portions of the Refuge, were heavier in June and September than calves born in the western calving area.

Arthur and Del Vecchio (2009) found that heavier calves were more likely to survive the following winter. Differences in the size of calves at birth and in September could be influenced by habitats on calving grounds, suggesting that the eastern calving area has higher habitat quality (Arthur and Del Vecchio 2009). Caribou from east and west calving areas overlap on summer ranges. Central Arctic caribou use the coastal plain between the Colville River in the National Petroleum Reserve-Alaska and the Okpilik River on Arctic Refuge from late June through mid- or late July. In August and September, they expand their distribution southward into the foothills and mountains (Arthur and Del Vecchio 2009). The Prudhoe Bay-Kuparuk oilfields, the Trans-Alaska Pipeline System, and the Dalton Highway lie in the herd's range. The herd uses riparian areas as travel corridors and for foraging during spring and summer. In late summer and fall, some Central Arctic caribou are found scattered across the coastal plain south of Camden Bay, in the foothills north of the Sadlerochit Mountains, and in uplands south of the Sadlerochit Mountains, where they may remain for the winter.

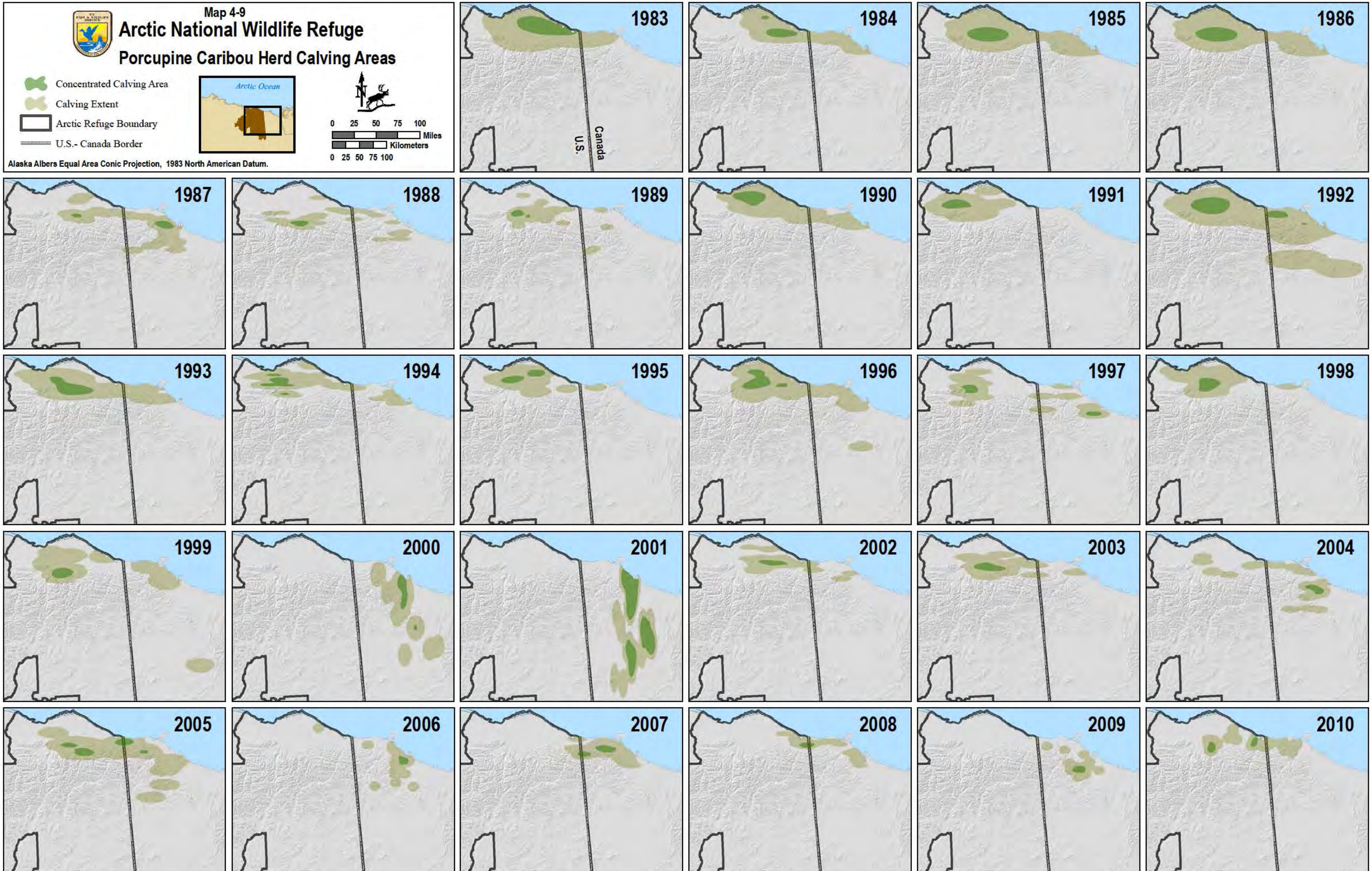
During most winters, scattered groups of animals range throughout the coastal plain west of the Katakturuk River and adjacent uplands to the south. Between 2002 and 2009, the winter distribution of the Central Arctic caribou was north and south of the Brooks Range in Arctic Refuge. In some years, they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

Residents of Kaktovik hunt caribou from both the Central Arctic and Porcupine Caribou Herds depending on annual herd distributions. Other visitors to Arctic Refuge also hunt Central Arctic caribou north of the Brooks Range. In the years when Porcupine and Central Arctic caribou overlap in wintering ranges south of the Brooks Range, animals from both herds are harvested by people from Arctic Village.

Teshekpuk Caribou Herd

This herd was first identified as a distinct herd in the 1970s (Davis et al. 1978). Like the Central Arctic caribou herd, it increased rapidly in the past two decades (Figure 4-4). The year-round distribution of these caribou is generally in the vicinity of Teshekpuk Lake, 150 miles west of Arctic Refuge in the National Petroleum Reserve-Alaska. Teshekpuk caribou occasionally winter as far east as Arctic Refuge (Carroll 2007). During fall 2003, an extreme ice storm apparently caused some caribou from the Teshekpuk herd to move east to Arctic Refuge. Several hundred caribou overwintering near Barter Island died of starvation in the winter of 2003–2004 (K. Beckmen, veterinarian, ADFG, Fairbanks, Alaska, pers. comm.). Other caribou wintering in the Brooks Range in Arctic Refuge experienced higher survival rates (G. Carroll, wildlife biologist, ADFG, pers. comm.). This was the only documented use of Arctic Refuge by the Teshekpuk caribou herd in the past three decades.

Map 4-9. Porcupine Caribou Herd Calving Area. Porcupine caribou herd annual calving areas in the Arctic National Wildlife Refuge, Alaska, and northern Yukon, Canada, 1982–2010. Calving distribution was based on locations of radio collared Porcupine caribou cows in early June. Tan = extent of calving grounds determined by the isopleths encompassing 95 percent of the fixed kernel utilization distribution of locations of females with a calf. Green = concentrated calving areas (areas with greater than average densities of female caribou with calves). Data sources: Griffith et al. (2002), Caikoski (2009), J. Caikoski, wildlife biologist, ADFG, pers. comm.


Map 4-9
Arctic National Wildlife Refuge
Porcupine Caribou Herd Calving Areas
Concentrated Calving Area
Calving Extent
Arctic Refuge Boundary
U.S.- Canada Border
Arctic Ocean
0 25 50 75 100
Miles
Kilometers
0 25 50 75 100
Alaska Albers Equal Area Conic Projection, 1983 North American Datum.
1983
U.S.
Canada
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010

Other Ungulates (Hoofed Mammals)

In addition to caribou, three other large ungulates provide hunting and viewing opportunities for local residents and visitors to Arctic Refuge.

Dall's sheep (Ovis dalli)

This species occupies mountain habitats in Alaska and western Canada. The Sadlerochit Mountains in the northwestern portion of Arctic Refuge constitute the northernmost extent of the species range (Smith 1979). Dall's sheep have high fidelity to traditional winter and summer ranges, including lambing areas and mineral licks. Their activities are confined almost exclusively to the alpine zone in barren and sparsely vegetated areas of dry prostrate dwarf scrub where forbs, dwarf shrubs and graminoids constitute their primary foods. In alpine habitats, sheep are often near cliffs or steep rocky ridges that they use as escape terrain to avoid predators. Winter habitat consists of windblown slopes and ridges, often with a southerly aspect. Winter conditions are an important determinant of adult survival. Deep snowpack or icing conditions that reduce access to browse can cause increased mortalities. Predators of Dall's sheep include humans, wolves, and golden eagles.

Dall's sheep are social ungulates. Throughout most of the year, rams are segregated from ewes, lambs, and subadults. Dominant rams join these ewe groups during November and December, when breeding occurs. Dall's sheep in Arctic Refuge give birth to a single lamb and can experience years of high production followed by years of low production. Lambs are typically born in May. The births are highly synchronized, and most lambs are of similar age (Bowyer and Leslie 1992).

Smith (1979) estimated that there were 6,800 sheep in the original 8.9-million-ac (3.6-million ha) Arctic Range in 1979. Sheep densities are generally higher on the north side of the Brooks Range (3.7 sheep per square mile between the Sagavanirktok and Atigun rivers) than on the south side (0.6 sheep per square mile in portions of the Chandalar River drainage) (Mauer 1990). Recent sheep counts have focused on smaller areas, particularly the Hulahula River drainage, and on population composition counts during the post-lambing period in index areas in Atigun Gorge, the Hulahula River, and the Arctic Village Sheep Management Area.

The Hulahula River drainage is an area of high-quality sheep habitat on the north side of the Brooks Range in Arctic Refuge. This drainage provides sheep hunting opportunities for federally qualified subsistence hunters from Kaktovik and for general hunters, as well as possibilities for Refuge visitors to observe Dall's sheep.

In the early 1990s, the sheep population declined in the Hulahula and Atigun drainages (Figure 4-5). During this period, similar declines in sheep populations occurred elsewhere in arctic Alaska as a result of severe winters (Caikoski 2008). The number of Dall's sheep taken by general hunters and the percentage of successful hunters throughout the Refuge also declined in the 1990s (Figure 4-6). As sheep numbers declined, they were less available to hunters.

In recent years, Dall's sheep populations across the eastern Brooks Range appear to have stabilized. However, populations remain below those observed in the mid-1980s, and current survival rates, distribution and habitat quality are not completely known (Caikoski 2008).

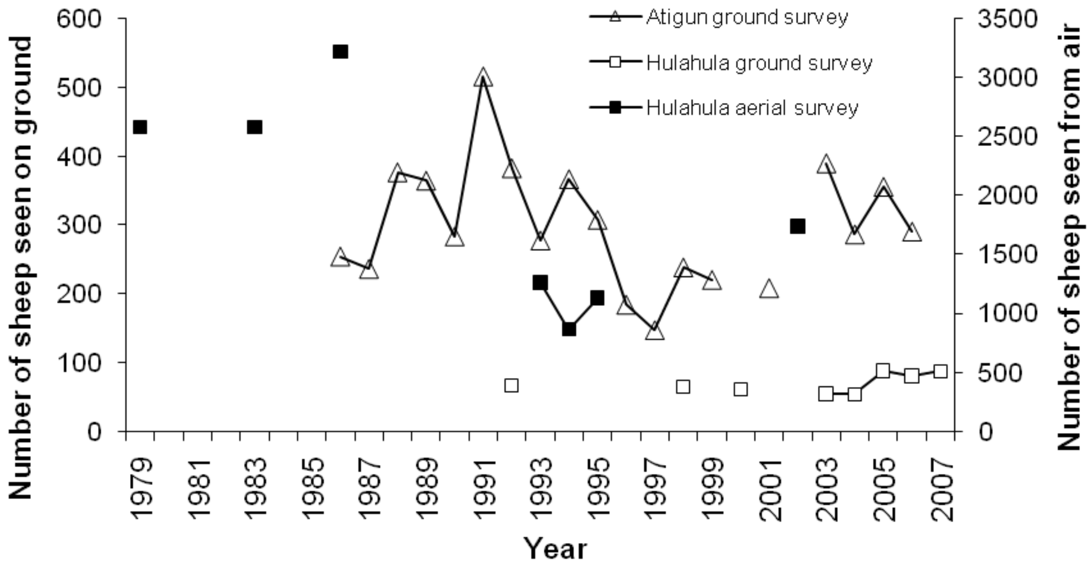


Figure 4-5. Dall’s sheep population trends in two northern drainages, Arctic National Wildlife Refuge, Alaska. Data sources: Caikoski 2008, U.S. Fish and Wildlife Service unpublished data

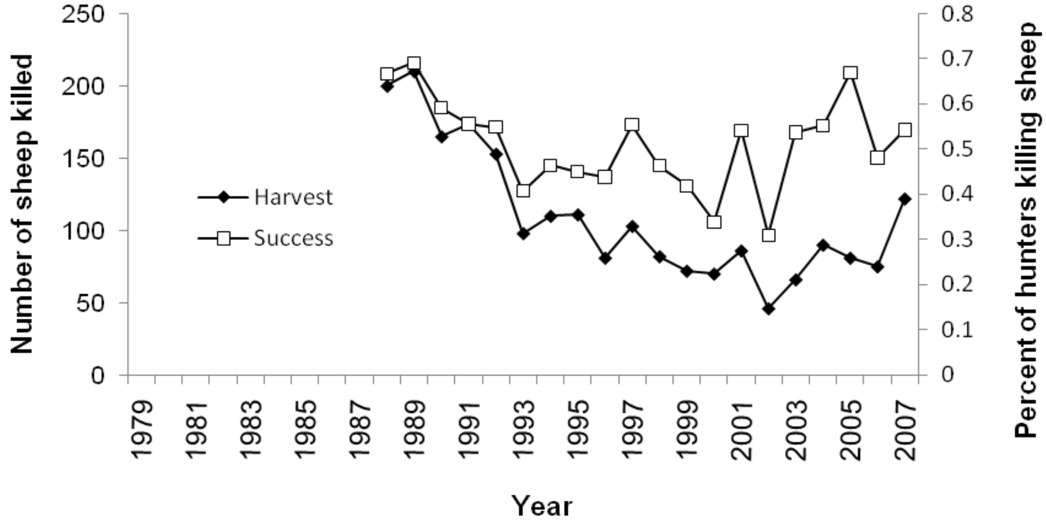


Figure 4-6. Hunter success and number of Dall's sheep killed by all general hunters in Arctic National Wildlife Refuge, Alaska 1988–2007. Data source: U.S. Fish and Wildlife Service unpublished data summarized from ADFG harvest records.

The Arctic Village Sheep Management Area was established in 1991 to include that area west of the East Fork Chandalar River between Crow Nest Creek and Cane Creek. The area was expanded in 1995 to include the entire drainages of Red Sheep Creek and Cane Creek. In this area, only local resident subsistence hunters could kill sheep, and general hunting was prohibited. In 2006, the Federal Subsistence Board approved a temporary Special Action to open hunting for full-curl rams to general hunters in the Red Sheep Creek and Cane Creek drainages, which comprise the northern portion of the Arctic Village Sheep Management Area and made the change permanent in 2007. In 2012, the Federal Subsistence Board once again limited sheep hunting in Red Sheep and Cane Creek drainages to federally qualified subsistence hunters from the communities of Arctic Village, Venetie, Fort Yukon, Chalkyitsik, and Kaktovik. Further, the Refuge does not authorize commercial big-game guides in the area around Arctic Village, including the Arctic Village Sheep Management Area, to minimize conflicts between local and nonlocal users. Payer (2006) estimated that the density of Dall's sheep was 1.7 per sq. mile in this area, slightly less than the 1990–1991 estimates of 1.9 to 2.2 sheep per sq. mile, but nearly eight times greater than the estimated density in the southern portion of the Arctic Village Sheep Management Area (Mauer 1990).

Dall's sheep are found throughout the mountains of Arctic Refuge. Densities are higher on shale slopes where vegetation communities are more extensive than on limestone slopes that have less soil development, lower nutrients, and sparser vegetation (Mauer 1990). During the hottest summer weather, sheep are most frequently seen on green alpine meadows between 3,000 and 4,000 ft (915 and 1208 m), although they may climb above 6,000 ft (1830 m) to reach areas where temperatures are cooler and insects less bothersome. They often lie in the shade of rocky areas near feeding sites. These sheep are excellent climbers and usually stay near rocky areas and cliffs that provide escape terrain from wolves and other predators.

Sheep traditionally move between summer and winter ranges. In early winter as the snowline descends and lowlands become snow covered, sheep move to their wintering grounds on windswept ridges and promontories. With the approach of spring, sheep concentrate on south-facing slopes in valley bottoms where vegetation first emerges. They may be seen in these valley bottoms at any time of the year, either crossing between mountain ranges or feeding in areas of new plant growth. Ewes with young lambs seek steep, rocky areas with maximum security from predators during the first few weeks after lambing and later join larger groups of ewes, lambs, and sub-adults.

Dall's sheep in the Refuge are hunted by people living in the communities of Kaktovik and Arctic Village (federally qualified local resident subsistence hunters), as well as by general hunters visiting the Refuge. In 1988–2007, most sheep (annual mean = 83 percent) harvested by general hunters were taken on the north side of the Brooks Range (ADFG harvest data summarized by Arctic Refuge). The total number of sheep killed by local residents of Kaktovik and Arctic Village is not well documented. Dall's sheep on the Refuge also provide memorable viewing opportunities for non-hunting visitors to Arctic Refuge.

Dall's sheep in Arctic Refuge are at the northern limit of the species' range. Warming temperatures in the arctic may have consequences for montane habitats and alpine vegetation in the mountains of the Brooks Range if vegetation communities shift up mountain slopes. Dall's sheep in Arctic Refuge could be vulnerable to adverse effects of climate change, including altered vegetation communities, increased incidence existing or novel diseases and parasites, and more frequent occurrence of icing conditions or deep snow (Martin et al. 2009). According to Delach and Matson (2011), Dall's sheep are "highly vulnerable" to climate change because they are adapted to specific niches that could change.

Muskoxen (Ovibos moschatus)

This arctic-adapted ungulate is found only at high latitudes. Females, sub-adults and males live in social groups. Adult males are often solitary in summer and found in small male-only groups in winter (Reynolds et al. 1999).

Muskoxen in Arctic Refuge have a relatively low reproductive potential. Age at first breeding can be delayed until age four or five. Females produce a single calf, and most only breed every other year or less frequently (Reynolds 2001). Unlike caribou that give birth in early June just as nutritious sedges are emerging, most muskox calves are born between mid-April and mid-May when winter conditions still prevail. Pregnant and lactating females do not have access to high quality green forage for 4-6 weeks after the birth of calves. Muskoxen must maintain their body reserves throughout the long winter, followed by calving and early lactation periods, to successfully reproduce. Conserving energy by reducing activity and movements during winter and subsisting on small amounts of poor-quality winter forage (Adamczewski et al. 1994) are important strategies for this species. Groups of muskoxen frequently remain in one small area for most of the winter (Reynolds 1998a).

Muskoxen are year-round residents of the coastal plain and foothills of Arctic Refuge. During the growing season, groups often live in riparian habitats along drainages and in moist herbaceous and prostrate shrub habitats in adjacent uplands, where they feed on shrubs, forbs, and graminoids (During the 8–9 months of winter, muskoxen select areas of soft shallow snow, often on windblown ridges or areas with micro-terrain that provides windswept areas (Reynolds et al. 2002a, Nellemann and Reynolds 1997). In winter, muskoxen in Arctic Refuge eat mostly dried sedges and grasses, mosses and forbs (Reynolds et al. 2002a).

Muskoxen disappeared from Alaska and northwestern Canada by the late 1800s but were successfully returned to the State when animals from Greenland were released on Nunivak

Island in 1935–1936. Survivors and offspring from this population were successfully moved to four other regions of the State between 1967 and 1981. In 1969 and 1970, 64 muskoxen were released in two areas near the Refuge (Reynolds 1998b).

The population in the Refuge increased rapidly from 1978 to 1985 and was relatively stable through the late 1990s (Reynolds et al. 2002a) (Figure 4-7). The population range expanded as some groups left the Refuge and moved west into north central Alaska and east into Yukon, Canada. Abundance of muskoxen declined rapidly between 1998 and 2002, and numbers remained very low (1-44) in 2002–2010. In Arctic Refuge, only one muskox was observed in the 2006 census, a few small groups moved between the Refuge and adjacent regions in 2007–2010 and none were counted in April 2011 (Reynolds 2011).

The entire population increased from about 1978 to 1995, declined between 1996 and 2006, and was relatively stable for the past six years (Figure 4-7). Most of the 50 percent decline in population abundance was due to losses from Arctic Refuge. Today the population appears to be split into two distinct populations with about 200 muskoxen living in northern Alaska west of Arctic Refuge and 100 muskoxen living in the northern Yukon, east of Arctic Refuge (Reynolds 2011).

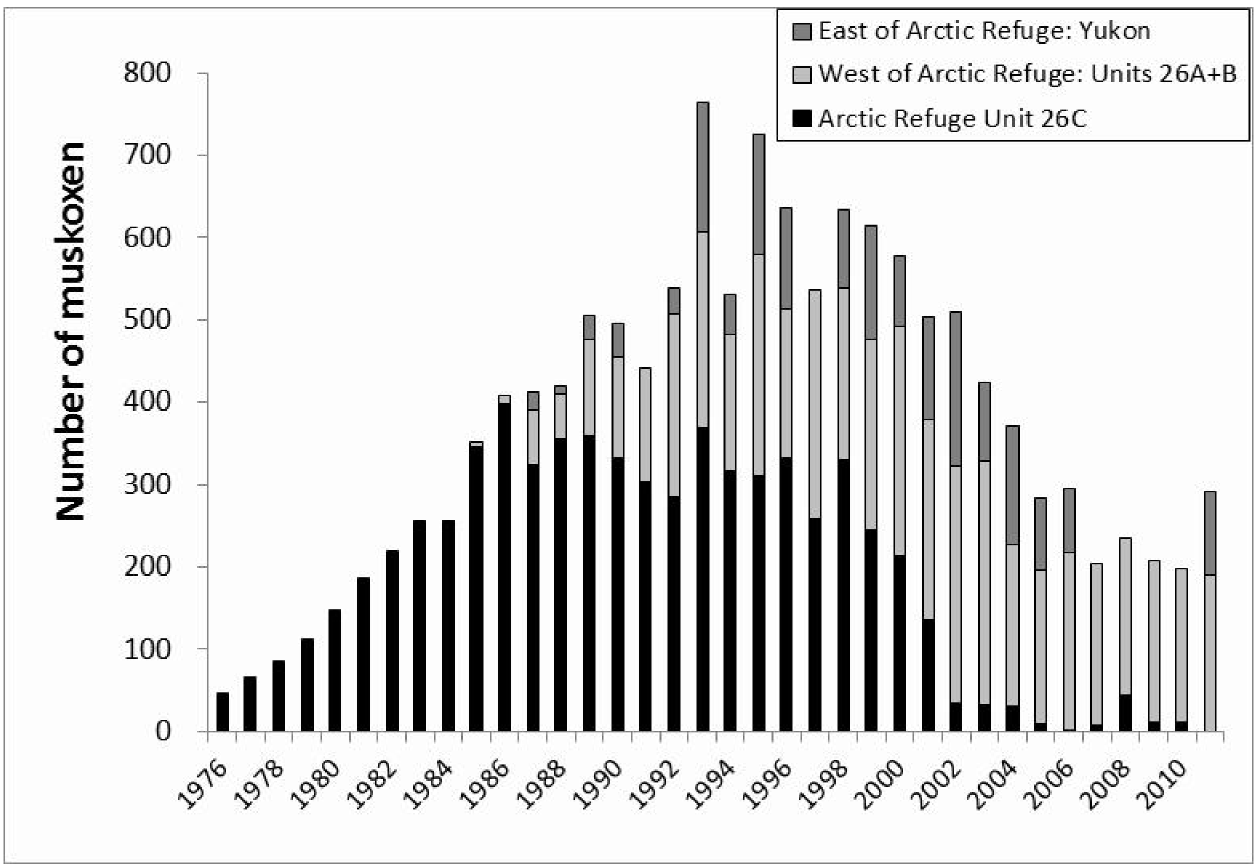


Figure 4-7. Abundance of muskoxen in the Arctic National Wildlife Refuge and adjacent areas in northern Alaska and northern Yukon, Canada, 1976-2011.

Note: Muskoxen were not surveyed or only partly surveyed in the Yukon in 1991-1992, 1994, 1997, and 2007-2010. Total censuses in 2006 and 2011 covered the entire range of the population from Judy Creek in northern Alaska to the Babbage River in northern Yukon. Data sources: Reynolds 2006, Lenart 2007c, Cooley and McDonald 2010, Reynolds 2011, and S. Arthur, wildlife biologist, ADFG, pers. comm.

The decline in the muskox population in northeastern Alaska and the disappearance of most muskoxen from Arctic Refuge since 1999 was caused by low calf recruitment, reduced survival of adults, and shifts in distribution. A combination of interacting factors, including predation, severe winters, and disease, could have affected recruitment, adult female survival, and movements of muskoxen (Reynolds 2011, S. Arthur wildlife biologist, ADFG, pers. comm.).

Brown bears and wolves prey on muskoxen, but bears are the dominant predator. Several incidents of bears killing muskoxen have been documented (Reynolds et al. 2002b, S. Arthur, wildlife biologist, ADFG, pers. comm.). Predation events, including human hunting, can cause groups to fracture into smaller units and move long distances; it can also result in the abandonment of young calves (Reynolds 2006).

Winters with deep snow or freezing rain-on-snow (icing) events likely reduce access to forage and increase energetic costs for muskoxen. An icing event in October 2003 likely caused the deaths of hundreds of caribou on the coastal plain of Arctic Refuge (K. Beckmen, veterinarian, ADFG, pers. comm.) and thousands of muskoxen on Banks Island (Grenfell and Putkonen 2008). Snow conditions may limit winter habitats used by muskoxen (Reynolds et al. 2002a). Because muskoxen move infrequently in winter, habitats occupied by large groups for several consecutive winters may become overgrazed. Diseases and parasites as well as possible copper deficiencies may also be affecting rates of successful production and adult survival (K. Beckmen, veterinarian, ADFG, pers. comm.).

In 1982, the ADFG opened hunting in the Refuge and issued five permits to residents of Alaska to hunt muskoxen in Arctic Refuge, Unit 26C. From 5–10 registration permits were issued until 1992 (Lenart 2007c). In 1992, the Federal government took over responsibility for hunting on Federal lands and limited muskox hunting in the Refuge to federally qualified subsistence hunters from the community of Kaktovik. Muskox permits issued by the Federal Subsistence Board to residents of Kaktovik increased to a high of 15 per year (including three females) in 1996–1997 through 2001–2002 (Reynolds 2011). Because of concerns about low abundance, the harvest limit in the Refuge was reduced to two bulls per year in 2002–2003. Harvest levels ranged from 12 males and three females in the 1996–1997 season to two males in 2001–2002. Current Federal regulations in Arctic Refuge (Unit 26C) limit the annual subsistence hunt to three percent of the number counted during a pre-calving census. Because of low numbers, no muskox permits were issued between 2003–2004 and 2010–2011, except for one issued for the 2007—2008 season. No muskoxen have been killed during a legal subsistence hunt in Arctic Refuge since April 2001 (Reynolds 2011). In 2003, the State of Alaska closed all hunting of muskoxen (Tier I, Tier II, and drawing hunts) on State lands adjacent to the Refuge (Unit 26B) in response to the decline in muskox numbers (Lenart 2007c).

As an arctic-adapted species with low reproductive potential, muskoxen are relatively vulnerable to local weather events and climatic changes in the northern environment. Icing events or deep snow likely affect successful reproduction, recruitment, and survival of adult females. If icing events increase in frequency as a result of temperatures warming in winter, muskox populations could be adversely affected and abundance and distribution could change. Increases in the length of the summer season may provide a longer foraging season and increased reproductive rates. However, warmer and longer summers would likely increase the incidence of diseases such as lungworm, which could negatively affect muskox populations (Kutz et al. 2004). Delach and Matson (2011) found that muskoxen are “highly vulnerable” to climate change because of the species’ adaptations to the arctic environment and its low genetic diversity).

Moose (Alces americanus)

Moose are the largest member of the deer family and one of the largest terrestrial mammals in North America. In arctic Alaska, moose are living at the northern limit of their North American range. Their presence here may represent a relatively recent range extension (Kelsall 1972). Chesemore (1968) found evidence that moose were established in the region by 1940.

Moose usually mate in late September or early October and give birth, often every year, to one or two young in May and early June. Calf mortality is usually high, although females aggressively defend their young from bears and wolves. Moose are solitary except when breeding but sometimes form aggregations on winter ranges (Peterson 1999).

Moose occur throughout Arctic Refuge, primarily along drainages with patchy, willow-dominated riparian communities. River bars with tall and low willows (*Salix alaxensis* and *Salix planifolia*) are common habitats for moose.

Four regions in the Refuge have been periodically surveyed for moose: Unit 26B (northern drainages from Accomplishment Creek to the Canning River that includes State and Refuge lands); Unit 26C north (northern drainages east of the Canning River between the Sadlerochit and Egaksrak rivers on Arctic Refuge); Unit 26C south (upper reaches of the Kongakut and Firth rivers and Mancha Creek); and Unit 25A east (Sheenjek and Chandalar rivers south of the Brooks Range).

Moose populations in Unit 26B-east and other arctic areas increased rapidly from the mid-1950s and the late 1980s, expanding into limited riparian habitats. From 1989 to 1994, moose populations throughout Unit 26B declined by 50 percent or more, and moose hunting on State lands was closed during 1996–2005 (Lenart 2008). A similar decline occurred in the Refuge (Figure 4-8). Fall calf survival was only 4 percent in 1994 and 5 percent in 1995, 10 percent lower than in the early 1990s. Several dead adult females were found on the Colville River west of Arctic Refuge in 1995. Disease or copper deficiency, exacerbated by long winters and short growing seasons, were factors that may have caused the decline; predation and forage conditions appeared to be less important (Lenart 2008). By 2002, numbers of moose in western drainages of Unit 26B began to increase, but recovery has not occurred on the Canning River in Arctic Refuge (Lenart 2008) (Figure 4-8).

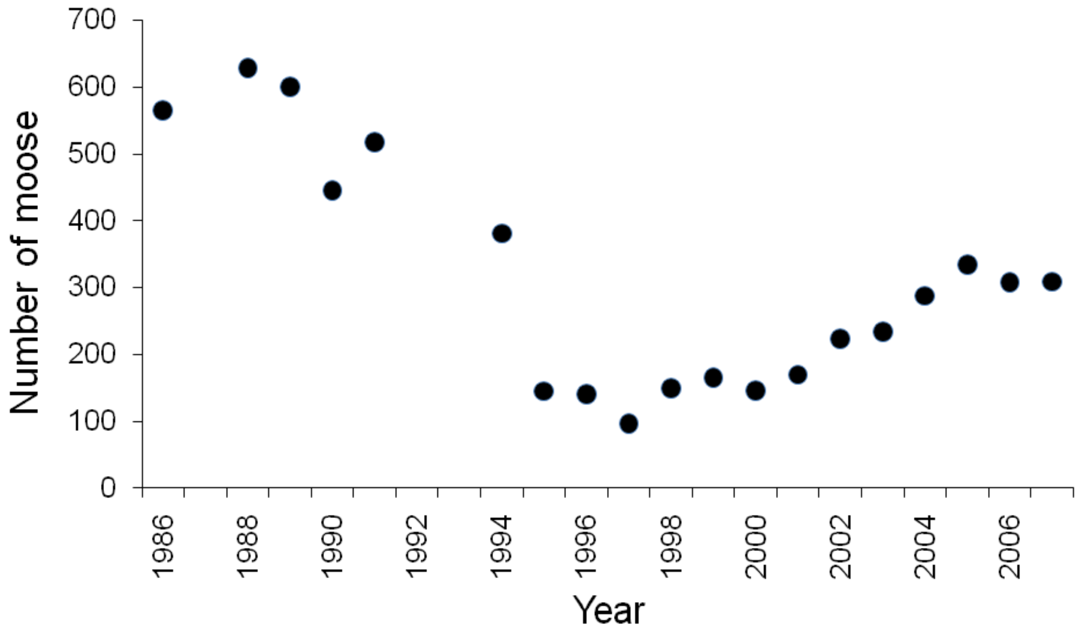


Figure 4-8. Moose surveys of the North Slope drainages between the Canning River and Accomplishment Creek.

Notes: 1986-1998 surveys were conducted in the fall and the 1999-2008 surveys were conducted in the spring (Lenart 2002, Lenart 2008).

Relatively few moose live east of the Canning River on the coastal plain and northern foothills of Arctic Refuge. In 2002–2008, 47–61 moose were observed during surveys of Unit 26C-north between the Sadlerochit and Egaksrak rivers (U.S. Fish and Wildlife Service, unpublished data). Moose on the upper reaches of the Kongakut and Firth rivers (north of the Brooks Range divide) are more numerous, but abundance here apparently also declined during the 1990s, as did moose numbers south of the Brooks Range divide along the Coleen and Sheenjek rivers (Figure 4-9).

In 1995-1996, a study of seasonal movements of moose in the upper reaches of Kongakut, Firth, Coleen, and Sheenjek rivers showed that 86 percent of collared moose wintering in these drainages moved to the Old Crow Flats in Yukon, Canada, where they spent the summer (Mauer 1998). In 2007, biologists from Yukon territories begin monitoring satellite-collared moose spending summers in the Old Crow Flats. Many moved to Arctic Refuge to winter on the Firth, Coleen, or Kongakut rivers. Others wintered north or southeast of Old Crow Flats (D. Cooley, Project Leader, Environment Yukon, pers. comm.).

Natural mortality factors affecting Arctic Refuge moose populations are poorly documented. Brown bears and wolves prey on moose, but predation rates are unknown. Moose are taken by subsistence hunters from Arctic Village and Kaktovik and by general hunters visiting the Refuge. Total harvest varied by region and declined over time as populations decreased in abundance. Because of concerns about small population size, subsistence harvest of moose in the northwestern portion of the Refuge is restricted, and there is currently no open season for general hunters in Unit 26C.

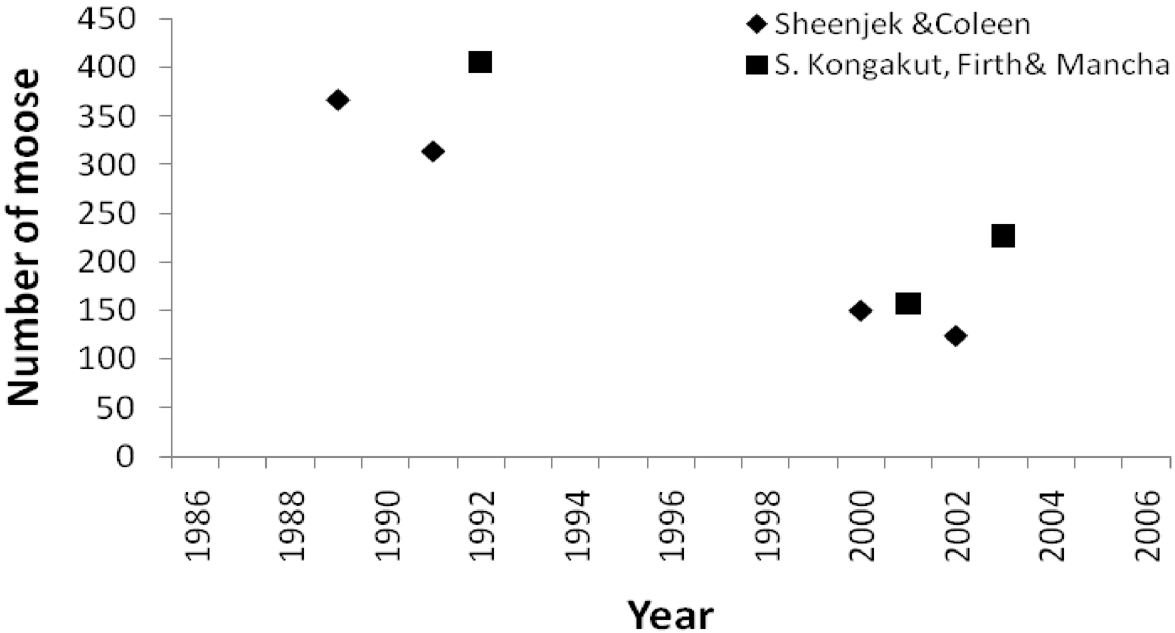


Figure 4-9. Moose counts along Sheenjek and Coleen rivers south of the Brooks Range Mountains and southern reaches of the Kongakut and Firth-Mancha drainages, Arctic National Wildlife Refuge, Alaska, 1989–2004.

Data source: U.S. Fish and Wildlife Service, Arctic Refuge.

Changes in climate that increase the length of the growing season may benefit moose if shrub habitats continue to increase in northern Alaska. Delach and Matson (2011) found that moose in Arctic Refuge are “not vulnerable/presumed stable” to climate change because their body configuration can cope with possible increases in snow and their use of early successional stages of vegetation will benefit if these plant communities increase as the climate warms.

Bears

Arctic Refuge is one of the few conservation areas in the world where all three species of North American bears occur. Polar bears use the northern edge of the Refuge, black bears occur only in southern regions in boreal forests, and brown bears are found throughout Arctic Refuge.

Polar bears (Ursus maritimus)

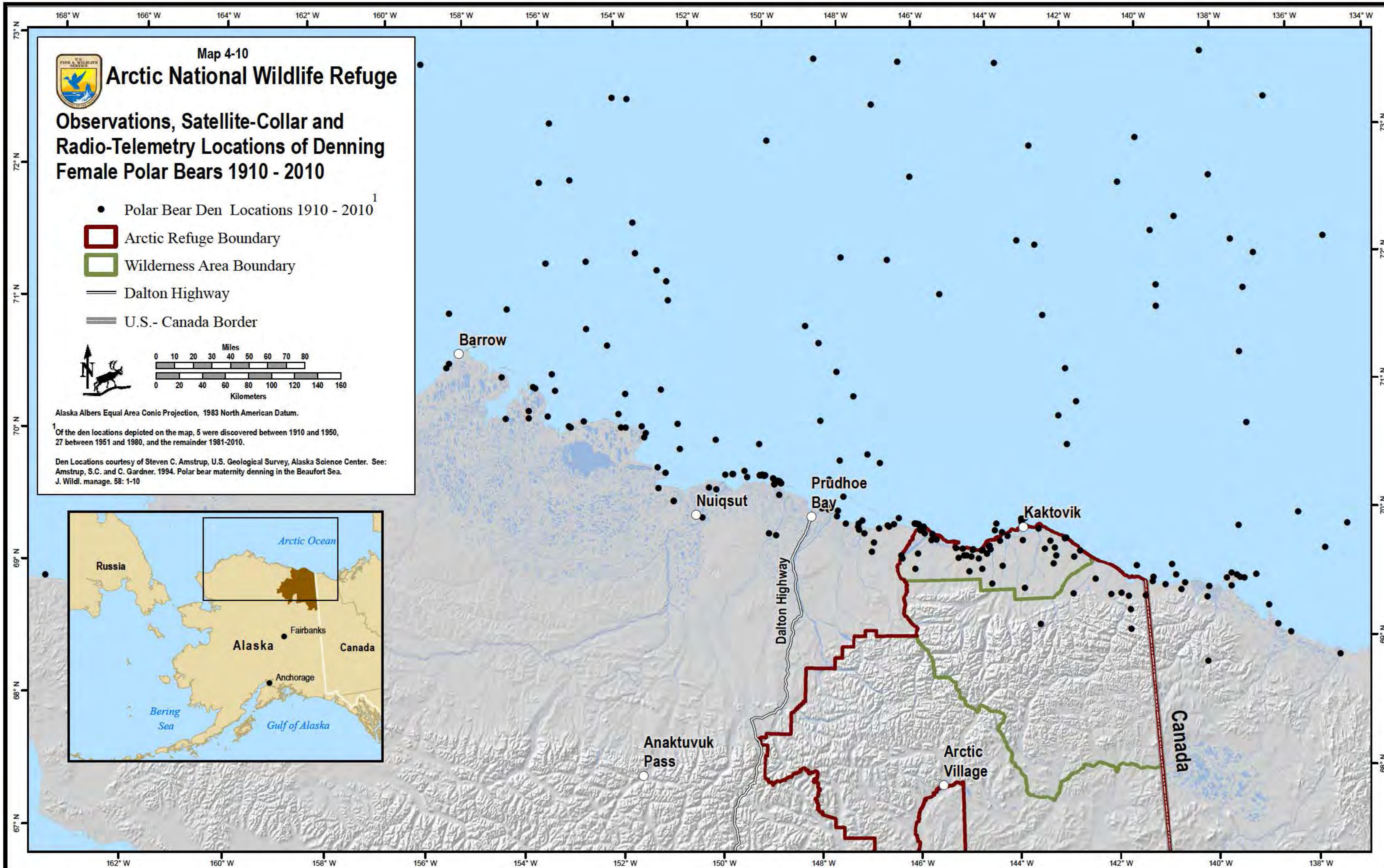
Polar bears are a relatively new species, having branched off the brown bear/grizzly bear lineage during the Late Pleistocene Epoch approximately 150,000 years ago (Lindqvist et al. 2010). Polar bears live throughout the arctic regions of the world and are classified as a marine mammal. The southern limit of their distribution is determined by the limit of arctic pack ice and annual land fast ice during winter (DeMaster and Stirling 1981). They are typically found on broken sea ice in areas with abundant ring seals *(Phoca hispida)* or bearded seals *(Erignathus barbatus)*, their principle prey (MacDonald and Cook 2009). Because of their strong association with ice seals, polar bears depend on sea ice for survival.

Polar bears first reproduce at age five or six. They mate in April and May, but—like other bear species—fertilized eggs do not begin to develop until September or October. One to three cubs are born in December in winter dens, which pregnant females excavate in snowdrifts offshore on stable pack ice or onshore in large drifts along drainages (Amstrup 2002). Males and non-pregnant females remain active throughout the winter on the pack ice.

Polar bears associated with Arctic Refuge are part of the southern Beaufort Sea stock, whose range extends from Icy Cape, west of Point Barrow, Alaska, to Pearce Point, east of Paulatuk, Canada (Brower et al. 2002). Polar bears in the southern Beaufort Sea spend most of their time in shallow waters over the continental shelf, in areas with greater than 50 percent ice cover, where they have access to ringed and bearded seals (Durner et al. 2006, Durner et al. 2009).

The coastal plain of Arctic Refuge has more potential terrestrial denning habitat for pregnant polar bears than other areas of arctic Alaska because it has uplands and hills and is bisected by streams and rivers. These features lead to formation of snow drifts that provide potential den sites (Durner et al. 2006). Sea ice forms earlier in the fall in northeastern Alaska, which may allow pregnant bears to access terrestrial habitats from the pack ice more readily (Lentfer et al.1980). Thinning sea ice has apparently contributed to a shift from denning on sea ice to denning on land in this region, as evidenced by a decline in the proportion of dens on pack ice from 62 percent in 1985–1994 to 37 percent in 1998–2004 (Fischbach et al. 2007). This shift emphasizes the importance of Arctic Refuge coastal plain to polar bears, as does the distribution of known polar bear dens in northern Alaska (Map 4-10).

Polar bears occur at low densities because they are long lived and have delayed sexual maturity, long intervals between reproductive events, and small litters (Lentfer et al. 1980, DeMaster and Stirling 1981). In the early 1960s, overhunting resulted in polar bear population declines in the southern Beaufort Sea (Amstrup et al. 1986). The Marine Mammals Protection



Map 4-10
Arctic National Wildlife Refuge
Observations, Satellite-Collar and Radio-Telemetry Locations of Denning Female Polar Bears 1910 - 2010
Polar Bear Den Locations 1910 - 2010[1]
Arctic Refuge Boundary
Wilderness Area Boundary
Dalton Highway
U.S.- Canada Border
Miles
0 10 20 30 40 50 60 70 80
0 20 40 60 80 100 120 140 160
Kilometers
Alaska Albers Equal Area Conic Projection, 1983 North American Datum.
[1] Of the den locations depicted on the map, 5 were discovered between 1910 and 1950, 27 between 1951 and 1980, and the remainder 1981-2010.
Den Locations courtesy of Steven C. Amstrup, U.S. Geological Survey, Alaska Science Center. See: Amstrup, S.C. and C. Gardner. 1994. Polar bear maternity denning in the Beaufort Sea. J. Wildl. manage. 58: 1-10
Russia
Arctic Ocean
Alaska
Fairbanks
Canada
Anchorage
Bering Sea
Gulf of Alaska
Barrow
Nuiqsut
Prudhoe Bay
Kaktovik
Dalton Highway
Anaktuvuk Pass
Arctic Village
Canada
168° W
166° W
164° W
162° W
160° W
158° W
156° W
154° W
152° W
150° W
148° W
146° W
144° W
142° W
140° W
138° W
136° W
134° W
73° N
72° N
71° N
70° N
69° N
68° N
67° N

Act of 1972 restricted harvest of Alaskan polar bears to Alaska Natives but allowed unlimited harvest—provided that it was not wasteful—and the sale of handicrafts made from bear parts (U.S. Fish and Wildlife Service 2010a). Following passage of the Marine Mammals Protection Act, the size of the southern Beaufort Sea polar bear population increased, and likely stablized during the 1990s (Amstrup et al. 2001). From 2001-2006, a negative rate of population growth (Hunter et al. 2007) and declining recruitment, survival (Regehr et al. 2010 and body condition and size (Rode et al. 2010) suggest that the southern Beaufort Sea population of polar bears is currently declining. The most recent population estimate for the southern Beaufort Sea is 1526 polar bears (95 percent CI = 1211-1841; C.V. = 0.106) (Regehr et al. 2006).

Polar bears were designated a Threatened species under the Endangered Species Act in May 2008 (73 FR 76249-76269). Under the Marine Mammal Protection Act, polar bears in the southern Beaufort Sea are classified as "Depleted" and designated as a "strategic stock" (U.S. Fish and Wildlife Service 2010b). Conservation concerns for this population include "loss of sea ice habitat due in part to climate changes in the arctic, potential overharvest, and current and proposed human activities including industrial activities occuring in the nearshore and offshore environment." (U.S. Fish and Wildlife Service 2010b, p 4). This shift emphasized the importance of the Arctic Refuge coastal plain to denning polar bears, which is also supported by the distribution of known polar bear dens in northern Alaska (Map 4-10).

Harvest of the southern Beaufort Sea polar bear population is currently managed under the authority of the Polar Bear Agreement between the Inuvialuit Game Council of Canada and the Iñupiat of the North Slope Borough of Alaska (Brower et al. 2002). Canada has a well regulated and controlled harvest, while harvest in Alaska is voluntary (Brower et al. 2002). The agreement provides for a Joint Commission and Technical Advisory Committee appointed by the commission, an annual quota, hunting seasons, and protection of bears in dens and females accompanied by cub-of-the-year.

A quota of 80 bears (40 each in Alaska and Canada) was set by the agreement in 1998 and reviewed in 2000 based on a population estimate of 1,800–2,000 (Amstrupt et al. 1986, Amstrup et al. 2001, Brower et al. 2002). In 2003–2007, an average of 54 polar bears were killed by subsistence hunters each year in the Beaufort Sea population in Alaska and Canada combined (Brower et al. 2002). Based on an estimated sustainable harvest rate of 1.5 percent of the total population size taken as females and a 2-males-to-1-female ratio in the harvest, 4.5 percent of the total population (63 of 1526 polar bears) could be harvested annually (76 FR 47021). This rate of harvest has been proposed for polar bear populations that are capable of natural growth at near maximimal rates (Taylor et al.1987). It may not be sustainable for populations experiencing limitations due to climate change or other effects. In July 2010, at the most recent Inuvialuit-Iñupiat Polar Bear Management Meeting, the quota for the southern Beaufort Sea population was reduced from 80 to 70 bears per year (76 FR 47021).

Marine Mammals Management division of the Service monitors the annual harvest of polar bears killed in Alaska, including animals taken from the southern Beaufort Sea population in and near Arctic Refuge. In Alaska, 117 polar bears were killed by subsistence hunters in 2005-2009. This was 40 fewer bears (157) than were killed in Alaska in 2000-2004 (76 FR 47021).

In 2010, the Polar Bear Specialists Group indicated that the five-year average harvest of polar bears in the southern Beaufort Sea was 44 polar bears per year with a quota of 80, the status of the population was reduced, the trend was declining, and the probability of future decline was moderate (40–60 percent) (Polar Bear Specialist Group 2010). The Potential Biological Removal level, as defined by the Marine Mammals Protection Act, indicates the maximum number of animals (excluding natural mortalities) that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population was estimated to be 22 bears per year for the southern Beaufort Sea population (U.S. Fish and Wildlife Service 2010b).

Final regulations developed by the Service (76 FR 47010-47054) authorized nonlethal, incidental unintentional take of polar bears during year-round oil and gas industry exploration, development, and production operations in the Beaufort Sea and the adjacent north coast of Alaska from August 3, 2011, to August 3, 2016. The analysis found that oil and gas activities would have a negligible impact on polar bears during this five-year year period (76 FR 47010-47054).

The probability of a large oil spill (greater than1000 barrels) in and near the Beaufort Sea is low (11 percent) according to Marine Management Service (U.S. Fish and Wildlife Service 2010b). This may increase as exploration and development moves offshore. Potential adverse impacts to polar bears from a large oil spill are of major concern (Federal Register Vol. 76 No. 149 page 47031). Polar bears are most vulnerable during the open water period when aggregations of bears at whale carcasses on shore take place (76 FR 470334). Amstrup et al. (2006) found a low probability that a large number of bears (25-60) would be affected by a large offshore oil spill. He estimated 0-27 polar bears could be oiled by a spill in the southern Beaufort Sea if the spill occurred during open water conditions in September or an estimated 0-74 bears could be oiled in October. If the subsistence harvest continues to average 54 bears per year and the annual sustainable harvest is now less than 81 bears, the death of a few dozen bears could result in population decline or slow recovery (U.S. Fish and Wildlife Service 2010b).

The Service also concluded that the probability of a large offshore oil spill in the next five years was low. If a spill did occur, the likelihood that oil would contact important areas or habitats used by bear habitats was also low, and, although individual bears may be affected, the effect on the polar bear population would be minimal. Thus "only small numbers of polar bears are likely to be affected by a large oil spell in arctic waters with only a negligible impact" to the southern Beaufort Sea population (76 FR 47036-47037).

People are interested in viewing polar bears in and near Arctic Refuge. In the fall, polar bears are attracted to remains of bowhead whales harvested by residents of Kaktovik. Congregations of bears feeding on whale bones near Kaktovik at the edge of Arctic Refuge provide opportunities for visitors and residents to see these large carnivores. The Service's Marine Mammals Management division and Arctic Refuge staff cooperate to monitor the fall influx of bears near Kaktovik and assist the community in developing guidelines for polar bear viewing.

Critical habitat for polar bears was designated by the Service in December 2010 with the final rule effective on January 6, 2011 (75 FR 76086-76137). Designated habitat was 187,757 square mi (484,738 square km) in Alaska and adjacent territoral and U.S. waters.

Polar bears rely on sea ice for survival. Sea ice is declining throughout the Arctic as temperatures increase, melting periods lengthen, and freeze-up occurs later in the fall (Stroeve et al. 2007). Increased periods of open water reduce reflectance and cause additional warming of the Arctic Ocean, leading to further ice melt (http://iside.org/cryosphere/seaice/processes/albedo.html). Between 1985 and 2006, large losses of optimal polar bear habitat occurred in the southern Beaufort and Chukchi Seas (Durner et al. 2009). In the southern Beaufort Sea, these changes appear to be negatively affecting polar bears' body condition, size, recruitment, and survival (Rode et al. 2010, Regehr et al. 2010). Hunter et al. 2010 suggests that this decline is due to sea ice habitat loss and that the population may face severe declines in the future if sea ice loss continues as forcasted. Delach and Matson (2011) state that polar bears are "extremely vulnerable" to climate change because of their dependence on ice and snow.

Brown (grizzly) bears (Ursus arctos)

This species occurs in North America, Europe, and Asia, although they have been reduced or exterminated by humans over much of their historic range. In Alaska, brown bears still occupy most of their historic range. They are frequently solitary, except for females with dependent offspring, aggregations at clumped food resources, and mating pairs. Brown bears breed between mid-May and July, although development of fertilized eggs is delayed until October. One to three cubs are born in winter dens during January (Churcher 1999).

In Arctic Refuge, the average female brown bear did not successfully reproduce until age nine years (Reynolds 1976, Reynolds and Hechtel 1980). In other areas of the Arctic, the mean age at first reproduction was greater than eight years (Reynolds and Hechtel 1984, Case and Buckland 1998). Average litter size of brown bears in arctic areas is two, and cubs can have a high mortality rate during their first year of life. Weaning does not occur until age two or three years. The interval between successful litters exceeds three years. The delayed age at first reproduction, long inter-birth intervals, small litters and high cub mortality result in low rates of reproduction for brown bears in northern latitudes.

Male and female brown bears are dormant in dens during the arctic winter. Heart rate and body temperature decline slightly, metabolic rate is reduced, and bears neither urinate nor defecate while in the den (Reynolds et al. 1986, Watts and Jonkel 1988).

Unlike polar bears, which den in snow cavities, brown bears in Arctic Refuge usually excavate earthen dens in the mountains on steep, south-facing slopes above rivers. They enter their dens during September and October, and emerge from late March through May. Inclement weather, especially snow storms, is considered a major factor in stimulating denning activity (Craighead and Craighead 1972, Reynolds et al. 1976). Because arctic soils are coarse, the top layer must be frozen before dens can be successfully excavated. Dens generally collapse with spring thaw, so reuse of dens is rare (Garner and Reynolds 1986). Adult males generally enter dens later and emerge later than females with cubs of the year. In Arctic Refuge, brown bears spend more than half their lives in winter dens (Reynolds et al. 2010).

Brown bears are opportunistic omnivores. In Arctic Refuge, grizzlies eat a variety of foods depending on seasonal availability. In March-May, after emerging from winter dens, they dig roots of *Hedysarum* plants and kill or scavenge ungulates. They use habitats ranging from shrubby riparian corridors, lowlands, foothills and upland mountain slopes with moist herbaceous tundra and sparsely vegetated areas along rivers and high mountain ridges.

Brown bears eat ungulate carcasses primarily in April and May before green vegetation emerges. Satellite-collared brown bears consumed more caribou than moose or muskoxen (Reynolds et al. 2007). Stable isotope analysis of brown bear blood serum collected over a 30-year period showed that arctic brown bears eat primarily vegetation and that consumption of meat did not increase over time (Reynolds et al. 2006).

Brown bears living in and near Arctic Refuge prey on caribou and moose calves and are a predator of muskoxen (Reynolds et al. 2002b). Arctic ground squirrels and microtine rodents, when they are abundant, are important prey items for bears. Bears north of the Brooks Range divide did not shift their distribution in response to the presence of calving caribou. Annual variation in snow melt patterns appears to be a more important determinant of bear distribution (Young et al. 2002).

On the Sheenjek River in the southern part of the Refuge, brown bears consume spawning salmon (Lenart 2007d). North of the Brooks Range, however, bears have little access to fish, and few observations of bears fishing have been reported. Stable isotope analyses suggest little use of marine-based resources (Reynolds et al. 2006). However, brown bears have been observed feeding and displacing polar bears at whale carcasses in Kaktovik, Barter Island (S. Miller, Wildlife Biologist, Service's Marine Mammals Management, pers. comm.).

Brown bear densities in northern Alaska are lower than densities areas in southern and southeastern Alaska where bears have access to salmon (Miller et al. 1997) In unit 26B in and near Arctic Refuge, brown bear densities were 18 bears per 386 mi^2 (18 bears per 1000 km^2) in 1999–2003 (Reynolds et al. 2009). By contrast, on Kodiak Island, bear densities were 308 bears per 386 mi^2 (308 bears per 1000 km^2) (Van Daele 2007).

In Arctic Refuge, brown bears are more abundant in the foothills and mountains of the Brooks Range than on the coastal plain (Young et al. 2002, Lenart 2007d). Lenart (2007d) estimated there were 390 brown bears in the foothills and mountains between the Canning River and the U.S. Canada border (Game Management Unit 26C) and 269 brown bears in the northwestern Refuge and adjacent areas (Unit 26B). Population trends and distribution of brown bears south of the Brooks Range are not well known.

An average of 36 brown bears were killed per year by general hunters in Units 25A, 26B, and 26C in and near the Refuge during 1993–2006 (Lenart 2007d). The number of brown bears taken by subsistence hunters is unknown.

Because of their wide ranging distribution and diverse use of habitats, brown bears in Arctic Refuge are likely to be less affected by a changing climate than other species. Delach and Matson (2011) found that brown bears in Arctic Refuge are "moderately vulnerable" to climate change because bears can move and disperse over long distances .

American black bears (Ursus americanus)

In Arctic Refuge, this species is only found in boreal forests of the southern uplands and lowlands (MacDonald and Cook 2009). Like brown bears, American black bears are omnivorous—eating plants, young ungulate, and other resources. They breed in early summer, delay implantation of the fertilized egg until November, and give birth to tiny young in winter dens. American black bears have 2–3 cubs, but from 1–6 cubs have been observed (Rogers 1999). Habitats used by black bears in Arctic Refuge likely include open and closed spruce forests and mixed forest of spruce and birch. But little is known about the distribution, population trends and mortality factors of American black bears in Arctic Refuge. Because of their wide distribution and omnivorous habits, black bears may not be negatively affected by climate change. If the boreal forest expands northward, black bears may increase their range in northern Alaska.

Other Carnivores

Carnivores play important roles as predators and scavengers in the ecological balance of Arctic Refuge. Furbearing species are also important to trappers and hunters. In communities near the Refuge, furs are used for clothing and handicrafts, and are a source of income. Many people visiting the Refuge hope to see carnivores such as brown bears, wolves or wolverines.

Wolves (Canis lupus)

Wolves were formerly distributed throughout the Northern Hemisphere, but their range has been greatly reduced by humans. Wolves still occupy most of their historic range in Alaska, however, including the arctic and subarctic regions. The wolf is a social species, usually living in packs of 5–10 animals. At high latitudes, wolves breed once a year during April. Altricial pups are born about two months later and are weaned about nine weeks after birth. Wolves feed on a variety of prey but are primarily predators of ungulates (Mech 2002).

Wolf packs often occupy territories that are distinct from those of neighboring packs. Wolves move a few miles to 45 mi (72 km) per day at speeds of about five mph (8 kmh) (Mech 1999). Individual wolves may travel great distances. One radio-collared wolf from Arctic Refuge moved 479 mi (770 km) from its last location in Arctic Refuge (Garner and Reynolds 1986).

Wolves are found throughout Arctic Refuge. North of the Brooks Range divide between the Canning River and the U.S.-Canada border, packs were associated with 11 different dens, which were more likely to be found in the mountains or foothills than on the coastal plain (Young et al. 2002). In this region of the Refuge, only about 20-40 wolves were present.

During the caribou calving period, wolves were generally associated with den sites and killed relatively few caribou (Young et al. 2002). Caribou are the primary prey species for wolves, followed in importance by sheep and moose. Small mammals, birds, and ground squirrels are also taken on an opportunistic basis. Wolves studied in northern portion of the Refuge did not follow caribou to their winter ranges but tended to remain in pack territories all year (Young et al. 2002). Wolves in northern Alaska ate caribou from spring to fall but switched to Dall's sheep, moose, and small game during winter (Stephenson 2006).

On the North Slope of Alaska, wolves were more abundant prior to aerial wolf hunting and predator control practices of the mid-1950s. Though the practices were outlawed by 1970, the abundance of wolves did not return to historic levels. Reported harvest of wolves in Units 25A, 26B, and 26C averaged 39 per year from 1997 to 2005. Known harvest likely underestimates the number of wolves killed, particularly in Units 26B and 26C, as many furs are used locally and not sealed (Stephenson 2006). Wolf populations are also affected by dynamics of food supplies, rabies epidemics, and competition with other wolves (Stephenson 2006).

Wolves are generally less abundant in northern Alaska than in interior Alaska, where moose densities are higher. A 2003 aerial wolf survey in the foothills and mountains of Unit 26B between the Itkilik and Canning rivers indicated a density of about 4.8 wolves per 1000 square mi (Stephenson 2006). Numbers of wolves and wolf population trends in Arctic Refuge are not currently known.

Delach and Matson (2011) found that wolves in Arctic Refuge were "not vulnerable/presumed stable" to climate change because of their ability to use a diversity of habitats and their ability to disperse.

Wolverines (Gulo gulo)

This large member of the weasel family ranges widely over large distances and live in many habitats from sea level to mountain tops. Wolverines live throughout Alaska but are more numerous in the mountains and foothills of the Brooks Range than on the coastal plain (MacDonald and Cook 2009).

Breeding occurs from early spring through late fall. After a period of delayed implantation, two or three kits are born in snow dens between February and April. Natal dens are generally abandoned by mid-May. Although most of their food is carrion, wolverines also prey on ground squirrels, ptarmigan, snowshoe hares, and even caribou (Whitman 2002).

Very little is known about population trends or abundance of wolverines in Arctic Refuge although biologists record sightings of wolverines and other carnivores during the course of field work on many species. In the early 1980s, 11 wolverine sightings were made during intense field studies north of the Brooks Range (Mauer 1985b). In 28 years of annual spring surveys for muskoxen and moose between the Canning River and US-Canada border, three wolverines were seen. During radio-tracking flights in the Brooks Range in 2006-2009, one pair was observed. Less field work has been carried out south of the Brooks Range and less is know of wolverine densities in these regions.

Wolverines are an important furbearer species in the eastern interior of Alaska, including southern areas in Arctic Refuge (Szepanski 2007). An average of 25 wolverines per year were harvested in regions in or near the Refuge during 1996–2006. Most of these were taken south of the Brooks Range in Unit 25A (Szepanski 2007). Because wolverines taken by local residents are frequently used for clothing and may not be sealed, estimates of harvest are likely biased low.

Delach and Matson (2011) stated that wolverines in Arctic Refuge are “highly vulnerable” to effects of climate change because of “natural barriers to species range shift” and “dependence on snow.” Wolverines have natal dens in areas where snow cover persists until mid May. If changes in climate result in the loss of persistent snow cover and summer temperatures, the extent of wolverine habitats may be reduced (Copeland et al. 2010).

Arctic foxes (Vulpes lagopus)

This species lives in northern areas of the Refuge from the arctic sea ice to the Brooks Range mountains. Arctic foxes often spend winters on sea ice, feeding primarily on the carrion of seals killed by polar bears. In summer, primary prey are lemmings and voles, although they also take bird eggs and nestlings (Anderson 1999). Arctic fox populations vary widely depending on the availability of food such as lemmings (MacDonald and Cook 2009). Rabies is endemic in arctic fox populations in Alaska (Garner and Reynolds 1986, Ballard et al. 2001).

Arctic foxes are monogamous. In northern Alaska, breeding occurs in March through early April, and pups are born in May or June. Litter size is highly variable (from 2–20), and the number of pups weaned depends on vole and lemming populations (Anderson 1999). Denning occurs on land during summer, primarily near the coast.

Residents of Kaktovik trap arctic foxes during winter in moderate numbers, but harvest levels are not known. Red foxes, whose range extended into high latitudes during the 20th century, are dominant over and likely outcompete smaller arctic foxes (Selas et al. 2010). They also kill arctic foxes (Pamperin et al. 2006).

Arctic foxes are adapted to the cold arctic climate (Underwood and Reynolds 1980, Anderson 1999). Climate change may negatively affect arctic foxes because of their association with sea ice and polar bears in winter. Delach and Matson (2011) found that arctic foxes in Arctic Refuge are “extremely vulnerable” to changes in climate due to potential habitat loss, its dependence on ice and snow, and possible loss of prey species.

Red foxes (Vulpes vulpes)

This fox is the most widely distributed carnivore in the world. Red foxes live in diverse habitats, hunting and scavenging a wide variety of resources. Red foxes breed from late December through late March. An average of five pups are born 6 weeks later, which are raised by both parents (Seidensticker 1999). Red foxes occur throughout the Refuge, but they are most common in the riparian areas in the mountains and foothills of the Brooks Range (MacDonald and Cook 2009).

In northern Alaska, the range of red foxes may be expanding into the range of arctic foxes (Pamperin et al. 2006). The larger body size of red fox gives them a competitive advantage (Selas et al. 2010), and red foxes have been observed killing arctic foxes (Pamperin et al. 2006). As the climate becomes warmer, red foxes could benefit by the expansion of boreal forest habitats in Arctic Refuge. Delach and Matson (2011) found that that red foxes in Arctic Refuge are likely to increase their populations with climate change.

Canada lynx (Lynx canadensis)

Canada lynx are well adapted to living in snow, as are their primary prey, the snowshoe hare (*Lepus americanus*). Lynx are usually solitary. Breeding occurs during March and April, and an average of three kittens are born in May or June (Tumlison 1999).

The most important lynx habitats in Arctic Refuge are south of the Brooks Range in spruce and mixed forests and woodlands with dense understories of shrubs (MacDonald and Cook 2009). In times of prey scarcity, lynx range into tundra areas and have been observed as far north as the arctic coast.

Reported harvest of Canada lynx, red fox, mink, and American marten from Game Management Units south of the Brooks Range peaked in 1996. Mink harvest peaked again in 2004, and the number of harvested lynx continued to increase between 2003 and 2005 (Szepanski 2007). North of the Brooks Range divide, four Canada lynx were taken in 2003, and three Canada lynx were taken in 2006 (Szepanski 2007).

Canada lynx were classed as “highly vulnerable” to climate change based on its dependence on snow and forest habitats, and its dependence on a single prey species; however, the certainty of this vulnerability is low (Delach and Matson 2011).

Rodents and Hares

Rodents occupy a wide diversity of habitats on Arctic Refuge. Many are important in the food webs of the tundra and boreal forest ecosystems. High variability in rodent and hare abundance influences numbers and distribution of predators and scavengers and affects vegetation communities on which rodents and hares depend. Climate change could have positive or mixed effects on rodents and hares in Arctic Refuge. An increase in the length and warmth of the growing season could increase access to green forage for all herbivores. However, if wet graminoids tundra is replaced by dryer shrubbier tundra, singing voles (*Microtus miurus*), collared lemmings (*Dycrostonyx groenlandicus*), hares (*Lepus* sp.), and porcupines (*Erethizon dorsatum*) could benefit, while brown lemmings (*Lemmus trimucronatus*) and root (tundra) voles (*Microtus oeconomus*) may not (Martin et al. 2009). Delach and Matson (2011) found that collared and brown lemmings and root (tundra) voles were “extremely vulnerable” to climate change because of their “sensitivity to temperature change.” Alaska marmots (*Marmota browerii*), arctic ground squirrels (*Spermophilus parryii*), singing voles, and northern bog lemmings (*Synaptomys borealis*) were “highly vulnerable”and snow shoe hares, northern-red backed voles (*Myodes rutilus*), meadow voles (*Microtus pennsylvanicus*), red squirrels, (*Tamiasciurus hudsonicus*) and porcupines were considered to be not “vulnerable/presumed stable.” Inouye et al. (2000) found that Alaska marmots are likely to be affected by a warming climate because they live in mountain habitats that may change and because they are endemic to northern Alaska and could be rare. Climate change that results in more incidents of freezing rain or icing conditions in winter could affect rodents and hares, especially small species like lemmings and voles that are active all winter and depend on insulating layers of snow for warmth and protection from predators (Merritt 2010).

Alaska marmots (Marmota broweri)

This large squirrel is endemic to Alaska and occurs in some mountain areas in Arctic Refuge. Its distribution, status, and natural history are not well known. Marmots live in rocky alpine areas of tundra in scarcely vegetated scree type habitat. Alaska marmots are further discussed in the section on Endemic Species.

Arctic ground squirrels (Spermophilus parryii)

This medium-sized rodent is found throughout Alaska in habitats ranging from tundra, meadows, river banks and lakeshores (MacDonald and Cook 2009). In Arctic Refuge, it occurs in tundra regions of well-drained soils where burrows can be constructed. Moist sedge-Dryas tundra and moist sedge tussock tundra habitats are used by Arctic ground squirrels. In the Arctic Refuge, ground squirrels are s most numerous in the foothills and mountains of the Brooks Range (MacDonald and Cook 2009). Arctic ground squirrels are the northernmost hibernator in North America, spending up to nine months in winter dens (Buck and Barnes 1999). Arctic ground squirrels are an important food resource for brown bears and foxes.

Lemmings and Voles

Collared lemmings are found from the arctic coastal plain to the mountains of the Brooks Range frequently in moist sedge-willow tundra and moist sedge-tussock tundra in association with cotton grass (*Eriophorum vaginatum*). Of all the microtines, this species is best adapted to sub-freezing temperatures, ice and snow. In winter the coat of the collared lemming turns white and develops an enlarged claw for digging through snow.

Brown lemmings occupy a wider geographic range than collared lemmings and are found throughout Alaska. They are most abundant at higher latitudes and are the most common microtine on the coastal plain of Arctic Refuge. Brown lemmings live in wet sedge grass (graminoids) tundra.

Singing voles are the most common microtine in the Brooks Range and are less frequently found in the foothills and rarely on the coastal plain. Singing voles live in well-drained sites at the edge of swales or banks near early successional stages of vegetation and running water.

Root voles *(Microtus oeconomus)* are found throughout Alaska. In Arctic Refuge, they are abundant and widespread from the coastal plain and foothills to the north and south slopes of the Brooks Range. Root voles occupy a variety of open herbaceous habitats ranging from wet graminoids tundra to grass-forb meadows and bogs.

The northern red-backed vole (*Myodes rutilus*) is found primarily in the Brooks Range and along major river valleys. It lives in areas with overhead protection from rocks or vegetation such as scarcely vegetated scree, dwarf shrub, and woodland habitats. (MacDonald and Cook 2009).

Lemming and vole populations on the Refuge tend to fluctuate widely (Batzli and Pitelka 1983). When brown lemmings or other microtines are abundant, they have substantial effects on local plant communities and provide food resources for many other species, including brown bears, arctic and red foxes, least weasels (*Mustela nivalis*), and other mammalian and avian predators. Lemming "highs" cause shifts in predator distribution as species move in to take advantage of this abundant food resource.

Snowshoe hares (Lepus americanus)

This species occasionally occurs in boreal forests in the southern portion of the Refuge in riparian willow stands (MacDonald and Cook 2009). Hare sign observed in the mountains and northern foothills is likely also that of snowshoe hares. However, two other species of northern hares have been documented east and west of the Refuge and may occur on the Refuge itself,

although their presence has not been documented. Alaskan hares (*Lepus othus*) historically occurred as far east as the Colville River, about 100 miles west of Arctic Refuge (Best 1999a). Arctic hares (*Lepus arcticus*) are found in Northwest Territories, Canada, about 100 miles east of Arctic Refuge (Best 1999b).

Snowshoe hares are active year-round and can produce 2–5 litters of 1–8 young each per year. Young hares are born fully furred, grow rapidly, and are weaned within a month (Murray 1999). Snowshoe hare populations vary widely from year to year, often increasing over several years and then declining rapidly. At high densities, snowshoe hares are an important resource for medium to large predators. Lynx populations are closely tied to cycles of snowshoe hare populations (Tumlison 1999).

Endemic species

Two species of mammals occur only in Alaska, and both have been found on Arctic Refuge.

Alaska marmots (Marmota browerii)

This large squirrel lives in mountains north of the Yukon River, including the Brooks Range in Arctic Refuge (Gunderson et al. 2009). Its status is poorly understood (MacDonald and Cook 2009). Alaska marmots subsist on large amounts of low quality forage and choose den sites in bolder fields or rock outcroppings. Hibernation begins in September and ends in June, and members of a colony den together. Adult females produce only one litter per year, and sexual maturity is reached at several years of age.

Distribution of Alaska marmots is very patchy and scattered. Many details of the natural history of this species are unknown (Hoffmann 1999).

Alaska tiny shrews (Sorex yukonicus)

This shrew is a newly described species endemic to Alaska (Dokuchaev 1997). Little is known about the distribution and natural history of this tiny animal, which is the smallest shrew in the world. It appears to be widespread but rare in Alaska and occupies a wide range of forested and non-forest habitats, including riparian scrub (MacDonald and Cook 2009). A specimen was found dead on the Canning River delta in 2004, confirming that the species occurs on the Refuge (C. Villa, Refuge Operations Specialist, Arctic National Wildlife Refuge, pers. comm.).

4.3.7.4 Mammal-related Management Issues

Arctic Refuge is responsible for implementing Federal subsistence hunts pursuant to regulations adopted by the Federal Subsistence Board. Refuge staff distributes permits to local communities for the subsistence harvest of Dall's sheep, moose, and muskoxen in Unit 26C and Dall's sheep in the Arctic Village Management Area (Unit 25A). The number of permits issued typically depends on the population status of the species being hunted. Consequently, it is essential for Federal and State managers to have reliable, up-to-date information about population status and trends in order to properly plan for conservation of local species while allowing for subsistence and general hunting to the extent possible. The most effective means for obtaining information relating to population numbers and trends includes a combination of aerial surveys, ground counts, radio tracking (such as collaring), and habitat assessment by way of remote sensing and ground studies.

While Dall's sheep is an important subsistence species in this area, it is at the northern extent of its range and particularly vulnerable to overharvest. For that reason, improved understandings of population numbers and trends, seasonal movements, and distribution throughout the Refuge are needed. It will also be important to coordinate any sheep survey efforts on the Refuge with those in surrounding areas to enhance understandings of regional population trends.

Moose are another species in Arctic Refuge upon which local subsistence hunters are heavily reliant. Just as in the case of Dall's sheep, the moose populations on the Refuge have the potential to be overharvested if there is insufficient data for managers to make well-informed decisions. Consequently, in addition to developing base information about moose population trends and distribution, it will be important to conduct research that allows Federal and State managers to better understand patterns of movement and interaction between moose populations in the region.

For Federal managers to make appropriate decisions with regard to all of the ungulate populations on the Refuge, it will be necessary to develop an improved understanding of the local predator-prey relationships that impact those populations. To this end, monitoring of grizzly bears and wolves will be necessary. Information gathered will be used to better understand the dynamics of large predators living near the northern edge of their range as well as to clarify the nature of the relationships between these predators and their ungulate prey.

In the last two decades, caribou, sheep, muskoxen, and moose populations have fluctuated in Arctic Refuge, with some showing prolinged periods of decline. Similar declines occurred west of the Refuge, but most ungulates in those areas have since shown signs of recovery. Understanding the full range of factors that drive ungulate populations is essential for understanding and predicting population trends, and for managing subsistence harvests. The Refuge staff continues to participate in cooperative studies with ADFG, the Yukon Territory government, and others to ensure that these species will be conserved now and into the future.

4.4 Human Environment

4.4.1 Cultural and Historical Context

Over 530 archeological and historic and paleontological sites have been recorded within the boundaries of Arctic Refuge (ADNR Alaska Heritage Resources Survey 2001). These sites do not exist in isolation but in the context of a remarkable record of more than 10,000 years of human use of the land (Reanier 2003). At least seven prehistoric and two historic Native cultural traditions are represented on Arctic Refuge. Cultural resources on the North Slope and coastal plain are on or near the surface of the tundra and tend to be oriented along river corridors and coastal beaches. This means that many cultural resource sites on the Refuge are vulnerable to erosion and other natural forces, and to a lesser extent, from public use of Refuge lands and waters.

4.4.1.1 Archaeological and Historical Resources of Arctic National Wildlife Refuge

Currently, 212 archeological and 188 historical sites have been recorded within the boundaries of Arctic Refuge. Access to many areas of the Refuge is difficult and costly, requiring fixed-wing aircraft and substantial legwork. If the locations of known archaeological sites were plotted on a map, they would appear in clusters, reflecting the areas and extents of the surveys conducted. While the individual characteristics of the sites recorded within the boundaries of Arctic Refuge are unique, their nature can be generalized into several categories, which include:

- Coastal settlements, consisting of semi-subterranean driftwood or whalebone houses, in some cases associated with cemeteries and/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 and/or additional structures. This is the least known type of site on the Refuge.
- Tent ring complexes, consisting of arrangements of stones used to secure skin tents to the ground, often with associated hearths in and outside of the ring. These features are found along river corridors on elevated terraces and likely relate to seasonal caribou hunting by coastal people. In some cases, these complexes are situated near or adjacent to caribou drive lines or fences.
- Caribou drive lines and fences are found on the north and south sides of the Brooks Range. These linear arrangements of stone cairns (in the north) and spruce (in the south) were used to funnel the movements of caribou herds into corrals where they were dispatched by hunters. The development of this type of large-scale procurement strategy required considerable levels of social organization to plan, create, and execute.
- 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 to a site.
- Historic cabins built by indigenous peoples, early explorers, and trappers that offer insights into the early contact period.
- Prospecting and mining sites established during the late 19th and early 20th centuries document historic mineral exploration of the Refuge.

- Graves and cemeteries are sometimes associated with other types of archaeological and historic sites but may also be found in isolation.

4.4.1.2 Area History

The Arctic and its people, particularly the Eskimos, have fascinated Europeans since Frobisher's voyages in 1576. In the 1920s, archaeological research in the Bering Strait region delineated several proto-Eskimo cultural traditions. Most subsequent research in Alaska has focused on the west and northwestern coasts. Due to remoteness and a lack of development activity, very little work has occurred in the eastern Alaska arctic. Arctic Refuge Eskimo prehistory is based on broad regional patterns developed elsewhere.

The prehistory of interior Alaska, south of the Brooks Range, is very poorly known due to limited fieldwork, largely a result of challenging topography, vast distances, and difficult access. Interior sites also lack the flamboyant material culture of coastal sites (Shinkwin 1977, Workman 1996). Finally, most interior research focuses on the earliest settlement of the Americas to the near total neglect of later periods. With few excavated sites to draw on, regional culture history sequences for Arctic Refuge must be inferred from sites sometimes long distances from the Refuge.

Prehistory: the earliest period

The unglaciated Arctic coast served as a migration route for early nomadic hunters who migrated to America from Asia across the Bering Land Bridge. During the Itkillik glaciation, extensive valley glaciers prohibited human occupation of the Brooks Range. As the ice front retreated, by 10,000 B.C., people gradually penetrated the foothills. The area south of the Brooks Range remained ice-free during the last glaciations and was a route for entry of immigrants into the New World. Bones that were possibly modified by humans from Old Crow Flats in theYukon Territory may date to as old as 27,000 years ago.

Paleoindian Tradition (13,700–9,800 years ago)

Paleoindian refers to the first widespread and well-attested Native American cultural tradition. Paleoindian includes the well-known Clovis, Folsom, and Plano traditions in mid-continental North America. Characteristic artifacts include iconic fluted projectile points, edge-ground lanceolate projectile points, and other bifaces, multiple spurred gravers, and scrapers (Kunz and Reanier 1994, Kunz and Reanier 1995), all with exquisite technical workmanship. In Alaska, Paleoindian sites are almost all surface finds. Fluted points have been found in the Nenana and Tanana River valleys; on the North Slope (Reanier 1995, Kunz et al. 2003); in the Brooks Range and its northern foothills; and in Yukon Territory, Canada. Most known sites command impressive views of the surrounding landscape and appear to have been hunting lookouts and weapon repair stations. Paleoindian societies probably consisted of small mobile bands of big-game hunters focused on capturing now extinct Pleistocene mega-fauna: mammoths, horses, and bison. As the environment transformed at the end of the Pleistocene and large mammals disappeared, the Paleoindian tradition vanished from the north (Kunz et al. 2000).

The Putu Site, on the eastern slope of the Sagavanirktok Valley, excavated in the 1970s (Alexander 1987), was the first Alaskan site to produce fluted projectile points. Recent re-examination of the site questions the postulated 11,500-year-old date and raises the possibility that the tradition persisted in the Brooks Range until 8,800 years ago (Reanier 1995). The Mesa site, south of Barrow in the foothills of the Brooks Range, is the best documented site of this period (Kunz and Reanier 1994, Kunz and Reanier 1995). Radiocarbon samples from 30 hearths have produced dates ranging between 11,660 and 9,330 years ago. Other Paleoindian tradition sites include Bedwell (Sagavanirktok River), Hilltop (Atigun River Gorge), and Tuluaq Hill (Noatak River) (Kunz 1982, Kunz and Reanier 1994, Kunz and Reanier 1995, Reanier 1995, Rasic and Gal 2000, Kunz et al. 2003).

American Paleoarctic Tradition: 11,800–8,000 years ago

Overlapping with the Paleoindian tradition, the American Paleoarctic tradition (Anderson 1968) is the oldest, well-documented, Alaska-wide cultural tradition. The American Paleoarctic tradition is a loose technological construct (Anderson 1968, Anderson 1970, West 1981, Dumond 1987), with numerous variants distinguished by differences in frequencies of specific artifact types. Particular emphasis is placed on the presence or absence of microblades. Some of these variations include the Northwest Microblade Complex, the Nenana Complex, the Denali Complex, the Chindadn Complex, and the Sluiceway Complex. Many researchers consider them to be variations of a single tradition (Clark 1981, Clark 2001, Dumond 2001, Holmes 2001). Recent discoveries at the Nogahabara Sand Dunes on the Koyukuk Refuge support the concept that these traditions are a single with assemblage differences representing functional variation rather than distinct cultural groupings (Daniel Odess, pers. comm., 2005). Questions regarding the relationship between the American Paleoarctic tradition and its ancestral groups in Siberia, and the relationship of Paleoarctic and PaleoIndian peoples are hotly debated.

Wedge-shaped microblade cores, a variety of blades and microblades, and burins for working bone are hallmarks of the Paleoarctic tradition. The technology has clear antecedents in older sites from eastern Siberia (West 1996). The tradition is widespread, found across the North Slope and extending east through the Yukon, in the Koyukuk and Tanana river regions, Bristol Bay, the eastern Aleutians, southeast Alaska, and coastal and interior British Columbia. The sites appear to represent the camps of small bands of big-game hunters. Although the occasional horse, elk, moose, and musk ox has been found in sites, the economy was heavily dependent on caribou. Since caribou numbers appear to have been low at that time, making a living in north Alaska may have been quite challenging.

Paleoarctic sites on the North Slope include the Gallagher Flint Station near Galbraith Lake (Dixon 1975), the Lisburne Site on Iteriak Creek (Bowers 1982, Bowers 1999), Kurupa Lake (Schoenberg 1995), Kealok Creek (Reanier 2003), Tunalik (Gal 1982), and the Putuligayuk River delta overlook site at Prudhoe Bay (Lobdell 1985). Dated sites on the North Slope are younger than sites further south, suggesting a later arrival of this tradition to the far north. Kealok Creek site is one of the oldest Paleoarctic sites on the North Slope, at approximately 9,800 years old.

Prehistory: The middle period

Northern Archaic Tradition: 8,000–3,000 years ago

An unfilled gap appears in the sequence before the appearance of the forest-adapted Northern Archaic tradition about 6,000 years ago. The Northern Archaic tradition is a series of related cultures widely distributed across Alaska (Anderson 1968). Less is known about this tradition than any other in Alaska. Although there is an apparent gap, the tradition clearly derives from the Paleoarctic tradition, adding leaf-shaped spear points, large bifaces, end and side scrapers, tchi-thos (boulder spall scrapers), notched pebble axes, cobble choppers, and notched stone net sinkers to the Paleoarctic toolkit of microblades and side notched points.

First described from Cape Krusenstern and Onion Portage, Northern Archaic sites are known from Anaktuvuk Pass (Campbell 1961) and Kurupa Lake (Schoenberg 1995). Unlike earlier traditions, most sites are found in interior Alaska. Sites are found as far east as the Mackenzie River and south to Ugashik Lakes on the central Alaska Peninsula. On the coastal plain, sites are clustered around the mouth of the Colville River, at the Putuligayuk River Delta Overlook site (Lobdell 1985, Lobdell 1995), Kuparuk Pingo (Lobdell 1986, Lobdell 1995), Lisburne, and Kuna. South of the Brooks Range sites around Old John Lake on Arctic Refuge belong to the Northern Archaic tradition. Northern Archaic sites are absent from southeast Alaska and the Yukon-Kuskokwim basin.

During Northern Archaic times, the modern boundaries of the boreal forest were established and modern environmental conditions reigned. Environmental change from the dry Pleistocene steppe to wet tussock tundra probably reduced human mobility. The economic focus was on interior, terrestrial resources, notably caribou. Net sinkers signal a major shift in subsistence from big-game hunting to a mixed hunting and fishing economy. The geographic distibution of Northern Archaic largely corresponds to the modern distribution of western Athabascans and the tradition is likely ancestral to the modern people of the area.

Arctic Small Tool Tradition: 5,000–2,400 years ago

The Arctic Small Tool tradition is generally thought to be the earliest of the archaeological traditions that leads directly to modern day Eskimo peoples. As the name implies, it is typified by diminutive and beautifully made flaked stone tools. Among these are end and side blades (attached to an antler base to make composite projectile points), microblades, and mitten-shaped burins. The Arctic Small Tool tradition expanded across the Arctic from Alaska to Greenland, a surface distance of nearly 5,000 miles, in less than 500 years. They were the first people to inhabit the high arctic and occupied a much more extensive area than did the earlier Paleoindians or any subsequent Eskimo culture.

The Arctic Small Tool tradition appears rather abruptly and is associated with a climatic shift occurring at the end of the Holocene Warm Period. The tradition has several component cultures, but only the Denbigh Flint Complex is found in northern Alaska. Denbigh sites are common throughout the Brooks Range and extend south to the Kobuk River. A variant is found far to the south on the northern Alaska Peninsula (Dumond 1984). Excavated Denbigh sites in northern Alaska include Croxton, Punyik Point, Kurupa Lake, Mosquito Lake, and the Gallagher Flint Station, all lying along the northern edge of the Brooks Range. The average age of the Denbigh occupation at these sites is 4,000–3,400 years ago. Dates at Mosquito Lake and Gallagher Flint Station indicate occupation as late as 2,400 years ago (Kunz 1977). The Walakpa site near Barrow also contains Denbigh materials dated to around 2,400 years ago (Stanford 1971, Stanford 1976). Dates from the Putuligayuk River indicate this tradition lasted to around 2,000 years ago on the North Slope (Lobdell 1985). These slightly later assemblages contain—in addition to typical Denbigh materials—small, contracting stem, edge-ground, end blades.

The economy was broadly based with equal reliance upon maritime, land, and riverine resources. Their technology was geared towards caribou hunting even in coastal sites where seals were hunted (Giddings and Anderson 1986). People lived in caribou skin tents in the summer. More substantial shallow semi-subterranean houses exist and probably indicate winter occupation. These houses measure about 8 by 10 feet in size. A willow framework arched over the excavation and supported a roof of sod blocks sheathed by caribou skins (Kunz 2006). Denbigh people, like their earlier predecessors, made most of their stone tools from chert. However, they also exploited the Batza Téna obsidian source, on the Koyukuk Refuge's Indian River. Use of Batza Téna obsidian is evidence of their mobility, large population, and established trading networks.

Prehistory: the late period

Iñupiat Ancestors

Beginning about 2,000 years ago, people on the Arctic coast became more reliant on marine resources. Strong continuity in stone and organic tools suggests direct descent from earlier Arctic Small Tool tradition people.

Birnirk Culture (1,600–1,000 years ago)

The type site for this maritime based culture is Birnirk (Piåniq) at the base of the Barrow spit. Birnirk developed out of the Old Bering Sea, and Okvik cultures centered on St. Lawrence Island in the Bering Sea. Sites appear along the coast from Kotzebue to Barrow (Giddings and Anderson 1986), and include Walakpa (Stanford 1976), Point Hope (Larsen and Rainey 1948), and Cape Krusenstern (Giddings and Anderson 1986).

Birnirk houses and artifacts document a lifeway nearly identical to those of the historic Iñupiat (Ford 1959, Carter 1966, Stanford 1976). The people lived in substantial settlements in semi-subterranean winter houses. They were accomplished hunters of seal, walrus, and caribou, and occasionally hunted whales. They also harvested fish and waterfowl.

The tool assemblages include beautifully carved and decorated ivory harpoon heads. Flaked stone side and end blades, and ground slate tools such as ulus, were common. Bone, ivory, and antler were used to make numerous implements, including harpoon heads, tool handles, and composite tool parts. Although skin boats have likely been an important item in every Arctic culture's toolkit, the increased emphasis on marine resources suggests an increase in use, and possibly in size, of skin boats. Birnirk people were part of an elaborate interaction sphere involving contacts throughout Bering Straits, intercontinental trade, and warfare (Mason 1998).

Thule (1,000–400 years ago)

By 1,000 years ago, in response to climate moderation and technological advances related to whaling, the Birnirk culture had transformed into the Thule Culture. Thule people spread from northwest Alaska across northern Canada to Greenland, arriving during the same warm period that allowed the Norse to settle Greenland. Thule expansion rivals the Arctic Small Tool tradition colonization 3,000 years earlier.

Climate warming changed sea ice conditions to allow access to the bowheads through open water whaling. Technological changes included new harpoon types; development of specialized bone, antler, and ivory whale hunting tools; refinement of large open skin boats; and the invention of the dragfloat.

Other aspects of Thule culture are almost identical to that of their Birnirk ancestors. The toolkit contained flaked stone end and side blade insets, ground stone implements, and pottery. Reliance on whales allowed, and required, populations to aggregate in larger settlements and led to dramatic changes in social and political organization. Settlements consisted of single room dwellings of logs and sod arranged around a larger, multi-roomed dwelling occupied by the lead whaling family. Thule sites are found at Barrow, Walakpa (Stanford 1976), Point Hope (Larsen and Rainey 1948), Cape Prince of Whales, and Cape Kruzenstern (Giddings and Anderson 1986).

Athabascan Ancestors

Athabascan prehistory is a lifeway adapted to the boreal forest. There is no single identifiable prehistoric Athabascan tradition. Regional variability and adaptation are hallmarks of this tradition. Researchers disagree over how far into the past Athabascan people and cultures can be traced. Some see a recognizable Athabascan cultural pattern beginning with major environmental and adaptive changes that preceded the Northern Archaic tradition. Others believe the earlier people (Paleoindian/Paleoarctic) are related to American Indian groups now found further south, and Athabascan cultures represent a later migration. Drawing on linguistic evidence, Krauss and Golla (1981) suggested that 3,000 years may have elapsed since the numerous modern Athabascan languages diverged from a common language centered in Alaska.

Physically, there is an apparent gap in the archaeological record between Northern Archaic tradition sites and Athabascan components of the last 2,000 years. The gap is likely the result of limited field work, buried sites, erosion, cultural values prescribing behaviors that limit creation of visible sites, and periodic depopulation and resettlement (Moodie et al. 1992, West and Donaldson 2002). Complicating the picture in eastern Alaska, a major volcanic eruption 1,900 years ago in the Wrangell Mountains deposited the White River ash layer. Following this eruption, groups around Kluane and Aishihik lakes moved to the northwest, and Kavik points, tchi-thos, and other generalized Athabascan tradition implements appeared in the Brooks Range.

The Klo-Kut site, mid-way along the Porcupine River in Canada, provides the longest unbroken record of prehistoric Athabascan occupation, spanning 1,500 years and culminating in a historic Athabascan village (Morlan 1973). The earliest Athabascan tradition phase, identified by Le Blanc (1984) is Old Chief, extending from ca. 900 B.C. to A.D. 700. Old Chief exhibits relationships to Itkillik at Onion Portage, Minchumina Lake, and the Taye Lake phase in southwest Yukon. Artifacts include notched projectile points, and the assemblages lack microblades.

The later Klo-Kut Phase begins about A.D. 700 and continues through the arrival of European traders. Workman's Aishihik Phase is an equivalent Phase determination. The assemblage is closely related to the upper component of Dixthada, Kavik, and other sites throughout Alaska and western Canada (Shinkwin 1979). Artifacts include small, tapered-stem projectile points, groundstone hide and wood working tools, bone implements, and use of copper. Microblades are increasingly rare but never totally disappear from the record. Sites are larger than those of the earlier Northern Archaic and Paleoarctic peoples and contain semi-subterranean houses and cache pits. (Clark 1981).

Early North Alaska History

Modern Iñupiat

People of the Thule culture are directly ancestral to the modern Iñupiat of northern Alaska. Again, environmental change stimulated cultural change. An apparent decline in the number of whales around AD 1400 caused settlements around Kotzebue Sound to contract and houses to become smaller. Whaling continued at Point Hope and Barrow, where villages continued to grow in size and population. Eastward towards the MacKenzie delta, settlements were small with between one and four houses. People in these smaller communities relied on a broader range of resources, especially fish. The toolkit remained the same as in Birnirk and Thule times with the exception of the whaling technology. Asian and European trade items, chiefly iron, entered Alaska in the 17th century through trade networks across Siberia. Foreign trade goods are not common until the mid-1800s.

Two distinct but interrelated groups of Iñupiat make their homes on the North Slope. The Tagiugmiut have been primarily dependent on a marine economy based on the harvest of sea mammals; the bowhead whaling complex has been the focal point of their social and cultural development. Kaktovik residents primarily descend from this group of Iñupiat. The Nunamiut occupy the inland zone of the North Slope and rely on caribou. The two groups have strong cultural, social, and economic ties (Worl Associates 1978).

Barter Island has been an important trading site since aboriginal times. A large prehistoric village existed on the island, but in cultural memory, the site has always best been known as a trading center for Iñupiat from east and west along the coast and from inland areas (Jacobson and Wentworth, 1982). The Iñupiat who ultimately established permanent residence on the island after the turn of the century have close ties with relatives at Inuvik in Canada (Worl Associates 1978). Additional information on the history of Barter Island is found in Jacobson and Wentworth (1982).

The historic period in northern Alaska begins with the arrival of the European explorers who began the written record. Sir John Franklin's expedition sailed westward from the Mackenzie River, reaching the Return Islands just west of Prudhoe Bay in August 1826 before turning back (Franklin 1828). That same year, Beechey's expedition sailed north from the Bering Strait in H.M.S. Blossom, under the command of Thomas Elson, reaching Point Barrow only five days after Franklin's expedition left the Return Islands (Beechey 1831).

In about 1898, whaling vessels began rounding Point Barrow and sailing east to hunt in the Beaufort Sea. The whalers chose to allow their vessels to become frozen in protected shore ice where they remained over winter in order to be on the Beaufort whaling waters early in the open water season. The ships served as bases for inland exploration and stopped at many points along the Arctic coast where coastal and inland indigenous people traded for Euro-American goods.

Modern Gwich'in

Written history south of the Brooks Range began about 1844 when Hudson's Bay Company traders descended the Porcupine River to its confluence with the Yukon River in search of trade routes. Alexander Hunter Murray established a Hudson's Bay Company trading post, called Fort Yukon, at the confluence in 1847. The fur trade quickly dominated the region's economy and established what is considered today as a traditional vocation for Natives on the South Slope. The traders were followed into the region by the first missionaries in the early 1860s.

Prior to the introduction of rifles, caribou fences were used in harvesting caribou. Men, women, and children cooperated to build fences that could be several miles long. They funneled migrating caribou into semicircular corrals lined with snares. Once caribou entered the corrals, hunters dispatched snared and trapped animals using spears or bows and arrows. The use of caribou fences ended as rifles became more available in the late 1900s. Mckennan described the use and construction of these structures during his ethnographic work in the region (McKennan 1965). In the early 1970s, researchers located and mapped the remains of late prehistoric and historic caribou fences in northeastern Alaska and the adjacent Yukon Territory (Warbelow et al. 1975, Roseneau 1973, Andrews 1977). Dendrochronological dating of selected fences placed the earliest year of construction at approximately A.D. 1800, with most construction falling between approximately A.D. 1830 and A.D. 1860 (Blazina-Joyce 1989).

After Alaska was purchased by the United States from Russia in 1867, the Hudson's Bay Company was forced to vacate its holdings. The Fort Yukon post moved up the Porcupine River to Canadian soil at Old Rampart. Hudson’s Bay Company holdings operations were assumed by the Alaska Commercial Company.

In the late 1800s, gold prospectors explored the South Slope but found little evidence of gold. Prospectors were followed by geologists, methodically searching for signs of valued minerals and petroleum. These expeditions opened the door to direct Euro-American contact with Native people in interior northeastrn Alaska. It is important to note that European and Asian goods, especially tobacco, iron, and copper, had reached northern Alaska through Native trade routes long before these expeditions (Murdoch 1892).

Commercial whaling and the trade that ensued linked Native peoples to the larger economy. Western trade goods entered the Native trade networks, and goods were exchanged along the coast at annual trade fairs such as the one at Niåliq at the mouth of the Colville River or at trading posts set up by white traders along the Arctic coast.

The presence of Europeans, especially during the commercial whaling period that began in the 1850s, increased the availability of useful items such as metal and firearms, both of which became part of Iñupiat material culture. However, their presence also exposed the Native peoples to a host of European diseases against which they had no resistance. Diseases such as smallpox and influenza decimated northern populations, and by the end of the 19th century had caused major population shifts. By 1914, less than half of the Native residents of the Barrow area were descendents of its original inhabitants (Jenness 1957, Stefansson 1913).

From the close of World War I to about 1931, fox trapping was a second connection to the larger western economy (Spencer 1959). During the 1920s, fueled by the fashion industry, white fox pelts sold for about $50. By 1931, prices were down to $5 or less per pelt, and most trappers returned to traditional subsistence practices out of necessity. Mirroring the fox trapping experience was reindeer herding. Reindeer were introduced to Alaska in 1898, and beginning about 1915, after the collapse of commercial whaling, large herds were developed by the people of Wainwright, Barrow, and Barter Island (Spencer 1959). Herders struggled with problems such as disease, predation by wolves, and stampedes to which numerous animals were lost. As with fox trapping, reindeer herding ultimately ended with the collapse of the market for meat and hides in the early 1930s.

Until the late 1930s, the Gwich’in occasionally traveled to Barter Island to trade with the Iñupiat. The Gwich’in were known for trading babiche (moose or caribou hide cut into strips), wolverine skins, and spruce tree pitch with the Barter Island Iñupiat for seal oil, seal skins, tea, rifles, and ammunition. The first rifles acquired by the Nets'aii Gwich'in reportedly came from Iñupiat traders who had acquired them from whalers.

4.4.1.3 Contemporary Villages and Communities

The Iñupiat and Athabascan people of the region have used the lands and resources of the Refuge for many centuries. Although social, cultural, and economic changes have been occurring throughout this period, recent decades have brought an ever accelerating pace of change. Currently, only the Iñupiat community of Kaktovik located on Barter Island along the shore of the Beaufort Sea is located within the boundaries of Arctic Refuge. The Gwich'in Athabascan villages located on the south side of the Brooks Range near the Refuge include Arctic Village, Chalkyitsik, Fort Yukon, and Venetie (Map 4-1). These villages share similar languages, heritages, and traditonal homelands, which encompass large portions of the Refuge. To the west of the Refuge, along the Dalton Highway corridor, are the communities of Wiseman and Coldfoot. Coldfoot is predominantly a non-Native conmmunity, and Wiseman has a small percentage of Alaska Natives. Arctic Village and Kaktovik are the villages that are the most heavily dependent on the Refuge for subsistence use because of their immediate proximity to the Refuge. Residents of Chalkyitsik, Fort Yukon, and Venetie also use Refuge lands to lesser extents (K. Whitten, ADFG, pers. comm.). More information on contemporary subsistence use is found in sections 4.4.3.8 through 4.4.4.3. In addition, several families living outside the villages depend heavily on the natural resources for subsistence.

4.4.1.4 Cabins

Currently the Refuge has 15 cabins under permit, and 3 cabins for which a permit has expired and the permit holders have not requested renewal. All the cabins were all permitted for trapping activities. While cabins determined to be abandoned or in trespass may be disposed of in accordance with regulations at 50 CFR 36.33(b)(2), the Refuge does not plan to remove existing cabins not under permit unless their use causes safety, liability, or other substantial problems. In that case, the Refuge will follow the appropriate NEPA process, and if the cabin is in designated Wilderness, congressional notification will be provided.

4.4.2 Transportation and Access

4.4.2.1 Aircraft Access to Communities

Primary year-round access to the local communities and the Refuge is by aircraft. Each of the villages in or near the Refuge has an airport. All airports are State-owned, except for those in Arctic Village and Venetie, which are owned by the Venetie Tribal Government. The community runways range from 2,000 feet long at Wiseman to 5,810 feet long at Fort Yukon; all are gravel surfaced, and few have runway lights. Frequency of air service varies, but several communities have regularly scheduled air service, and commercial air operator services are also available.

4.4.2.2 Roads

There are no roads on Arctic Refuge lands. The nearest highway is the James Dalton Highway (also known as the Haul Road). It provides access to the North Slope for transport of materials, equipment, supplies, and visitors. The highway was opened to public use as far as Deadhorse in 1994, and has since experienced steady increases in visitor use. The highway serves as a major access corridor to Refuge lands and drainages. The Refuge boundary is approximately three quarters of a mile away from the highway at Atigun Gorge, a popular access location to the Refuge. Adjacent drainages are also easily accessible from the road. The Dalton Highway Corridor Management Area was established in 1980 and amended in 1985. The Management Corridor encompasses an area five miles east and west of the Dalton Highway. Alaska Statute prohibits the use of off-road-vehicles within five miles of the highway right-of-way in this area. The highway is maintained by the State of Alaska Department of Transportation and Public Facilities.

4.4.2.3 Easements and Rights-of-Way

ANCSA Section 17(b) Easements

Section 17(b) of the ANILCA of 1971 authorizes the Secretary of the Interior to reserve easements on lands conveyed to Native corporations to guarantee access to public lands and waters. Easements across Native lands include linear easements (e.g., roads and trails) and site easements. Site easements are reserved for use as temporary campsites and to change modes of transportation The map depicting ANCSA 17(b) Trail and Site Easements and State claimed Revised Statute 2477 Routes is located in Appendix E-2 on page E-5.

The Service is responsible for administering those public easements inside and outside Refuge boundaries that provide access to Refuge lands. Service authority for administering 17(b) easements is restricted to the lands in the easement and to the purpose of the easement. The size, route, and general location of 17(b) easements are identified on maps filed with conveyance documents. Conveyance documents also specify the terms and conditions of use, including the acceptable periods and methods of public access. Hunting and fishing are not prohibited uses of 17(b) easements. Currently, there are nine campsites, two landing areas, one streamside, and 11 trail easements established to access Arctic Refuge. If necessary to protect access to public lands and waters, additional easements may be reserved whenever lands are conveyed to Native corporations.

Revised Statute 2477 Right-of-Way Claims

The State of Alaska identifies numerous claims to roads, trails, and paths across Federal lands under Revised Statute 2477 (RS 2477), a section of the Mining Act of 1866 that states "The rights-of-way for construction of highways over public lands, not reserved for public uses, is hereby granted." RS 2477 was repealed by Section 706 (a) of the Federal Land Policy and Management Act of 1976, subject to valid existing rights.

Assertion and identification of RS 2477 rights-of way neither establishes the validity of these claims nor the public's right to use them. The validity of all RS 2477 rights-of-way may be determined either via demonstration that these rights were perfected prior to the enactment of the Federal Land Policy and Management Act of 1976 or through appropriate judicial proceedings. In Alaska Statute 19.30.400, the State of Alaska has identified the following six route(s) on Arctic Refuge it claims may be asserted as RS 2477 rights-of-ways (see Table 4-9 and Appendix E).

Table 4-9. Asserted RS 2477 Rights-of-Way

Trail Number	Name
476	Circle-Chalkytsik Yukon Border
560	Rampart House-Demarcation Point
1648	Gordon-U.S. Border (coastal)
1649	Simpson Cove-Tamayariak
466	Nation River-Rampart House Trail
85	Christian-Arctic Village Trail

ANILCA Title XI, Sections 1110(a) and (b) Access Requirements

Under Sections 1110(a) and 1110(b) of ANILCA, the Service must provide certain types of access across Refuge lands, subject to reasonable regulations. Section 1110(a) requires that the Refuge permit transportation access across Refuge lands for traditional activities and for travel to and from villages and home sites. Under Section 1110(b), when the State or a private party owns surface or subsurface land interests that are effectively surrounded by Refuge lands, the Service must provide "adequate and feasible access for economic and other purposes" to the property but subject to reasonable regulations to protect the natural and other values of the lands.

4.4.2.4 Airplane Access

The primary means of access into and out of the Refuge by non-local visitors is by aircraft, which can only land where topography and surface conditions or lake size are appropriate. Light aircraft equipped with either wheels, skis, or floats are used, depending upon the season. During summer months, wheel planes can land on some river gravel bars, beaches along the Beaufort Sea coast, and other flat areas to access more remote regions of the Refuge. Floatplanes can access some of the larger lakes, such as the Lake Peters and Lake Schrader area in the Brooks Range; however, they are more commonly used on the South Slope lakes than the North Slope region of the Refuge.

4.4.2.5 Snowmobile Access

ANILCA allows the public use of snowmobiles to access the Refuge during periods of adequate snow cover. Snowmobiles (locally referred to as snowmachines) are a common mode of transportation in and around the communities near the Refuge. They are also commonly used for travel between communities, for checking traplines, hunting, gathering firewood, and for other subsistence activities. The frozen river systems of the Refuge and the Beaufort Sea provide travel routes between villages during the winter months. Today, most winter travel is accomplished with snowmobiles, although dog sleds were more common in the past. A few individuals in communities near the Refuge still maintain and use dog teams. Today many dog teams are used for racing rather than subsistence hunting or trapping.

It is difficult to access the Refuge from the Dalton Highway by snowmobile because (with some exceptions) motorized vehicles are prohibited within five miles of the highway by Alaska Statute 5 AAC 92.530.7. Those exceptions include access to private property or mining claims, access to areas for research, or transiting from one side of the corridor to the other. This ban extends from the Yukon River Bridge to just south of Prudhoe Bay.

4.4.2.6 Subsistence Access

ANILCA Title VIII, Section 811

Title VIII Section 811 of ANILCA specifies that rural residents engaged in subsistence uses will have reasonable access to subsistence resources on public lands. Section 811 requires the Refuge permit the use of "snowmobiles, motorboats, dog teams, and other means of surface transportation traditionally employed for such purposes by local residents, subject to reasonable regulation." The Refuge manager can restrict the use of certain types of transportation on Refuge lands under the procedures set forth in 50 CFR 36.12.

Other Access

ANILCA Title XI Section 1110(a) addresses access for traditional activities and for travel to and from villages and home sites (see ANILCA Title XI in Section 4.4.2.3). While not specific to subsistence, Section 1110(a) is applicable to some subsistence users. Snowmobiles, motor boats, and foot travel provide primary means of access to traditional subsistence camps and harvest areas. Small aircraft are occasionally used to access remote or distant traditional camps, allotments, or harvest areas. Local rivers and coastal waters are major travel ways for subsistence users during ice-free months and in the winter. Residents also travel overland by snowmobile during the winter.

Lands conveyed to KIC; Doyon, Limited; North Slope Regional Corporation; and Native allotments in the Refuge are private lands, and access is generally limited to the corporation shareholders and their descendants, or the allotment family and friends. Subsistence hunting and fishing on these private lands is subject to Alaska State hunting regulations.

4.4.2.7 Off-Road Vehicle Access

General use of off-road vehicles is prohibited by Federal regulation (43 CFR 36.11) on national wildlife refuges in Alaska except on established roads, parking areas, and routes designated by the agency. Off-road vehicles, as defined in 50 CFR 36.2, include air boats and air-cushion vehicles along with motorized wheeled vehicles. No routes or areas have been designated for off-road vehicles in the Refuge.

Title VIII Section 811(b) of ANILCA and Alaska national wildlife refuge regulations in 50 CFR 36.12 allow the "use of snowmobiles, motorboats, dog teams and other means of surface transportation traditionally employed by local rural residents engaged in subsistence uses." Off-road vehicles as defined in 50 CFR 36.2 have not been determined to be a traditional means of subsistence access for Arctic Refuge. However, in Chapter 2, Objective 4.6, we propose a historical access study to help identify what are the traditional means of access to what are now Refuge lands and waters.

Alaska Statute 19.40.210 prohibits the use of off-road vehicles (including snowmobiles) for any purpose within five miles of the right-of-way of the Dalton Highway north of the Yukon River if the use begins or ends in the 10-mile-wide corridor. The Dalton Highway runs within about 1,000 ft (300 m) west of Arctic Refuge at its closest point. This statute precludes off-road vehicles from accessing the Refuge from the Dalton Highway at present, though there have been recent attempts to remove the prohibition. If the prohibition is lifted, off-road vehicle use in the corridor could increase substantially, potentially resulting in illegal off-road vehicle use on the Refuge.

4.4.2.8 Boat Access

Boats are used for fishing, sightseeing, hunting, and travel between villages. Motor boat use by visitors occurs primarily for fishing and hunting on the south side of the Refuge in the Porcupine River drainage. However, a few motorboats are used for polar bear viewing along the Arctic coast near Barter Island and on rivers accessible from the Dalton Highway. Non-motorized inflatable boats and kayaks, which can traverse the shallow and rocky stretches, are used mainly by non-local visitors. Rafts are the most common means of travel for river floaters, although kayaks and canoes are sometimes used.

Motorized boats are an important means of travel for local residents conducting subsistence activities and for travel between villages. Residents from villages south of the Brooks Range predominantly use boats to reach the Refuge. Summer season access is available from late May to early October via East Fork of the Chandalar and Porcupine rivers and their larger tributaries to the south. Boats are also used along the Beaufort Sea coast for subsistence hunting, fishing, and gathering. Heavy and bulky goods are delivered by barge to Fort Yukon via the Yukon River and its tributaries, and by barge to Kaktovik via the Beaufort Sea.

4.4.3 Description of the Socioeconomic Environment

The geographic area considered for describing socioeconomic effects generally consists of the communities in and near the Refuge. Socioeconomic effects outside of this area are expected to be minimal because of the area's geographic isolation. Local residents in and near the Refuge principally reside in seven communities: Arctic Village, Chalkyitsik, Coldfoot, Fort Yukon, Kaktovik, Venetie, and Wiseman. All the affected communities except Kaktovik are located in the Yukon-Koyukuk census Area, which encompasses a large area of 148,258 mi^2 (38,398 km^2) between the Yukon Territories, Canada, and the lower Yukon River in Alaska. Kaktovik, which sits on the northern border of the Refuge, is the only community to belong to a different census area, the North Slope Borough.

The six communities in the Yukon-Koyukuk census area are not incorporated in an organized borough, and the State of Alaska legislature has oversight of education, planning, and zoning in this unincorporated region. Cities and tribal organizations typically provide community services while the State provides education through Regional Educational Attendance Areas. Fort Yukon is the only one of these communities that has a sales tax (three percent).

Refuge lands currently are used most heavily by Kaktovik and Arctic Village residents; residents of Fort Yukon, Venetie, and Chalkyitsik use Refuge lands to a lesser extent (K. Whitten, ADFG, pers. comm.). Kaktovik, an Iñupiat community, is located on Barter Island onthe shore of the Beaufort Sea. The communities of Arctic Village, Chalkyitsik, Fort Yukon, and Venetie are all Athabascan villages located on the south side of the Brooks Range. The communities of Coldfoot and Wiseman, located along the Dalton Highway east of the Refuge, are primarily non-Native communities. The following community summaries are taken in large part from the State of Alaska Department of Commerce, Community, and Economic Development's Community Database Online[3].

Arctic Village

This village is located on the east bank of the East Fork of the Chandalar River, six mi (10 km) southwest of the junction of the Junjik River in the Brooks Range. It is adjacent to the southern Refuge boundary and is approximately 100 air mi (160 km) north of Fort Yukon and 290 mi north of Fairbanks. Arctic Village has always been a traditional community of Neets'aii Gwich'in Athabascans. Living a highly nomadic life, they traditionally used seasonal camps

[3] Alaska Community Database Community Information Studies, Department of Commerce, Community, and Economic Development, State of Alaska. Accessed on February 23, 2012, at http://www.commerce.state.ak.us/dca/commdb/CF_CIS.htm

and semi-permanent settlements such as Arctic Village, Venetie, Christian, and Sheenjek in pursuit of fish and game.

In the early 1900s, family groups began to gather more permanently at several locations with the first permanent residents settling at the present Arctic Village site in 1909. In 1943, the Venetie Indian Reservation was established due to the combined efforts of residents of Venetie, Arctic Village, Christian Village. and Robert's fish camp to protect their land for subsistence. When ANCSA was passed in 1971, Venetie and Arctic Village opted to take title to the 1.8 million acres of land in the former reservation. Representatives from Arctic Village and Venetie serve as members of the Native Village of Venetie Tribal Government.

The community is not located on the road system and access to Arctic Village is by aircraft. The Venetie Tribal Government owns and operates the 4,500-foot-long by 75-foot-wide gravel landing area approximately one mile south of the village. Like most rural Alaska village landing areas, there are no Federal Aviation Administration approved instrument approach procedures or facilities, and air service is occasionally interrupted by adverse weather conditions. Local transportation is by all-terrain vehicles, snowmobiles, motor boats, dog teams, and by walking.

The washeteria and school are the only facilities with running water. The village provides water to the school, which uses 17,000-gallon and 7,000-gallon holding tanks. When these tanks run dry, their primary source of water is the Chandalar River. None of the homes are plumbed, and other offices such as the health clinic and Village Council haul their own water. Outhouses or honey buckets are used by most residents. A number of housing upgrades have been made in recent years, and feasibility studies are underway to examine alternatives for a safer water source, washeteria improvement, and relocation of the landfill south of the landing area. The village uses a small solar-powered system to provide some of their electricity, and the remainder is provided via a new generator complex.

Chalkyitsik

The community of Chalkyitsik is located on the Black River approximately 21 miles from the southern Refuge boundary; it is 45 mi (70 km) northeast of Fort Yukon and 170 air mi (270 km) from Fairbanks. The community's location near the interface of the Yukon Flats and upland areas to the east allows access to a variety of wild plant and animal resources. Traditionally, Chalkyitsik was a Dr'aanjik Gwich'in (Black River) village, though today it is a mix of Gwich'in people from the Black River, Yukon Flats, Chandalar, and Porcupine River areas (Nelson 1973).

Access to Chalkyitsik is primarily by aircraft through use of a State-owned 4,000-foot-long by 90-foot-wide gravel runway. The Alaska Department of Transportation and Public Facilities anticipate that an airport improvement project will take place in the near future under the Aviation Improvement Program (Alaska Department of Transportation and Public Facilities 2010). The village is also accessible by small river boat. Chalkyitsik received cargo by barge at one time, but the service is no longer provided.

Residents use all-terrain vehicles, snowmachines, motor boats, dog teams, and foot travel for fishing, hunting, gathering, and recreation. No roads connect Chalkyitsik with other villages, although there is a winter trail to Fort Yukon.

Water is drawn from a well under the Black River, and it is treated, and stored in a 100,000-gallon tank. Residents haul water from the new water treatment plant/washeteria/clinic building and use honey buckets or outhouses for sewage disposal. No homes are plumbed. The village provides water to the school. A feasibility study was completed to provide piped water and a sewer system to the school and 10 homes on the west side, and a landfill relocation study is under way (Alaska Department of Commerce, Community and Economic Development, Alaska Community Database).

Coldfoot

The orginal settlement of Coldfoot, intially called Slate Creek, was located along the middle fork of the Koyukuk River near Slate Creek approximately 69 miles from the Refuge boundary. The settlement began around 1898 when thousands of prospecting miners flooded to the area in search of gold. The name was changed when a group of prospectors got "cold feet" about wintering in the district and headed south. At its height, Coldfoot had one gambling hall, two roadhouses, seven saloons, a number of brothels, and a post office. Mail was delivered once a month arriving from Fort Yukon in the winter by dogsled and in the summer arriving by foot. By 1912, the miners relocated to the richer ground in what is now known as Wiseman, 13 miles north. Many of Coldfoot’s original buildings were brought to Wiseman as construction material or used for firewood.

In the early 1970s, during the construction of the Trans-Alaska Pipeline, Coldfoot started coming back to life when a bustling pipeline camp was established not far from the original town site. Truckers found that Coldfoot was a convenient halfway place to stop along the haul road between Deadhorse to the north and Fairbanks to the south. The haul road, now known as the Dalton Highway, was opened to public travel in 1994 and has since experienced steady increases in road travelers. Electricity is provided by individual generators, and residents use household wells and septic tanks. There are no schools or health clinics in the community. Volunteers provide emergency services using highway and air access.

Most employment is in government and services to road travelers. There is a restaurant, a gas and service station, a recreational vehicle park and dump station, a motel, a State trooper and State fish and wildlife office, a BLM field office, and an Arctic Interagency Visitor Center. The State-owned gravel airport is 4,000-feet-long by 100-feet-wide, providing scheduled commercial and private aircraft access. A local commercial air operator provides charter air services to the surrounding area based from the airport.

Fort Yukon

Fort Yukon is located at the confluence of the Yukon and Porcupine rivers, approximately 63 miles from the southern Refuge boundary, and about 140 air mi (225 km) northeast of Fairbanks and is the largest village of the Kutchin or Gwich'in Athabascan people. The community has historically served as a meeting place for the Gwich'in Athabascan and neighboring peoples. Its location on the Yukon River makes it an important transportation center, as well as an important area for harvesting fish resources.

In 1847, Alexander Murray established Fort Yukon as a Canadian outpost in Russian territory. The Hudson’s Bay Company, a British trading company, operated at Fort Yukon from 1846 until 1869. The fur trade of the 1800s, the Klondike gold rush, and the establishment of the fort and trading post spurred economic activity, providing some opportunities for Native and non-Native residents in the region. A White Alice radar site and an Air Force station were established during the 1950s. More recently, Fort Yukon continues to serve as an important trading, supply, transportation, and administration center for the region.

Fort Yukon is not connected to the road system, however the community is accessible year-round by air and boat during the summer months. Heavy cargo is brought in by barge from the end of May through mid-September to a river off-loading area. Residents use riverboats and skiffs for recreation, hunting, fishing, and other subsistence activities. The State owns a 5,810-foot-long by 150-foot-wide lighted gravel landing area that is currently undergoing major improvements. Floatplanes use Hospital Lake, which is adjacent to the airport and the Yukon River for access. The community has about 17 miles of local roads and a city transit bus system, providing transport throughout the town. Snowmobiles and dog sleds are used on area trails or the frozen river during winter.

Water is drawn from two wells and is treated and stored in an 110,000-gallon tank. Approximately half of all homes are plumbed and are served by a combination of piped water, water delivery, and individual household wells. Residents use a flush/haul system, septic tanks, honey buckets, and outhouses for sewage disposal. The piped water system and household septic tanks were installed in 1984. The city has received funds to begin repairs to the piped water system and to construct a piped gravity sewer system to serve 250 residents and businesses.

Kaktovik

Kaktovik is an Iñupiat community located on Barter Island on the shore of the Beaufort Sea. Until the late 19th century, Barter Island was a major trade center for the Iñupiat and was especially important as a bartering place for Iñupiat from northeastern Alaska and Inuit from Canada. In 1923, a trading post was established on the island that provided a location for resident trappers to trade furs and obtain supplies.

Reindeer were introduced to the area in the 1920s, which—along with fur trade—provided more sustained economic activity. After World War II, the military selected Barter Island as

the location for the first Distant Early Warning Line System. The availability of military-related jobs and the opening of a school attracted more people to settle permanently in Kaktovik in the 1950s. The City of Kaktovik was incorporated as a second class city in 1971.

Economic opportunities in Kaktovik are limited, by standards of the contiguous United States because of the community's isolation (the Distant Early Warning Line System is now mostly automated, and the Kaktovik station usually only has two civilian contractors in residence), but compared to other communities in the region, a variety of economic opportunities exist in Kaktovik. Most of the private employment is for the provision of services, either for the North Slope Borough or the City of Kaktovik. The majority of jobs are with the local government, which includes the local school district. Part-time seasonal jobs, such as construction projects, also provide some employment for local residents. KIC employs a number of individuals and is involved in local business. Tourism has begun to develop on a small scale as a result of Kaktovik's proximity to the Refuge and increasing interest in viewing polar bears, observing traditonal whale harvest activities, and participating in other recreational opportunities.

Air travel to Kaktovik provides the only year-round access. The 4,800-foot Barter Island Airport is owned by the U.S. Air Force and operated by the North Slope Borough. The Air Force plans to transfer this landing area to the borough or Kaktovik in the near future, and the State of Alaska is planning to construct a new air strip in a more suitable location (the current air strip is low gravel spit and subject to fog and flooding). An environmental impact assessment was completed for this project in January 2009 (see Appendix C). Marine and land transportation provides seasonal access through barges and small boats in the summer and snowmachines in the winter.

The North Slope Borough provides all utilities in Kaktovik. Water is derived from a surface source and is treated and stored in a 680,000-gallon water tank. A newly constructed piped water and sewer system provides flush toilets, showers, and plumbing for most residences. The borough provides electricity and subsidizes diesel fuel for the community. The Harold Kaveolook School (pre-school through grade 12, and adult education) is an important focus of the community. Health care is provided by health aides, visiting physicians, and other specialists at the Tom Gordon Health Clinic. Emergency services, including a fire station housing an ambulance, a fire engine, and a water tender, are provided by volunteers and borough professionals.

Venetie

Venetie is located on the Chandalar River approximately 22 miles from the southern boundary of the Refuge and is about 45 mi (70 km) northwest of Fort Yukon and 140 air mi (225 km) north of Fairbanks. It is an original Neets'aii Gwich'in village, founded in 1895 by a man named Old Robert who chose Venetie because of its plentiful fish and game.

In 1899, the U.S. Geological Survey noted about 50 Natives living along the Chandalar River, some in small settlements of cabins about seven miles above the mouth of the River, but most in the mountainous part of the country beyond the Yukon Flats. By 1905, Venetie was a settlement of a about six cabins and 25 or 30 residents. The gold rush to the Chandalar region in 1906–1907 brought a large number of miners. A mining camp of nearly 40 cabins and a store was established at Caro, upriver from Venetie, and another store was located near the mouth of the East Fork. By 1910, the Chandalar was largely played out and Caro almost completely abandoned.

In 1943, the Venetie Indian Reservation was established, due to the combined efforts of the residents of Venetie, Arctic Village, Christian Village, and Robert's Fish Camp, who worked together to protect their land for subsistence use. At about this same time, a school was established at Venetie, encouraging additional families to settle in the village. Eventually, a landing area, post office, and store were built, and the use of seasonal camps declined during the 1950s and 60s. The Reservation was revoked by ANCSA. Under Section 19(b) of ANCSA, Venetie and their cultural neighbors in Arctic Village chose to not participate in ANCSA and instead took the lands of the former Venetie Indian Reservation in fee.

Access to Venetie is almost exclusively by air. The Native Village of Venetie Tribal Government owns and operates the 4,100-foot-long by 65-foot-wide gravel landing area. The Chandalar River provides access by boat from May to October, but there is no barge service due to shallow water. Motor bikes, four-wheelers, trucks, snowmobiles, and dog teams are used for local travel.

Water is drawn from a well near the Chandalar River and then treated and stored in a tank. Residents haul water and use honey buckets. A circulating water utilidor system and 49 household service connections were constructed in 1980, but the east loop froze in 1981 and the west loop in 1982. Twenty-nine individual household septic tanks installed in 1980 also froze during their first winter of operation. Currently, only eight homes have functioning plumbing. A flush/haul system is under construction in Venetie; four homes are currently served. The Stanley Frank Washeteria and Water Treatment Plant use a small solar-powered system to provide some electricity.

Wiseman

Wiseman is located on the middle fork of the Koyukuk River at the junction of Wiseman Creek in the Brooks Range; it is approximately 56 miles from the Refuge boundary. It lies 13 miles north of Coldfoot on the Dalton Highway, about 260 miles northwest of Fairbanks. Prior to white settlement, the Wiseman area was inhabited by the Dihai Kutchin and was in a region of contact between Nunamiut, Kobuk, and Selawik Eskimos to the north and west, and Koyukon Indians to the south.

Wiseman was established in 1907 to accommodate the needs of the growing number of gold miners and prospectors drawn to the placer rich creeks of this Koyukuk valley. Primarily a trading community, Wiseman once supported a population of about 250 residents and maintained a post office, general store, roadhouse, Pioneer Hall, telegraph office, and school. This is one of the few communities founded by non-Natives north of the Yukon River and is the furthest north "gold rush" settlement in the Brooks Range still in existence today.

Supplies were brought up the Koyukuk River to Wiseman Creek by horse-drawn barge, where a new town developed in 1907. A log post office operated from about 1909 to 1956, with mail and supplies freighted or flown in. A territorial school operated from 1934 to 1941. By 1974, the 414-mile pipeline "haul road" was constructed, which passes near Wiseman.

The school, operated in the Community Center, was closed in November 2002 because it was unable to meet the State's minimum enrollment. There are 30 original cabins from the 1920s still in use; 70 percent are used seasonally. Wiseman is situated between Arctic Refuge to the east and the Gates of the Arctic National Park and Preserve to the west. Subsistence hunting, fishing, and trapping sustain year-round residents.

Self-employment, seasonal visitor service jobs, seasonal highway maintenance jobs, and seasonal work at the Arctic Interagency Visitor Center in nearby Coldfoot or with the NPS provide some employment opportunities for Wiseman residents. Several residents sell handcrafted items and furs. A State-owned 2,000-foot-long by 30-foot-wide gravel landing area is available but is not consistently maintained.

4.4.3.1 Population

In 2010, the largest community in Arctic Refuge's Yukon-Koyukuk census area was Fort Yukon, with a reported total population of 583 persons. Kaktovik had the second highest population of 239 persons. With the exception of Coldfoot and Wiseman, which have seasonal populations, Chalkyitsik had the smallest population (69) in 2010 of all seven communties.

Since 1970, all communities, with the exception of Chalkyitsik, have experienced population growth. Kaktovik's population growth led the group, increasing by 94.3 percent over the 40 year period. Only Chalkyitsik had a population decline. Since 1970, Chalkyitsik's population has decreased by 47 percent. The decline in population is consistent with the overall Yukon-Koyukuk Census area's decline in population of nearly 21 percent.

Table 4-10 shows the population estimates for all seven communities from 1970 through 2010, along with the census areas and the State. These trends are also illustrated in Figure 4-10. Compared to the State's population increase of 135 percent between 1970 and 2010, the North Slope Borough also experienced a notable increase in population. Its population increased by 173 percent. A portion of this increase is likely due to the development and expansion of the oil industry's operations in the area. The table also shows that since the 2000 Census, every community experienced a decline in population over the last decade. Figure 4-10 illustrates the trend in population for the communities.

Table 4-10. Population by selected region

Region / Community	1970	1980	1990	2000	2010	Percent Change 1970–2010
Arctic Village	85	111	96	152	152	78.82
Chalkyitsik	130	100	90	83	69	-46.92
Coldfoot	-	-	-	13	10	nc
Fort Yukon	448	619	580	595	583	30.13
Kaktovik	123	165	224	293	239	94.31
Wiseman	-	8	33	21	14	nc
Venetie	112	132	182	202	166	48.21
Yukon-Koyukuk Census Area	7,064	7,873	6,713	6,551	5,588	-20.89
North Slope Borough	3,451	4,199	6,043	7,385	9,430	173.25
State of Alaska	302,583	401,851	550,043	626,932	710,231	134.72

"nc" indicates no change; - (a dash) indicates no data available

Sources:

1. Alaska Census Data, Alaska Department of Labor and Workforce Development. Available at http://labor.alaska.gov/research/census. Retrieved on 2/13/2012.

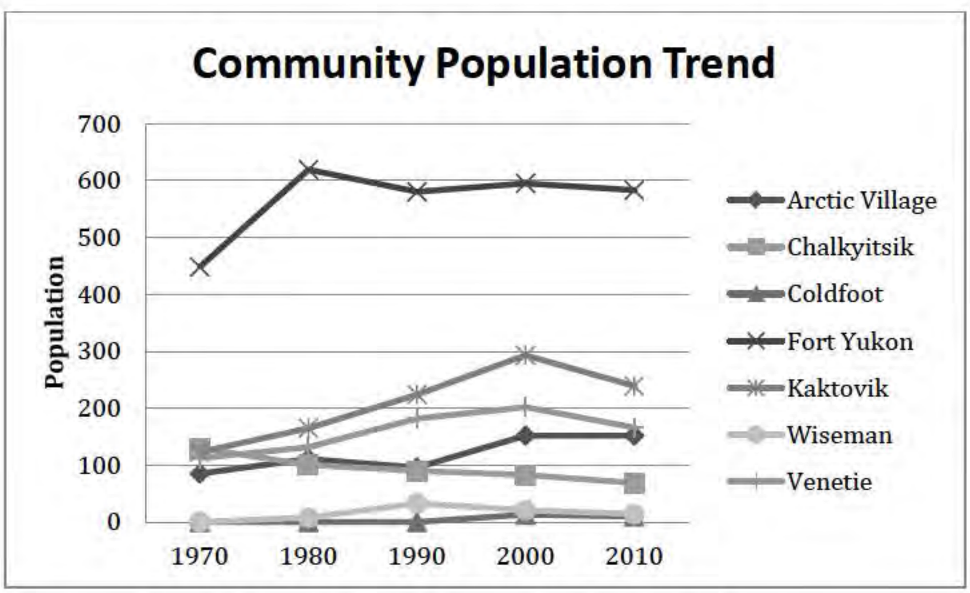


Figure 4-10. Population trends for communities nearest to Arctic Refuge.

4.4.3.2 Population Projections

Figure 4-11 shows the forecasted change in total population for the Yukon-Koyukuk census area and the North Slope Borough, respectively. The figure shows that over the next 25 years, the total population of the North Slope Borough is expected to grow 30 percent, from 6,807 individuals in 2006 to 8,867 in 2030. By contrast, the population for the Yukon-Koyukuk census area is forecast to decline by 13 percent, from 5,860 total individuals in 2006 to 5,111 individuals by the end of 2030. Both populations, however, are projected to remain very small (i.e., less than one percent) of the entire population of Alaska.

Table 4-11 shows the underlying dynamics for the projected changes in population. Both regions are forecast to experience a net loss in future years due to emigration out of the area. The forecasted growth in the North Slope Borough's population, however seems to be attributable to a much higher number of expected births. The number of births in the North Slope Borough far exceeds the number of individuals forecasted to leave the area, while the number of births in the Yukon-Koyukuk census area is only slightly greater than the number of emigrants.

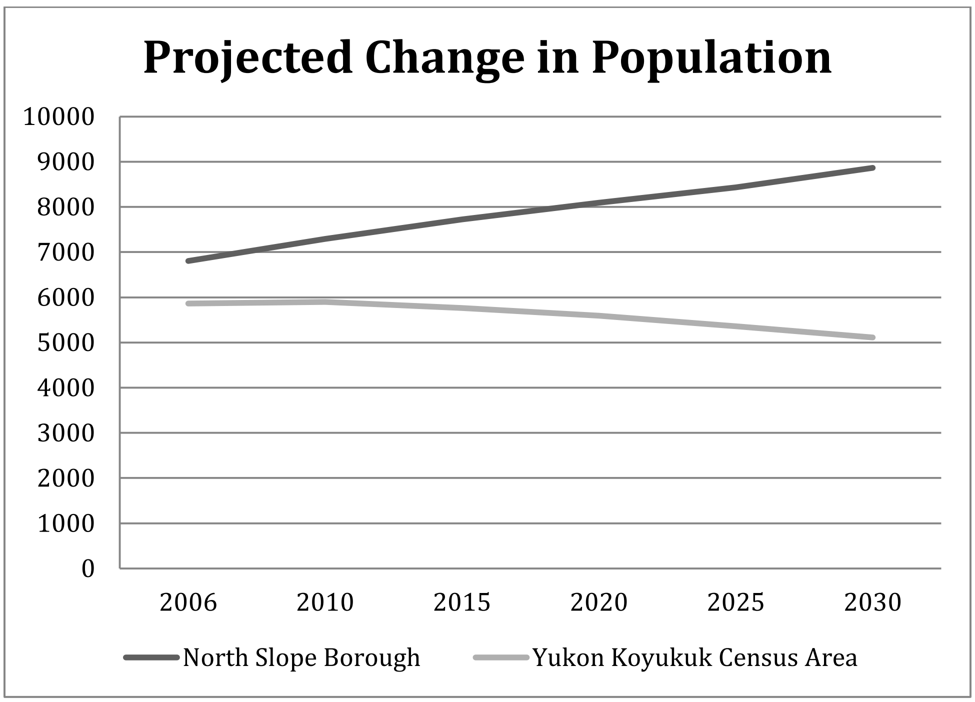


Figure 4-11. Projected change in population. Source: Alaska Department of Labor and Workforce Development 2007.

Table 4-11. Projected births, deaths, and net migration 2006-2030. North Slope Borough and Yukon-Koyukuk census area.

Census Area	2006–2010	2010–2015	2015–2020	2020–2025	2025–2030
	Average Annual Births				
North Slope Borough	159	183	189	187	196
Yukon-Koyukuk Census Area	81	99	101	92	78
	Average Annual Deaths				
North Slope Borough	44	43	47	50	55
Yukon-Koyukuk Census Area	50	49	50	52	53
	Average Annual Net Migration				
North Slope Borough	6	-54	-68	-69	-55
Yukon-Koyukuk Census Area	-21	-77	-85	-87	-75

Source: Alaska Department of Labor and Workforce Statistics 2007

4.4.3.3 Demographics

Table 4-12 provides a general overview of the demographic composition of the communities. Most communities, with the exception of the very small Dalton Highway communities of Coldfoot and Wiseman, have a very high proportion of Alaska Natives relative to the percentages in the State. The proportion of residents that are Alaska Native range from a low of 85.5 percent in Chalkyitsik to a high of 91.6 percent in Venetie. The median age for the State of Alaska is 33.8 years, which is higher than that for all communities with the exception of Coldfoot. Of this group, the median ages for Arctic Village, Chalkyitsik, and Wiseman are all less than 30 years.

Table 4-12 also shows the percentage of residents that are under 18 years, between 18 and 64 years of age, and 65 years and older. While the State average for working age adults (18-64 years) is 65.9 percent of the total population, only Coldfoot has a population percentage greater than the State average in this range (70.0 percent). Conversely, the communities all have a higher percentage of residents under 18 years of age than the State average, with the exception of Coldfoot. Arctic Village and Venetie have a higher percentage of adults over the age of 65 than the State average. The communities of Arctic Village, Coldfoot, Fort Yukon, Kaktovik, and Venetie all have a higher percentage of males living in their communities than the State average of 52.0 percent.

Table 4-12. Socioeconomic characteristics of communities nearest to Arctic Refuge

Region/Community	Median Age	Under 18	18-64	65 and Over	Male	Alaska Native
Arctic Village	29.0	28.3%	64.5%	7.2%	56.6%	88.8%
Chalkyitsik	27.5	34.8%	55.1%	10.1%	50.7%	85.5%
Coldfoot	43.0	20.0%	70.0%	10.0%	60.0%	10.0%
Fort Yukon	33.7	28.6%	63.3%	8.1%	55.7%	89.2%
Kaktovik	30.5	30.1%	61.9%	7.9%	52.3%	88.7%
Wiseman	28.5	28.6%	64.3%	7.1%	50.0%	0.0%
Venetie	30.5	31.9%	61.4%	6.6%	60.2%	91.6%
North Slope Borough	35.1	23.9%	71.9%	4.3%	62.6%	54.1%
Yukon-Koyukuk Census Area	35.3	27.8%	62.0%	10.2%	54.2%	71.4%
Alaska	33.8	26.4%	65.9%	7.7%	52.0%	14.8%

Source: Alaska Department of Labor and Workforce Development 2010

4.4.3.4 Households and Housing

Similar to the population profiles, household numbers are greatest in Fort Yukon (246) and least in Coldfoot (6) and Wiseman (5). The U.S. Census defines a household as all of the people who share a housing unit. According to the Census, a household could consist of a single person. Groups of people sharing a housing unit, even if they are unrelated, would be counted as a single household. In contrast a family is a group of two people or more (one of whom is the householder) related by birth, marriage, or adoption and residing together. The percentage of family households in the communities ranges from a low of 17 percent in Coldfoot to a high of 80 percent in Wiseman. These communities, however, are extremely small. The range for the remainder of the communities is 53 percent family households in Fort Yukon to a high of 72 percent in Kaktovik. The State average is 66 percent. Fort Yukon also has the highest proportion of family households with children headed by a female. Over 40 percent of the family households with children under 18 are headed by a female in this community. This is roughly double the state-wide percentage. Arctic Village also has a very high proportion of family households with children headed by a female (67 percent). Median household incomes ranged from a low of $9,583 in Venetie to a high of $61,250 in Coldfoot. Of the larger communities, Kaktovik reported the second highest median household income ($46,458).

Most of the population of Alaska lives in urban areas with utilities and services. The villages near Arctic Refuge are isolated rural communities. According to the 2000 Census, the housing characteristics for communities nearest to Arctic Refuge are vastly different from those typical of the State[4]. For example, the majority of homes in the State are heated with natural gas that is brought into the home via utility infrastructure. This is not the case for Arctic Refuge communities. The majority of homes in Arctic Village, Chalkyitsik, and Venetie heat with wood. The major heating fuel source for Kaktovik homes is fuel oil, which is also the primary heating fuel source for homes in Fort Yukon. Only Kaktovik shows that some homes heat with utility gas, and only the community of Wiseman heats with bottled gas, which is their primary heating source.

[4] At the time this research was conducted (February 2012), Census 2010 Tables DP-4 were not yet available.

In general, the homes in communities near Arctic Refuge are less densely occupied than those of the State. On average, there are 2.4 residents per household across the State. Only the communities of Arctic Village and Venetie have averages in this vicinity. Kaktovik has more residents per household than the State average at 3.3. The remainder of the communities have far fewer residents per household.

Homes in communities in and near the Refuge are different from the typical Alaska home in several other categories: the vast majority of homes in these communities lack complete plumbing and kitchen facilities; a large number of them lack telephone service; and most were provided through Housing and Urban Development programs.

Table 4-14 provides a summary of select housing characteristics for the communities nearest to Arctic Refuge and for the State.

Table 4-15 provides an overview of select characteristics associated with each community's estimated annual civilian workforce over the five-year period 2006 through 2010. The U.S. Census Bureau defines the labor force to include all people not in the military both employed and not employed, 16 years and over. Of the seven communities, Fort Yukon has the greatest number of people in the workforce (270) followed by Kaktovik (220). Coldfoot, Wiseman, Chalkyitsik, and Arctic Village had the smallest number of individuals in the workforce. Coldfoot and Wiseman are waypoint communities along the Dalton Highway and are a frequent stopping point for travelers. Both communities (Coldfoot and Wiseman) reported no unemployment, which is most likely attributable to the extremely small workforces and populations in these communities.

Median worker earnings were all lower than the State average. Community earnings ranged from a low of $7,045 for a worker in Venetie to a high of $20,000 in Fort Yukon. Both Arctic Village and Venetie appear to have the most struggling economies of all the communities. They have the lowest median household incomes and the highest percentage of their residents living beneath the poverty line. Unemployment in Venetie is nearly 50 percent of the total workforce.

At the time the surveys were taken ten percent of all Alaskan residents lived below the poverty line. All communities and regions in the area of Arctic Refuge reported higher estimated population levels living beneath the poverty level. The percentage of community residents living in poverty ranged from 11.5 percent in Chalkyitsik to 34.9 percent in Arctic Village.

4.4.3.5 Commercial Economy

The economies of the communities in the vicinity of Arctic Refuge are not very diverse. State and local government agencies, including the school districts, provide for nearly 70 percent of the employment. Only the communities of Coldfoot and Wiseman have greater percentages of workers in the private sector than in the public sector. Both of these communities have a very small number of individuals in the labor force compared to the other Refuge communities.

Fort Yukon and Kaktovik have relatively diversified employment bases. Both communities report employment in every major private industrial sector. While both communities report the greatest number of employees working for local governments, other industrial sectors with relatively large number of employees include the trade, transportation, and utilities sector and construction for Fort Yukon and the finance and professional services sector for Kaktovik. The communities of Coldfoot, Fort Yukon, and Kaktovik are unique in that they are the only communities that showed employment in the natural resources sectors of agriculture, forestry, fishing and hunting, and mining.

Table 4-13. Household characteristics of communities nearest to Arctic Refuge

Region/Community	Total Households	Average Household Size	Family Households	Percent Family Households	Family Household with Child under 18	Female Family Head with Child under 18	Median Household Income
Arctic Village	65	2.3	37	57	21	14	$22,500
Chalkyitsik	24	2.9	16	67	9	5	$41,250
Coldfoot	6	1.7	1	17	1	-	$61,250
Fort Yukon	246	2.4	130	53	66	27	$30,500
Kaktovik	72	3.3	52	72	26	5	$46,458
Wiseman	5	2.8	4	80	1	-	$23,750
Venetie	61	2.7	41	67	19	6	$ 9,583
North Slope Borough	2,029	3.3	1,443	71	803	222	$33,712
Yukon-Koyukuk Census Area	2,217	2.5	1,318	59	642	229	$68,517
Alaska	258,058	2.7	170,750	66	85,121	17,577	$32,384

Source: Alaska Department of Labor and Workforce Development 2010

- (a dash) indicates no data available

Table 4-14. Housing characteristics of communities nearest to Arctic Refuge compared to the State of Alaska

Characteristic	Community							
	Arctic Village[1]	Chalkyitsik[1]	Coldfoot	Fort Yukon[1]	Kaktovik	Venetie	Wiseman	State of Alaska
Total housing units	66	63	13	316	90	80	29	260,978
Average residents per unit	2.3	1.3	1.0	1.9	3.3	2.5	0.7	2.4
Type of heating fuel								
Utility gas	0.0%	0.0%	0.0%	0.0%	2.3%	0.0%	0.0%	45.9%
Bottled, tank, or LP gas	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	42.9%	2.2%
Electricity	0.0%	0.0%	0.0%	0.8%	2.3%	0.0%	0.0%	10.2%
Fuel oil, kerosene, etc.	20.8%	34.4%	100.0%	60.8%	95.5%	4.5%	28.6%	35.8%
Coal or coke	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%
Wood	79.2%	65.6%	0.0%	38.4%	0.0%	95.5%	28.6%	3.7%
Solar energy	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Lack complete plumbing	89.6%	100.0%	0.0%	54.0%	67.0%	100.0%	71.4%	6.3%
Lack complete kitchen	89.6%	100.0%	50.0%	54.0%	14.8%	93.9%	100.0%	5.6%
No telephone service	16.7%	15.6%	0.0%	24.9%	18.2%	18.2%	42.9%	3.0%

Source: U.S. Census Bureau 2000, Profile of General Demographic Characteristics, Table DP-4 [Note: At the time the Plan was updated (February 2012), Table DP-4 for the 2010 Census were not yet available.]

[1] These communities are in a census designated place (CDP), which is a statistical geographic entity representing a closely settled, unincorporated community that is locally recognized and identified by name.

Table 4-15. Estimated annual workforce characteristics (2006–2010) for communities nearest to Arctic Refuge

Community	Characteristics				
	Median Earnings for Workers ($)	Civilian workforce	Percent of civilians unemployed[1]	Percent older than 16 yrs not in labor force[2]	Percent of all persons below poverty line
Arctic Village	15,625	38	13.7	47.9	34.9
Chalkyitsik	9,432	32	25.5	31.9	11.5
Coldfoot[3]	NA	5	0.0	0.0	0.0
Fort Yukon	20,000	270	14.6	32.0	20.6
Kaktovik	10,040	220	7.4	52.4	13.3
Wiseman[3]	NA	10	0.0	16.7	10.5
Venetie	7,045	91	49.1	14.2	24.1
Yukon-Koyukuk Census Area	15,865	2,739	15.5	35.9	23.6
North Slope Borough	20,592	4,354	15.7	36.2	11.8
State of Alaska	32,389	380,443	9.6	28.0	9.9

Source: U.S. Census Bureau 2010. Data in tables reflect sampling averages; margins of error are not reported.

[1] All civilians 16 years old and over are classified as unemployed if they (1) were neither "at work" nor "with a job but not at work" during the reference week, and (2) were actively looking for work during the last 4 weeks, and (3) were available to accept a job. Also included as unemployed are civilians who did not work at all during the reference week, were waiting to be called back to a job from which they had been laid off, and were available for work except for temporary illness.

[2] The labor force includes all people classified in the civilian labor force, plus members of the U.S. Armed Forces (people on active duty with the U.S. Army, Air Force, Navy, Marine Corps, or Coast Guard). The civilian labor force consists of people classified as employed or unemployed.

[3] The ACS did not sample anyone over 16 years of age (i.e., working age adults). Median Earnings were not reported for Coldfoot. Wiseman earnings reflect CPI adjusted Census 2000 findings. All other data obtained from Census 2000.

Table 4-16 shows the total number of jobs by industry sector for each community along with the percentage of total jobs for all communities combined. In general, community employment is highly dependent on local and state government jobs. The top private sector jobs are in the trade, transportation, and utilities sector and in construction. There are no manufacturing or wholesale trade jobs in any of the communities.

Table 4-17 shows the net change in employment by industry sector for each Arctic Refuge community. Most communities, with the exception of Arctic Village, lost jobs in the natural resources sector. Retail trade jobs increased across the board for the communities, in contrast to the overall State experience. Other sectors with considerable increases included educational, health and social services, and public administration jobs.

Table 4-16. 2010 Employment by industry sector (number of individuals) for communities nearest to Arctic Refuge

2010 Workers by Industry	Arctic Village	Chalkyitsik	Coldfoot	Fort Yukon	Kaktovik	Venetie	Wiseman	Total	Percent of Total
Natural Resources and Mining	-	-	2	2	1	-	3	8	1.1%
Construction	2	1	1	16	1	42	-	63	9.0%
Trade, Transportation, and Utilities	1	-	1	27	4	1	-	34	4.8%
Information	1	-	-	13	-	-	-	14	2.0%
Financial Activities	-	-	-	1	22	-	-	23	3.3%
Professional and Business Services	-	-	-	5	13	-	1	19	2.7%
Educational and Health Services	3	3	-	15	1	5	-	27	3.8%
Leisure and Hospitality	2	5	8	5	4	2	-	26	3.7%
State Government	-	2	1	8	-	-	1	12	1.7%
Local Government	69	26	-	149	96	65	-	405	57.6%
Other	3	2	-	59	-	7	1	72	10.2%
Total	81	39	13	300	142	122	6	703	100.0%

Source: Alaska Department of Labor and Workforce Development 2010

Table 4-17. Number of people changing their type of employment between 1990 and 2000 in communities nearest to Arctic Refuge; numbers in parentheses indicate a decrease in number for that type of employment

Industry	Arctic Village[1]	Chalkyitsik[1]	Coldfoot	Fort Yukon[1]	Kaktovik	Venetie	Wiseman	Alaska (% change)
Agriculture, forestry, fishing, and hunting and mining	2	(2)	-	(8)	(2)	(2)	-	-21.7
Construction	-	-	2	3	(12)	4	-	26.9
Manufacturing	-	-	-	-	-	-	-	-36.7
Wholesale trade	-	-	-	(4)	-	-	-	-2.9
Retail trade	1	2	3	6	10	3	-	-17.6
Transportation and warehousing, and utilities	3	2	-	-	5	2	-	34.3
Information	(3)	2	-	(2)	(5)	-	-	-0.4
Finance, insurance, real estate, and rental and leasing	-	2	-	2	4	-	-	15.6
Professional, scientific, management, administrative, and waste management services	2	-	-	5	3	-	-	110.1
Educational, health, and social services	1	(3)	-	12	23	(7)	5	50.2
Arts, entertainment, recreation, accommodation, and food services	2	-	-	3	6	1	5	684.2
Other services (except public administration)	(2)	5	-	(8)	-	(3)	-	-43.6
Public administration	11	(2)	-	58	6	11	-	-1.0
Total	17	6	5	67	38	9	10	14.7
Percent Change	61	55	nc	39	48	26	nc	

Source: U.S. Census Bureau 2000, Profile of General Demographic Characteristics, Table DP-3. [Note: At the time the Plan was updated (February 2012), Table DP-3 for the 2010 Census were not yet available.]

[1] These communities are in a census designated place (CDP), which is a statistical geographic entity representing a closely settled, unincorporated community that is locally recognized and identified by name.

4.4.3.6 Commercial Recreation Opportunities on the Refuge

Visitors use the Refuge for many recreational activities, including river floating, hiking, backpacking, camping, mountaineering, hunting, fishing, and wildlife observation and photography. There is no direct visitor registration system, thus the Refuge has no specific means by which to monitor the number of visitors, activities, and lengths of stay for individuals entering the Refuge on their own. The Refuge does, however, require commercial service providers to have special use permits to operate on the Refuge. These permits are primarily obtained by commercial guides (recreation and hunting guides) and by air operators who fly visitors onto the Refuge. The remainder of this section discusses the approximate economic benefits to the area resulting from these services. See section 4.4.5 for a comprehensive summary of visitor use of the Refuge.

Guided Hunting on the Refuge

General hunters are attracted to the Refuge to pursue big-game animals, including caribou, Dall's sheep, grizzly bear, and moose. With few exceptions, non-Alaska residents are required by law to hire a guide to hunt sheep, brown bear, and mountain goats (goats don't occur on Arctic Refuge). Non-Alaska resident aliens—people who are not citizens of the United States—must hire a guide to hunt any big-game species (State of Alaska hunting regulations).

There are 16 geographically separate exclusive hunt guide use areas identified for the Refuge (Map 4-11), which are awarded through a competitive permitting process. Several of Arctic Refuge's hunting guide permittees have permits for two guide use areas, resulting in a total of 11 hunting guide service providers on the Refuge. One of the guide use areas, ARC12[5], remains vacant because it surrounds Arctic Village and includes the Arctic Village Sheep Management Area, which is reserved for federally qualified subsistence users from the villages of Arctic Village, Venetie, Kaktovik, and Chalkyitsik for sheep hunting. ARC10a is not open to big-game guiding due to its proximity to the Dalton Highway and the associated high concentration of visitors (hunters and recreationists).

Most guided hunters pursue multiple species during a 9- or 10-day hunt. However, Arctic Refuge data reflect that over the past several fall hunting seasons, an average of 97 animals were harvested by an average of 85 hunters annually (Arctic Refuge 2011). Therefore, although hunters target multiple species on a guided hunt, each hunter harvests one animal on average.

Depending on the unit hunted, the primary target species is usually a Dall's sheep, moose, or grizzly bear. Other hunted species may include caribou, black bear, or wolf. The Refuge receives the highest number of general hunters between August and September. Although the Refuge is open to hunting some species beyond these months, weather and other factors typically restrict general hunting to these times.

The typical price for a 10-day guided Dall's sheep or grizzly bear hunt is around $14,500. That price includes air transportation to and from the Refuge; one client to one guide hunting service; food and shelter during the hunt; equipment use; and field care of game meat and trophies. Additional expenses incurred by the hunter include lodging before and after the hunt, license and tag fees, meat processing, and shipping of meat and trophies. Hunters should

[5] ARC## (e.g., ARC12) are unique identifiers for exclusive commercial hunt guide use areas in Arctic Refuge. ARC stands for "Arctic Refuge" and is not an acronym.

budget an additional $2,500–$3,500 for these expenses, depending on whether they intend to have their taxidermy work conducted in Alaska. Additionally, guides are typically paid a gratuity, which may average about $1,000. Based on these assumptions, the direct economic impact to the State economy per guided hunt would be about $18,500[6].

Based on the average number of guided hunt clients during the fall season (85) and an average hunt cost of $18,500, the direct economic impact to the State would be approximately $1.57 million. These expenditures support additional jobs in the State as the dollars are spent on other goods and services by the recipients (i.e., indirect economic impacts) before the dollars ultimately leave the State for purchases of imported goods and services. Based on previous research conducted by the Service concerning the economic impacts associated with visits to national wildlife refuges, a dollar circulates approximately 0.6 times before leaving the State. Thus, a direct expenditure of $1.57 million would result in a total economic impact to the State of approximately $2.5 million.[7]

Special Use Permit System

Commercial operators who are permitted to work on the Refuge support visitors as air operators or recreation guides. While Refuge visitors are not required to obtain permits to enter the Refuge, commercial operators must obtain special use permits to operate in the Refuge. Table 4-18 summarizes the combined number of permits issued for commercial recreation and air transportation in the Refuge. The total number of permits issued has steadily increased since 1980 (Figure 4-12, Section 4.4.5.3). These permit numbers reflect air operations; recreational guiding (which includes backpacking, base-camping and/or day hiking, river rafting, polar bear viewing, and dog mushing); educational pursuits; and guided sport fishing permits. During the past 10 years, the annual number of permitted air operators has grown from about 10 to 14, and the number of permitted recreational guiding businesses has grown from 16 to as many as 28.

There are no quotas for the number of commercial air operator or recreational guiding permits that may be issued each year. These permits are non-competitive; the businesses simply must complete the application process and agree to abide by the conditions of their permit. Each permit is validated for use in the area specified by the permittee. In other words, permits are not issued by location, and there are no Refuge recreational units. There are no limits to the number of people an air operator may taxi to the Refuge. Similarly, there are no limits to the number of trips a recreational guide may offer; however, recreational guides may not have more than one guided group in the same river drainage at any given time. At the end of the permit period, permittees are required to report their use of the Refuge (i.e., number of clients, dates, locations, type of use, etc.).

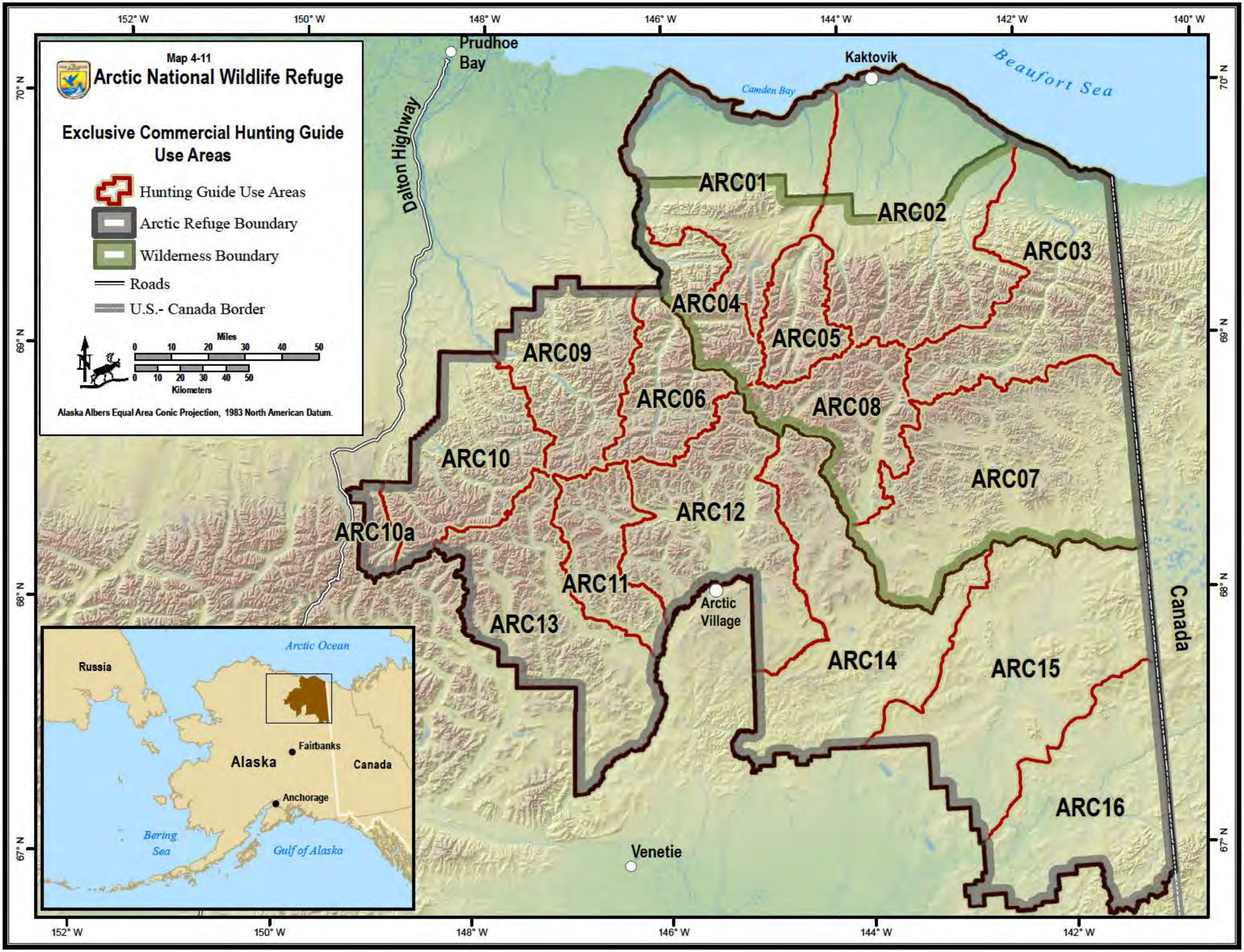
[6] Hunters also incur an additional expense for air transportation to the State. However, only part of the airfare would be expected to directly benefit the State economy because a large portion of the cost would flow to corporate offices for operational expenses. Most of the major airlines serving Alaska are headquartered out of state.

[7] Caudill, J. and E. Carver, Banking on Nature, U.S. Fish and Wildlife Service, Division of Economics, 2006. $2.5 million = (1.6 multiplier * $1.57 million).

Table 4-18. Commercial recreation and air operations permits

Year	Number of Special Use Permits Issued		
	Recreation	Air Operations	Total Permits
1980	7	-	7
1981	8	-	8
1982	7	-	7
1983	14	-	14
1984	10	-	10
1985	9	-	9
1986	14	-	14
1987	12	3	15
1988	18	3	21
1989	21	8	29
1990	17	12	29
1991	16	12	28
1992	15	14	29
1993	17	10	27
1994	19	9	28
1995	16	9	25
1996	14	11	25
1997	14	9	23
1998	17	11	28
1999	16	11	27
2000	16	8	24
2001	22	10	32
2002	21	10	31
2003	25	11	36
2004	24	11	35
2005	28	11	39
2006	27	10	37
2007	22	12	34
2008	22	13	35
2009	25	14	39

Source: Arctic Refuge Special Use Permit Files


Map 4-11
Arctic National Wildlife Refuge
Exclusive Commercial Hunting Guide Use Areas
Hunting Guide Use Areas
Arctic Refuge Boundary
Wilderness Boundary
Roads
U.S.- Canada Border
Miles
0 10 20 30 40 50
0 10 20 30 40 50
Kilometers
Alaska Albers Equal Area Conic Projection, 1983 North American Datum.
Prudhoe Bay
Dalton Highway
Kaktovik
Camden Bay
Beaufort Sea
Arctic Village
Venetie
Canada
ARC01
ARC02
ARC03
ARC04
ARC05
ARC06
ARC07
ARC08
ARC09
ARC10
ARC10a
ARC11
ARC12
ARC13
ARC14
ARC15
ARC16
152° W
150° W
148° W
146° W
144° W
142° W
140° W
70° N
69° N
68° N
67° N
Russia
Arctic Ocean
Alaska
Fairbanks
Anchorage
Canada
Bering Sea
Gulf of Alaska

Commercial Air Operator Services

On Arctic Refuge, there are two types of air transportation services offered: air-taxis and air transporters. Air-taxis may fly in hunters, but hunters are incidental to their air-taxi business, and hunters are charged the same hourly rate as their other clients (river rafters, backpackers, etc.). When a client hires the service of an air-taxi, the hunter decides the drop-off and pick-up locations. Transporters offer fly-in services to hunters, and they directly target the business of hunters through advertisements. The transporter may be responsible for determining the hunting location, and a fixed rate is paid by each client to the transporter for all transportation services needed, including that of gear and game meat. Transporter fees are typically higher than air-taxi fees. Because of this, the economic impacts of non-hunting recreationists and hunters need to be evaluated differently.

Non-hunting Recreational Guiding

Accurate commercial recreational guiding trip cost averages across the entire Refuge are very difficult due to the number of variables in trip length and location, and are approximations on extrapolated data. There is an average trip cost for guided non-hunting recreation on or to the Kongakut River. Based on information provided on permittees' websites, the average cost of a guided nine-day Kongakut River trip, including food, equipment, and roundtrip transportation from Fairbanks, is $4,125.00 per person. Considering our limited basis for estimation, the costs on the Kongakut River trips is being used to approximate non-hunting guided recreation cost for Arctic Refuge. From 2001 to 2009, an average of 989 commercially-supported people visited the Refuge each year. Of these visitors, 56 percent were guided, and 44 percent were non-guided. Therefore, guided non-hunting recreation on the Refuge contributes approximately $2,124,375 to the State's economy annually[8].

Commercially-Supported Non-guided Non-hunting Recreational Visitation

Though air-taxi operators charge a fixed hourly rate, air-taxi costs vary widely depending on the point of origin, the destinations, the number of people in the party, the amount of gear, and the type of aircraft used, accurate estimates of commercially supported, non-guided, non-hunting recreational visitation are difficult to make. On average, air-taxi services cost between $1,000 and $1,500 per person.This would mean the 344 non-guided, non-hunting visitors[9] contributed between $344,000 and $516,000 to the State economy annually for air transportation to and from the Refuge[10].

Non-guided Hunting Visitation

When hunters use the services of a transporter, the cost of air transportation to and from the Refuge tends to be much higher than an air-taxi. Transporters charge a rate per person rather than an hourly rate, and may consider points of origin, the destinations, and the type of

[8] 989 x 0.56 = 554, 554 x 0.93 = 515, 515 x $4,125 = $2,124, 375

[9] 989 x 0.44 = 435, 435 x 0.79 = 344

[10] 344 x $1,000 = $344,000; 344 x $1,500 = $516,000

aircraft used when establishing their rates for individuals. Based on permittees' websites, the lowest per person rate is $1,750, and the highest per person rate is $4,995[11].

Hunters comprise about 28 percent of Refuge visitation annually. Between 2001 and 2009, there was an average of 989 visitors each year, meaning about 277 of those visitors were hunters; of those hunters, 25 percent, or 69 individuals, were guided. Therefore, on average, 208 non-guided hunters contribute between $364,000[12] and $1,038,960[13] to the State economy annually for air transportation to and from the Refuge.

When combining the economic contributions to the State economy of guided non-hunting and non-guided visitation (all types), it is important to realize this total is likely a low estimate, since additional expenses in Alaska incurred by most visitors likely include hotel stays, food, and travel to Fairbanks before and after their trip.

4.4.3.7 Economic Impact of Refuge Management Activities

Refuge operations entail the hiring of permanent and seasonal employees for research, management, visitor services, maintenance, law enforcement, and aviation services. To conduct these activities, the Refuge has a budget for salaries and supplies (Table 4-19). Local Arctic Refuge communities and the city of Fairbanks, where the Refuge headquarters is located, benefit from these expenditures in terms of jobs created and associated income and economic output. The Refuge spends money on a variety of goods and services in a manner similar to any other business. Likewise, Refuge employees spend their salaries in the community on a variety of consumer goods and services.

These direct expenditures are only part of the total picture. Those businesses and industries that supply local retailers where purchases are made also benefit from these expenditures. For example, if a Refuge employee and her family decide to go out for dinner in Fairbanks, the restaurant keeps the total bill. The restaurant in turn pays a food wholesaler who in turn pays a food processor. The food processor then spends a portion of this income to pay businesses supplying the food processor. In this fashion, each dollar of local expenditures can affect a variety of businesses at the local, regional, and State level. Consequently, Refuge budget expenditures can substantially affect economic activity, employment, and household income.

In fiscal year 2011, Arctic Refuge budget expenditures totaled $3,286,004. Non-salary expenditures totaled $1,221,865, or 37 percent of the total budget. Salaries, including personnel benefits, totaled $2,064,139, which represents 63 percent of the total budget. Between 2005 and 2009, the total Refuge budget saw modest annual increases to its base budget. In 2010 and 2011, Refuge budgets declined slightly, decreasing by 1.4 percent in 2011 from the 2009 level.

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[11] These figures represent a range of charges from the public websites of air transporters authorized to operate in the Refuge in 2010.

[12] 208 x $1,750 = $364,000

[13] 208 x $4,995 = $1,038,960

Rent, communications, and utilities are paid primarily to Government Services Administration for the Refuge's Federal building office space. Approximately $4,000 is paid to the North Slope Borough annually for the Refuge's Kaktovik bunkhouse utilities (electric and water), and approximately $10,000 is paid to KIC annually for the Refuge's Kaktovik bunkhouse heating fuel. Arctic Refuge currently employs 23 permanent full-time and part-time staff members, one term full-time staff member, and two temporary, intermittent employees. These employees range from a GS-0325-05 Refuge clerk to a GS-485-14 Refuge manager. All of these employees are based in Fairbanks.

The Refuge also employs two temporary, intermittent GS-1001-07 Refuge information technicians. These employees are based in Arctic Village and Kaktovik.

Generally, three to five temporary, seasonal employees are hired each year to support summer biological field work. These employees are hired through the Delegated Examining Unit, with job opportunities announced on the USA Jobs website every January. They are hired as GS-4 to GS-7 Biological Science Technicians. Based on the 2011 budget, their salary costs range from $16.17 per hour for the GS-4 to $22.42 per hour for the GS-7, including a 16.46 percent locality pay and 10.56 percent Alaska Cost of Living Adjustment.

Each year, between 5 and 11 high school students in remote Refuge communities are hired for summer Youth Conservation Corps projects in their villages. In 2011, students were paid the Alaska minimum wage of $8.00 per hour, and the student leaders were paid $10.00 per hour. In 2011, 10 students worked for 20 days for a total cost of $15,432.00.

Table 4-19. Total Arctic Refuge budget (2005 – 2011)

Description	2005	2006	2007	2008	2009	2010	2011
Full-time permanent employees	$ 1,176,952	$ 1,238,014	$ 1,238,191	$ 1,314,740	$ 1,392,474	$ 1,334,105	$ 1,400,887
Personnel benefits	$ 595,964	$ 631,273	$ 624,457	$ 674,680	$ 706,583	$ 617,967	$ 663,252
Travel and transportation	$ 65,095	$ 81,619	$ 109,517	$ 115,552	$ 141,896	$ 180,377	$ 116,682
Transportation of supplies, material, etc.	$ 13,459	$ 10,700	$ 35,102	$ 25,883	$ 43,672	$ 46,909	$ 64,081
Rent, communications, and utilities	$ 329,092	$ 347,464	$ 281,854	$ 271,445	$ 383,814	$ 415,713	$ 428,403
Printing and reproduction	$ 504	$ 222	$ 3,063	$ 2,233	$ 311	$ 1,617	$ 1,715
Other contractual services	$ 158,521	$ 253,553	$ 469,633	$ 337,064	$ 411,702	$ 297,939	$ 326,300
Supplies and materials	$ 198,442	$ 163,562	$ 248,159	$ 202,378	$ 173,570	$ 208,168	$ 163,502
Equipment	$ 68,023	$ 52,604	$ 58,577	$ 36,121	$ 26,360	$ 25,940	$ 50,937
Land and structures	$ 5,000	$ 174,801	$ -	$ 1,650	$ 41,698	$ 53,052	$ 2,105
Grants and contributions	$ 10,000	$ -	$ 55,006	$ 61,403	-	$ 139,567	$ 68,130
Total	$ 2,621,052	$ 2,953,812	$ 3,123,559	$ 3,043,149	$ 3,322,080	$ 3,321,354	$ 3,286,004

Source: Alaska Region Division of Finance, March 1, 2012

Contracts with Alaska-based vendors are primarily used for aviation fuel, volunteer lodging, maintenance projects, and field equipment that costs more than $3,000 (boats, motors, etc.). Other large purchases are made using established DOI contracts for computers, animal satellite tracking or radio-collar equipment, etc.

To estimate the impacts of Refuge budget expenditures on employment, income, and economic output, 2011 Refuge budget expenditures were used in conjunction with an economic modeling method known as input-output analysis. This analysis estimated the total economic activity generated by the Refuge, including the number of jobs and job-related incomes associated with these expenditures. The Refuge employs people, and pays them wages that they spend part or all of in various communities for goods and services that add economic value. The following estimates assume that all Refuge budget expenditures take place in the combined area of Fairbanks, North Slope, and the Yukon-Koyukuk census areas. Table 4-20 summarizes the economic impacts of the Refuge budget expenditures[14].

Table 4-20. Economic impacts associated with 2011 Arctic Refuge budget expenditures

Budget	Direct Expenditure	Total Output	Total Jobs	Multipliers	
Salary Only	$ 2,064,139	$3,327,630	25.35	Output	1.61
Non-Salary	$1,221,865	$1,969,787	15.00	Jobs/$million	12.28
Total	$3,286,004	$5,297,418	40.35		

Source: Calculations conducted by the Division of Economics, U.S. Fish and Wildlife Service using Minnesota IMPLAN Group, Inc. software on March 15, 2012.

4.4.3.8 Subsistence Harvest, Barter, and Trade Economies

Past Subsistence Barter and Trade Economies

Hunting, fishing, and gathering activities traditionally constituted the economic base of life for Alaska Native peoples. Native trade networks for the barter and exchange of goods and resources were in existence long before European and Euro-American contact along Alaska's coast and throughout the interior regions. Introduction of western trade goods did not become common in the Native trade networks until the mid-1800s (Wentworth 1979).

South of the Brooks Range, Hudson's Bay Company traders descended the Porcupine River to the Yukon River in search of trade routes. This led to the establishment of the Hudson's Bay Company trading post at Fort Yukon in 1847 (Wilson 1947). The fur trade quickly expanded to become a dominant element in the region's economy and established what is considered today a traditional vocation for rural residents.

[14] Economic effects include the direct, indirect, and induced effects of Refuge spending. Direct effects are production changes associated with the immediate effects of changes in final demand (in this case, changes in Refuge budget expenditures); indirect effects are the production changes in those industries that supply the inputs to industries directly affected by final demand; and induced effects are changes in regional household spending patterns caused by changes in regional employment (generated from the direct and indirect effects).

North of the Brooks Range, whaling vessels began rounding Point Barrow and sailing east to hunt in the Beaufort Sea in 1854. Some whalers permitted their vessels to become frozen in protected shore ice where they remained during winter in order to begin whaling early in the open water period of the Beaufort Sea. These whaling ships also stopped along the Arctic coast and traded with coastal and inland Native peoples. Gwich'in Indians from south of the Brooks Range occasionally traveled north to Barter Island to trade with the Iñupiat until the late 1930s (Wentworth 1979). Commercial whaling, fur trapping, and the trade that ensued linked Native peoples to the larger economy. Western trade goods entered the Native trade networks and were exchanged along the coast at annual trade fairs or at trading posts.

Modern Mixed Subsistence-Market Economies

Title VIII of ANILCA recognizes the customary and traditional uses by rural Alaska residents of wild, renewable resources for direct personal consumption as food, shelter, fuel, clothing, tools, or transportation. It also recognized the traditional sharing and barter of subsistence resources for personal and family consumption, for making and selling of handicraft items out of non-edible byproducts of fish and wildlife resources, and for the practice of customary trade.

The Alaska Federation of Natives (2005) describes subsistence as:

- The hunting, fishing, and gathering activities which traditionally constituted the economic base of life for Alaska's Native peoples and which continue to flourish in many areas of the State today. Subsistence is a way of life in rural Alaska that is vital to the preservation of communities, tribal cultures, and economies. Subsistence resources have great nutritional, economical, cultural, and spiritual importance in the lives of rural Alaskans.
- Subsistence, being integral to our worldview and among the strongest remaining ties to our ancient cultures, is as much spiritual and cultural, as it is physical.

Subsistence is part of a rural economic system, referred to as a "mixed subsistence-market" economy, characterized by mutually supportive "market" and "subsistence" sectors (Wolfe and Ellanna 1983). Families invest money in small-scale, efficient technologies to harvest wild foods such as gillnets, fish wheels, guns and ammunition, traps, camp gear, motorized skiffs, all-terrain vehicles, and snowmobiles. Modern mixed subsistence-market economies require cash income sufficient to allow for the purchase of this equipment, as well as for the operational supplies of fuel, oil, mechanical parts, and the maintenance of such equipment. Subsistence is not oriented toward sales, profits, or capital accumulation but is focused toward meeting the self-sustaining needs of families and small communities (ADFG 2000). Participants in this mixed economy in rural Alaska augment their subsistence harvests by cash employment. Cash from firefighting, trapping, commercial fishing, oil and gas industry jobs, construction jobs, Alaska Permanent Fund or Native corporation dividends, and/or wages from the public sector supplement their subsistence pursuits. The combination of subsistence and commercial-wage activities provides the economic basis for the way of life so highly valued in rural communities (Wolfe and Walker 1987).

Subsistence harvest levels can vary widely from one community to the next, and sharing of harvest is common in rural Alaska between individuals and communities (ADFG Community Subsistence Information System). Federal regulations define barter as the exchange of fish or wildlife or their parts taken for subsistence uses for other fish, wildlife or their parts or for other food or for non-edible items other than money. An example of modern barter activities would be the intercommunity exchange of subsistence resources between the communities of Kaktovik and Anaktuvuk Pass. Under this exchange, muktuk and whale meat is sent to Anaktuvuk Pass from Kaktovik, and caribou is sent from Anaktuvuk Pass to Kaktovik. Caribou is a much more variable resource for Kaktovik than for Anaktuvuk Pass, and Anaktuvuk Pass does not have access to bowhead whales or other marine mammals. However, this exchange is not barter in the strictest sense because in years when Kaktovik does not harvest a whale, they still receive caribou from Anaktuvuk Pass and vice versa. Most of the food acquired by harvest and trade is exchanged and redistributed at public functions and feasts such as major holidays of Thanksgiving, Christmas, Easter, and the Fourth of July (HDR 2011).

South of the Brooks Range, an example of different geographic abundance and availability of fish and wildlife resources and the subsequent sharing and exchange of resources would be Arctic Village and Venetie's better access to caribou and sheep resources from the Brooks Range and Fort Yukon and Beaver's better access to various runs of salmon and moose from the Yukon River region. These are just a few of the resources that are bartered and shared between these villages especially in time of shortage of one species or the other (J. Bryant, Community Liaison, Arctic Refuge, pers. comm.). On a much larger scale and scope, there are many more customary and traditional resources of the Gwich'in and Koyukon people that are important for barter, trade and exchange such as, but not limited to, furs such as wolverine, lynx, marten, and beaver; berries such as blueberries and salmon berries; plants and herbs such as Labrador tea; whitefish such as grayling; waterfowl; and small game such as ground squirrel. Additionally the list of villages which participate in this barter and trade in the southern regions include, but are not limited to, Chalkyitsik, Circle, Birch Creek, Stevens Village, and Old Crow, Canada.

Customary trade is defined by Federal law and regulations as the exchange of cash for fish or wildlife resources to support personal and family needs, so long as the trade does not constitute a major commercial enterprise. Customary trade of edible fish and wildlife resources is highly regulated by Federal and State regulations. Examples of customary trade include the sale of a small portion of a rural Alaskan resident's subsistence caught salmon prepared as salmon strips to another rural resident for their personal consumption or the sale of fur from trapped furbearers.

Another common practice involves the making and selling of handicrafts items out of non-edible byproducts of fish and wildlife that have been taken for subsistence. Non-edible parts of subsistence resources are used to make many functional and/or artistic items. Hides and pelts are used to make bedding, clothing, slippers, mukluks, hats, dolls, drums, and masks. Ivory, bone, and antler are carved for knife handles, needle cases, and figurines. Jewelry and decoration for clothing and other artistic crafts are made from many items, such as ivory, baleen, antler, and feathers (ADNR 2008).

In recent years, the cost of fuel in villages, often exceeding $8.00 a gallon, has negatively impacted subsistence use activities. Subsistence harvesting is conducted closer to villages to reduce travel fuel costs. If travel to distant harvest areas is necessary, several families or hunters may combine funds for the purchase of fuel and travel with fewer boats or snowmachines. Often a resident in the village with a job will purchase fuel or ammunition for a family member or household who does not have income, and the resulting harvest is shared amongst them.

4.4.4 Subsistence Uses

Arctic Refuge encompasses much of the traditional homelands of both the Iñupiat and Gwich'in peoples and their ancestors. As described in section 4.4.1.2, archeological records indicate early man use sites exist on Refuge lands along Arctic coastal areas as well as areas south of the Brooks Range which remained ice free during the glaciation periods providing important immigration routes from Asia to the Americas. Over 70 archeological and historical sites have been documented in the northern region representing a long, rich and vibrant history of Iñupiat or their ancestors use. A prehistoric Iñupiat village existed on Barter Island and area has served as an important trading site since aboriginal times for Iñupiat from the east and west along the coast and from inland areas to the south including the Gwich'in people. It is clearly evident that Arctic Refuge is a treasure cultural landscape for both the Iñupiat and Gwich'in people. Their contemporary use sites are often shared with millennia-old archeological sites continuing the living link between past and present. Hall and McKennan (1973) located numerous prehistoric sites at Old John Lake near Arctic Village during their survey with artifacts similar to those found at Anaktuvuk Pass, which have been dated at 4500 B.C. Archeological sites near Chalkyitsik included artifacts dating from approximately 4000 B.C. to 2000 B.C. and microblades possibly indicating a date as early as 10,000 years B.C. (Mobley 1982).The subsistence way of life encompasses much more than just a way of obtaining food or natural materials. It involves traditions that are important mechanisms for maintaining cultural values, family traditions, kinships, and passing on those values to younger generations (Alaska Federation of Natives 2010). It involves the sharing of resources with others in need, showing respect for elders, maintaining a respectful relationship to the land, and conserving resources by harvesting only what is needed. Subsistence is regarded as a way of life, a way of being, rather than just an activity (Alaska Federation of Natives 2010).

Presently, six communities (Arctic Village, Chalkyitsik, Fort Yukon, Kaktovik, Venetie, and Wiseman) are in or relatively close to Arctic Refuge and use the Refuge for subsistence purposes. Residents of Arctic Village and Kaktovik utilize the Refuge most frequently due to their close proximity in or adjacent to the Refuge. Residents of Fort Yukon, Venetie, Chalkyitsik, and Wiseman use Refuge lands to a lesser extent (Service 1988a). In addition, the following communities have geographic or cultural ties to Arctic Refuge and its subsistence resources: Beaver, Circle, Birch Creek, and Stevens Village in Alaska, and Old Crow in Canada. In general, communities harvest the subsistence resources most available to them, concentrating their efforts along rivers or coastlines or in the mountains, depending on the season and availability of resources at particularly productive sites (HDR 2011).

Determining when and where a subsistence resource will be harvested is a complex activity due to variations in seasonal distribution of animals, migration patterns, extended cyclical variation in animal populations and ever changing and complex hunting regulations. Human factors such as timing constraints (due to employment or other responsibilities), equipment (or lack thereof) to participate, and hunter preference (for one resource over another or for one sort of activity over another) are important components in determining the overall community pattern of subsistence resource harvest.

4.4.4.1 Subsistence Management

One of the purposes of ANILCA and for Arctic Refuge is to provide the opportunity for local rural residents engaged in a subsistence way of life to continue to do so (ANILCA Section 101(c) and Section 303 (2)(B)(iii)). Subsistence uses are defined in ANILCA as:

> *"...the customary and traditional uses by rural Alaska residents of wild, renewable resources for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation; for the making and selling of handicraft articles out of non-edible 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."*

ANILCA recognizes that the continued opportunity for subsistence uses on public lands is essential to Native physical, economic, traditional, and cultural existence, and to non-Native physical, economic, traditional and social existence (ANILCA Section 801). In recognizing the importance of Native and non-Native rural residents' subsistence needs, ANILCA established a rural priority for the subsistence uses of fish and wildlife over other consumptive users in times of scarcity (ANILCA Section 802).

Case and Voluck (2002) identify three elements of subsistence in ANILCA: economic and physical reliance on natural resources, cultural or social value of subsistence activities, and customs and traditions of Alaska Natives. For most rural residents, subsistence activities follow seasonal cycles and are linked to social and cultural traditions. The traditions of celebrations and sharing are woven into the fabric of the community, forming a complex network of social, psychological, and spiritual life. The term "customary and traditional use" describes the physical acts of hunting, fishing, and gathering evident in cultural and social values. The values are handed down from one generation to the next, linking the past and forming a basis for the future (Case and Voluck 2002).

Arctic Refuge boundaries encompass private Native allotments and lands conveyed to ANCSA groups and Federal lands. Subsistence hunting, fishing and trapping in the Refuge is regulated under a dual management system by the Federal government and the State of Alaska, which sometimes overlap, depending on where the harvest occurs. The reason for the dual State and Federal management of subsistence in Alaska is described by the Service (2008b) as follows:

> *"ANILCA, passed by Congress in 1980, mandates that rural residents of Alaska be given a priority for subsistence uses of fish and wildlife. In 1989, the Alaska Supreme Court ruled that ANILCA's rural priority violated the Alaska Constitution. As a result, the Federal government manages subsistence uses on Federal public lands and waters in Alaska—about 230 million acres or 60 percent of the land in the State. To help carry out the responsibility for subsistence management, the Secretaries of the Interior and Agriculture established the Federal Subsistence Management Program."*

Federal subsistence law is based on Title VIII of the 1980 ANILCA Act and regulations found in 36 CFR 242.1 (applies to U.S. Forest Service) and 50 CFR 100.1 (applies to DOI). The Federal Subsistence Board creates regulations for subsistence hunting, fishing, and trapping on Federal public lands, unconveyed ANCSA lands, and federally reserved waters in Alaska. Federal public land does not include the privately held Native allotments and ANCSA conveyed lands. State subsistence law is based on Title 16 of Alaska Statute 16 and Title 5 of the Alaska Administrative Code, Chapter 99. The Alaska Board of Fisheries and the Alaska Board of Game create regulations for subsistence fishing, hunting, and trapping on all Alaskan lands and waters, as well as lands conveyed to ANCSA groups. Regulations created by these Federal and State boards use proposals, information, and comments from the public, Federal Subsistence Regional Advisory Councils, local advisory committees, tribal governments and Native organizations, agencies, and other interests.

ANILCA Subsistence Management on Federal Public Lands

The Federal Subsistence Management Program initiated in 1990 utilizes public meetings and Federal Subsistence Regional Advisory Councils to provide opportunities for discussions on subsistence regulations and for development and review of proposals. Members of the public, the Subsistence Regional Advisory Councils, local advisory committees, tribal governments and Native organizations, agencies, and organizations may make recommendations to the Federal Subsistence Board for consideration. The North Slope Subsistence Regional Advisory Council represents rural users for the region north of the Brooks Range, including the community of Kaktovik, and the Eastern Interior Subsistence Regional Advisory Council represents users south of the Brooks Range.

In 1999, the Federal Subsistence Management program assumed management of Federal subsistence fisheries on Alaska rivers and lakes and limited marine waters in and adjacent to Federal public lands. This was directed by the 9th Circuit Court in the Katie John case and meets the requirements of the rural subsistence priority in ANILCA Title VIII. The Federal Subsistence Board publishes Federal regulations for subsistence hunting and fishing on Federal public lands every two years. The Federal Subsistence Regional Advisory Councils, State of Alaska representatives, and public play an active role in the regulatory process.

ANILCA directs that the utilization of public lands in Alaska is to cause the least adverse impact possible on rural residents who depend upon subsistence uses of resources; it also mandates that the use must be consistent with management of fish and wildlife in accordance with recognized scientific principles and the purposes for which the area was established. Subsistence management on Refuge lands is a complex, at times controversial, and often politically sensitive issue.

ANILCA contains many other provisions supporting continued opportunity for subsistence. For example, Section 811 ensures that subsistence users can access public lands by snowmobile, motorboat, and other traditionally employed means of surface transportation, subject to reasonable regulations. Section 810, directs that the land managers evaluate the effects of a proposed activity on their lands to determine whether the activity would “significantly restrict” subsistence uses. If it was determined that a proposed activity would probably result in significant adverse effects to subsistence resources or use, the land manager would follow requirements identified in Section 810 before making a final decision on the proposal.

Subsistence Use of Migratory Birds

As early as 1916, migratory bird treaties with Canada and Mexico failed to recognize Alaska’s traditional spring and summer subsistence harvest. The Migratory Bird Treaty Act of 1918 (16 U.S.C. 703-712), as amended, established a Federal responsibility for the conservation of migratory birds. After years of negotiations, treaties were amended in 1997 to recognize this customary and traditional harvest. An allowance for the Secretary of the Interior to establish seasons for the taking of birds and the collection of their eggs by "indigenous inhabitants" of Alaska for their own nutritional and other essential needs was created (16 U.S.C. 712).

The Alaska Migratory Bird Co-management Council was established, which included representatives from the Alaska Native community, the ADFG, and the U.S. Fish and Wildlife Service acting as equal partners. The council's primary purpose is to develop recommendations for subsistence migratory bird harvest regulations. Eleven regional management bodies were created to provide local input to the council on the bird list, regional season dates, methods and means, and other annual regulatory recommendations. Alaska subsistence spring and summer migratory bird harvest season runs from April 2nd through August 31st. Migratory bird hunting from September 1st through March 10th is managed under separate Federal regulations in 50 CFR Part 20 and State regulations in 5AAC 85.065.

Subsistence Use of Marine Mammals

The Marine Mammal Protection Act of 1972, as amended (16 U.S.C. 1361-1421h; 50 CFR 13, 18, 216, and 229, as amended) established a Federal responsibility for conservation of marine mammals. The Service is responsible for management of polar bears, sea otters, and Pacific walrus. The act established a moratorium on the taking and importation of marine mammals and products made from them. Alaska Natives who take marine mammals for subsistence purposes, however, were exempt from the moratorium.

Polar bear management requires international coordination between the United States, Russia, and Canada, as well as a cooperative working relationship with Alaska Natives, who

may harvest polar bears for subsistence purposes as outlined under the Marine Mammal Protection Act. The Service monitors harvest through local taggers in 15 communities hired through the Marking, Tagging, and Reporting Program. Taggers gather important information from hunters about polar bears harvested around their community, including the date and location of harvest, and the sex, age, and condition of the bear. Harvest levels in Alaska have remained stable during the past 20 years in the southern Beaufort Sea but have declined in the Chukchi and Bering Seas (Service 2009).

4.4.4.2 Contemporary Village Subsistence Use

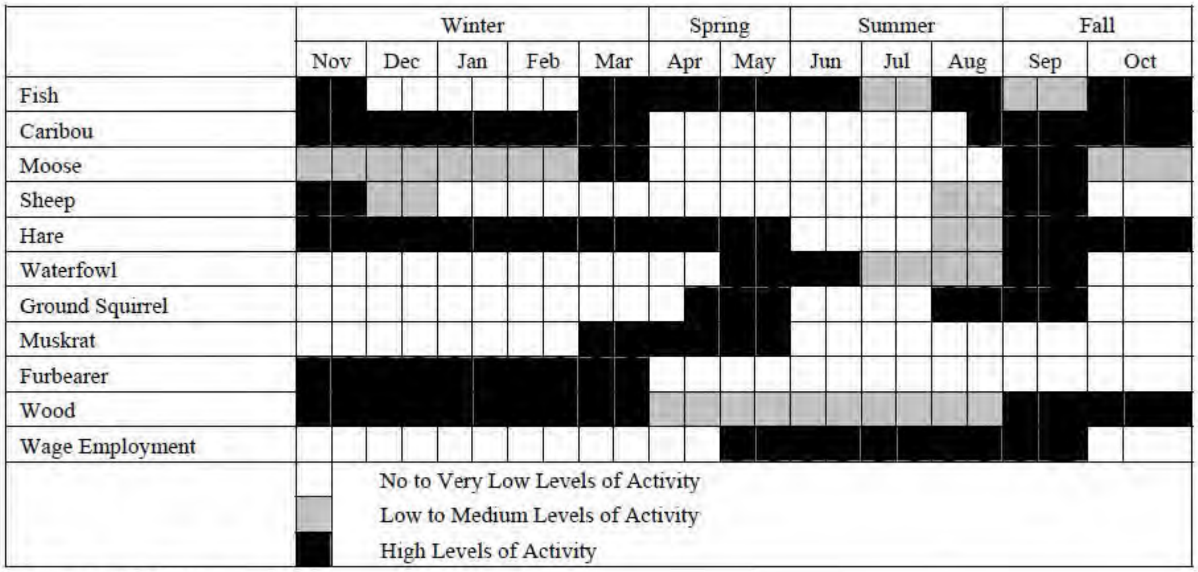
Arctic Village

Reverend Albert Tritt, a Neets'aii Gwich'in born in 1880, wrote that his people led a nomadic life, traveling to the Arctic Coast, Rampart, Old Crow, the Coleen River, and Fort Yukon in the 1880s and 1890s. In the early 1900s, family groups began to gather more permanently at several locations, with the first permanent residents settling at the present Arctic Village site in 1909 (Caulfield 1983). This village is located adjacent to the Refuge on the east bank of the East Fork of the Chandalar River, 6 mi (10 km) southwest of its junction with the Junjik River in the Brooks Range. This location is important for its proximity to nearby fishery resources, availability of timber for firewood and cabin logs, ready access to Dall's sheep on the nearby mountains, and—most importantly—for its access to the Porcupine caribou herds annual migration routes. For the northern Gwich'in people, caribou is still the most important food and cultural resource and is often referred to as their "source of life," providing as much as 80 percent of their diet by weight in some years (ADFG Community Subsistence Information System). The Porcupine caribou herd annual migration between the Porcupine River drainage and the Arctic North Slope has provided for the Gwich'in people for hundreds—even thousands—of years. In addition to being people of the mountains, the northern Gwich'in refer to themselves as "caribou people" (Caulfield 1983). For the Gwich'in people, the Porcupine caribou herd's calving grounds on Arctic Refuge's coastal plain is considered sacred ground, a birthing place for thousands of caribou each year (Gwich'in Nation 1988).

Arctic Village residents generally harvest resources near the community from either tribal reservation lands or Arctic Refuge lands. Residents hunt and fish on Old John Lake, the Chandalar, Sheenjek, Junjik, and Wind rivers, and on Red Sheep Creek. The most recent representation of a seasonal round of subsistence activities for Arctic Village is based on observations and interviews representing the period 1970 to 1982 (Table 4-21) (Caulfield 1983).

Spring begins with the break-up of the river ice in late May to early June, and once the ice thins, nets are set for whitefish, pike, grayling, and suckers; muskrats and waterfowl were hunted in the lakes. Summer begins with fishing by hook and line, as well as nets for whitefish, pike, grayling, suckers, and lake trout. By mid-August, migrating caribou pass nearby, and berries become ripe enough for picking, processing, and storing. Fall begins in mid- to late September. Caribou hunting continues during the fall and through the winter; moose are hunted in September. Fishing with gillnets through the ice begins, and it continues until the ice becomes too thick, when emphasis changed to jigging through the ice. Residents hunt sheep in the nearby mountains in September and November, and fur trappers return to their traplines to set and run them through March (Caulfield 1983).

Table 4-21. Annual cycle of subsistence activities for Arctic Village, 1970–1982



Source: Caulfield 1983.

Arctic Village Subsistence Harvests

Subsistence resource harvest data collected by the ADFG from 1993–1997, and by the Council of Athabascan Tribal Governments for moose, bear, and wolf harvest data in 2001 and 2002, are summarized in Appendix J of the Yukon Flats National Wildlife Refuge Environmental Impact Statement for the Proposed Land Exchange (Service 2010c). Total subsistence harvest for residents of Arctic Village during this time period was 10,000 to 21,000 pounds, with caribou and moose constituting more than 90 percent of the harvest by weight in most years (ADFG Community Subsistence Information System). Other important species included whitefish and, in some years, Dall's sheep and ducks. Andersen and Jennings (2001) reported 437 birds harvested in Arctic Village for the 2000 harvest year.

Arctic Village Subsistence Use Areas

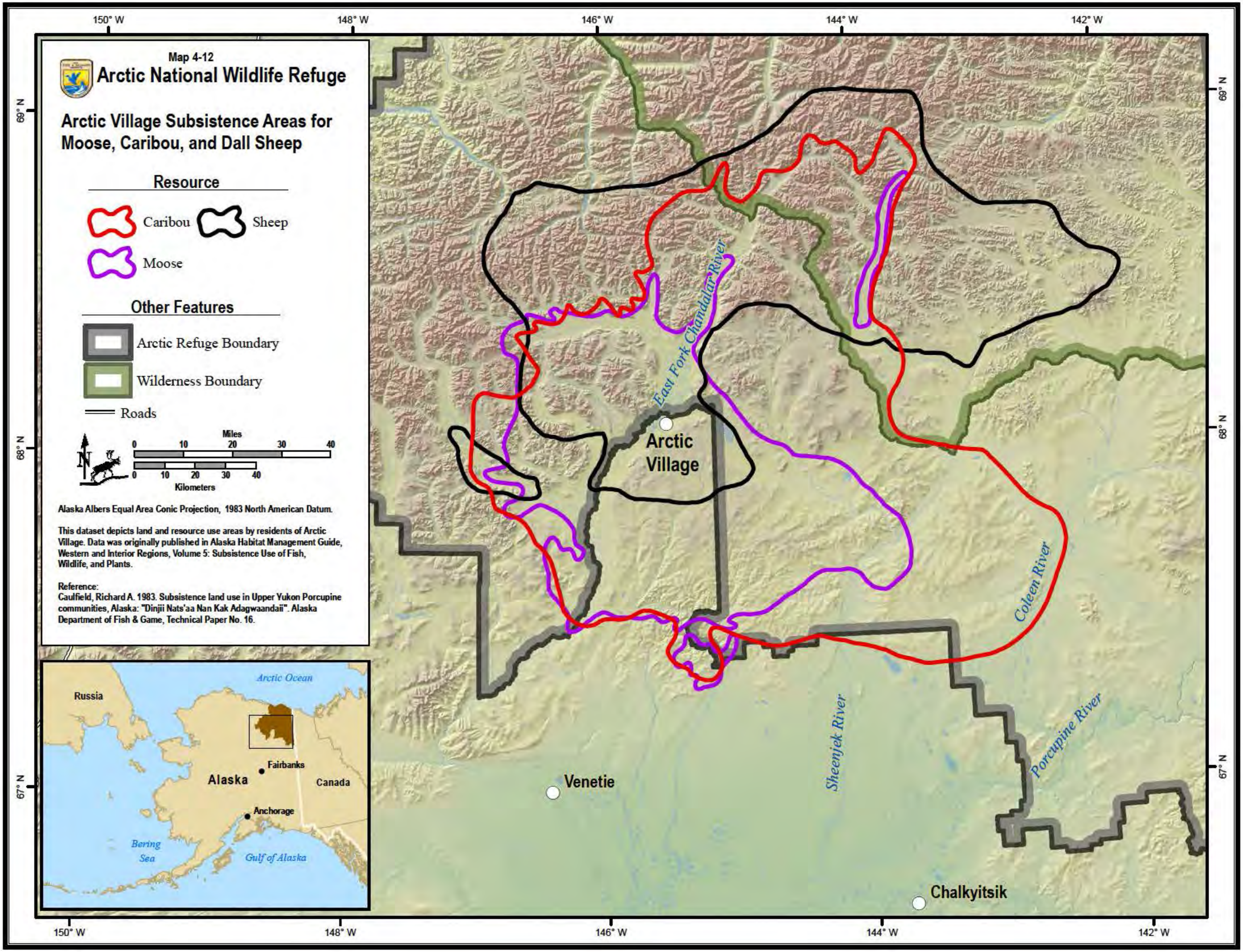
Arctic Village subsistence harvest areas shown on Maps 4-12, 4-13, and 4-14 are based on data collected by Caulfield (1983). These data are based on 1980 interviews documenting 11 respondents' lifetime subsistence use areas. This data may not represent the full range and extent of Arctic Village residents' contemporary use areas for resource harvesting. Harvest and use areas may have changed over time due to factors such as fluctuating populations of fish and wildlife resources, changing migration patterns, availability of resources, shifting climate and changes in habitat, and the impact of high fuel prices.

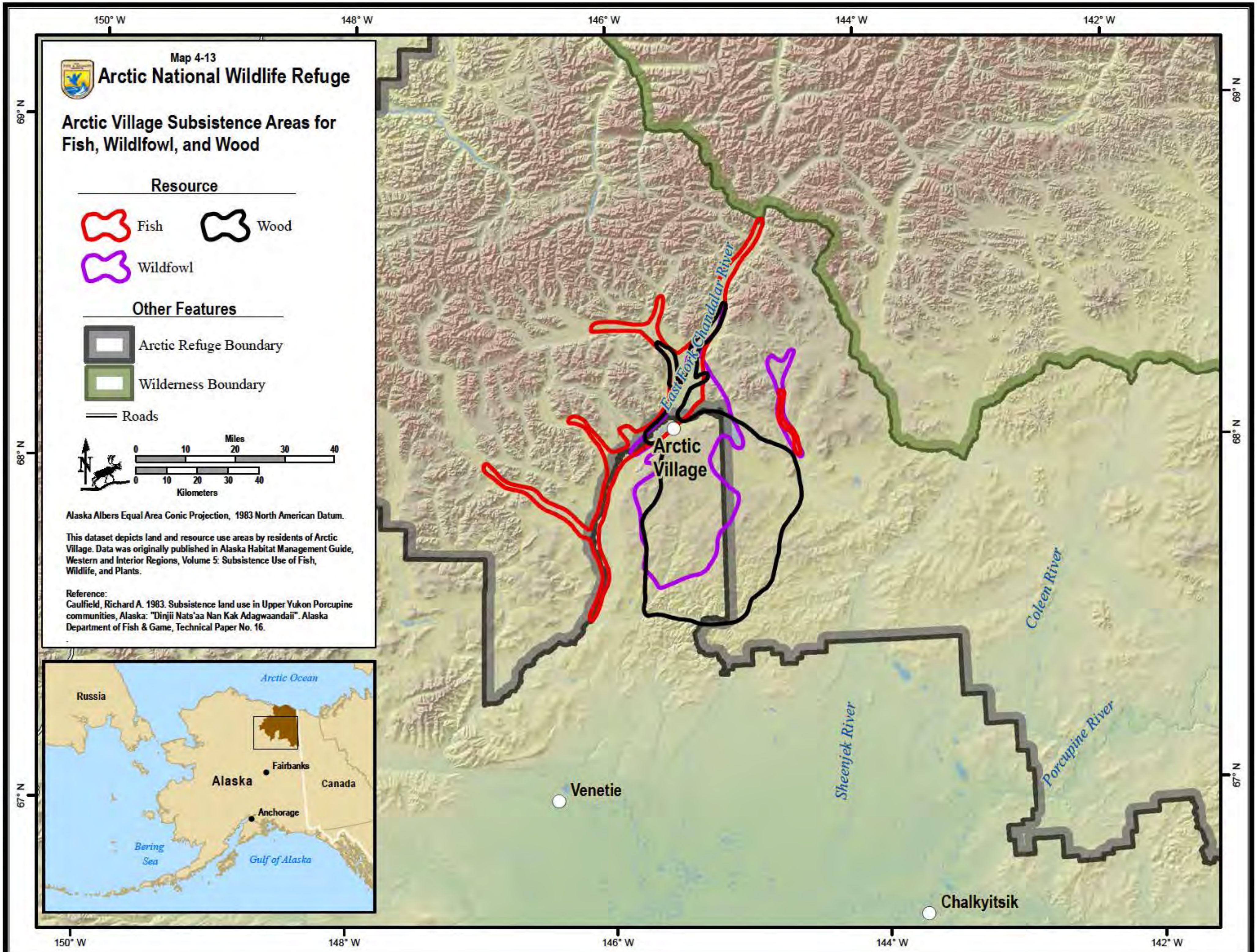
Map 4-12 includes lifetime subsistence use areas for caribou hunting, moose hunting, and sheep hunting. Map 4-13 depicts lifetime subsistence use areas for fishing, wildfowl hunting, and wood fuel and structural materials gathering. Map 4-14 includes lifetime subsistence use areas for bear hunting, furbearer hunting and trapping, and small mammal hunting. The most widespread of these use areas included traplines, usually set along streams or sloughs to trap furbearing animals.

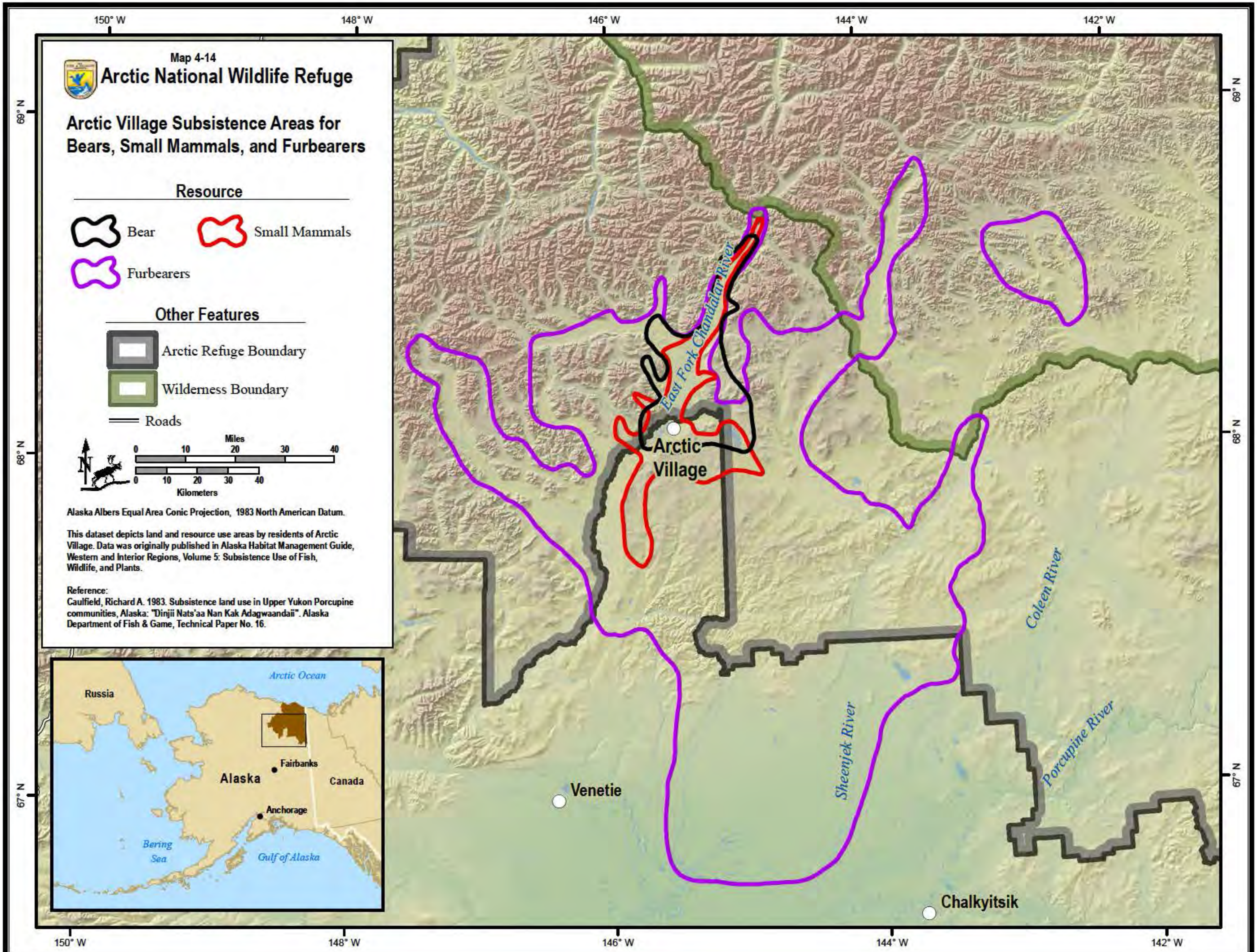
Chalkyitsik

Chalkyitsik means "fish hooking place," and the village has traditionally been an important seasonal fishing site for the Gwich'in (Caulfield 1983). Chalkyitsik is located on the Black River about 21 miles from the Refuge's boundary and 50 miles east of Fort Yukon. Village elders remember a highly nomadic way of life, living at the headwaters of the Black River from autumn to spring, and then floating downriver to fish in summer. Archdeacon MacDonald encountered them on the Black and Porcupine rivers, as well as trading and socializing in Fort Yukon and Rampart, on a number of occasions from 1863 to 1868 (Caulfield 1983). The community's location near the interface of the Yukon Flats and upland areas to the east allows access to a variety of wild plant and animal resources (Alaska Department of Commerce, Community and Economic Development, Alaska Community Database).

Currently, most subsistence harvests occur outside of Arctic Refuge boundaries. However, some residents continue to use Arctic Refuge for hunting and trapping in the fall and winter (Table 4-22, Caulfield 1983). In the fall, some Chalkyitsik residents hunt moose or caribou, usually along the Porcupine River. In November, trapping begins for marten, mink, lynx, beaver, wolf, and fox. Commonly used traplines extend north to the Porcupine and Coleen rivers. Trapping continues until about mid-March. Moose hunting sometimes occurs in conjunction with trapping. Caribou are occasionally harvested during spring and are valued as a source of variety in local diets.

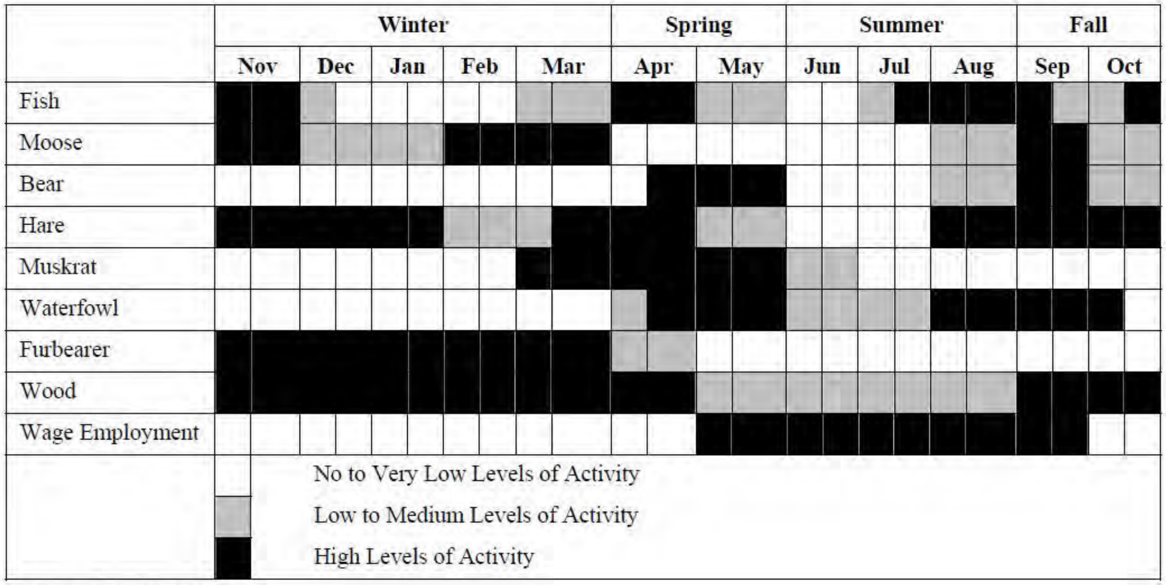

Map 4-12
Arctic National Wildlife Refuge
Arctic Village Subsistence Areas for Moose, Caribou, and Dall Sheep
Resource
Caribou
Sheep
Moose
Other Features
Arctic Refuge Boundary
Wilderness Boundary
Roads
Miles
0 10 20 30 40
0 10 20 30 40
Kilometers
N
Alaska Albers Equal Area Conic Projection, 1983 North American Datum.
This dataset depicts land and resource use areas by residents of Arctic Village. Data was originally published in Alaska Habitat Management Guide, Western and Interior Regions, Volume 5: Subsistence Use of Fish, Wildlife, and Plants.
Reference:
Caulfield, Richard A. 1983. Subsistence land use in Upper Yukon Porcupine communities, Alaska: "Dinjii Nats'aa Nan Kak Adagwaandaii". Alaska Department of Fish & Game, Technical Paper No. 16.
Arctic Ocean
Russia
Alaska
Fairbanks
Canada
Anchorage
Bering Sea
Gulf of Alaska
150° W
148° W
146° W
144° W
142° W
69° N
68° N
67° N
East Fork Chandalar River
Arctic Village
Coleen River
Sheenjek River
Porcupine River
Venetie
Chalkyitsik


Map 4-13
Arctic National Wildlife Refuge
Arctic Village Subsistence Areas for Fish, Wildlfowl, and Wood
Resource
Fish
Wood
Wildfowl
Other Features
Arctic Refuge Boundary
Wilderness Boundary
Roads
Miles
0 10 20 30 40
0 10 20 30 40
Kilometers
Alaska Albers Equal Area Conic Projection, 1983 North American Datum.
This dataset depicts land and resource use areas by residents of Arctic Village. Data was originally published in Alaska Habitat Management Guide, Western and Interior Regions, Volume 5: Subsistence Use of Fish, Wildlife, and Plants.
Reference:
Caulfield, Richard A. 1983. Subsistence land use in Upper Yukon Porcupine communities, Alaska: "Dinjii Nats'aa Nan Kak Adagwaandaii". Alaska Department of Fish & Game, Technical Paper No. 16.
Arctic Ocean
Russia
Alaska
Fairbanks
Canada
Anchorage
Bering Sea
Gulf of Alaska
150° W
148° W
146° W
144° W
142° W
69° N
68° N
67° N
East Fork Chandalar River
Arctic Village
Coleen River
Sheenjek River
Porcupine River
Venetie
Chalkyitsik



Map 4-14
Arctic National Wildlife Refuge
Arctic Village Subsistence Areas for Bears, Small Mammals, and Furbearers
Resource
Bear
Small Mammals
Furbearers
Other Features
Arctic Refuge Boundary
Wilderness Boundary
Roads
Miles
0 10 20 30 40
0 10 20 30 40
Kilometers
Alaska Albers Equal Area Conic Projection, 1983 North American Datum.
This dataset depicts land and resource use areas by residents of Arctic Village. Data was originally published in Alaska Habitat Management Guide, Western and Interior Regions, Volume 5: Subsistence Use of Fish, Wildlife, and Plants.
Reference:
Caulfield, Richard A. 1983. Subsistence land use in Upper Yukon Porcupine communities, Alaska: "Dinjii Nats'aa Nan Kak Adagwaandaii". Alaska Department of Fish & Game, Technical Paper No. 16.
Russia
Arctic Ocean
Alaska
Fairbanks
Canada
Anchorage
Bering Sea
Gulf of Alaska
150° W
148° W
146° W
144° W
142° W
69° N
68° N
67° N
East Fork Chandalar River
Arctic Village
Venetie
Chalkyitsik
Sheenjek River
Coleen River
Porcupine River

Table 4-22. Annual cycle of subsistence activities for Chalkyitsik, 1970–1982T



Source: Caulfield 1983.

Chalkyitsik Subsistence Harvests

ADFG collected subsistence harvest data by household in Chalkyitsik for 1993, 1994, 1995, 1996, and 1997. The Council of Athabascan Tribal Governments collected subsistence harvest data in 2001 and 2004 for moose, bear, and wolves (CATG 2002, CATG 2005). Busher and Hamazaki (2005) reported subsistence harvests of salmon in Chalkyitsik in 1992 to 2003, and Busher et al. (2007) reported the same data for 2005 in addition to harvest of non-salmon species. These subsistence harvest data are summarized in Appendix J of the Yukon Flats National Wildlife Refuge Environmental Impact Statement for the Proposed Land Exchange (Service 2010c). Estimated total subsistence harvest from 1993 to 1997 ranged from 1,900 to 7,700 pounds (ADFG Community Subsistence Information System). Moose constituted 73 to 85 percent of the harvest; other important species representing five percent or more of the estimated harvest during some of these years included black bear, ducks, northern pike, and chum salmon. Annual total subsistence salmon harvests ranged from 30 to 1,750 fish from 1992 to 2003 and in 2005. No per-capita harvest data are currently available for Chalkyitsik (ADFG Community Subsistence Information System). Andersen and Jennings (2001) reported a harvest of 568 total birds in Chalkyitsik for the 2000 harvest year.

Chalkyitsik Subsistence Use Areas

Map 4-15 represents selected Chalkyitsik "lifetime" subsistence use areas for caribou, bear, and moose hunting, and furbearer trapping. (Caulfield 1983). These data are based on 1980 interviews documenting eight respondents' lifetime subsistence use areas. This data may not represent the full range and extent of Chalkyitsik residents' contemporary use areas for resource harvesting. Harvest and use areas may have changed over time due to factors such as fluctuating populations of fish and wildlife resources, changing migration patterns, availability of resources, shifting climate and changes in habitat, and the impact of high fuel prices.

Fort Yukon

Fort Yukon is located at the confluence of the Yukon River and the Porcupine River, about 63 miles from Arctic Refuge boundary The community has historically served as a meeting place for the Gwich'in Athabascan and neighboring peoples. Its location on the Yukon River and confluence with the Porcupine River makes it an important transportation center, as well as an important area for harvesting fish resources. Fort Yukon today is the largest village of the Kutchin or Gwich'in Athabascan people and the administrative, transportation, communication, and economic center for the upper Yukon-Porcupine region. It is a large community with a blend of wage employment opportunities and subsistence components.

Research indicates that Fort Yukon residents reported spending less time in resource harvest activities each year than did residents of other communities in the region; however, their diversity of subsistence resources harvested was reported to be greater (Institute of Social and Economic Research 1978). Possible explanations for this may include the broad diversity of resources available due to Fort Yukon's central location in the region with ready access to numerous major river corridors and enhanced use of access equipment made possible by income from wage employment. Most contemporary subsistence harvests occur outside of Arctic Refuge boundaries on Native lands or on Yukon Flats National Wildlife Refuge.

Currently, the Porcupine and Coleen drainages are the primary areas used by Fort Yukon residents in Arctic Refuge. Table 4-23 depicts the annual cycle of subsistence activities at Fort Yukon from 1970–1982 and 1986–1987 (Caulfield 1983, Sumida and Andersen 1990). Fort Yukon's seasonal rounds have not changed substantially between Caulfield's 1983 study and Sumida and Anderson's 1990 study with the exception of accommodating new technologies in access equipment and regulatory constraints. The Porcupine River is utilized for moose, bear, waterfowl, and caribou hunting. It is also used for fishing, gathering house logs and firewood, and berry picking. In the fall, some residents travel up the Porcupine River or its tributaries, such as the Coleen River, to hunt moose; bears may also be taken in conjunction with moose hunting. Moose are sometimes harvested during the winter, usually in November and/or during February and March. Caribou hunting usually occurs in mid-September near Canyon Village or Old Rampart as animals from the Porcupine caribou herd cross the Porcupine River (Caulfield 1983). Many people in Fort Yukon today have kinship ties to residents in Arctic Village and Venetie and occasionally utilize these areas for hunting and fishing.

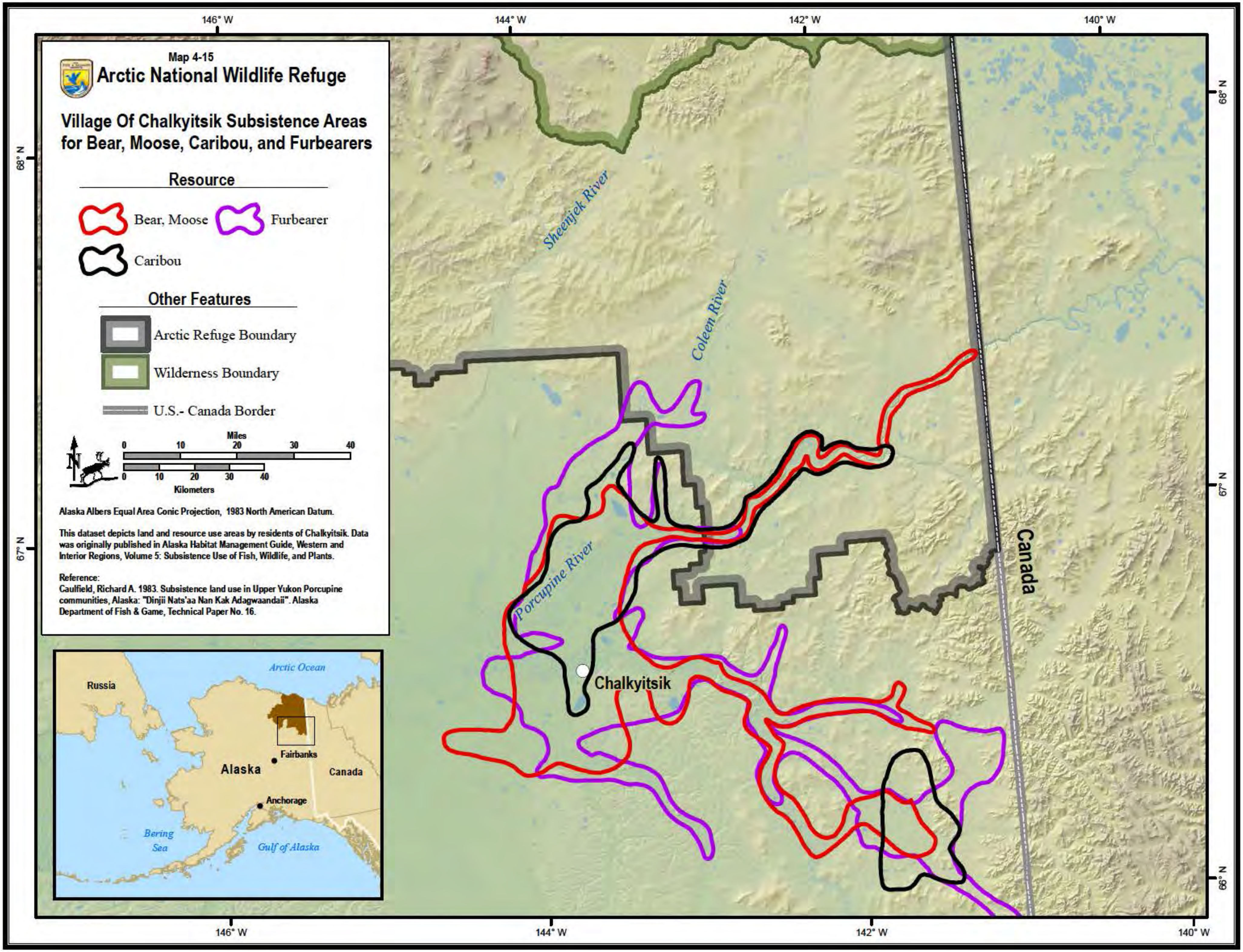
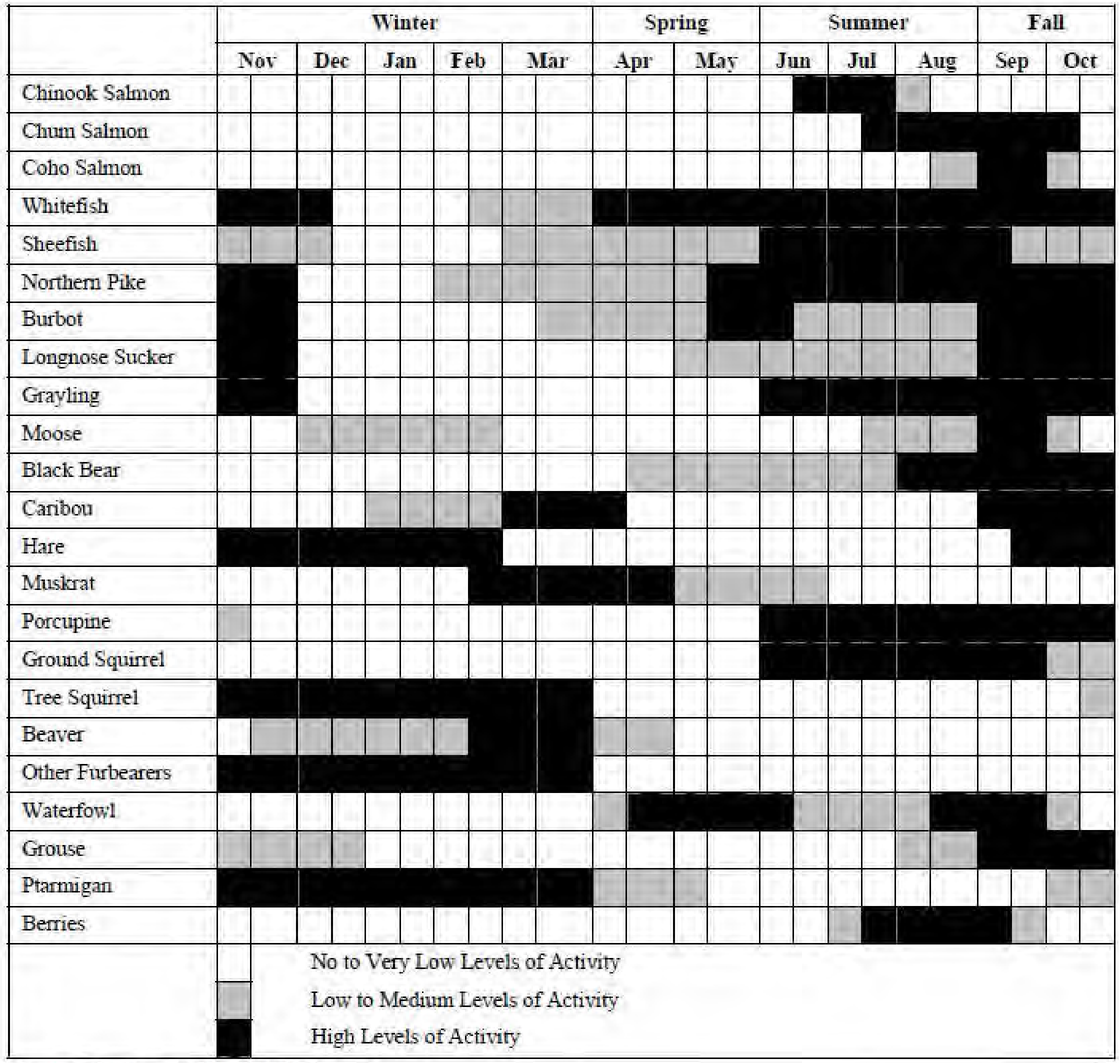

Map 4-15
Arctic National Wildlife Refuge
Village Of Chalkyitsik Subsistence Areas for Bear, Moose, Caribou, and Furbearers
Resource
Bear, Moose
Furbearer
Caribou
Other Features
Arctic Refuge Boundary
Wilderness Boundary
U.S.- Canada Border
Miles
0 10 20 30 40
0 10 20 30 40
Kilometers
Alaska Albers Equal Area Conic Projection, 1983 North American Datum.
This dataset depicts land and resource use areas by residents of Chalkyitsik. Data was originally published in Alaska Habitat Management Guide, Western and Interior Regions, Volume 5: Subsistence Use of Fish, Wildlife, and Plants.
Reference:
Caulfield, Richard A. 1983. Subsistence land use in Upper Yukon Porcupine communities, Alaska: "Dinjii Nats'aa Nan Kak Adagwaandaii". Alaska Department of Fish & Game, Technical Paper No. 16.
Sheenjek River
Coleen River
Porcupine River
Chalkyitsik
Canada
146° W
144° W
142° W
140° W
68° N
67° N
Russia
Arctic Ocean
Alaska
Fairbanks
Anchorage
Canada
Bering Sea
Gulf of Alaska

Table 4-23. Annual cycle of subsistence activities for Fort Yukon, 1970–1982, 1986–1987



Source: Sumida and Andersen 1990.

Fort Yukon Subsistence Harvests

ADFG collected subsistence harvest data for the community of Fort Yukon in 1987, 1993, 1994, 1995, 1996, 1997, and 1998. The Council of Athabascan Tribal Governments collected information on subsistence harvests in Fort Yukon for moose, bear, and wolves in 2001, 2003, and 2004. Busher and Hamazaki (2005) provided information on Fort Yukon subsistence salmon harvests from 1992 to 2003, and Busher et al. (2007) provided the same data for 2005. These subsistence harvest data are summarized by year and by species in Appendix J of the Yukon Flats National Wildlife Refuge Environmental Impact Statement for the Proposed Land Exchange (Service 2010c).

Based on data collected by ADFG, household participation rates were high during the 1987 study year. No participation data are available for the 1993 to 1998 study years. Estimates of total subsistence harvest ranged from 3,100 to 625,700 pounds (ADFG Community Subsistence Information System). Moose represented 16 to 48 percent of the harvest annually by weight during study years from 1987 to 1998. Chinook and chum salmon were very important components of the annual harvest, ranging from 40 to 65 percent of the harvest. Geese and whitefish were the only other species groups that constituted more than five percent of the annual harvest. Other species harvested included snowshoe hare, black bear, beaver, lynx, ducks, geese, grouse, and ptarmigan. Andersen and Jennings (2001) reported 3,615 birds harvested by Fort Yukon respondents in the 2000 harvest year. Based on data provided in Busher and Hamazaki (2005) and Busher et al. (2007), Fort Yukon residents harvested large quantities of chum and Chinook salmon and lesser quantities of Coho salmon from 1992 to 2003 and in 2005.

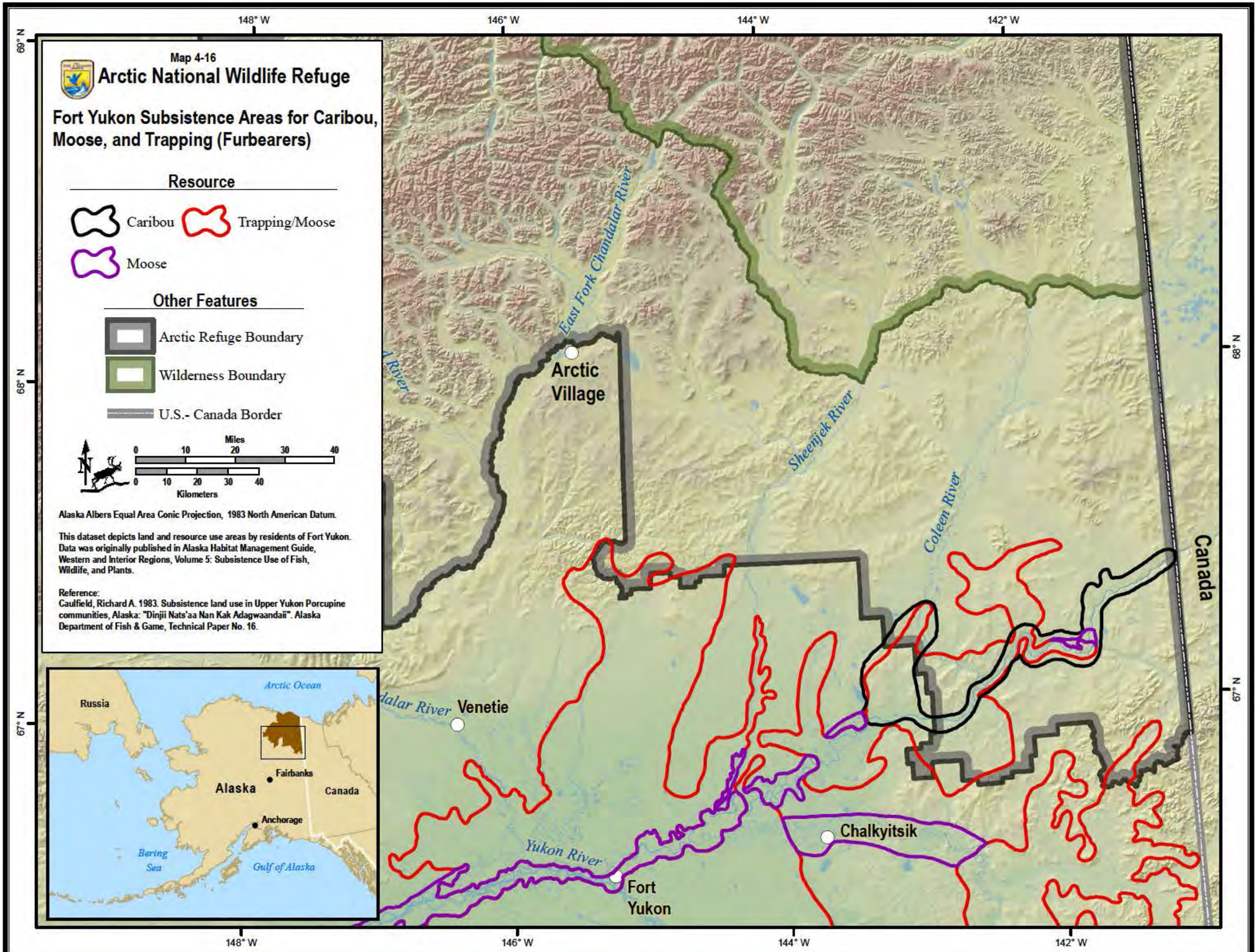
Fort Yukon Subsistence Use Areas

Map 4-16 represents selected Fort Yukon "lifetime" (circa 1925–1987) subsistence use areas (Caulfield 1983, Sumida and Andersen 1990) extending onto Arctic Refuge. These data are based on 1981 (10) and 1988 (26) interviews documenting respondents' lifetime subsistence use areas and may not represent the full range and extent of Fort Yukon residents' contemporary use areas for resource harvesting. Harvest and use areas may have changed over time due to factors such as fluctuating populations of fish and wildlife resources, changing migration patterns, availability of resources, shifting climate and changes in habitat, and the impact of high fuel prices.

Kaktovik

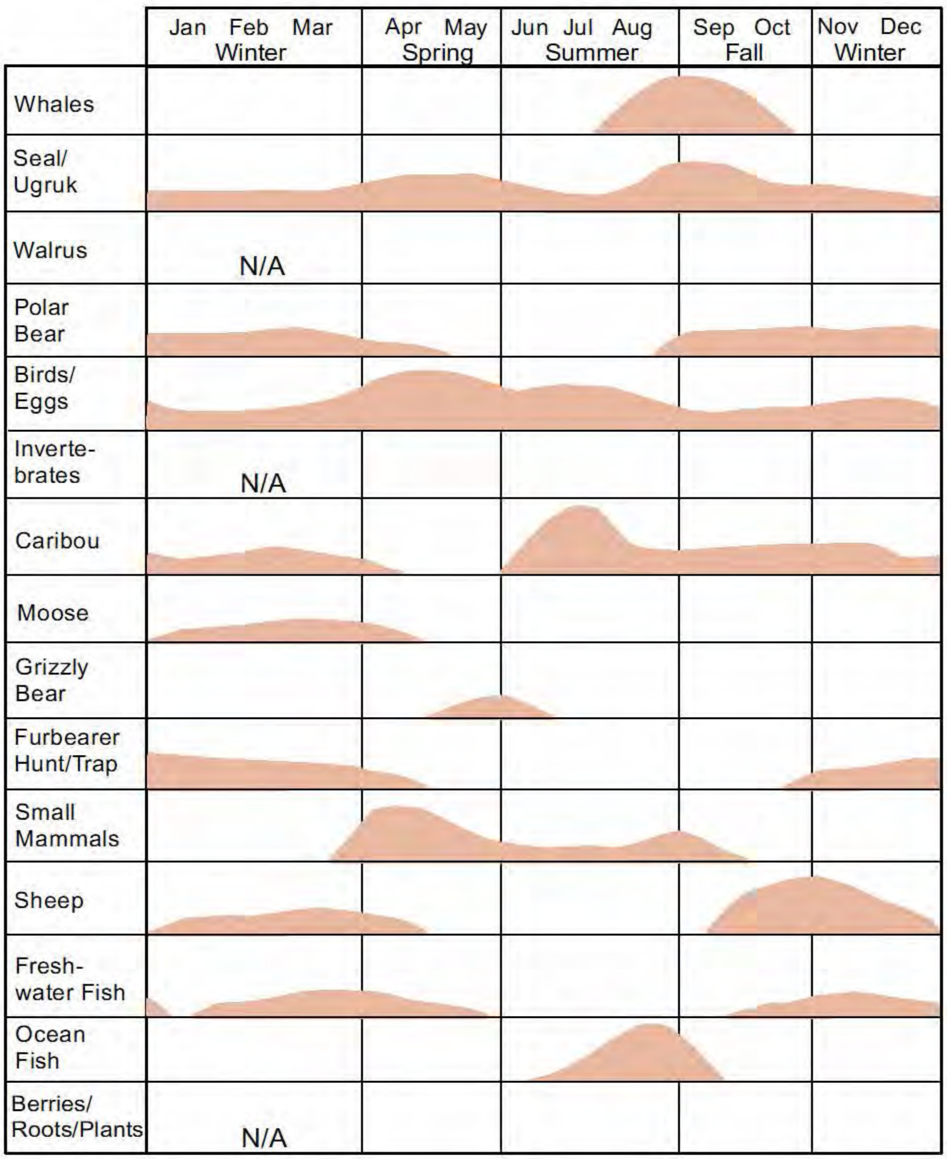
Kaktovik is an Iñupiat community located on Barter Island on the shore of the Beaufort Sea. Until the late 19th century, the island was a major trade center for the Iñupiat and was especially important as a bartering place for Iñupiat from northeastern Alaska and Inuit from Canada. As in the past, the Kaktovikmiut's way of life is heavily dependent on the subsistence harvest of marine and terrestrial animals and fish. Approximately 93 percent of Iñupiat households in Kaktovik participate in the subsistence economy, and 80 percent of non-Iñupiat households use subsistence resources (Shepro et al. 2003). The annual subsistence cycle for Kaktovik is described in Table 4-24. This may not perfectly represent current use patterns but is based on the best available published information. The community's harvest of subsistence resources can fluctuate widely from year to year because of variable migration patterns of game and because harvesting techniques are extremely dependent on snow and ice conditions and weather.

Caribou hunting occurs throughout most of the year, with a peak in the summer when open water allows hunters to use boats to access coastal areas and river drainages for caribou. Bowhead whaling occurs between late August and early October, with the exact timing depending on ice and weather conditions (Minerals Management Service 2003). The whaling season can range anywhere from longer than one month to less than two weeks, depending on these conditions. Other marine mammal hunting (mainly seals) can take place year-round, as does hunting for birds. However, most birds are taken during the spring and fall migrations. Furbearers and sheep are taken in the winter, when surface travel by snowmachine is possible. Fresh water fish are harvested mainly in the winter under the ice, while ocean fish are taken during the open water season. Moose are not a preferred species in Kaktovik, primarily due to their low population levels and limited hunting seasons where harvest numbers have been restricted in recent years.



Map 4-16
Arctic National Wildlife Refuge
Fort Yukon Subsistence Areas for Caribou, Moose, and Trapping (Furbearers)
Resource
Caribou
Trapping/Moose
Moose
Other Features
Arctic Refuge Boundary
Wilderness Boundary
U.S.- Canada Border
Miles
0 10 20 30 40
0 10 20 30 40
Kilometers
Alaska Albers Equal Area Conic Projection, 1983 North American Datum.
This dataset depicts land and resource use areas by residents of Fort Yukon. Data was originally published in Alaska Habitat Management Guide, Western and Interior Regions, Volume 5: Subsistence Use of Fish, Wildlife, and Plants.
Reference:
Caulfield, Richard A. 1983. Subsistence land use in Upper Yukon Porcupine communities, Alaska: "Dinjii Nats'aa Nan Kak Adagwaandaii". Alaska Department of Fish & Game, Technical Paper No. 16.
Russia
Arctic Ocean
Alaska
Fairbanks
Anchorage
Canada
Bering Sea
Gulf of Alaska
148° W
146° W
144° W
142° W
69° N
68° N
67° N
East Fork Chandalar River
Arctic Village
Sheenjek River
Coleen River
Canada
Venetie
Chalkyitsik
Yukon River
Fort Yukon

Table 4-24. Annual subsistence cycle for Kaktovik (qualitative presentation)



Source: Galginaitis et al. 2001, based on Wentworth 1979

Note: Patterns indicate desired periods for pursuit of each species based on the relationships of abundance, hunter access, seasonal needs, and desirability. Heights of graphs indicate level of effort.

Kaktovik Subsistence Resources

Marine Mammals—Whaling resumed in Kaktovik in 1964. In years when Kaktovik residents harvest and land a whale, marine resources have composed 59 to 68 percent of their total subsistence harvest. Bowhead whaling occurs between late August and early October, with the exact timing depending on ice and weather conditions (Minerals Management Service 2003). There are at least 10 whaling crews in Kaktovik, and the community has a quota of three strikes (whether the animals are landed or not). Kaktovik has what is essentially an intercommunity agreement with Anaktuvuk Pass under which muktuk, whale meat, and other marine mammal products (especially seal oil) are sent to Anaktuvuk Pass, and caribou and other land mammal products are sent from Anaktuvuk Pass to Kaktovik. Caribou is a much more variable resource for Kaktovik than for Anaktuvuk Pass, and Anaktuvuk Pass does not have access to bowhead whales or other marine mammals. Other marine mammal hunting (mainly seals) can take place year-round. Kaktovik residents also harvest a large number of bearded and smaller seals, and the occasional beluga whale or polar bear.

Terrestrial Mammals—Land mammals are the next largest category of harvest, ranging from 17–30 percent in those same years. The primary land mammal resource is caribou, but Kaktovik residents also harvest a considerable number of Dall's sheep. Of lesser abundance and availability are muskox, moose, and grizzly bears. While Kaktovik hunters have taken moose and muskox, harvest opportunities are restricted due to their low population numbers. Kaktovik's annual caribou harvest fluctuates widely because of the unpredictable movements of the herds, weather-dependent hunting technology, and ice conditions. Caribou hunting occurs throughout most of the year, with a peak in the summer when open water allows hunters to use boats to access coastal and river areas for caribou.

Fishery Resources—Fish comprise 8–13 percent of the total subsistence harvests. Fish may be somewhat less subject to these variable conditions but still exhibit large year-to-year variations. In some winter months, fish may provide the only source of fresh subsistence foods. Kaktovik's harvest effort seems to be split between Dolly Varden and whitefish, with the summer fishery at sites near Kaktovik being more productive than winter fishing on the lower reaches of the Hulahula River.

Bird Resources—Birds and eggs making up 2–3 percent of the total harvest. Since the mid-1960s, subsistence use of waterfowl and coastal birds has been growing, at least in seasonal importance. Most birds are taken during the spring and fall migrations. Important subsistence species are black brant, long-tailed duck, eider, snow goose, Canada goose, and pintail duck. Waterfowl hunting occurs mostly in the spring from May to early July (Minerals Management Service 2003). Ptarmigan are also a seasonally important bird.

Furbearer Resources —Trapping of furbearers in the Kaktovik area has decreased with time. Furbearers are taken in the winter when surface travel by snowmachine is possible. Hunters pursue wolf and wolverine by searching and harvesting them with rifles, primarily between March and April or in conjunction with winter sheep hunting. Some hunters may go out in the fall or early winter, but usually weather and snow conditions are poor at that time, and people are more concerned with meat than with fur.

Kaktovik Subsistence Harvests

Community subsistence harvest data for Kaktovik is somewhat dated in terms of the in-depth subsistence community use surveys, which were conducted in 1985, 1986, 1992 (ADFG 1985, ADFG 1986, ADFG 1992). In 1995, the North Slope Borough began to systematically collect subsistence harvest data for the eight villages in the borough. However, the borough was only able to collect subsistence harvest data for the village of Kaktovik in 1994–1995 and in 2002–2003 (Table 4-25).

Subsistence harvest studies for Kaktovik in 1995 indicated that 61 percent of the subsistence harvest (in edible pounds of food) were from marine mammals, consisting of bowhead whales, bearded seals, ringed seals, spotted seals, polar bears, and beluga whales. Terrestrial mammals comprised another 26 percent of the estimated edible pounds harvested, consisting

Table 4-25. Kaktovik community subsistence harvest surveys, major resource categories

Kaktovik Community Subsistence Harvest Surveys												
	1985			1986			1992			1995		
	Number	Pounds	% of Total Pounds	Number	Pounds	% of Total Pounds	Number	Pounds	% of Total Pounds	Number	Pounds	% of Total Pounds
All Resources	9,585	61,664	100	6,484	84,060	100	21,035	170,940	100	5,180		
Fish	6,866	11,403	18	4,416	6,951	8	18,464	22,952	13	4,426		11
Salmon	0	0	0	0	0	0	50	105	0	1		
Whitefish	3,546	2,482	4	2,402	1,682	2	8,823	6,051	4	2,358		
Other	3,320	8,921	14	2,014	5,269	6	9,591	16,796	10	2,067		
Land Mammals	714	35,491	58	382	24,946	30	425	28,867	17	178		26
Caribou	235	27,941	45	178	21,188	25	158	19,136	11	78		
Moose	4	1,893	3	1	596	1	4	2,011	1	1		
Dall Sheep	47	4,622	7	17	1,710	2	44	4,379	3	30		
Muskox	1	748	1	2	1,413	2	5	3,179	2	9		
Other	427	287	0	184	39	0	214	162	0	60		
Marine Mammals	174	10,762	17	67	49,723	59	123	115,645	68	46		61
Bearded Seal	21	3,776	6	17	2,936	3	24	4,246	2	21		
Other Seal	152	6,360	10	45	1,901	2	46	1,858	1	19		
Walrus	0	0	0	0	0	0	0	52	0	0		
Beluga	0	0	0	0	0	0	0	0	0	1		
Bowhead Whale	0	0	0	3	43,704	52	3	108,160	63	3		
Polar Bear	1	626	1	2	1,182	1	3	1,330	1	2		
Birds & Eggs	1,831	3,995	6	1,561	2,382	3	1,796	3,249	2	530		2
Vegetation	NA	13	0	58	58	0	227	227	0	NA		

Notes:
Source: ADF&G Community Information System (http://www.subsistence.adfg.state.ak.us/CSIS/) and Brower et al. 2000.
1985, 1986, and 1992 were ADF&G surveys. 1995 was a NSB survey and did not provide harvest in terms of pounds, but did provide the percentages shown for the 1995 subcategories of resources. "Pounds" for 1995 could not be calculated as for Nuiqsut, since only aggregated category percentages were provided in the published document.

of caribou, Dall's sheep, muskox, moose, and brown bear. The primary land mammal resource is caribou (Table 4-26), but Kaktovik residents also harvest a large number of Dall's sheep. Fishery resources accounted for 11 percent of the estimated total edible pounds of harvest. Seven species of fish accounted for the 4,426 fish harvested, of which Arctic Cisco and Dolly Varden represented 4,233 of the fish caught. The harvest of birds accounted for the remaining two percent of edible pounds of subsistence harvest, with 530 birds reported harvested (Brower et al. 2000).

In the 1995 study, 31 different species were reported harvested, with key species being caribou and Dall's sheep for terrestrial mammals; bowhead whales, and ringed and bearded seals for marine mammals; brant and ptarmigan for birds; Arctic cisco and Dolly Varden char for fish; and wolf and ground squirrels for furbearers.

Table 4-26. Estimated caribou harvest by year for Kaktovik

Documented Annual Caribou Harvest Kaktovik	
Year	**Estimated Harvest Kaktovik**
1981	43
1982	160
1983	107
1985	235
1986	201
1987	189
1990	113
1991	181
1992	158
1995	78[a]
2003	112

Sources: ADFG Community Information System (http:www.subsistence.adfg.state.ak.us/(CSIS), Brower et al. 2000, Brower and Hepa 1998, Harper 2007, Bacon et al. 2009 (for 2002–2003)

[a] Number reported as harvested; total estimated harvest not available.

In addition to the Beaufort Sea, Kaktovik residents have access to a number of rivers and lakes that support subsistence fish resources. Pedersen and Linn (2005) conducted surveys of the Kaktovik subsistence fishery in 2000–2001 and 2001–2002, with estimated community harvests of fish at 5,970 pounds and 9,748 pounds, respectively. Dolly Varden, lake trout, and Arctic cisco were the only fishery resources reported harvested by Kaktovik households in this study (Table 4-27). Dolly Varden was the most commonly harvested fish in terms of numbers harvested and estimated harvest weight, with Arctic cisco and lake trout ranking second and third (Pedersen and Linn 2005).

Table 4-27. Kaktovik estimated fish harvest, sample years 1985–2002

Kaktovik Fish Harvest, by Year							
Year	Reported Harvest (pounds)	Estimated Harvest (pounds)	Using	Attempting	Harvesting	Giving	Receiving
2002	3,056	9,748	76	55	47	32	47
2001	3,719	5,970	61	43	38	36	52
1992	17,123	22,952	94	83	81	70	70
1986	5,833	6,951	96	75	72	66	87
1985	9,036	11,403	100	86	81	45	93

Notes:
Source: Pedersen and Linn 2005, and ADF&G Community Information System (http://www.subsistence.adfg.state.ak.us/CSIS/).

Kaktovik Subsistence Use Areas

Contemporary subsistence use areas for caribou, bowhead whales, seals, and fish for Kaktovik are shown on Map 4-17, Map 4-18, and Map 4-19. Map 4-17 depicts caribou land use in total extent and primary areas of use. Map 4-18 depicts contemporary subsistence bowhead whale use areas and subsistence seal use areas. Map 4-19 depicts contemporary fishing areas and important sites. Harvest and use areas may have changed over time due to factors such as fluctuating populations of fish and wildlife resources, changing migration patterns, availability of resources, shifting climate and changes in habitat, and the impact of high fuel prices.

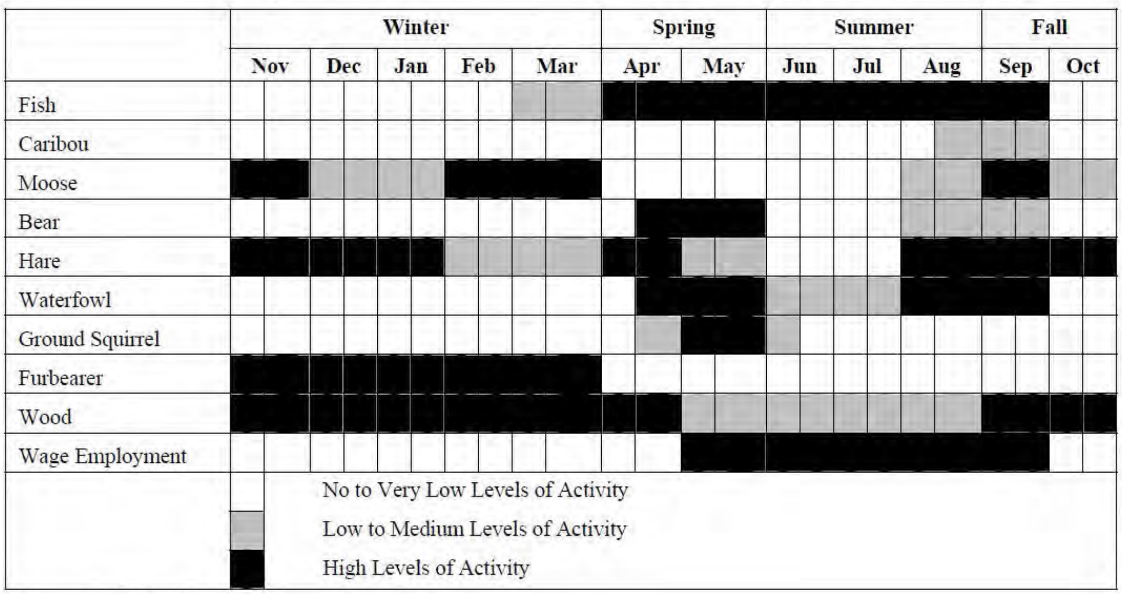
Venetie

Venetie is located on the Chandalar River, about 22 mi from Arctic Refuge and about 45 mi (70 km) northwest of Fort Yukon. The village's location in the Yukon Flats near the foothills of the Brooks Range provides access to resources of the lakes, rivers, and slough systems of the Yukon Flats, as well as to the resources of the upland regions of the Brooks Range (Caulfield 1983). The lower portions of the Chandalar River, including the East Fork of the Chandalar River drainage, are the primary area used by Venetie residents. High use areas in Arctic Refuge include the East Fork of the Chandalar River for harvesting caribou, moose, sheep, bears, fish, and furbearers.

Muskrats and ground squirrels are trapped and black bears are hunted in the spring. Waterfowl hunting usually begins in early May and continues until early June. Once the ice has melted from the rivers and small streams, gillnets are placed in the East and North Forks of the Chandalar River to harvest whitefish, pike, and suckers. Moose hunting is primarily along rivers, and gillnet fishing for salmon and whitefish are major fall activities. Black bear are also taken occasionally when encountered along rivers, as are caribou in late summer (Caulfield 1983). Trapping activities begin in November, and primary species sought are marten, mink, beaver, lynx, fox, wolf, and muskrat. In the Refuge, most trapping occurs along the East Fork of the Chandalar River (Caulfield 1983).

In November and early December, moose are occasionally taken by hunters on snowmachines. In some years, caribou travel to within hunting distance north of Venetie and are sought by snowmachine throughout the winter. A few people may hunt caribou with their relatives near Arctic Village, especially in years when caribou are not available near Venetie. In February and March, trapping focuses on beaver and muskrat (Table 4-28).

Table 4-28. Annual cycle of subsistence activities for Venetie, 1970–1982

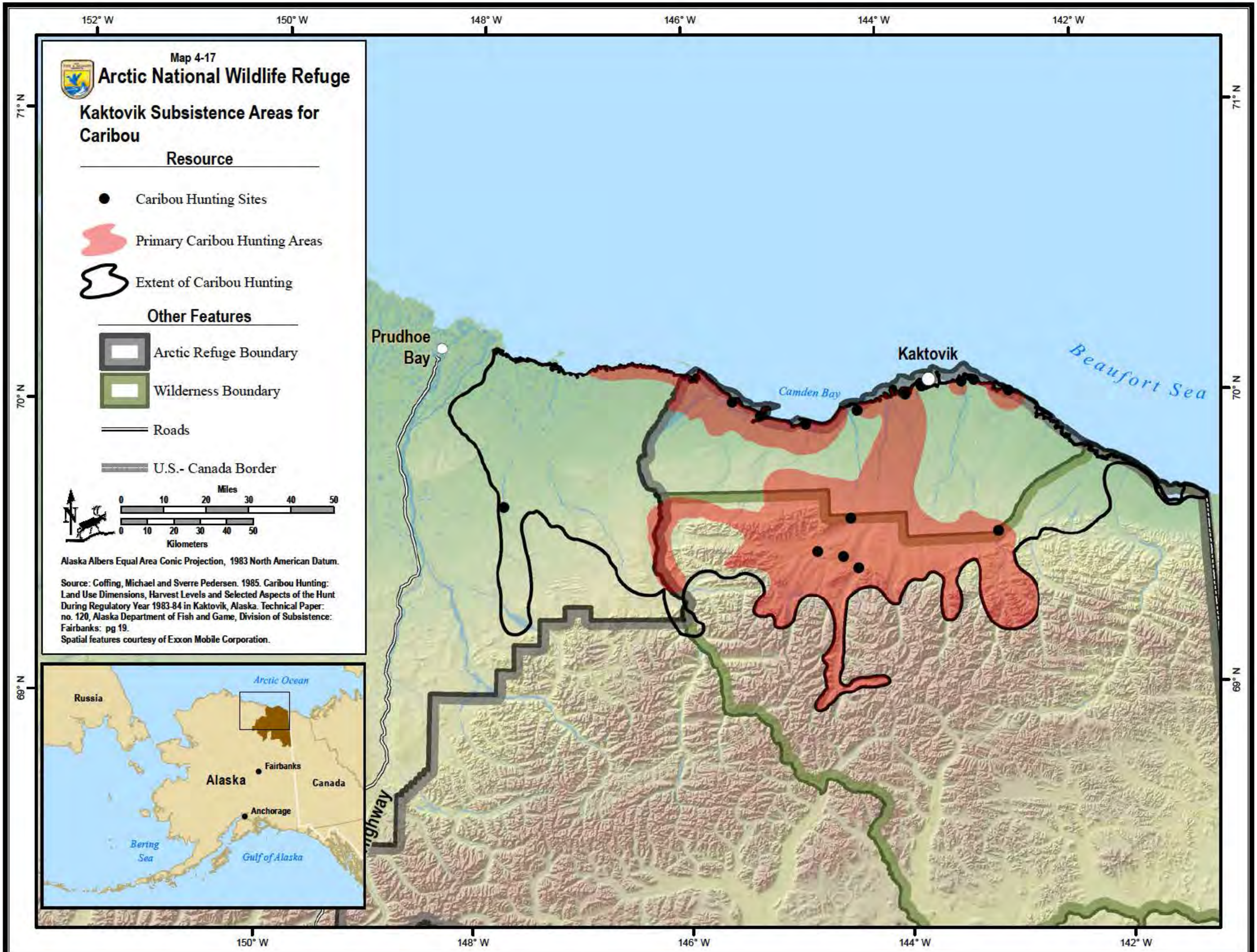


Source: Caulfield 1983.

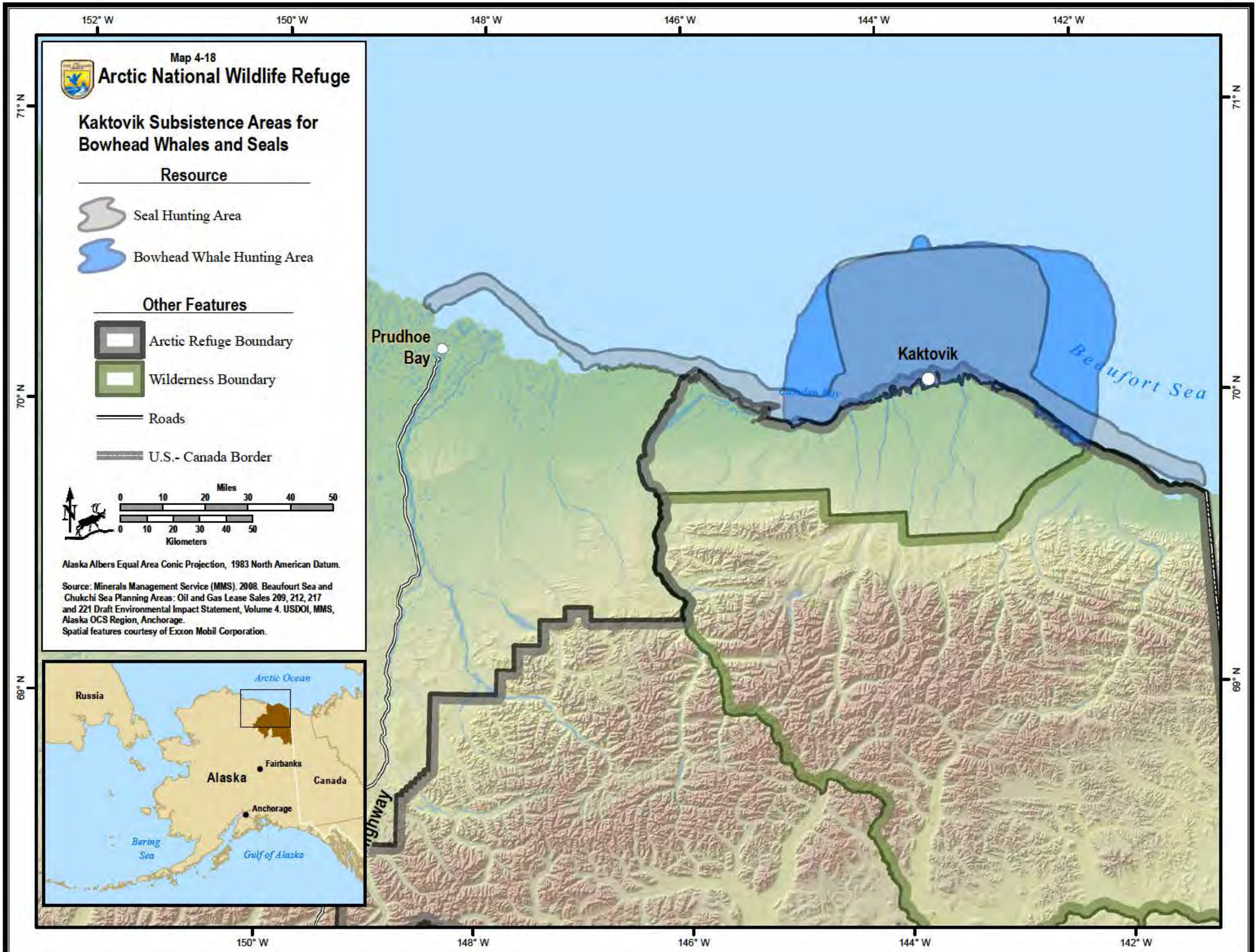
Venetie Subsistence Harvests

ADFG collected subsistence harvest data for Venetie in 1993, 1994, 1995, 1996, and 1997. The Council of Athabascan Tribal Government provided subsistence harvest information for moose, bear, and wolves for 2003 and 2004 (CATG 2002, CATG 2003, CATG 2005). Busher and Hamazaki (2005) reported subsistence harvests of salmon by Venetie residents for the years 1992 to 2003, and Busher et al. (2007) provided the same data for 2005. No per-capita or household participation rate data are available for Venetie (ADFG Community Subsistence Information System). These subsistence data are summarized by year and by species in Appendix J of the Yukon Flats National Wildlife Refuge Environmental Impact Statement for the Proposed Land Exchange (Service 2010c). Because much of the data are from years of noted reduced availability, none of the study years are considered by ADFG to be "most representative" (ADFG 2005). Estimated total annual subsistence harvests ranged from 11,000 to 24,000 pounds (ADFG Community Subsistence Information System). Estimated moose harvest from 1993 to 1997 ranged from 26 to 94 percent of the total harvest.

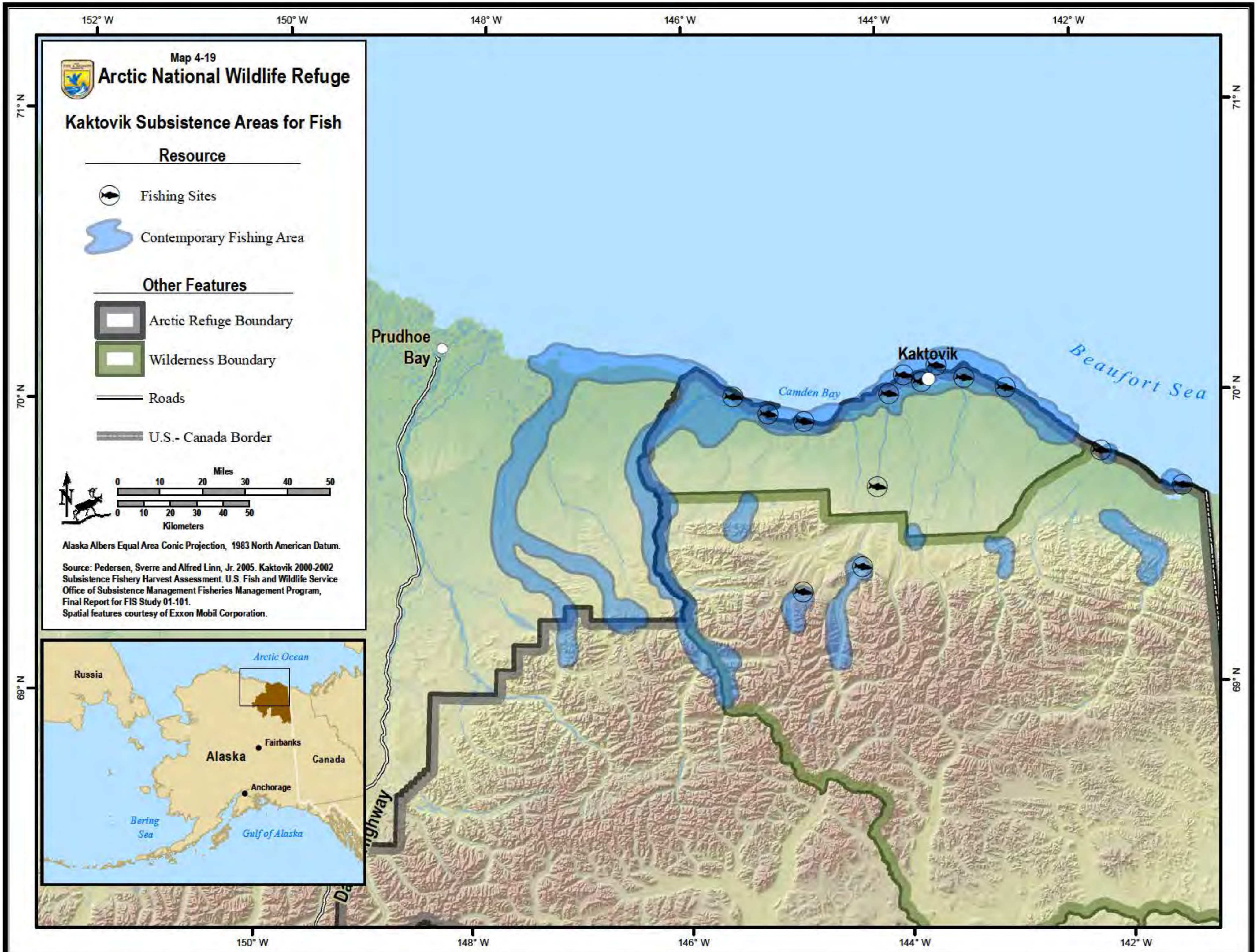
Caribou were very important components of the harvest during some years (as much as 71 percent of harvest) but not others—when no caribou harvest was reported. Fish, primarily chum salmon and whitefish, were important harvest components during some years but not others—ranging from 0.1 to 40 percent of the harvest. Busher and Hamazaki (2005) reported that the salmon harvest ranged for 233 to 8,010 fish from 1992 to 2003, and Busher et al. (2007)



Map 4-17
Arctic National Wildlife Refuge
Kaktovik Subsistence Areas for Caribou
Resource
Caribou Hunting Sites
Primary Caribou Hunting Areas
Extent of Caribou Hunting
Other Features
Arctic Refuge Boundary
Wilderness Boundary
Roads
U.S.- Canada Border
Miles
0 10 20 30 40 50
0 10 20 30 40 50
Kilometers
Alaska Albers Equal Area Conic Projection, 1983 North American Datum.
Source: Coffing, Michael and Sverre Pedersen. 1985. Caribou Hunting: Land Use Dimensions, Harvest Levels and Selected Aspects of the Hunt During Regulatory Year 1983-84 in Kaktovik, Alaska. Technical Paper: no. 120, Alaska Department of Fish and Game, Division of Subsistence: Fairbanks: pg 19.
Spatial features courtesy of Exxon Mobile Corporation.
Russia
Arctic Ocean
Fairbanks
Alaska
Canada
Anchorage
Bering Sea
Gulf of Alaska
Prudhoe Bay
Kaktovik
Camden Bay
Beaufort Sea
152° W
150° W
148° W
146° W
144° W
142° W
71° N
70° N
69° N



Map 4-18
Arctic National Wildlife Refuge
Kaktovik Subsistence Areas for Bowhead Whales and Seals
Resource
Seal Hunting Area
Bowhead Whale Hunting Area
Other Features
Arctic Refuge Boundary
Wilderness Boundary
Roads
U.S.- Canada Border
Miles
0 10 20 30 40 50
0 10 20 30 40 50
Kilometers
Alaska Albers Equal Area Conic Projection, 1983 North American Datum.
Source: Minerals Management Service (MMS). 2008. Beaufourt Sea and Chukchi Sea Planning Areas: Oil and Gas Lease Sales 209, 212, 217 and 221 Draft Environmental Impact Statement, Volume 4. USDOI, MMS, Alaska OCS Region, Anchorage.
Spatial features courtesy of Exxon Mobil Corporation.
Prudhoe Bay
Kaktovik
Beaufort Sea
Russia
Arctic Ocean
Fairbanks
Alaska
Canada
Anchorage
Bering Sea
Gulf of Alaska
152° W
150° W
148° W
146° W
144° W
142° W
71° N
70° N
69° N


Map 4-19
Arctic National Wildlife Refuge
Kaktovik Subsistence Areas for Fish
Resource
Fishing Sites
Contemporary Fishing Area
Other Features
Arctic Refuge Boundary
Wilderness Boundary
Roads
U.S.- Canada Border
Miles
0 10 20 30 40 50
0 10 20 30 40 50
Kilometers
Alaska Albers Equal Area Conic Projection, 1983 North American Datum.
Source: Pedersen, Sverre and Alfred Linn, Jr. 2005. Kaktovik 2000-2002 Subsistence Fishery Harvest Assessment. U.S. Fish and Wildlife Service Office of Subsistence Management Fisheries Management Program, Final Report for FIS Study 01-101.
Spatial features courtesy of Exxon Mobil Corporation.
Russia
Arctic Ocean
Fairbanks
Alaska
Canada
Anchorage
Bering Sea
Gulf of Alaska
Prudhoe Bay
Kaktovik
Camden Bay
Beaufort Sea
152° W
150° W
148° W
146° W
144° W
142° W
71° N
70° N
69° N

reported a harvest of 1,860 fish in 2005. Andersen and Jennings (2001) reported that Venetie respondents harvested 2,078 migratory birds in 2000.

Venetie Subsistence Use Areas

Subsistence use areas for Venetie are shown on Map 4-20, Map 4-21, and Map 4-22. These maps represent selected Venetie “lifetime” subsistence use areas identified by (Caulfield 1983). These data are based on 1980 interviews documenting nine respondents’ lifetime subsistence use areas. This data may not represent the full range and extent of Venetie residents’ contemporary use areas for resource harvesting. Harvest and use areas may have changed over time due to factors such as fluctuating populations of fish and wildlife resources, changing migration patterns, availability of resources, shifting climate and changes in habitat, and the impact of high fuel prices.

Map 4-20 depicts lifetime subsistence use areas for brown and black bear hunting, caribou hunting, and moose hunting. Map 4-21 depicts lifetime subsistence use areas for furbearer hunting and trapping, small mammal hunting, and wildfowl hunting. Map 4-22 depicts lifetime subsistence use areas for fishing, use of plants and berries, and the harvest of wood fuel and/or structural materials.

Wiseman

Wiseman is located on the middle fork of the Koyukuk River at the junction of Wiseman Creek in the Brooks Range approximately 56 miles from the Refuge boundary. Wiseman is located a short distance from the Dalton Highway about 260 miles northwest of Fairbanks. Wiseman residents who have lived in the area since the early 1970s indicate that their total area of renewable resource use has not changed over time; however, the intensity of subsistence use in specific regions of the area has changed considerably. This occurred primarily in response to changing modes of access and restrictions on their use, construction of the pipeline and haul road, and changing land management policies and hunting regulations. Construction of the Dalton Highway and oil pipeline, along with the establishment of the Gates of the Arctic National Park, greatly altered Wiseman’s spatial use patterns, shifting use away from what is now the pipeline corridor and away from Gates of the Arctic National Park areas to the west (Scott 1993).

Changing land management policies and regulations, such as hunting closures and restrictions in the Dalton Road corridor, along with the increased sport hunting (particularly guided hunting) to the east of the corridor after the State’s individually managed (exclusive) guide areas were abolished (Owsichek v. State, Guide Licensing, 1988,763 P.2d 488) resulted in substantially increased competition for resources between local and general hunters. With increasing numbers of sport hunters in the corridor and to the east, many of Wiseman subsistence hunters shifted their use areas more intensively back to the west (Scott 1993).

Wiseman subsistence use areas south of the Brooks Range, where aircraft access is allowed, extended eastwardly up to the edge of Arctic Refuge (J. Reakoff, Chair of the Western Interior Federal Subsistence Regional Advisory Council, pers. comm.). On the north side of the Brooks Range, Wiseman residents have a long history of utilizing the Atigun Gorge and Galbraith Lake area, and the Sagavanirktok, Ribdon, and Ivishak River drainages to hunt and fish. Caribou would be hunted in the summer and fall, as would sheep in late winter (J. Reakoff, Chair of the Western Interior Federal Subsistence Regional Advisory Council, pers.

comm.). Wiseman residents are known to travel down the Atigun Gorge, traveling outside of the Dalton Road corridor to hunt. Federal Subsistence Regulations list Wiseman as having customary and traditional use of Dall's sheep and caribou in Game Management Unit 26B (Map 4-24), which includes Refuge lands north of the Brooks Range.

In addition to changing land management policies and regulations affecting local use area and increased competition for resource by non-local users, Wiseman's subsistence harvest and use areas may have changed over time due to factors such as fluctuating populations of fish and wildlife resources, changing migration patterns, availability of resources, shifting climate and changes in habitat, and the impact of high fuel prices.

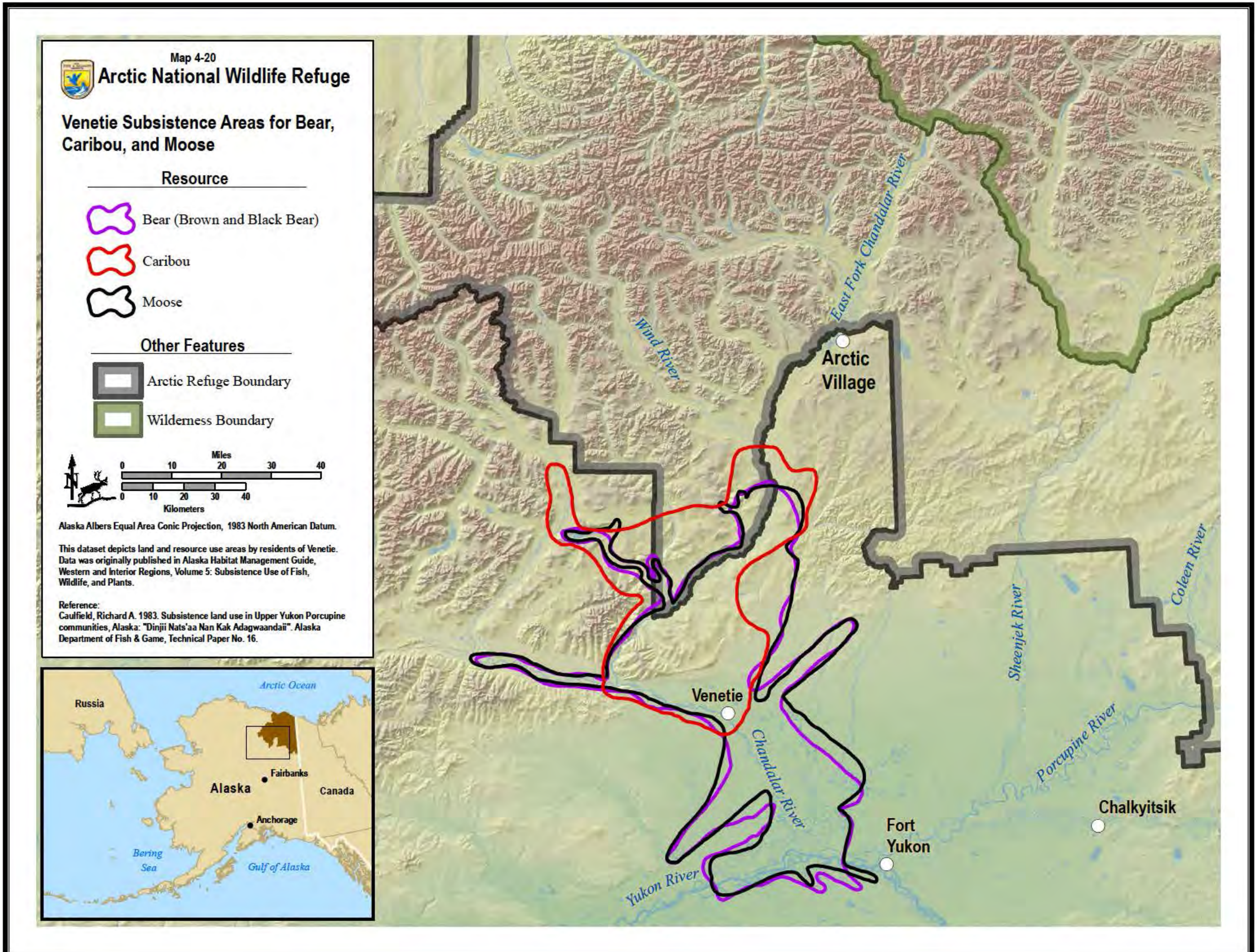
Map 4-23 depicts the land use areas by Wiseman residents from Scott's 1993 study regarding land and renewable resource use over time. The Primary Use Area illustrates the land area Wiseman residents consider to be of critical importance in conducting their resource harvest activities. The Extent of Use Area on the map illustrates the land area that residents consider extremely important in conducting their resource harvest activities.

4.4.4.3 Trapping

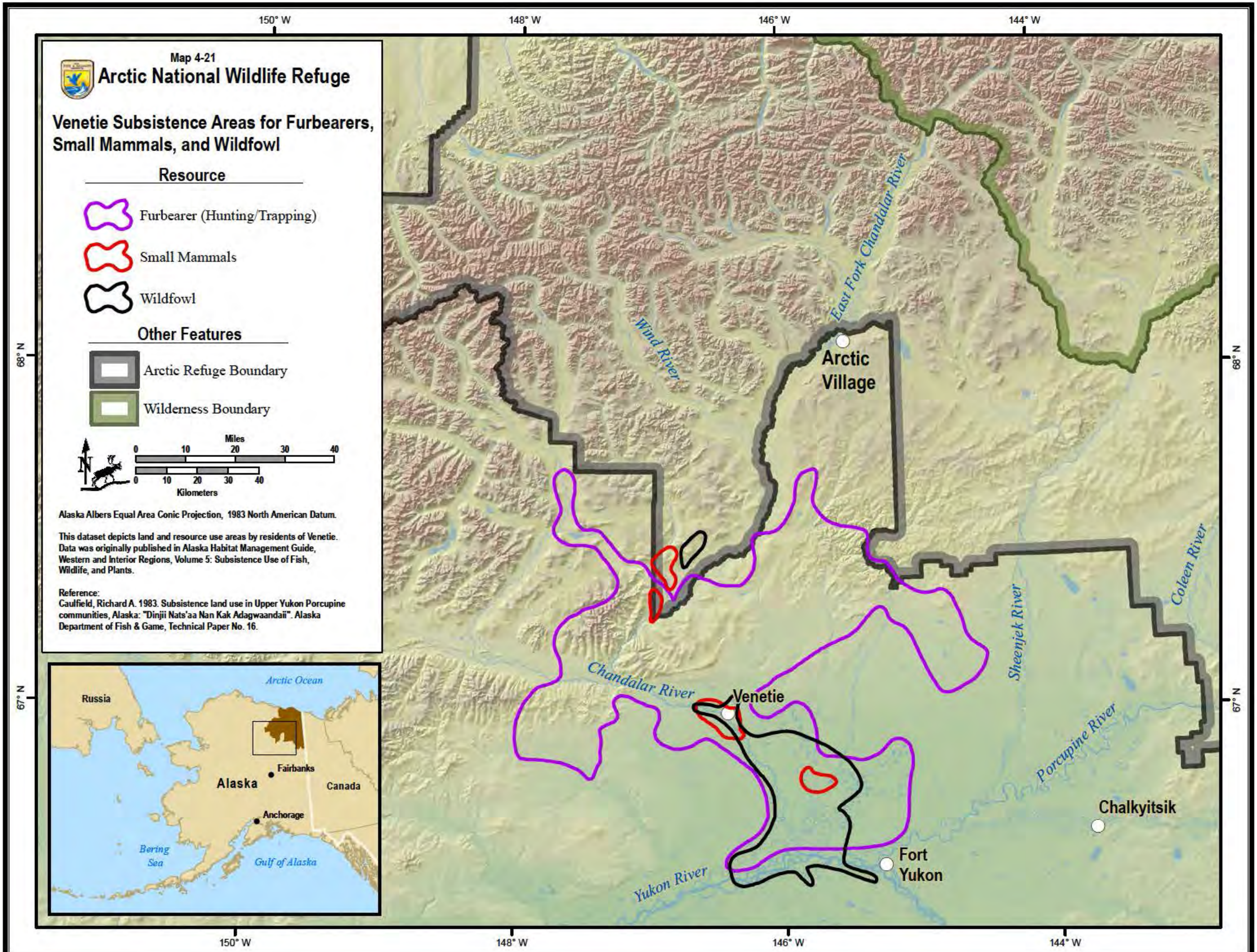
Early subsistence trapping harvest information is poorly documented, but the use of fur has long been an important resource for making clothing items, such as hats, gloves, parkas, moccasins, or mukluks, or using as material for bedding and rugs. Historically, the sale of fur for cash income by residents of communities near the Refuge has been an important component of the local economy. While incomes from trapping have been low in recent years, trapping still represents one of the few cash-earning options for residents during the winter months and remains an integral part of the mixed subsistence-cash economy of the study area communities (Andersen 1993). Some residents also use fur to make Alaska Native handicrafts for personal use and for sale. Meat from furbearers such as beaver, muskrat, and lynx is prized for its nutritional value (Caulfield 1983).

Trapping does not involve a large number of people, but it does require use of large geographic areas to locate and harvest various furbearer species. Trapping remains a highly labor-intensive activity, demanding long hours and hard work for relatively small and often uncertain returns. Most village subsistence economies are characterized by few full-time jobs and limited opportunities to earn cash. Over the years, local residents have returned to trapping after short periods of wage labor provided by seasonal road construction, firefighting, commercial fishing, oil industry jobs, military service, and other limited wage earning opportunities.

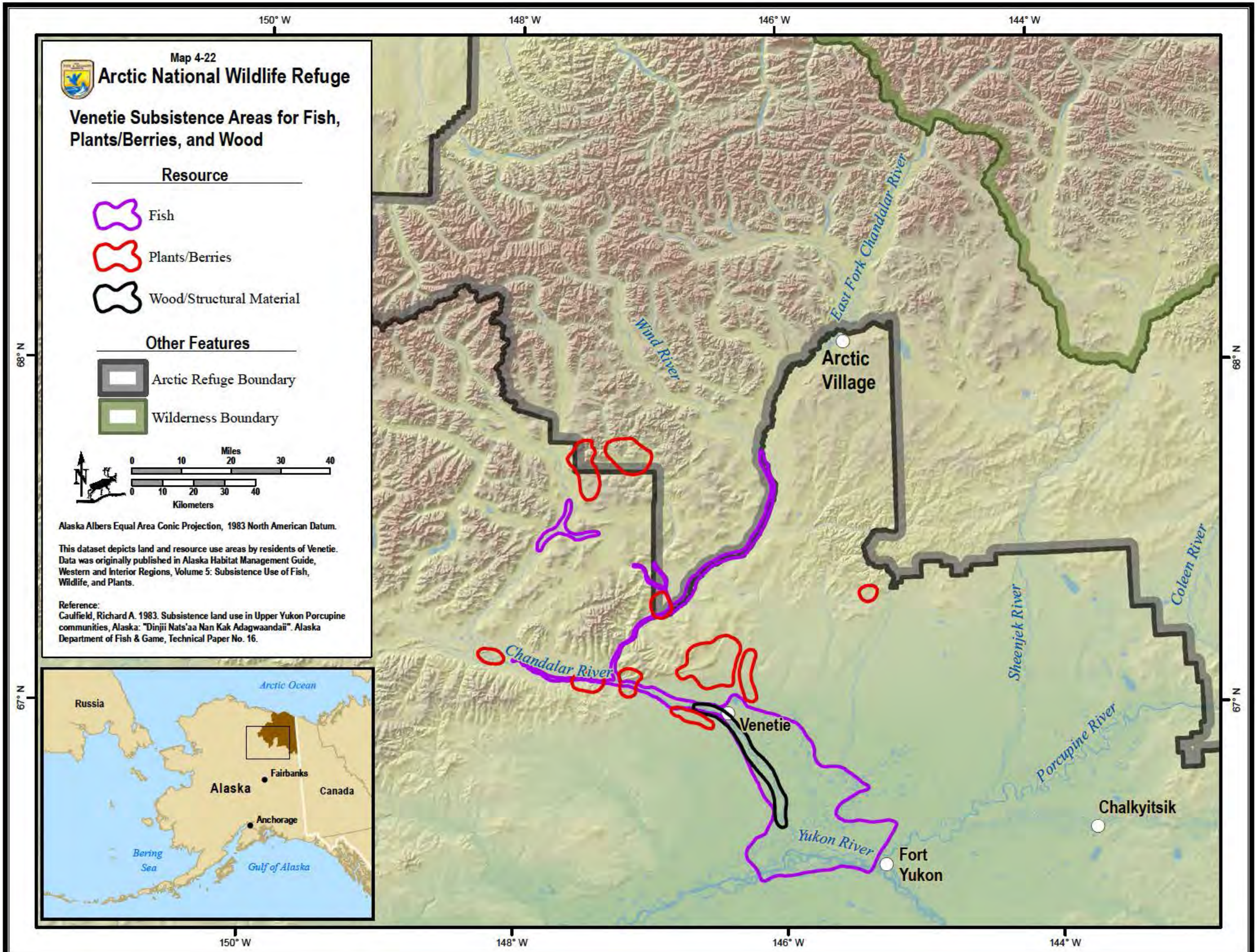
On the South Slope, trapping continues to be an important activity for residents of the upper Yukon region. Several mammal species are trapped for fur, including marten, lynx, red fox, beaver, muskrat, wolf, wolverine, mink, and river otter. Residents of Arctic Village, Venetie, Chalkyitsik, and Fort Yukon trap these species on the Refuge during winter. Established traplines may be trapped for several years then left fallow for other years depending on abundance and distribution of furbearers. Historically, beaver have been an important furbearing animal in the Yukon region. Muskrats also have been important, exceeding the value of beaver in some years. The key to profits has often been the abundance of beaver and muskrat (the amount of species harvested), not necessarily the per unit price of the pelts. Based on current fur prices and resource abundance, marten is probably the most important

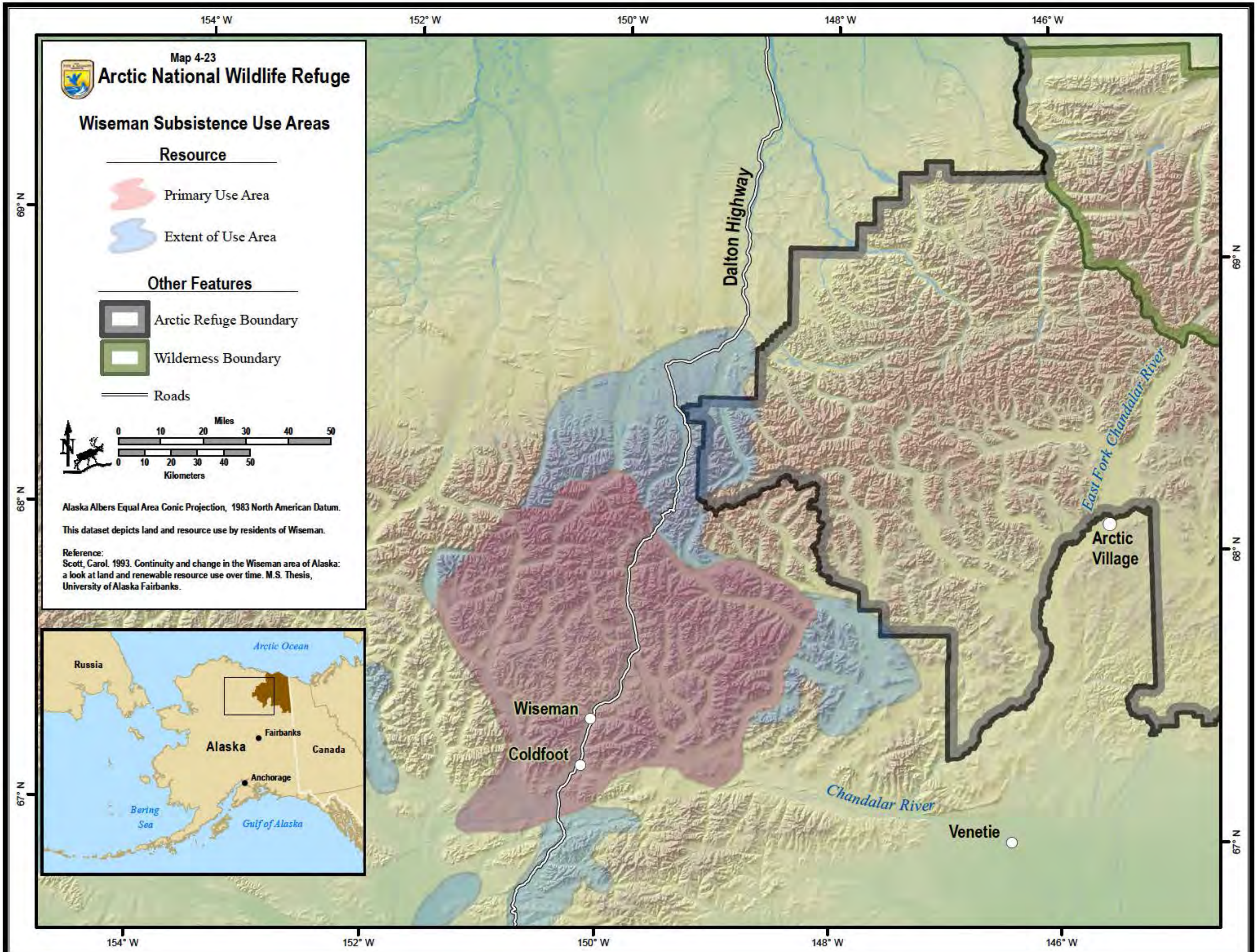


Map 4-20
Arctic National Wildlife Refuge
Venetie Subsistence Areas for Bear, Caribou, and Moose
Resource
Bear (Brown and Black Bear)
Caribou
Moose
Other Features
Arctic Refuge Boundary
Wilderness Boundary
Miles
0 10 20 30 40
0 10 20 30 40
Kilometers
Alaska Albers Equal Area Conic Projection, 1983 North American Datum.
This dataset depicts land and resource use areas by residents of Venetie. Data was originally published in Alaska Habitat Management Guide, Western and Interior Regions, Volume 5: Subsistence Use of Fish, Wildlife, and Plants.
Reference:
Caulfield, Richard A. 1983. Subsistence land use in Upper Yukon Porcupine communities, Alaska: "Dinjii Nats'aa Nan Kak Adagwaandaii". Alaska Department of Fish & Game, Technical Paper No. 16.
Arctic Ocean
Russia
Alaska
Fairbanks
Canada
Anchorage
Bering Sea
Gulf of Alaska
East Fork Chandalar River
Wind River
Arctic Village
Venetie
Chandalar River
Fort Yukon
Yukon River
Sheenjek River
Coleen River
Porcupine River
Chalkyitsik



Map 4-21
Arctic National Wildlife Refuge
Venetie Subsistence Areas for Furbearers, Small Mammals, and Wildfowl
Resource
Furbearer (Hunting/Trapping)
Small Mammals
Wildfowl
Other Features
Arctic Refuge Boundary
Wilderness Boundary
Miles
0 10 20 30 40
0 10 20 30 40
Kilometers
Alaska Albers Equal Area Conic Projection, 1983 North American Datum.
This dataset depicts land and resource use areas by residents of Venetie. Data was originally published in Alaska Habitat Management Guide, Western and Interior Regions, Volume 5: Subsistence Use of Fish, Wildlife, and Plants.
Reference:
Caulfield, Richard A. 1983. Subsistence land use in Upper Yukon Porcupine communities, Alaska: "Dinjii Nats'aa Nan Kak Adagwaandaii". Alaska Department of Fish & Game, Technical Paper No. 16.
150° W
148° W
146° W
144° W
68° N
67° N
East Fork Chandalar River
Wind River
Arctic Village
Chandalar River
Venetie
Sheenjek River
Coleen River
Porcupine River
Chalkyitsik
Fort Yukon
Yukon River
Arctic Ocean
Russia
Alaska
Fairbanks
Anchorage
Canada
Bering Sea
Gulf of Alaska


Map 4-22
Arctic National Wildlife Refuge
Venetie Subsistence Areas for Fish, Plants/Berries, and Wood
Resource
Fish
Plants/Berries
Wood/Structural Material
Other Features
Arctic Refuge Boundary
Wilderness Boundary
Miles
0 10 20 30 40
0 10 20 30 40
Kilometers
Alaska Albers Equal Area Conic Projection, 1983 North American Datum.
This dataset depicts land and resource use areas by residents of Venetie. Data was originally published in Alaska Habitat Management Guide, Western and Interior Regions, Volume 5: Subsistence Use of Fish, Wildlife, and Plants.
Reference:
Caulfield, Richard A. 1983. Subsistence land use in Upper Yukon Porcupine communities, Alaska: "Dinjii Nats'aa Nan Kak Adagwaandaii". Alaska Department of Fish & Game, Technical Paper No. 16.
Russia
Arctic Ocean
Alaska
Fairbanks
Anchorage
Canada
Bering Sea
Gulf of Alaska
150° W
148° W
146° W
144° W
68° N
67° N
East Fork Chandalar River
Wind River
Arctic Village
Chandalar River
Venetie
Sheenjek River
Coleen River
Porcupine River
Yukon River
Fort Yukon
Chalkyitsik



Map 4-23
Arctic National Wildlife Refuge
Wiseman Subsistence Use Areas
Resource
Primary Use Area
Extent of Use Area
Other Features
Arctic Refuge Boundary
Wilderness Boundary
Roads
Miles
0 10 20 30 40 50
0 10 20 30 40 50
Kilometers
Alaska Albers Equal Area Conic Projection, 1983 North American Datum.
This dataset depicts land and resource use by residents of Wiseman.
Reference:
Scott, Carol. 1993. Continuity and change in the Wiseman area of Alaska: a look at land and renewable resource use over time. M.S. Thesis, University of Alaska Fairbanks.
Arctic Ocean
Russia
Alaska
Fairbanks
Canada
Anchorage
Bering Sea
Gulf of Alaska
Dalton Highway
Wiseman
Coldfoot
Arctic Village
Venetie
East Fork Chandalar River
Chandalar River
154° W
152° W
150° W
148° W
146° W
69° N
68° N
67° N

fur animal sought by trappers south of the Brooks Range. Fur trapping provides the only notable export item for the South Slope communities, although revenues can vary greatly from year to year depending on harvest levels and fur prices (Andersen 1993).

On the North Slope, residents of Kaktovik trap red fox in inland areas and arctic foxes in coastal areas. Wolf and wolverine are also valued for their fur, but on the North Slope are usually taken by hunting rather than trapping. Because of decreased demand and dropping fur prices, as well as the considerable time investment in setting and checking a trapline, trapping activity has decreased with time for Kaktovik residents. ADFG's estimated harvest for wolf and wolverine from Refuge lands in the mid-1980s is still a good indicator of harvest effort and take. On the North Slope, 11 wolves were harvested in 1983–1984, 5 wolves in 1984–1985, and 1 wolf in 1985–1986.

Wolverines are also highly valued for their fur, especially for making parka ruffs. Kaktovik residents harvest wolverines most often in the foothills and northern mountainous areas of the Sadlerochit, Hulahula, and Okpilak rivers. ADFG records indicate that an average of about one wolverine per year is harvested; this may be an underestimate because of incomplete reporting (Clough et al. 1987). During the winter of 1980–1981, seven wolverines were taken by Kaktovik residents (Jacobson and Wentworth 1982).

4.4.5 Visitor Use and Recreation

4.4.5.1 Overview

We define visitor use as any use of the Refuge by recreational visitors or general hunting and fishing visitors, not including federally qualified subsistence users or other local residents (Appendix M). Subsistence use and harvest on Refuge lands are not discussed in this section; we only discuss general hunting and trapping harvest data available from records compiled by the State of Alaska.

People from around the State, the nation, and the world visit Arctic Refuge. Visitors to Arctic Refuge may experience wilderness qualities and opportunities that are unique relative to most protected areas in North America. While visiting, people may travel and explore Refuge lands for days or weeks without seeing another person. Arctic Refuge is a place where people may experience and appreciate remarkable scenery, diverse wildlife resources, and remoteness (Christensen and Christensen 2009).

Visitors to Arctic Refuge participate in a variety of activities, such as river floating, hiking, backpacking, camping, long-distance expeditions, mountaineering, dog sledding, berry picking, wildlife observation, and photography. Hunting is also a popular activity at the Refuge. Most recreational hunters (referred to as general hunters) visit the Refuge to hunt Dall's sheep, caribou, moose, and/or brown bears.

Recreational fishing (referred to as general fishing) may be a secondary activity for some visitors, but managers do not consider general fishing to be a primary reason for visiting Arctic Refuge. General fishing is not discussed in this section because it is not a prominent recreational activity, and managers do not have data on general fishing.

4.4.5.2 Early Records of Visitor Use

There was little recreational use in 1960 when the original Arctic National Wildlife Range (Range) was established. A small number of hikers, backpackers, and general hunters occasionally visited the Range in the early 1960s. According to Arctic Refuge Draft River Management Plan and Environmental Assessment (1993), few people were canoeing in the Range in the 1960s. Commercial hunting guides most likely began working in the Range as early as the late 1960s, but observations and data on visitor use from that time is substantially limited because the Range was not staffed until fall 1969. Complete and accurate data recording early use are not available, and we report best estimates of visitor numbers for the Range.

By the early 1970s, Arctic Alaska and the Brooks Range were receiving considerable national and international attention due to proposals to create public lands and discovery of oil at Prudhoe Bay in 1968. Use of the Range by visitors was less than 1,000 use days per year (a use day is defined as one person spending one 24 hour period in Arctic Refuge) but was most likely increasing at relatively slow rates (Arctic Refuge 1993). A bush pilot named Walt Audi began flying from Kaktovik in 1968, offering commercial fight services in 1972. People were known to hike between Barter Island and Arctic Village or explore parts of the Refuge for extended periods of recreation (Arctic Refuge 1976). Other early visitors were mountain climbing, fishing, trapping, photographing, canoeing, boating, camping, and berry picking. Hunting for Dall's sheep was especially popular. Hunting guide Joe Want began taking horses from Circle to the upper Sheenjek River in the early 1970s, and Marlin Grasser was operating on the Hulahula River during this time.

A visitor use study estimated that 281 persons visited the original Range in 1975. More than half of these visitors were general hunters. The study reported the greatest number of use days for backpackers, many of whom reportedly hiked and camped in the upper Hulahula and Okpilak river valleys. Another study estimated that 248 general hunters and 186 recreational visitors visited in 1977. General hunters accounted for 51 percent of the use days (Arctic Refuge 1993). In addition to this early visitation data, a descriptive study of activities, attitudes, and management preferences of recreationists was conducted on the Arctic National Wildlife Range and published in 1980 (Warren 1980).

Eight to ten general hunting guides were thought to be operating commercially in the area in 1974 (Arctic Refuge 1993). One recreation guide was issued a commercial permit in 1975, increasing to five permits in 1977 (Arctic Refuge 1977). A similar level of commercial activity related to general hunting continued annually through 1979 (Arctic Refuge 1979, Arctic Refuge 1980).

A new era of visitor use activity began with the expansion of the Range to the Arctic National Wildlife Refuge in 1980. Guided and private recreation continued to increase, especially near the end of the 1980s. Several factors contributed to this increase, including changes brought about by the Alaska National Interest Lands Conservation Act of 1980 and the State of Alaska's efforts to promote tourism. Talk of possible oil and gas development at Arctic Refuge most likely heightened public awareness of the Refuge (Arctic Refuge 1987).

In the early 1980s, backpacking and camping were the most popular summer activities, followed by river floating. General hunting for big game was the most popular fall recreational activity on the Refuge in the 1980s. River floating became the most popular activity at the Refuge by the end of the decade (Arctic Refuge 1990). Wildlife observation and photography also were integral parts of most recreational visits. Fishing occasionally occurred as a secondary or incidental activity on recreational trips (Arctic Refuge 1993).

In the early 1980s, the Dalton Highway was not yet open to the public, but some data on travel by vehicles servicing facilities were collected. In 1983, an average of 103 vehicles per day was estimated to pass the Yukon River Bridge. In 1984, averages of 150 vehicles per day were estimated to pass the bridge (State Department of Transportation Planning, pers. comm.).

The Refuge first required permits for commercial air operators in 1987. These operators were required to record details about their clients' trips, which provided the best and most trusted source of data on numbers of visitors to the Refuge. During 1980 and 1981, the Refuge estimated 3,450 use days by recreational visitors and general hunters, who were guided and transported by commercial air operators (non-guided). This only represents a portion of the total use for those years because the number of unreported charters and private aircraft that flew into the Refuge is unknown.

Data provided by Audi Air, Inc., a primary air operator service at that time based on the North Slope of the Refuge, show some evidence of an increase in visitor use beginning around 1983. Audi Air flew 109 people in 1983, 147 in 1984, and 165 in 1985 (Arctic Refuge 1984, Arctic Refuge 1985, Arctic Refuge 1986). Data from 1986 continues this trend, and shows Audi Air provided the majority of the charter air service north of the Brooks Range in the Refuge and reported flying in 568 hunters, backpackers, floaters, fishermen, and other charters during that year. This dramatic increase might be attributed to improvements in record-keeping by Audi Air, but it also includes charters originating from Prudhoe Bay (which may or may not have landed in the Refuge), in addition to those originating from Barter Island, in the Refuge. Since there were also an undetermined additional number of visitors who were flown in by other charter services and by privately-owned aircraft, the approximate estimate provided by Audi Air in 1986 serves as a reasonable indicator of increasing, but not necessarily dramatically increasing use during this time (Arctic Refuge 1987).

Substantial increases in visitor use at the Refuge occurred in 1988 and 1989, especially in two main river valleys. In the three-year period between 1987–1989, commercial river use was reported to have increased by 395 percent on the Kongakut River and 518 percent on the Hulahula River (Arctic Refuge 1988, Arctic Refuge 1989, Arctic Refuge 1990). The number of permits issued by the Refuge to commercial service providers had increased from seven in 1980 to 20 in 1989. The 20 guides provided 56 float or river-based backpacking trips to groups that ranged from 3 to 28 people. The increase in visitor use recorded in the 1980s prompted interest and support for the development of the Arctic Refuge Draft River Management Plan and Environmental Assessment which was drafted but never formally adopted or implemented (Arctic Refuge 1993).

In 1992, after soliciting public comments on a draft policy, the Service established a Regional Policy and formal process in which big-game guides were competitively selected to operate on Refuge lands. An environmental assessment was completed with the original guide allocation and a compatibility determination done which found guided hunting to be compatible with Refuge purposes. This competitive permit system was later codified in 50 CFR 36.41. The draft regulations were published in the "Federal Register" on November 1, 1996 for a 60-day public review period. Public meetings were held in Anchorage and Fairbanks, Alaska, during the period of public review of the draft regulations. The competitive application process used to select big-game hunting guides on Arctic Refuge continues to this day, and is what defines the available number of guided hunting opportunities, which is not increasing.

Managers at Arctic Refuge have limited unguided hunting and recreational visitor information for the period between 1992 and 1997. Collection methods for the data that exist are unconfirmed.

4.4.5.3 Contemporary Records of Visitor Use

Arctic Refuge is vast, geographically remote, and primarily managed to provide visitors with a wilderness experience (Service 1988a). There are no maintained facilities on the Refuge, and visitors may come and go from the Refuge without campsite assignments or registration requirements. The Refuge has no formal registration system to comprehensively track visitor use and recreation trends, and managers currently use no formal methods to document visitors who access the Refuge on their own without the commercial services of a guide or commercial air operator. An unknown number of visitors enter the Refuge each year by private planes and boats or by hiking.

The Refuge staff requires permits for all commercial uses. The number of hunt guide permits issued is limited, and hunt guide permits are issued for multiple years under a competitive program, whereas other service providers apply annually for an unlimited number of permits. Big-game guide permits are valid for five years, and guides can opt for a one-time, five-year permit extension based on good performance, after which guides must again compete for the opportunity to obtain new permits. Because guided hunting permits are competitively awarded, hunting guides are the most regulated, restricted, and monitored user group on Arctic Refuge. On Arctic Refuge, permitted hunting guides have exclusive commercial use of a guide use area but they do not have exclusive hunting use. In other words, all guide use areas are open to unguided hunting by the general public.

The State of Alaska hunting regulations require, under most circumstances, non-residents to hunt with a guide if they're pursuing brown bear, Dall's sheep or mountain goat. By allowing commercial hunting guides on national wildlife refuges in Alaska, the Service is providing hunting opportunities to all visitors, not just Alaska residents.

Since 1980, the Refuge has issued an increasing number of annual permits to commercial recreation operators and commercial air operators (includes air-taxis and air transporters) for the purpose of bringing visitors to the Refuge (Figure 4-12).

This increase in number of annual permits issued is particularly notable among visitors guided in Atigun Gorge, which is accessible from the Dalton Highway. The number of service providers operating in the Atigun Gorge has increased from one to five businesses since 2001 (Arctic Refuge Commercial Permit Database, Service, unpublished data). Preliminary data also suggests a recent notable increase in the number of unguided general hunters served by permitted, State-licensed, air transporters (Appendix M) (Arctic Refuge Commercial Permit Database, Service, unpublished data).

Guides and air operators are required to submit client use reports as a condition of their permits. Beginning in 2001, managers clarified and enforced the instructions given to commercial operators for reporting numbers of clients and other data to ensure consistency. Managers have created a database of numbers of visitors and other information provided in the client use reports. Managers use this database as a consistent source of data for estimating how many people use commercial services to access the Refuge each year. Client use reports also provide insights about group size and distribution of visitors.

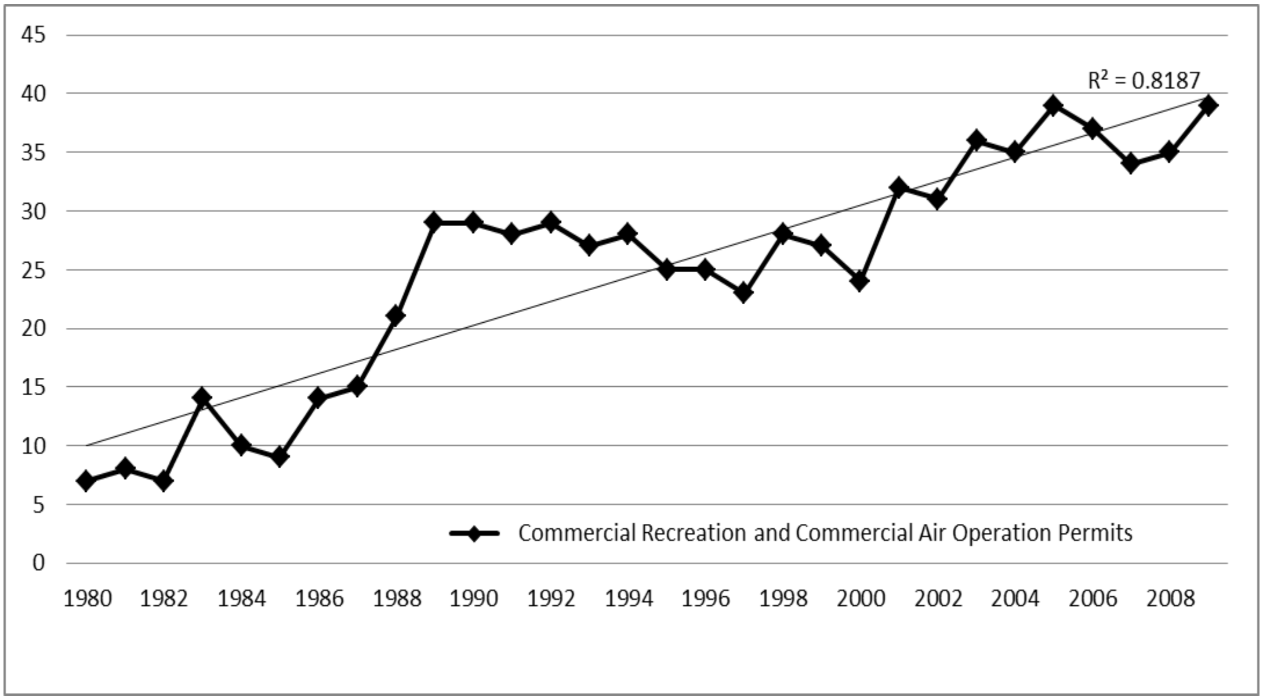


Figure 4-12. Numbers of commercial permits issues by Arctic Refuge, 1980–2009 (excludes hunt guide permits).

The numbers of visitors who were flown in or guided by a commercial operator during 2001–2009 ranged from a low of 852 visitors in 2009 to a high of 1,128 visitors in 2005 (Figure 4-13). In most years from 2001 to 2009, about one-half of commercially-supported visitors were accompanied by a permitted guide. Numbers of guided visitors decreased after 2005, while numbers of non-guided visitors remained relatively stable (Figure 4-14). A reduced group size or number of trips taken by each guide business may account for this decrease coincident with an overall increase in permitted operators.

Managers at Arctic Refuge suspect a substantial amount of visitors originate from lands outside or adjacent to the Refuge boundary, such as the Dalton Highway and airports served by commercial airlines near the Refuge boundary. On an annual basis, managers collect voluntary reports of independent visitor use from people who drive the Dalton Highway and visit the Arctic Interagency Visitor Center in Coldfoot. The Refuge collects similar information about residents of the University of Alaska-Fairbanks Institute of Arctic Biology Toolik Field Station north of Galbraith Lake from Station managers. Arctic Refuge occasionally participates in recreation research surveys to learn about visitor use.

In 2009, the Refuge estimated that the total number of documented visitors was approximately 1,000 people (Figure 4-13). About 12 percent of these visitors voluntarily reported traveling to the Refuge from the Dalton Highway. Of this smaller group, eight percent were people working at Toolik Field Station and four percent were visitors who voluntarily reported their travels in or near the Refuge at the visitor center in Coldfoot. The number of visitors who do not use commercial services to access the Refuge is most likely higher than what is reflected by the voluntary reports collected at these locations.

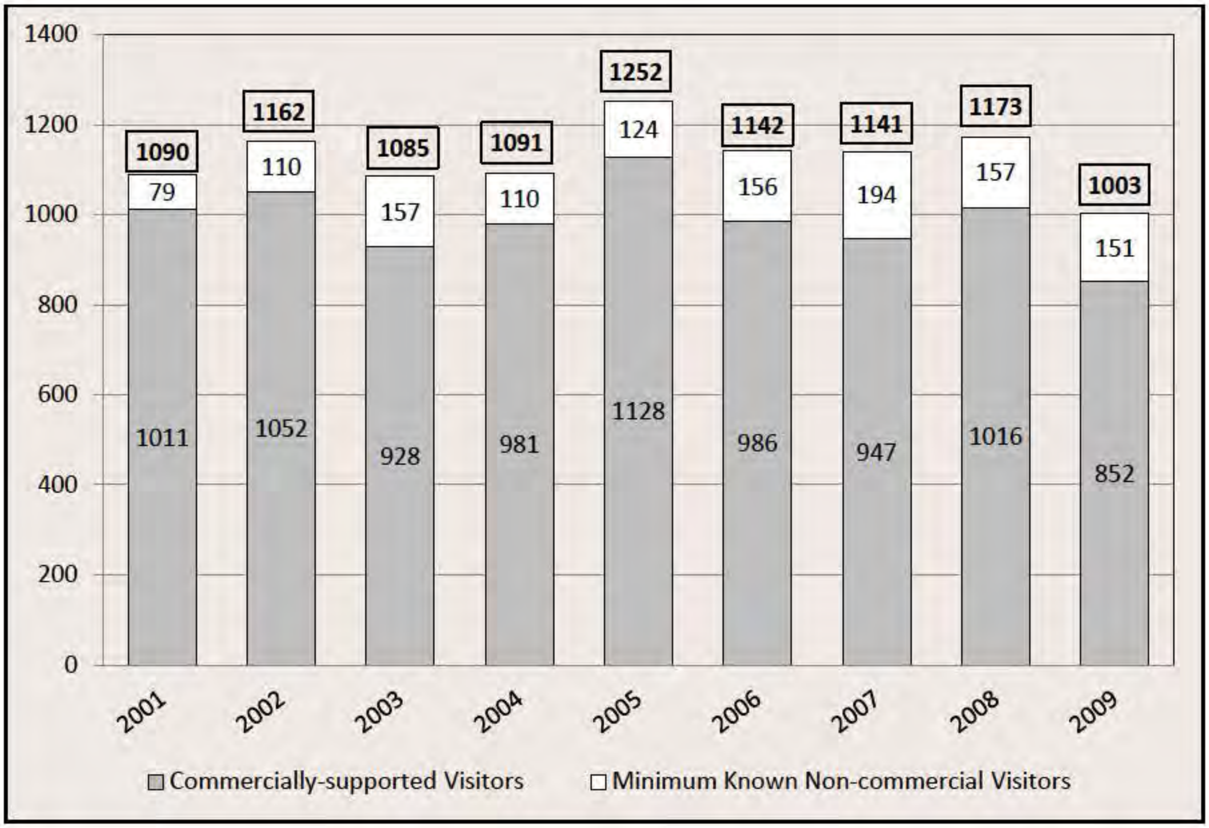


Figure 4-13. Total number of documented visitors. Visitors at Arctic Refuge based on client use reports and voluntary reports from Toolik Lake and Coldfoot Visitor Center, 2001–2009.

People who visit the Refuge on their own without using the services of a commercial operator may concentrate in the Atigun Gorge area (Reed and St. Martin 2009). Since the Dalton Highway was opened to the public in 1994, the number of people driving it and visiting the surrounding area has increased. The highway provides an access corridor to Arctic Refuge for hikers, hunters, mushers, and skiers (Christensen and Christensen 2009). The scenic Atigun Gorge and adjacent drainages are easily accessible from this road, while most other Refuge lands are more difficult to reach because of the absence of roads.

Alaska residents travelling the Dalton Highway reported accessing lands between Atigun Pass and Toolik and in the Galbraith Lake area (Stegmann et al. 2008). The Alaska Residents Statistics Program reported 11 percent of residents of interior Alaska who responded to this survey had visited areas accessible from the Dalton Highway, including Arctic Refuge (Fix 2009).

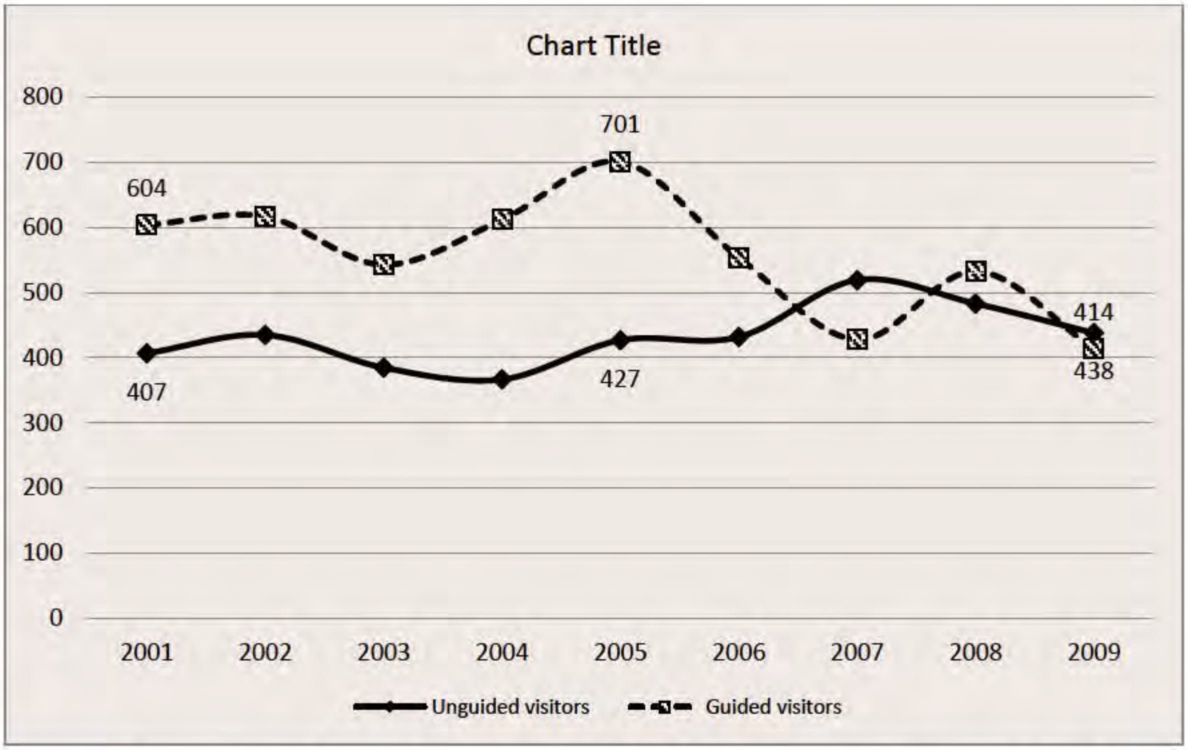


Figure 4-14. Comparison of guided and non-guided commercially-supported visitors to Arctic Refuge, 2001–2009.

4.4.5.4 Recreational Activities

Recreational activities by commercially-supported visitors occur in five primary categories: general hunting, hiking and/or backpacking, river floating, base-camping, and other recreation (Appendix M). General hunters usually hike, camp, and float rivers while hunting. Recreational visitors, including some hunters, may also engage in wildlife observation, including polar bear viewing, bird watching, photography, mountaineering, dog sledding, sea kayaking, and fishing. A more detailed summary of commercially-supported recreational visitor activity by year can be viewed on the Arctic Refuge website (Arctic Refuge 2011).

Floating rivers is the most frequently reported activity for commercially-supported visitors to Arctic Refuge, but hunting and hiking and/or backpacking are also popular (Figure 4-15). These data include the number of clients and guides for river floating and hiking but do not include the number of guides for hunting. Recent research that surveyed over 300 Refuge visitors corroborates these popular activities: 49 percent of respondents were river floating, 40 percent were backpacking and/or hiking, and 21 percent were hunting (Christensen and Christensen 2009).

Because the air space of Arctic Refuge is regulated by the Federal Aviation Administration—not the Refuge—commercial flightseeing trips are not currently subject to regulation, nor are they monitored or quantified unless the pilot lands on the Refuge. If commercial flightseeing trips were to land on the Refuge, they would require a special use permit, and the visit(s) would be reported in client use reports submitted by these commercial air operators.

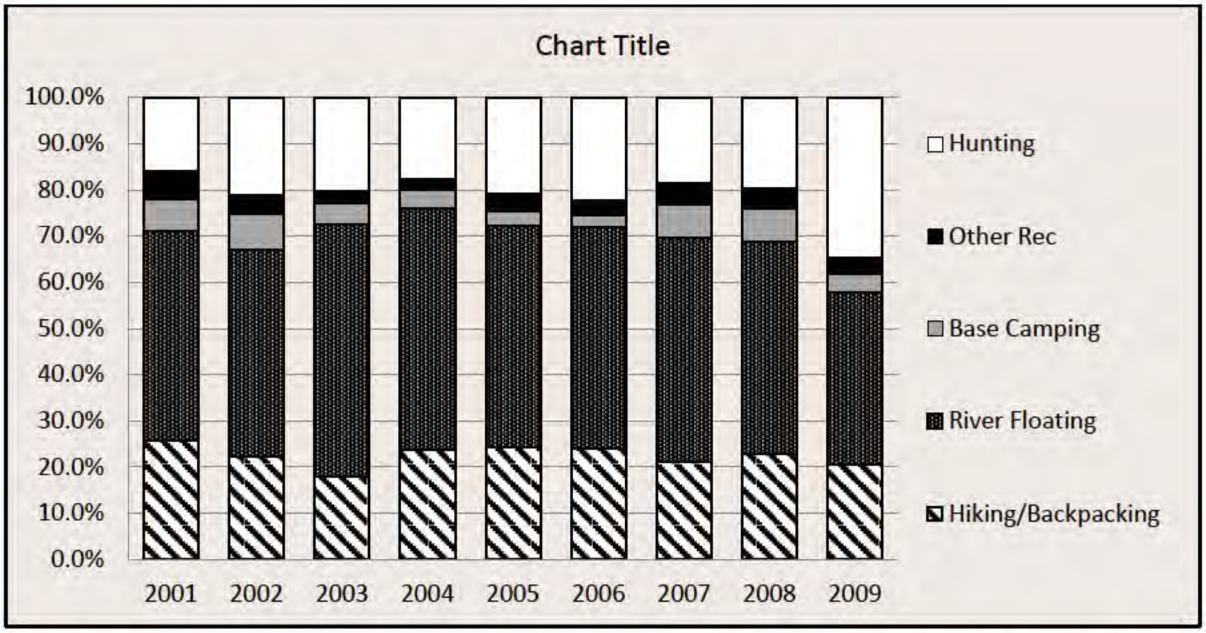


Figure 4-15. Comparison of guided and non-guided commercially-supported visitors to Arctic Refuge, 2001–2009.

4.4.5.5 Visitor Access, Distribution, and Group Size

Managers have documented that most people visit Arctic Refuge during the summer and fall seasons during June, July, August, and September. Managers suspect that most undocumented visitors also prefer this time of year, but some most likely visit the Refuge in spring and winter. The main recreational season is short due to weather and river conditions, with a total of six to eight weeks when water levels in most rivers are adequate for floating and the weather is ideal for backpacking. With long periods of summer daylight, rivers may be floated in three to five days, but most groups tend to spend considerable time relaxing and hiking, extending their trips to more than five days (Arctic Refuge 2011, Christensen and Christensen 2009).

The primary means of access for all visitors in and out of Arctic Refuge is by aircraft. Pilots can only land where ground topography or lake size are appropriate, limiting the number of useable access sites. Wheeled aircraft are predominantly used, particularly on the North Slope, though float planes are occasionally used in the Refuge. Motorboat use by visitors, which is generally not common, occurs almost exclusively on the south side for general hunting. Motorboats are occasionally used for polar bear viewing along the Arctic coast near Barter Island and on rivers accessible from the Dalton Highway. Inflatable rafts and other types of non-motorized craft are commonly used when and where water depth is adequate. Recreational floaters tend to use rafts, although packrafts, kayaks, and canoes are sometimes used.

Rivers in the northern parts of the Refuge often have open and treeless riparian areas, allowing recreational visitors to observe the presence of other groups of visitors over long distances. Hikers and floaters tend to make use of the same primary aircraft access sites, mostly along rivers. Hikers tend to wander away from riparian areas to traverse side valleys, ridge tops, and mountainsides, encountering floaters only intermittently while crossing rivers or camping in riparian areas. Concentration and overlap of visitors around primary access sites can occur, but there is little competition for camping areas, and few encounters occur between hikers and river floaters away from access and egress sites. The exact locations of hiking routes and distributions of hikers in river corridors are difficult to determine. Managers track where visitors enter the Refuge but have less data on their travel routes.

On average, 77 percent of commercially-supported visitor use occurs north of the Brooks Range, while about 23 percent occurs on the south side, and nearly 24 percent of commercially-supported visitors to the Refuge visit the Kongakut River drainage (Arctic Refuge 2011). Other popular North Slope rivers include the Hulahula River (10 percent), Marsh Fork-Canning River (nine percent), Jago River (six percent), and main stem of the Canning River (five percent). Similar to the data from client use reports, a recent visitor survey found that the most common entry places reported by respondents were the Kongakut (27 percent), Canning (Marsh Fork and main stem combined) (18 percent), and Hulahula (13 percent) drainages (Christensen and Christensen 2009). South of the Brooks Range, the Sheenjek River (10 percent) is most commonly visited. The Coleen River also has notable amounts of visitor use (four percent) (Arctic Refuge 2011).

Group size and length of stay may affect resource conditions and people's wilderness experience. In 2001, commercial groups were restricted to no more than 10 individuals on rivers and 7 when travelling on land. Managers continue to require these group sizes for commercial operators and recommend them to non-guided visitors, though reports of non-guided Dalton Highway-based hiking visitors exceeding group size recommendations are common (Arctic Refuge 2008a). In summer and fall of 2008, researchers found that average group size was six visitors, and groups spent an average of 11 days and camped at an average of six locations during their trips to Arctic Refuge (Christensen and Christensen 2009). Over 80 percent of respondents in this study said that they support limits on group size, preferring on average a maximum of nine people for float trips and base camping (Christensen and Christensen 2009). In 2009, client use reports showed that

visitors spent about nine days in the Refuge in groups that averaged five people. The calculation of this weighted average excludes guided hunters because hunting guides are not required to report group size (Arctic Refuge 2011).

Commercially-supported visitor use data shows that groups on the Kongakut River tend to be slightly larger than groups visiting other river drainages. The Sheenjek River is generally visited by much smaller groups than other rivers in the Refuge, and floaters on the Sheenjek River tend to stay one day longer than the overall average. For the four most popular rivers in Arctic Refuge, numbers of visitors are down in recent years, while visitor numbers for the Canning River, particularly the Marsh Fork, have slightly increased since 2001 (Arctic Refuge 2011).

4.4.5.6 Recreational Floating of the Kongakut River

Approximately 240 Refuge visitors travel to the Kongakut River within a six to eight week period each year. Most people visit the Kongakut River corridor during two peak times: two weeks in mid- to late June to witness the mass caribou migration on the lower portions of the river and two weeks in mid-August to hunt Dall's sheep in the mountainous headwaters (Figure 4-16).

In a recent visitor study, survey respondents reported that they encountered an average of two other groups during their trip on the Kongakut River; they also observed four airplanes and saw an average of one site with evidence of previous visitors (Christensen and Christensen 2009). Managers suspect that encounters between groups of floaters on the Kongakut River are higher than at other areas of the Refuge. During limited monitoring efforts from the air and on the ground, Refuge staff have observed large numbers of individuals (i.e., as many as five groups totaling at least 39 visitors at one time) at primary access points along the Kongakut River (Bartlett 2007). Visitor impact monitoring, which has documented 27 impacted sites and at least 10 impaired sites (Appendix M) along the river, is limited, occurring approximately every six years (Arctic Refuge 2010). Typically, only one or two officers will float the river one time during June to check permits of air operators and recreational guides; private users are contacted incidentally during these efforts. During the Dall's sheep hunting season, an officer occasionally flies over the Kongakut River and contacts floaters and/or hunters where it is safe to land.

A number of concerns about issues related to recreation on the Kongakut River have been identified by managers, permittees, visitors, and residents of the village of Kaktovik. Refuge managers consider the potential effects of current conditions on visitor experiences. With a primary responsibility to preserve Wilderness character, clear objectives—and an understanding of how those objectives will be attained to achieve desired conditions (Appendix M)—is needed for the Kongakut River and other places on the Refuge (Cole 2004, Landres 2004).

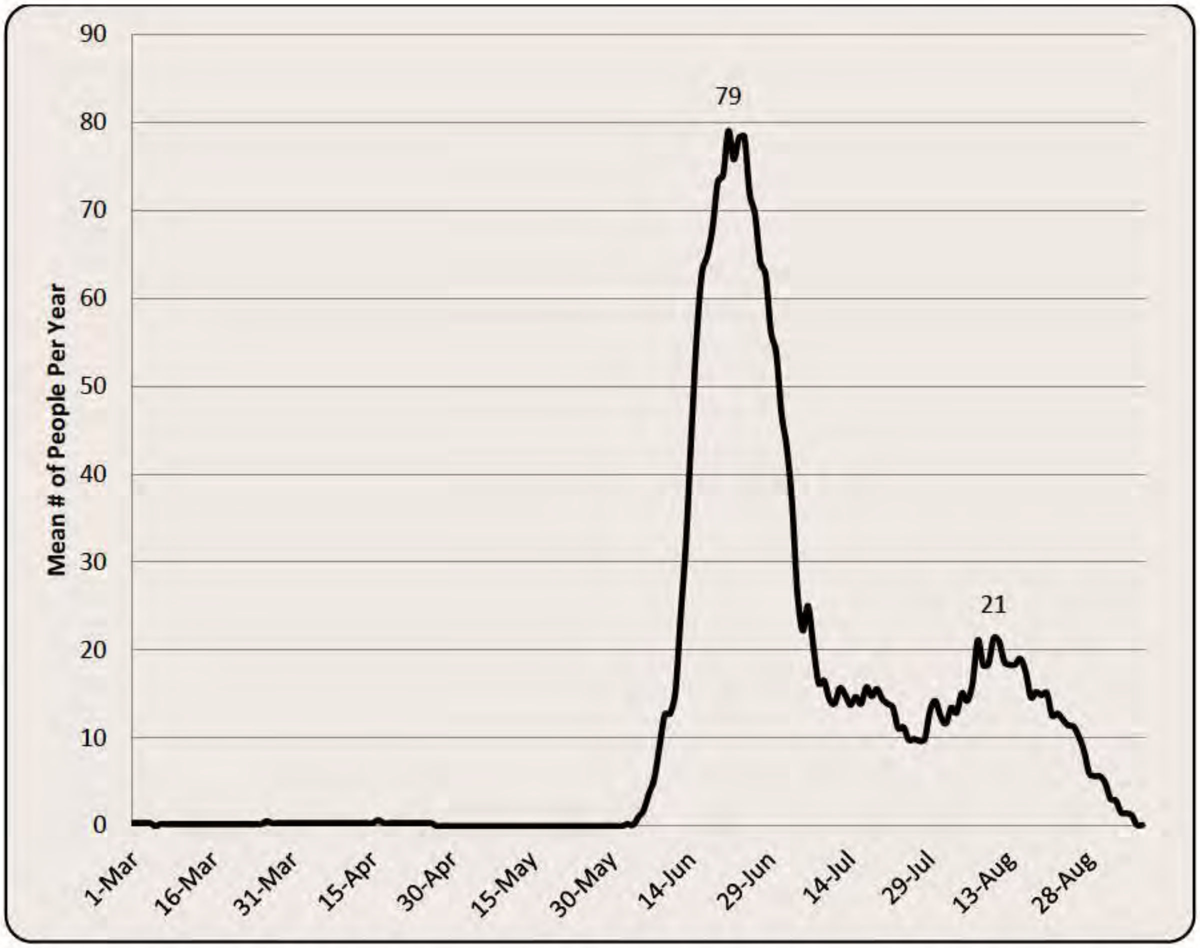


Figure 4-16. Mean daily distribution of commercially-supported visitors on the Kongakut River in Arctic Refuge, 2001–2009.

4.4.5.7 State Harvest Records for General Hunting and Trapping

General hunting and trapping are considered recreational activities at Arctic Refuge and records do not include subsistence harvests by federally qualified rural residents of the area.

ADFG is the agency responsible for regulating and monitoring general hunting and trapping throughout Alaska. This section summarizes the species and numbers of animals harvested—not the number of hunters and trappers on the Refuge. The number of hunters and trappers physically present on the Refuge is substantially lower than the total number of reports.

The State of Alaska is divided into 26 GMUs (Map 4-24). These units are divided into subunits identified by letters. Arctic Refuge is primarily located in GMU 25A, 26B, and 26C. Units 25A and 26B include lands outside Refuge boundaries. Harvest data collected by the State for units 25A, 26B, and 26C encompass the majority of Arctic Refuge and depict general trends in harvest for the Refuge. GMU 26B includes the Dalton Highway Management Corridor Area, which is a popular and road-accessible caribou hunting destination that accounts for most of the caribou hunting in this unit. Caribou harvested in unit 26B are most likely members of the Central Arctic herd.

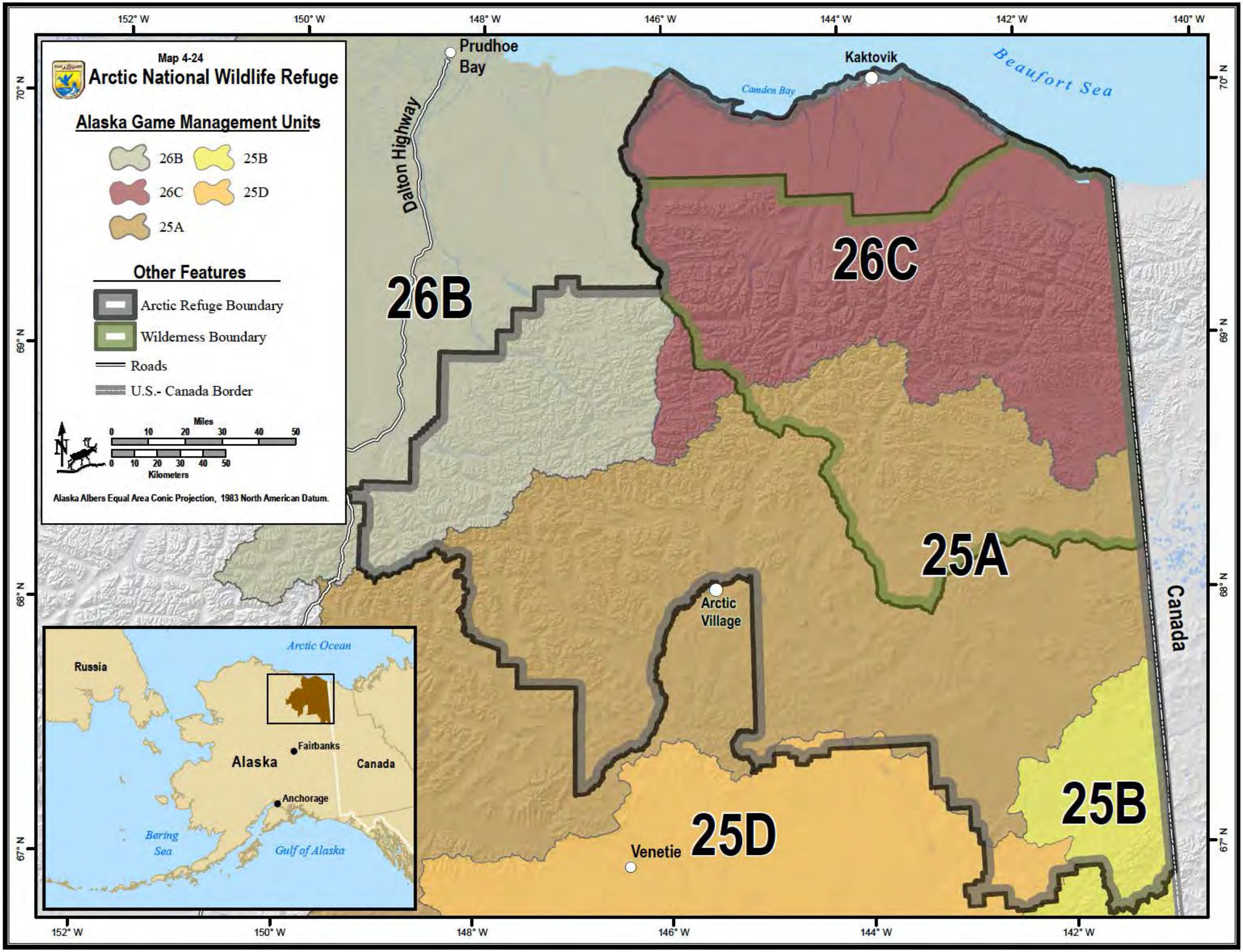
The harvest records for general hunting and trapping that are summarized in this section were accessed from the ADFG Wildlife Information Network (WinfoNet) at http://winfonet.alaska.gov. WinfoNet is an online database that stores all general hunting and trapping reports, harvest records, and fur sealing information for Alaska. The WinfoNet database contains records for hunters who properly obtain, complete, and return harvest tickets, and for trappers who have their furs sealed. Hunters are required to return a harvest ticket to ADFG whether they harvest an animal or not. Harvest tickets are used to collect data such as hunters' names, hunting locations (not land ownership), number of animals harvested, dates hunted, and dates of harvest. Harvests by hunters and trappers who do not comply with the harvest ticket or fur sealing regulations are not recorded in this database.

The State uses sealing certificates to record the number and location of animals harvested by trapping. Sealing certificates do not provide data on trapping effort in the Refuge (i.e., total number of trappers). Trappers in the Refuge are required to seal river otter, lynx, wolf, or wolverine. Trappers in the Refuge do not need to seal other species that they harvest. Trapping data discussed in this section reflects the number of times a trapper sealed furs and the species. Trappers often seal furs multiple times throughout the trapping season. A new sealing certificate is issued each time a trapper seals a fur or multiple furs of the same species. For example, if a trapper has a wolverine and three wolves to be sealed, one certificate would be issued for the wolverine, and a separate certificate would be issued for the wolves and would specify that three wolves were sealed. The same trapper could return later in the season to have more furs sealed, at which time more sealing certificates would be issued.

For the years 2001 through 2009, general hunters (guided and non-guided) comprised, on average, 28 percent of the total number of commercially-supported visitors to the Refuge. Of these, guided hunters made up 25 percent of the total, while non-guided hunters made up 75 percent. This was the case, in part, because guides are limited to a certain number of clients, which varies by guide use area. Each guide use area has a different amount and quality of habitat used by big-game species and a different number of feasible access and egress points. When deciding how many guided hunting clients to allow in each guide use area, managers consider the number of clients proposed during the competitive application process and the number of clients the area can support.

When reviewing the information for Arctic Refuge in the following graphs, please note:

1. Approximately one-third of lands in GMU 25A and approximately two-thirds of lands in GMU 26B are outside the Refuge. State lands in GMU 25A receive substantial sheep hunting pressure. GMU 26B includes the Dalton Highway Management Corridor Area, which is a popular and road-accessible caribou hunting destination and accounts for most of the caribou hunting efforts in GMU 26B. Caribou in this unit are most likely associated with the Central Arctic caribou herd.
2. Trapping activity is believed to be higher than what these numbers represent because harvest by people who did not have their furs sealed is not represented in this data set. Trappers, whether rural or non-rural residents, are required to have their furs sealed, yet many rural residents do not.
3. The trapping data reflect the number of sealing certificates and the number of animals harvested. They do not include the number of trappers or trapping effort. Numbers for black bear, brown bear, and trapping records indicate the number of animals harvested but do not indicate the number of hunters or trappers. The State does not



Map 4-24
Arctic National Wildlife Refuge
Alaska Game Management Units
26B
25B
26C
25D
25A
Other Features
Arctic Refuge Boundary
Wilderness Boundary
Roads
U.S.- Canada Border
Miles
0 10 20 30 40 50
0 10 20 30 40 50
Kilometers
Alaska Albers Equal Area Conic Projection, 1983 North American Datum.
152° W
150° W
148° W
146° W
144° W
142° W
140° W
70° N
69° N
68° N
67° N
Prudhoe Bay
Dalton Highway
Kaktovik
Camden Bay
Beaufort Sea
26B
26C
25A
25B
25D
Arctic Village
Venetie
Canada
Russia
Arctic Ocean
Alaska
Fairbanks
Anchorage
Canada
Bering Sea
Gulf of Alaska

require a report for unsuccessful bear hunting or trapping efforts; it only requires post-harvest sealing, which is done by ADFG or a designated representative.

4. Many of the hunters on Arctic Refuge hunt various species during the same hunt. It is common for a hunter to have sheep, caribou, and/or grizzly tags for a north side hunt or moose, sheep, caribou, and/or grizzly tags for a south side hunt. Therefore, the number of hunters physically present on the Refuge is much lower than the total of all of the hunting reports.
5. A hunter can have multiple harvest tickets for caribou. The hunting information does not reflect the number of hunters; it reflects the number of submitted harvest tickets. Therefore, the number of hunters present on the Refuge is lower than the numbers reported.
6. The Wildlife Information Network provides data; it does not provide inferences to trends. Many variables affect hunting and trapping efforts, which makes it difficult to determine trends.
7. The graphs here provide a visual representation of hunting and trapping efforts on Arctic Refuge. The first two graphs provide an overview of all hunting and trapping efforts on Arctic Refuge, and the remaining graphs depict hunting and trapping efforts by GMU and species. This information is meant to provide a general understanding of the documented harvests occurring on Arctic Refuge.

Harvest Information

Figure 4-17 depicts harvest data for GMUs 25A, 26B, and 26C. Caribou harvest (Figure 4-18) is shown separately because: 1) caribou data were only available for 10 years, and 2) more caribou are harvested than any other species each year. Displaying caribou data along with data for other species would make it difficult to discern annual variations for the other species. Most of the increase in caribou harvest has occurred along the Dalton Highway in GMU 26B, which is off the Refuge.

Trapping records for Arctic Refuge are shown in Figure 4-19. Trapping records reflect a substantial trapping effort by a limited number of trappers. In other words, a relatively low number of trappers are responsible for the recorded harvest. The total trapping harvest is likely underestimated because there are no designated fur sealers in many communities, and the fur from animals is often used locally and never sealed (Stephenson 2006).

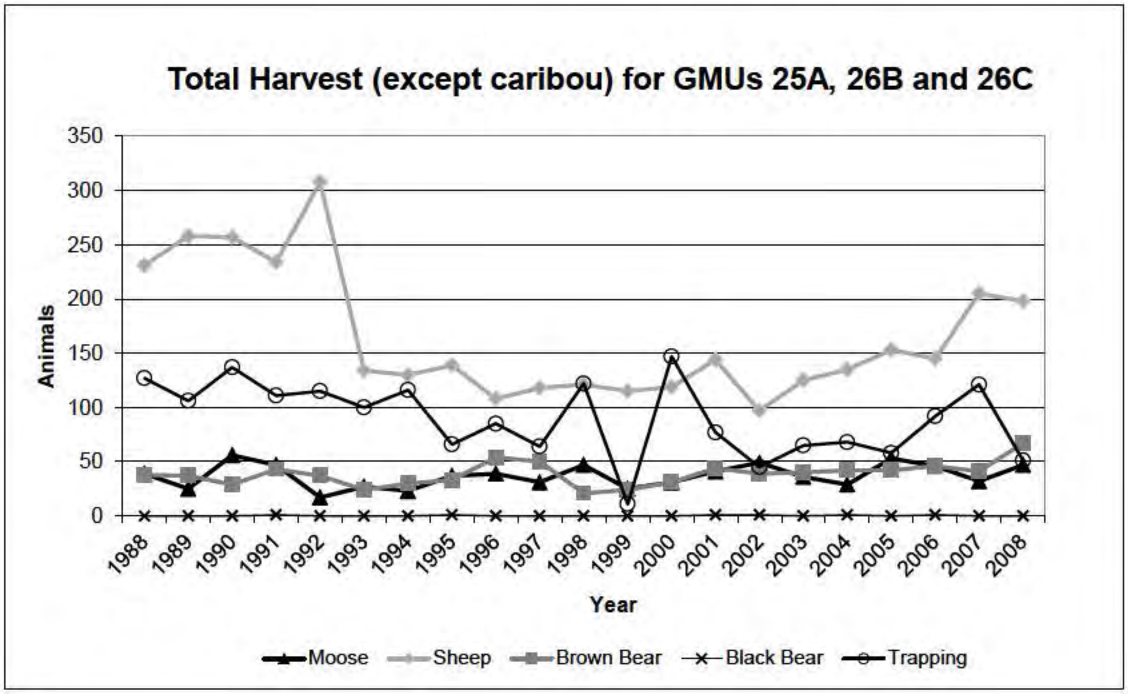


Figure 4-17. Harvest information (except caribou) from Game Management Units of Arctic Refuge over the 20-year period 1988–2008. Trapping harvest includes lynx, wolf, wolverine, and otter.

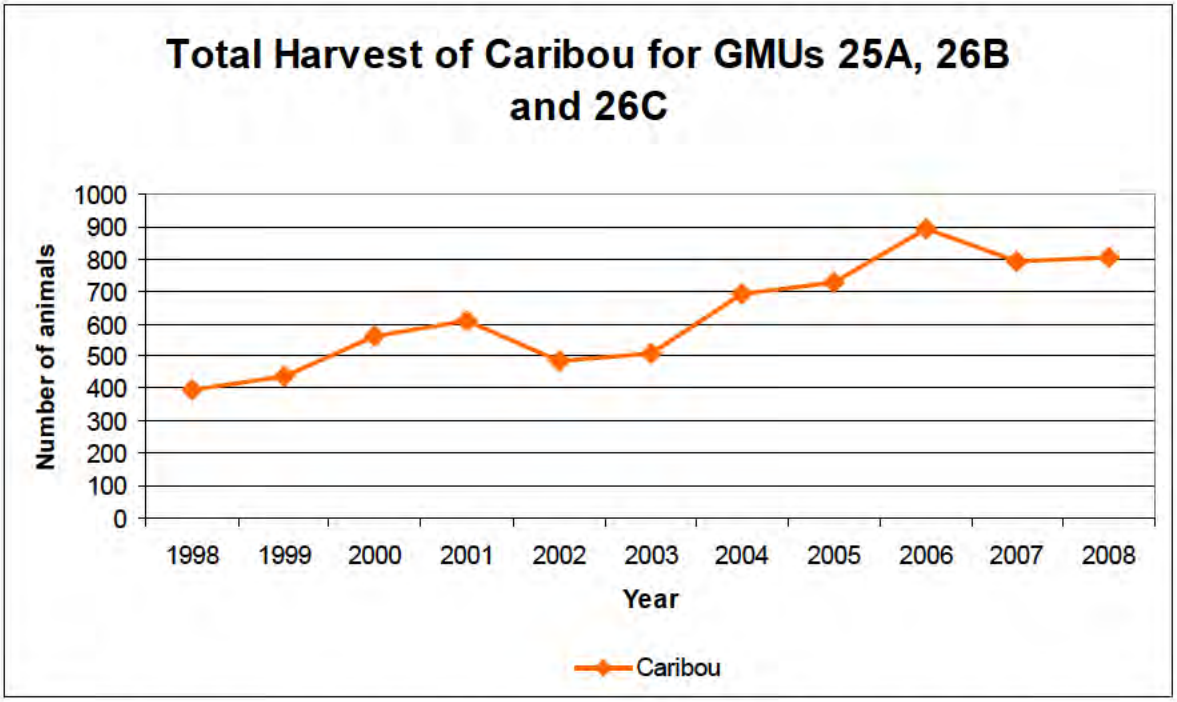


Figure 4-18. Caribou harvests from Game Management Units of Arctic Refuge during the 20-year period 1998–2008 (includes harvest on State-owned lands).

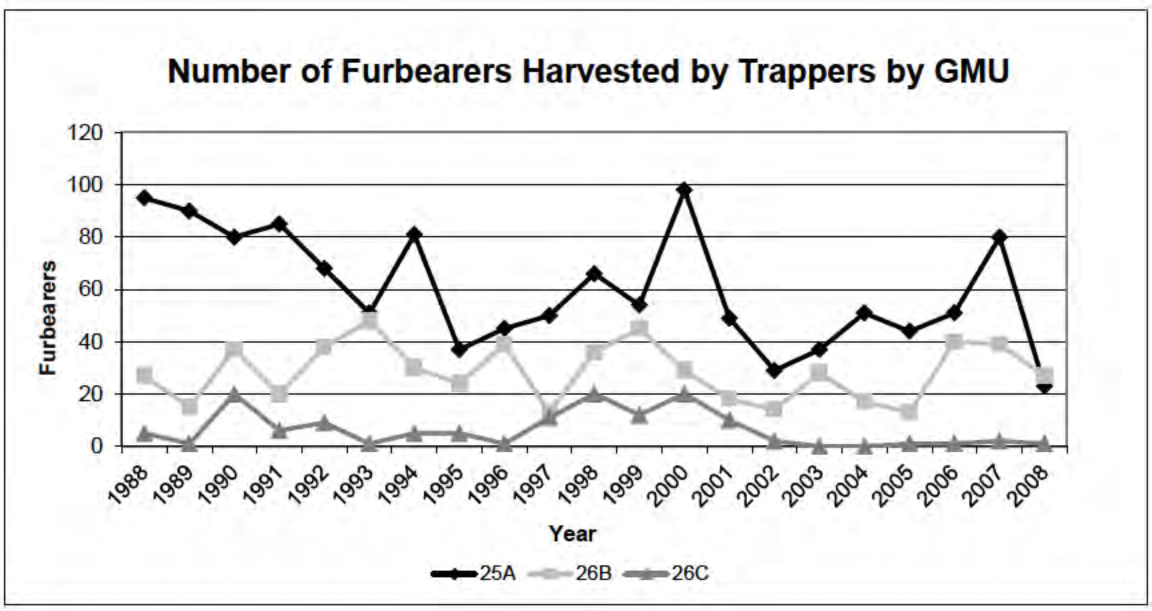


Figure 4-19. Trapping records of furbearers (lynx, wolf, wolverine, and otter) harvested in GMUs 25A, 26B, and 26C during the 20-year period 1988–2008.

GMU 25A

About two-thirds of GMU 25A falls in Arctic Refuge; therefore, some harvest occurs off the Refuge. However, most of the viable sheep hunting habitat is in the Refuge. Harvest records for GMU 25A are shown in Figure 4-20.

GMU 26B

Only one-third of GMU 26B is in Arctic Refuge, and the percent of the harvest of big game outside the Refuge, shown in Figure 4-21, is unknown. However, most of the GMU's sheep habitat lies in the Refuge portion of the Unit, so most sheep harvests occur on Arctic Refuge. By contrast, most of the caribou harvest in GMU 26B occurs off the Refuge. The increase in caribou harvest in GMU 26B in recent years is attributed to increased hunting pressure along the Dalton Highway, which was opened to the public in 1994. However, the western portion of the Refuge may also be experiencing increased caribou hunting pressure due to 1) more commercial air operators offering services along the Dalton Highway; 2) the Refuge's proximity to the Dalton Highway; and 3) the dramatic increase in the Central Arctic Caribou herd population.

Moose hunting was prohibited in GMU 26B from 1996-2005 because of declining moose populations. In recent years, a limited hunt for moose has been permitted by the State of Alaska in GMU 26B.

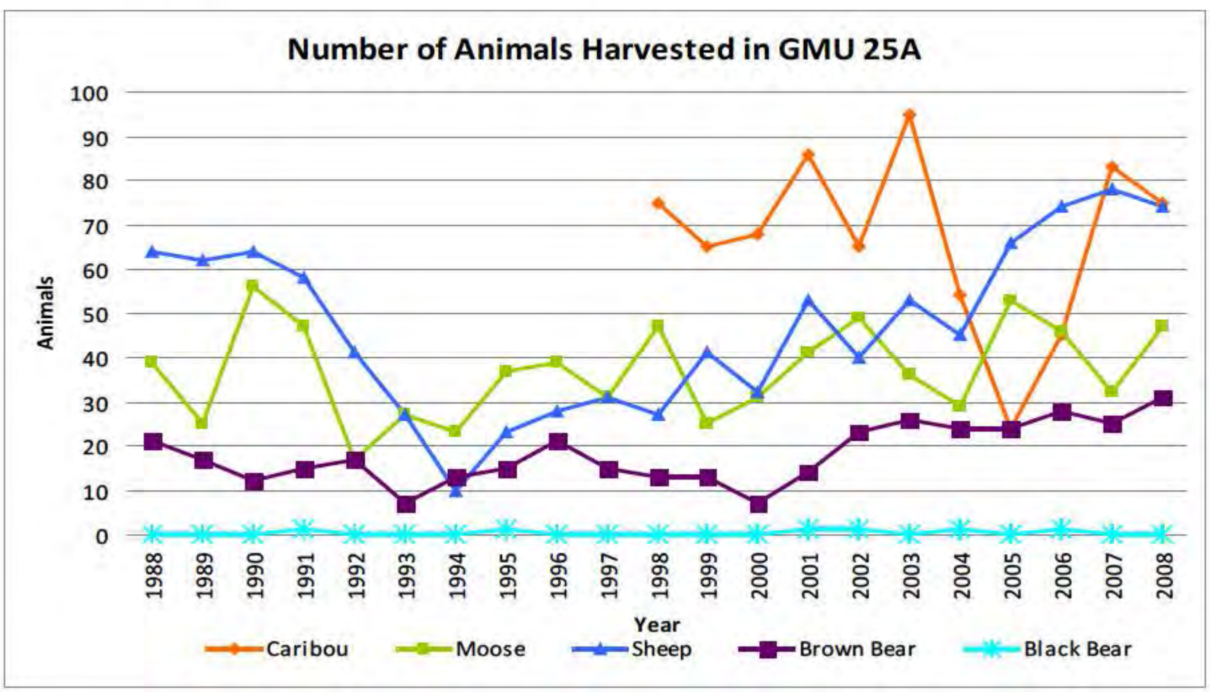


Figure 4-20. Hunting records from Game Management Unit 25A for harvest of each big-game species over the 20-year period 1988–2008.

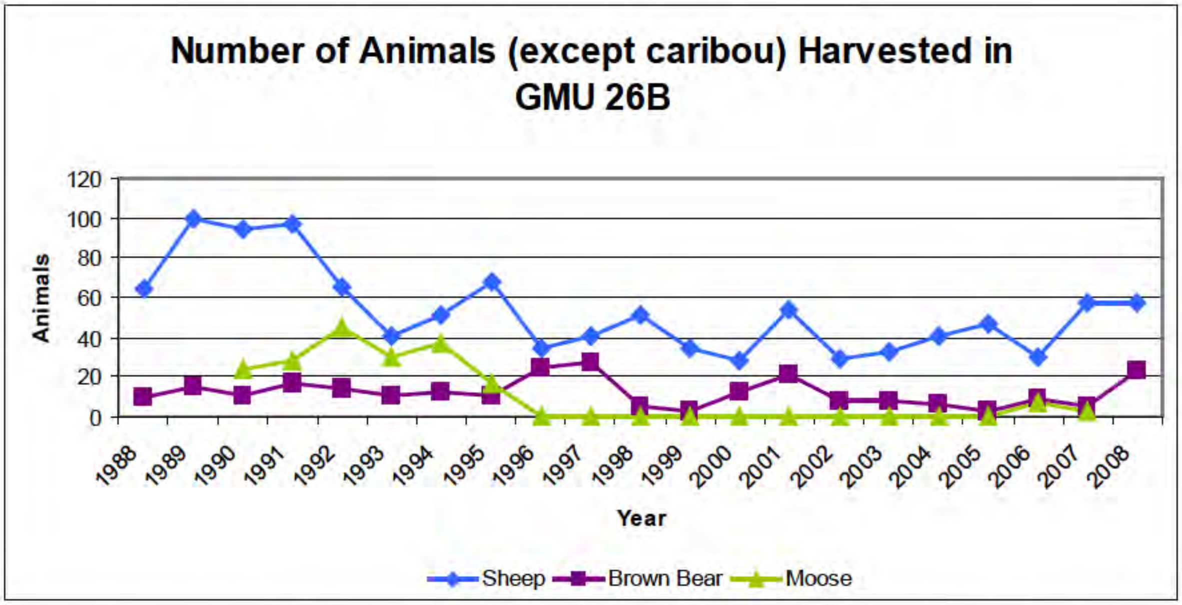


Figure 4-21. Harvest records (excluding caribou) from Game Management Unit 26B over the 20-year period 1998-2008.

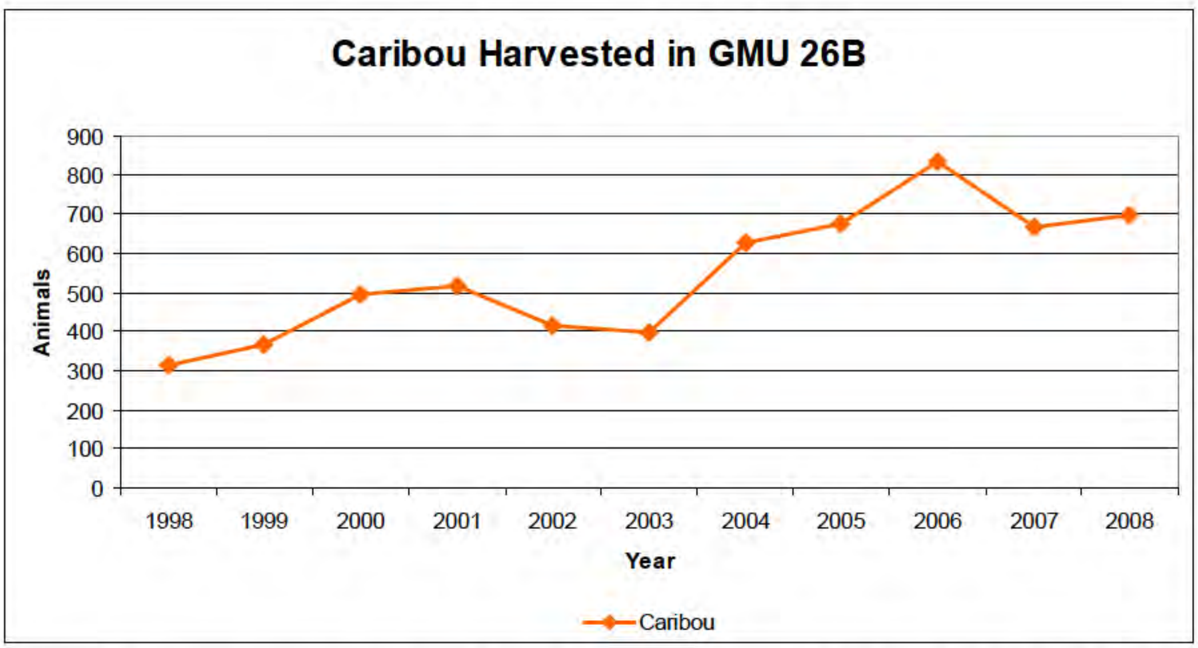


Figure 4-22. Caribou harvest records from Game Management Unit 26B for Arctic Refuge, 1998–2008 (includes harvest on State-owned lands).

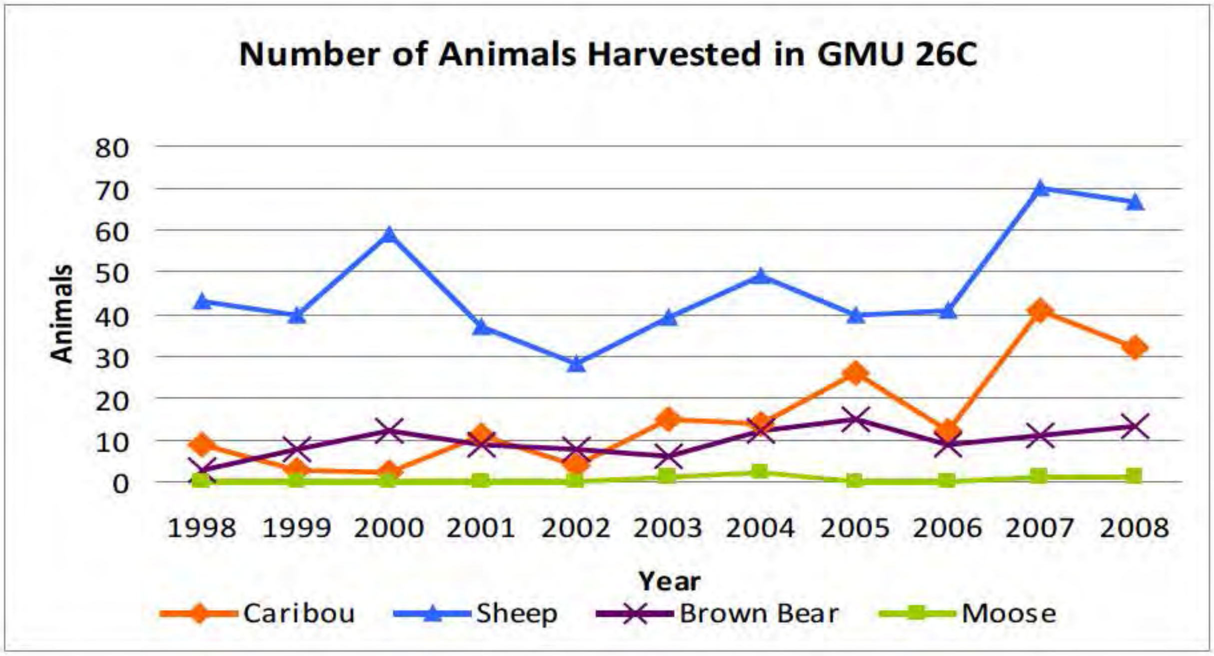


Figure 4-23. Harvest records for each big-game species from GMU 26C during the 10-year period 1998–2008.

GMU 26C

GMU 26C lies completely in Arctic Refuge; therefore, all of the animals were harvested from Refuge lands. Big-game harvest records are depicted in Figure 4-23.

4.4.5.8 Perceived Crowding, Conflict, and Resource Impacts

At times, hunting and other recreation groups find themselves in the company of other groups that may or may not be engaged in the same activity or behaviors. Encounters of this nature often are due to weather, high demand, or simply the nature of access at the Refuge (e.g., limited aircraft landing sites). This can lead to impacts to visitor experience and resource conditions such as crowding, social conflicts, accumulation of human waste, or site-hardening (Appendix M). Conflicts reported between groups have tended to be between groups of similar activity types (e.g., hunters complaining about other hunters). Recently, managers have begun to hear complaints from recreational floaters about hunting floaters or vice versa.

In recent years, the number of air transporters applying for commercial permits has increased (Arctic Refuge Commercial Permit Database, Service, unpublished data). Because hunting guide permits are awarded competitively and restricted to certain areas, and air transporter permits are non-competitive and not restricted to certain areas, the potential for competition and conflict may be increasing. For example, the clients of guides, air-taxis, and transporters, and non-commercially-supported hunters often overlap and concentrate at access points in places where people want to hunt Dall's sheep, which increases the potential for competition for places to hunt. Managers have observed growing tensions between hunting guides and transporters, particularly in the northwest portions of the Refuge. The amount and distribution of Refuge use by general hunting private pilots remains unknown.

At Arctic Refuge, managers currently do not identify different use zones, or recreational units, with varying goals for visitor use management; visitors are asked to disperse activities throughout the Refuge, while focusing their traffic on the most durable natural surfaces that will show fewer signs of their passing (Arctic Refuge 2008b, Marion 2009). Popular areas are showing site-hardening where repeated use is compromising the wilderness characteristics of naturalness, and signs of previous users are obvious. In order to balance quality of recreational opportunities in a wilderness setting with high demand for these opportunities, managers may eventually choose to identify different zones with different management goals. In moderate to high use zones, such as camping areas immediately adjacent to popular landing areas, infrastructure (e.g., Hardened campsites meant to accommodate intensive recreation traffic while minimizing impacts (Marion 2009)) may be designed to blend in with surroundings to optimize natural wilderness characteristics while accommodating higher use levels. In low use zones, managers frequently implement "dispersal" strategies designed to prevent the occurrence of visitor impacts (Hammitt and Cole 1998, Leung and Marion 1999) and stress visitor practices that reduce signs of previous visitor use.

To preserve desired conditions (Appendix M) managers decide the specific conditions and visitor experiences that will be available to the public, and develop condition goals, standards, indicators, measures, and threshold that trigger management actions, to insure management condition goals are maintained.

Managing visitor-caused impacts and maintaining visitor experience opportunities requires long-term monitoring of visitor experience opportunities and resource conditions. Efforts are ongoing through visitor surveys, recreation impacts monitoring, and by observation on the Refuge's most-visited rivers and along the western boundary of the Refuge, but managers currently have no detailed plans for addressing impacts once they are identified. Aplanned management program with actions that violate standards, and budget and personnel/resources dedicated to implementing management actions are needed to preserve desired conditions.

4.4.5.9 Dalton Highway Visitors and Resource Impacts

In addition to the previously noted increase in commercial guided day hiking and overnight trips to Refuge areas along the Dalton Highway, managers believe that non-guided visitation to areas adjacent to this area has increased considerably over the past decade (Reed and St. Martin 2009). The Dalton Highway, which was open to the public in 1994, allows relatively easy and inexpensive access to western portions of the Refuge, particularly the Atigun Gorge area, which is recognized for exceptional scenery, wildlife values, and wilderness qualities. The Dalton Highway Corridor Management Area extends five miles on either side of the Dalton Highway from the Yukon River to the Arctic Ocean. The ADFG currently uses the area five miles on either side of the highway to regulate hunting limiting it to certified bow hunters only. Hunting regulations in this area are intended to prevent overharvest of wildlife by limiting the number of hunters who use the area. Licensed highway vehicles are allowed only on designated public roadways. To protect fragile tundra and wetland vegetation, recreational use of off-road vehicles or snowmachines is prohibited by State law within the five-mile corridor. However, people may access the area at any time by boat, airplane, foot, ski, or dog team, depending on the season. Federal Subsistence Management regulations do authorize the use of snowmachines for subsistence hunting and trapping by residents living within the Dalton Highway Corridor Management Area. However, any user can start outside the five-mile corridor on a snowmachine and then cross the highway corridor to access other hunting areas or villages.

The Dalton Highway was designated a scenic byway by the State of Alaska, which continues to expand road infrastructure to facilitate tourism in northern Alaska. Managers predict that the western portion of the Refuge will become a more popular destination for visitors as awareness and use of the Dalton Highway increase. Continued improvements to the highway will most likely increase visitors to the area, particularly when rental car companies authorize their customers to drive this increasingly-paved and straightened road. Beyond the Arctic Interagency Visitor Center in Coldfoot, there are no developed facilities or formally constructed trails in areas such as Atigun Gorge, but greater numbers of visitors to this area could substantially increase day hiking activity and, most likely, the proliferation of informal (visitor-created) trail networks in tundra habitat currently managed for dispersal. (Monz et al. 2009).

Land managers frequently experience substantial challenges successfully implementing dispersal strategies for several reasons, including 1) inadequate educational programs that fail to communicate when activities should be dispersed, what durable surfaces are, and a compelling rationale for practicing dispersal; 2) visitation levels that are too high to support effective dispersal; 3) lack of sufficiently durable surfaces; and 4) topography or vegetation that constricts traffic to a common route (J. L. Marion, Unit Leader of Virginia Tech Field Station, Patuxent Wildlife Research Center, USGS, pers. comm.). These challenges apply to areas of the Refuge along the Dalton Highway—particularly in Atigun Gorge.

To balance quality of recreational opportunities in the Atigun Gorge with high demand for these opportunities, and as Refuge objectives for desired conditions are defined, the creation of some informal trails may be determined to be acceptable, provided they are associated with acceptable types of visitor activity and at access points of interest that allow travel through constricted topography. However, recent research cautions that visitors choose less sustainable trail alignments and can create unnecessarily duplicative networks of trails that entail a substantial amount of avoidable impact as compared to planned hardened sites and trails designed to accommodate common visitor use patterns, such as where visitors commonly travel, stop to rest, or gather to view scenery and wildlife (Leung et al. 2011, Wimpey and Marion 2010). The Refuge has not developed visitor use management strategies for the Atigun Gorge.

A recreation research study of the Atigun Gorge area is in progress to develop and implement monitoring protocols for measuring the number, distribution, and condition of emerging informal trails in and adjacent to the Atigun Gorge (Monz et al. 2009). Managers at Arctic Refuge must provide messages to visitors before their arrival that are clear and easy to understand but complex enough to clarify preferred visitor behavior in transition areas or where impacts are emerging (J. L. Marion, Unit Leader of Virginia Tech Field Station, Patuxent Wildlife Research Center, USGS, pers. comm.). Managers continue to consider increasing the efficacy of their outreach messages about minimum impact techniques such as Leave No Trace and to better understand ways to manage impacts to fragile tundra resources and visitor experiences in Arctic Refuge areas adjacent to the Dalton Highway.

4.4.5.10 Polar Bear Viewing

In the previous eight years, there has been increasing polar bear viewing activity on Refuge lands and non-Refuge lands within the external boundary of Arctic Refuge (Miller 2010). Managers suspect that polar bear viewing has become more popular in recent years for a number of reasons. Beginning in 2002, a large number of polar bears were observed aggregating near the Alaska Native community of Kaktovik, around Barter Island. This area is known to host the highest density of polar bears along the north coast of Alaska and western Canada. The number of polar bears on shore seems to be closely correlated to the distance of ice from shore and the high density in the area of ringed seals, a preferred food; the presence of carcasses of subsistence-harvested whales also attract bears (Kaktovik Polar Bear Committee et al. 2010). This phenomenon most likely spurred an increase in commercial interests and enterprises focused on providing opportunities to members of the public who want to see polar bears in the wild. Increased infrastructure was developed in Kaktovik to house visitors, and local airlines began accommodating charter requests and actively promoting bear viewing tours. In May of 2008, the Service listed the polar bear as threatened under the Endangered Species Act. This Federal action was surrounded by increased media reports featuring global climate change, disappearance of sea ice, and the plight of the polar bear in the Arctic, which attracted public attention to the species.

The opportunity to view polar bears outside of captivity offers a valuable tool for delivering conservation messages to the public. To minimize potential disturbance to polar bears caused by bear viewing activities, the Service has intensified public education and outreach about polar bear safety and about its cooperative management program with the community of Kaktovik, which is designed to achieve conservation goals for the species, reduce human-bear conflicts, and educate the community and visitors about human-bear safety. After conducting broad efforts to increase partnerships, training opportunities, and education, the Refuge implemented a special use permit requirement for commercial guided polar bear viewing and received applications from eight local operators for the activity on Refuge lands and waters surrounding Kaktovik.

Managers at Arctic Refuge share concerns about future developments for polar bear viewing, including the potential use of tour ships, helicopters, and other methods commonly used in other parts of the circumpolar north where polar bear viewing occurs.

4.4.5.11 Packrafting

Commercially manufactured packrafts are lightweight, inflatable rafts that can be packed into an area using backpacks or similar gear. This new type of watercraft is making rivers and streams that were once un-floatable, due to low water or lack of access, more available to recreational visitors. Managers believe that this technology has some potential to change patterns of recreational activity at Arctic Refuge. Having a packraft may encourage more people to explore or pioneer routes into areas of the Refuge that have not previously had much, if any, use by visitors. With the proliferation of packraft use, visitors may spend more time at the Refuge pursuing a combination of backpacking and river floating in one adventure. Increasing use of packrafts may provide more opportunities for floating rivers and streams, dispersing these visitors across a broader swath of the Refuge.

4.4.5.12 Winter Camping

Managers at the Refuge have begun to observe more unrestricted use by non-motorized visitors along the western Refuge boundary and visitors who embark with snowmobiles from villages or other areas near Refuge boundaries. Snowmachine use on Refuge lands is generally legal except during periods of inadequate snow cover, except for certain size and weight classes of machine, and except where prohibited by State law. Potential management concerns include illegal use of snowmachines along the Dalton Highway corridor, especially during periods of inadequate snow cover, and increased use of snowmachines in sensitive habitat used by wintering wildlife or during sensitive times, such as the spring when polar bears are in maternal dens.

4.4.6 Interpretation and Environmental Education

At Arctic Refuge, outreach and education programs are tailored toward three distinct audience types with information designed to meet their interests.

One audience consists of people who come to visit the Refuge, including those from outside the area and local residents. Outreach specialists at the Refuge provide this group with specific information that will help them enjoy safe and rewarding experiences while minimizing impacts. Information includes how to plan their trip, what to bring, what minimum impact techniques are appropriate for a wilderness setting, what regulations they must follow, and how to identify and respect private lands. Refuge staff does not direct visitors to specific locations or destinations. Outreach messages do include information that will help visitors avoid conflicts with bears and avoid disturbing other wildlife. Visitors are told about wildlife conservation and stewardship of Refuge lands and natural resources. They are provided information about invasive plants and reducing their footprint, especially in popular places where visitors tend to congregate.

Another main audience consists of those who live in communities and/or visit the visitors center in interior and northeast Alaska. These people are interested in interpretive and environmental education programs about plants and wildlife, Wilderness, and management activities at Arctic Refuge. The Refuge serves this audience at a variety of venues, including community gatherings, visitor centers, and other facilities located outside the Refuge. Refuge staff creates and presents materials and activities for kindergarten through college-aged students at schools in Fairbanks, Kaktovik, Arctic Village, Venetie, and other locations in interior and northeast Alaska. These educational efforts include in-classroom programs and summer camps. The Refuge staff also produces posters to display at kiosks throughout the region.

The third group is a distant audience. These are members of the public who live far from the Refuge. They are widely dispersed throughout Alaska, the remainder of the US, and internationally. This group tends to be interested in Arctic Refuge and its management issues, but most of its members may never have the opportunity or desire to visit. They are interested in information about an extensive range of topics including the biological sciences, Wilderness, conservation, public uses of the Refuge, management of Refuge lands, arctic and boreal environments and wildlife, climate change, and energy development. Outreach methods include personal communications, oral presentations, brochures, and other printed materials. Outreach is primarily conducted via the Internet, email, and telephone.

4.4.6.1 Web-based Information

Arctic Refuge staff created a website (http://arctic.fws.gov) in 1995 and has expanded it each year since. This website is the Refuge's primary outreach tool and is especially important for reaching distant audiences. The site contains nearly all the outreach materials and products produced at the Refuge, and it has become the Refuge's most effective communication tool.

The number of page visits to the Arctic Refuge website reached a peak in 2005, after almost a decade of intense political and media interest in the Refuge. That year, the public visited the Refuge's web pages an average of 1,850 times per day. In fiscal year 2010 (October 1, 2009-September 30, 2010), a period during which there was relatively limited political and media interest in the Refuge, the website received an average of 761 page visits per day (Figure 4-24). Twice as many pages were visited during the school months (an average of 880 per day from November to May) as during the summer months (an average of 453 per day for July and August). These data suggest that the majority of Arctic Refuge web visitors are students or educators making use of the Refuge's web content for academic purposes.

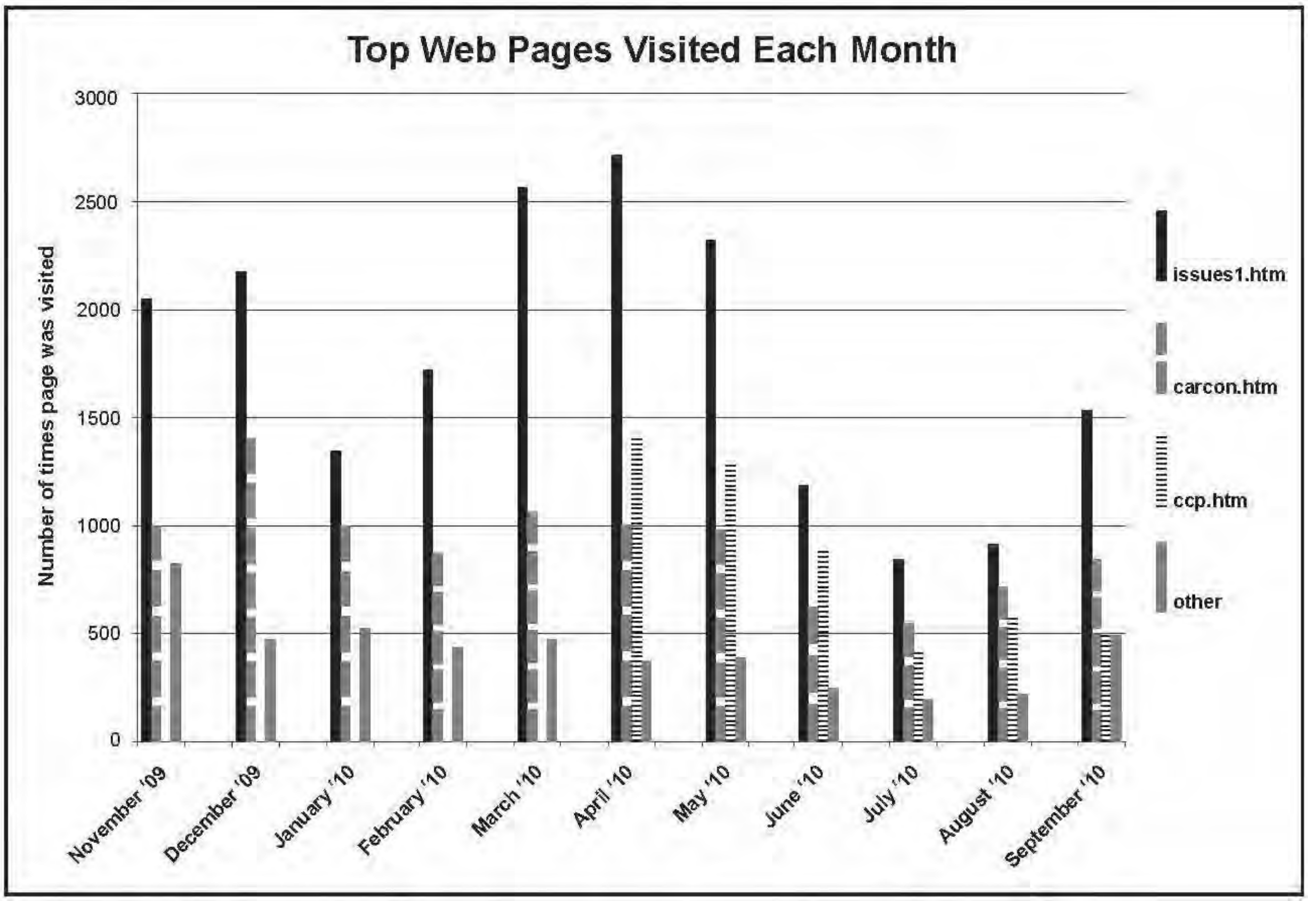


Figure 4-24. Number of visits per month to the most popular Arctic Refuge web pages, fiscal year 2010.

Notes: issues1.htm = "Potential Impacts of Proposed Oil and Gas Development on Arctic Refuge's Coastal Plain." carcon.htm = "Frequently Asked Questions about Caribou." ccp.htm = the Comprehensive Conservation Plan.

The two most popular Refuge web pages in fiscal year 2010 were "Potential Impacts of Proposed Oil and Gas Development on Arctic Refuge's Coastal Plain: Historical Overview and Issues of Concern" and "Frequently Asked Questions about Caribou." In most instances, pages that focus on wildlife ranked third each month. In April 2010, during the period of public scoping for this Plan, the Refuge's Comprehensive Conservation Plan web page ranked second in number of visits.

4.4.6.2 Arctic Interagency Visitor Center

Since 1989, the BLM, the NPS, and the Service have cooperated to provide information to travelers along the Dalton Highway. Staff from these agencies help visitors prepare for, enjoy, and participate safely in a variety of recreational activities on Federal lands in the region. Through personal contacts, interpretative programs, exhibits, and publications, visitors can gain a better understanding of the arctic and its unique resources.

In 2003, a new Arctic Interagency Visitor Center opened in Coldfoot, Alaska. This visitor center operates from late May to mid-September each year and provides Federal agencies with a major point of contact for people traveling the Dalton Highway. The facility includes a 60-seat theatre for delivering education programs and special events, a trip planning room for hikers, dioramas and displays about the arctic and boreal forest, and a sales area where Alaska Geographic (formerly the Alaska Natural History Association) sells educational and interpretative items. The visitor center provides the public with information about the Refuge System and Arctic, Kanuti, and Yukon Flats refuges.

4.4.6.3 Arctic Village Visitor Contact Station

Arctic Village serves as an important access hub community for visitors to Arctic Refuge due to its location next to the Refuge's southern boundary and the community's airport, which has regularly scheduled commercial flights. The Refuge operates a small visitor contact station that provides brochures, maps, and other information and an opportunity to view a video about the Refuge. This facility is frequently used by local residents traveling on regularly scheduled commuter planes. The contact station is used by visitors as a place to stage trips to and from locations inside the Refuge with commercial air operators. An informational kiosk is located on the airport ramp area, and a second kiosk is located in town.

The Arctic Interagency Visitor Center in Coldfoot, Alaska

4.5 Refuge Infrastructure and Administration

4.5.1 Administrative Facilities

Administrative facilities described in this section include offices, bunkhouses, maintenance shops, vehicles storage, aircraft hangar, airport leases or tie-down space, storage sites for fuel and other hazardous materials, and remote administrative sites.

4.5.1.1 Fairbanks

The primary administrative facilities for the Refuge are located in Fairbanks, approximately 170 air miles south of the Refuge's southernmost boundary. The Refuge headquarters is co-located with those of the Kanuti and Yukon Flats refuges and the Fairbanks Fish and Wildlife Field Office in the Fairbanks Federal building. A 2-acre parcel located immediately west of the Federal building off of Noble Street is used for boat, vehicle, and material storage. A maintenance shop is located adjacent to the Federal building and is shared with the other Service offices located on the premises. The Service maintains a hangar at the Fairbanks International Airport east ramp where Arctic Refuge stores three aircraft. The hangar facility is also utilized by other Service offices. An aircraft tie-down slip is rented for securing a float plane at the Fairbanks International float pond.

4.5.1.2 Kaktovik

The Refuge owns and maintains a 3,100-square-foot field station in the city of Kaktovik located on Barter Island. The facility can house up to 16 people and includes four bedrooms, two bathrooms, a garage with a storage loft and workshop, two storage sheds, and an above ground 560-gallon heating fuel storage tank. The bunkhouse was constructed in 1987, replacing a smaller bunkhouse that was donated to the Native Village of Kaktovik in the late 1990s. The bunkhouse receives a majority of its use from June through September during the field season, providing temporary housing and/or staging for field crews. The bunkhouse is also used by non-government, State, and other Federal partners performing resource related field work near Kaktovik. The bunkhouse lot is leased from the City of Kaktovik. In collaboration with the Kaktovik community, the Refuge maintains two informational kiosks—one located at the airport ramp area and the second along the community access road near the harvested whale processing area.

In addition to the bunkhouse facilities in Kaktovik, the Refuge owns and maintains two 4,000-gallon fuel storage tanks and accompanying refueling pump sheds. One contains aviation fuel and is located adjacent to the former Department of Defense aircraft hangar located next to the Barter Island Airport. The other tank contains jet fuel for helicopters and is located adjacent to the helicopter pad west of the airport. Fuel tank lots are leased from the Department of Defense, U.S. Air Force.

Barter Island Bunkhouse and Field Station in Kaktovik

The Barter Island airport is located on a gravel bar spit extending from the northeast corner of Barter Island. The runway is exposed to the Beaufort Sea and the Kaktovik Lagoon on three sides and is periodically submerged by floods from sea storms surges. The North Slope Borough operates and maintains the existing runway through a lease from the Department of Defense. The North Slope Borough, in cooperation with the Federal Aviation Administration, proposed to resolve the recurrent flooding at Barter Island Airport by relocating the airport to higher ground on the island approximately one mile southwest of the community. The existing airport would be decommissioned and abandoned for all aviation use.

The new location of the airport would be on land owned by KIC. Upon completion of the new airport, the Refuge would negotiate a lease or the purchase of a lot on which to relocate the aviation fuel and jet fuel storage tanks and accompanying refueling pump sheds. The lot would be of sufficient size to accommodate future aviation support needs such as aircraft tie-down space or an aircraft hangar.

Storage Shed, Visitor Contact Station, and Aviation Fuel Tank at Arctic Village Airport Runway

4.5.1.3 Arctic Village

In Arctic Village, near the airport ramp area, the Refuge has a 305-square-foot visitor contact station, which includes a small office space used primarily by the local Refuge information technician. This building is rented from the Arctic Village Council.

Other facilities at this site include an informational kiosk, an outhouse, and a 2,500-gallon aviation fuel tank and storage shed. The storage shed was constructed in 2008, and is used to store field gear, tools, a four-wheeler, and other equipment. The storage shed also houses an alternative energy solar system that was installed in 2010 and provides electricity to the shed and the aviation fuel tank. The fuel tank and storage shed lots are leased from the Native Village of Venetie Tribal Government.

Administrative Cabin and Storage Shed at Big Ram Lake

4.5.1.4 Big Ram Lake

The Big Ram Lake Field Station is located near the Wind River in the southwest corner of the Refuge. The facility consists of three structures: the bunkhouse (288 square feet), a cookhouse (240 square feet), and an outhouse. The original buildings were constructed in the 1970s by private individuals who used them for prospecting and hunting. The Refuge acquired the facilities in the late 1980s. Several of the original buildings were removed, while the remaining buildings were renovated to accommodate administrative uses. The site currently receives use for wildlife surveys and law enforcement patrols amounting to an average of five days per year. The site is accessed via float plane in the summer or ski plane in the winter.

4.5.1.5 Galbraith Lake

The Galbraith Lake Field Station is situated on BLM land at the Galbraith Lake Airport located on the north side of the Brooks Range and at mile 275 of the Dalton Highway. The original cabin (384 square feet) was built in 2001 and consisted of one large room with a kitchenette. In 2006, it was expanded (600 square feet) to include two bunkrooms, a small living area, a full kitchen, and a screened-in porch for storage or sleeping. The site also contains an above ground 300-gallon heating fuel storage tank and a 2,500-gallon aviationAvgas fuel tank. The facilities operate off an alternative energy wind and solar power

Refuge Field Station at Galbraith Lake

system that was added in 2006 and updated in 2009. The facility receives the majority of its use from May to September during the field season. It has provided long-term and short-term housing to Refuge staff for various field projects. It is also used by a variety of non-government, State, and other Federal partners working in the area. The site is accessed via the Dalton Highway or by fixed-wing aircraft.

4.5.1.6 Lake Peters

The G. William Holmes Research Station, also known as Lake Peters facility, consists of four structures located on the east side of Lake Peters, a part of the Neruokpuk Lakes PUNA in the Franklin Mountains. The facility was originally constructed in the late 1950s by the USGS to serve as a research facility. Soon thereafter, the Department of the Navy, Naval Arctic Research Laboratory in Barrow took over the facility as one of several field sites on the North Slope of Alaska. After Naval Arctic Research Laboratory was closed down, the Refuge acquired the facility and improved it. The Lake Peters facility and vicinity was included in the Wilderness area established by ANILCA in 1980. In 1999, the Service altered and reduced the footprint from the original facility; it now includes a bunkhouse (448 square feet), a cookhouse (360 square feet) with a full kitchen, a warehouse (320 square feet) to store tools and equipment, and a newly renovated outhouse.

Over the years, the facility has been used as a base camp; technician training location; and study site for sheep, caribou, bear, small mammals, lake productivity, and fish investigations. It remains a good site for such work, as well as for studies on tundra vegetation, alpine birds, Alaska marmots, limnology, and climate change. The facility also provides shelter for scientists working in the region and for field visits by agency leaders and others. The site is used at irregular intervals throughout the year, can be unoccupied for long periods, and is costly to maintain. The facility is accessed via ski plane in the winter and float plane during the summer.

4.5.1.7 Recreation Facilities

There are no public recreation facilities in the Refuge. There are no developed trails, signage (other than private property signs), or public use cabins. To preserve the wild, unaltered character of the Refuge, there are no plans to develop any of these facilities in the future.

4.5.1.8 Refuge Staffing

Arctic Refuge staff presently consists of 22 permanent full-time positions, one permanent part-time position, one full-time term position, and four temporary intermittent positions. There are six positions in Arctic, Kanuti, and Yukon Flats refuges that are shared (duty station indicated in the following text), two of which are full-time employees assigned to Arctic Refuge and are included in the Refuge's total count of permanent full-time staff.

G. William Holmes Research Station on the Eastern Shore of Lake Peters

Biology

- Supervisory Ecologist
- Ecologist
- Botanist (Permanent Part-time)
- Wildlife Biologist – Ungulates
- Fish and Wildlife Biologist
- Wildlife Biologist – Avian
- Aquatic Ecologist

Facilities Management

- Maintenance Mechanic

Fire Management

- Fire Management Officer (Shared; Kanuti National Wildlife Refuge)
- Assistant Fire Management Officer (Shared; Kanuti)

Law Enforcement

- Park Ranger – Law Enforcement/Refuge Officer and Airplane Pilot

Outreach

- Wildlife Interpretive Specialist
- Park Ranger – Visitor Services
- Park Ranger – Village Liaison
- Visitor Services Specialist (Full-time Term)
- Visitor Services Technician (Temporary Intermittent)
- Refuge Information Technician (2 Temporary Intermittent)

Refuge Management

- Refuge Manager
- Deputy Refuge Manager
- Assistant Manager – Law Enforcement/Airplane Pilot
- Wilderness Specialist – Airplane Pilot
- Wildlife Refuge Specialist

Support Staff

- Airplane Pilot
- Supervisor Information Technology Specialist (Shared; Arctic)
- Information Technology Specialist (Shared; Arctic)
- Information Technology Specialist (Temporary Intermittent)
- Contracting Officer (Shared; Kanuti)
- Administrative Officer
- Administrative Support Technician

Subsistence Management

- Refuge Subsistence Coordinator (Shared; Yukon Flats National Wildlife Refuge)

Generally, three to five temporary, seasonal employees are hired each year to support summer biological field work. Depending on experience, they are hired as GS-4 to GS-7 biological science technicians. Many of these employees are hired through seasonal employment registers generated from positions advertised on the USA Jobs website. Others are hired through other authorities, e.g., Student Temporary Experience Program, Student Career Experience Program, Alaska Native Science and Engineering Program, Student Conservation Association, or other internships. The number of seasonal employees varies depending on the number and complexity of the planned projects and available funding. Appointments for seasonal employees usually run from mid-May to early September, although some have been extended on a part-time basis to assist with additional work. An additional four to six volunteers per year are recruited for various field or office projects.

High school students in remote communities near Arctic Refuge are hired for summer Youth Conservation Corps projects in their villages. Between 5 and 11 high school students have been hired each year to support various projects taking place either in Arctic Village or elsewhere on the Refuge. Appointments usually run from four to eight weeks in length from early June until mid-August.

4.6 Poker Flat Research Range

4.6.1 Overview

Since the late 1960s, the National Aeronautics and Space Administration (NASA), other government agencies, and various educational institutions have carried out scientific research using suborbital rockets launched from the Poker Flat Research Range (Poker Flat), a University of Alaska-Fairbanks-owned facility located on the Steese Highway between 155-185 miles (mi) (250-300 kilometers (km)) south of Arctic Refuge.

Poker Flat is the only high-latitude rocket launching facility in the United States where a sounding rocket can readily study not only the aurora borealis but also the interaction between the sun and earth's upper atmosphere. Much of the research conducted at Poker Flat focuses on the understanding of geospace—a vast region in the earth's ionosphere/magnetosphere stretching from the earth's atmosphere to thousands of miles beyond. The processes that occur in this region have been found to have far-reaching implications for life on earth and therefore must be better understood. Poker Flat's location and range characteristics (e.g., northerly trajectories, downrange observation sites) provide a unique opportunity to study these processes at a relatively low cost via sounding rockets.

4.6.2 Types of Research Conducted

A majority of the science enabled by Poker Flat can be considered fundamental science (or pure science), the goal of which is to understand the most basic characteristics of nature. The knowledge gained by the research at Poker Flat can then be applied practically by scientists and engineers in atmospheric and space physics, as well as disciplines such as communications and electrical distribution.

The data collected at Poker Flat also benefits climate change research, though mainly indirectly. For example, data collected by sounding rockets (e.g., ionospheric density, neutral density and temperature, electric fields, etc.) in upper atmospheric regions can be utilized to develop and calibrate atmospheric models to assess change (e.g., Qian et al. 2008). Of particular note are those "whole atmosphere" models that can consistently simulate the dynamic processes of the Sun-Earth system (Liu et al. 2010). These models require data to perform realistic predictions. The only way to gather the necessary measurements in the upper atmosphere (between 20-100 mi (30-160 km) altitudes) is with probes on sounding rockets.

In addition to the majority of Poker Flat missions, which study the aurora and its associated physical processes, some missions' objectives are directly related to weather and climate change. For example, a February 2011 mission investigated a technique to measure the nighttime distribution of nitric oxide; a compound produced by aurora and thought to descend to lower altitudes during long polar nights, where it is a destroyer of ozone. If this process occurs, it is likely to impact the wind patterns of the stratosphere, which would then affect the Earth's climate.

4.6.3 Launch Site Operations

Since its first launch in March 1969, Poker Flat has supported approximately 219 NASA rockets and an additional 116 for other agencies and organizations. Since 1995, all launches have been NASA-funded missions. Over the past 10 years, launch frequency has averaged approximately four rockets flights per year, with all launches occurring during the winter months when scientific conditions are optimum. This level of activity is expected to remain constant into the reasonably foreseeable future.

As the rockets launched from Poker Flat are suborbital, meaning that they do not place objects into orbit around the earth, all items onboard return to earth, most following a ballistic trajectory. Along its flight path, a sounding rocket “sheds” various components, including rocket motors once their propellant is consumed, and small doors and nosecones prior to the collection of the desired scientific information. Ultimately the scientific experiment, referred to as the payload, also returns to earth. The amount and final landing location of rocket hardware is highly mission-dependent, and varies based upon the rocket configuration and the ultimate scientific objectives. Depending on the nature of the experiment, some payloads may be recovered from their landing locations for analysis or subsequent re-use. Post-flight recovery operations are generally conducted with a combination of fixed and rotary wing aircraft.

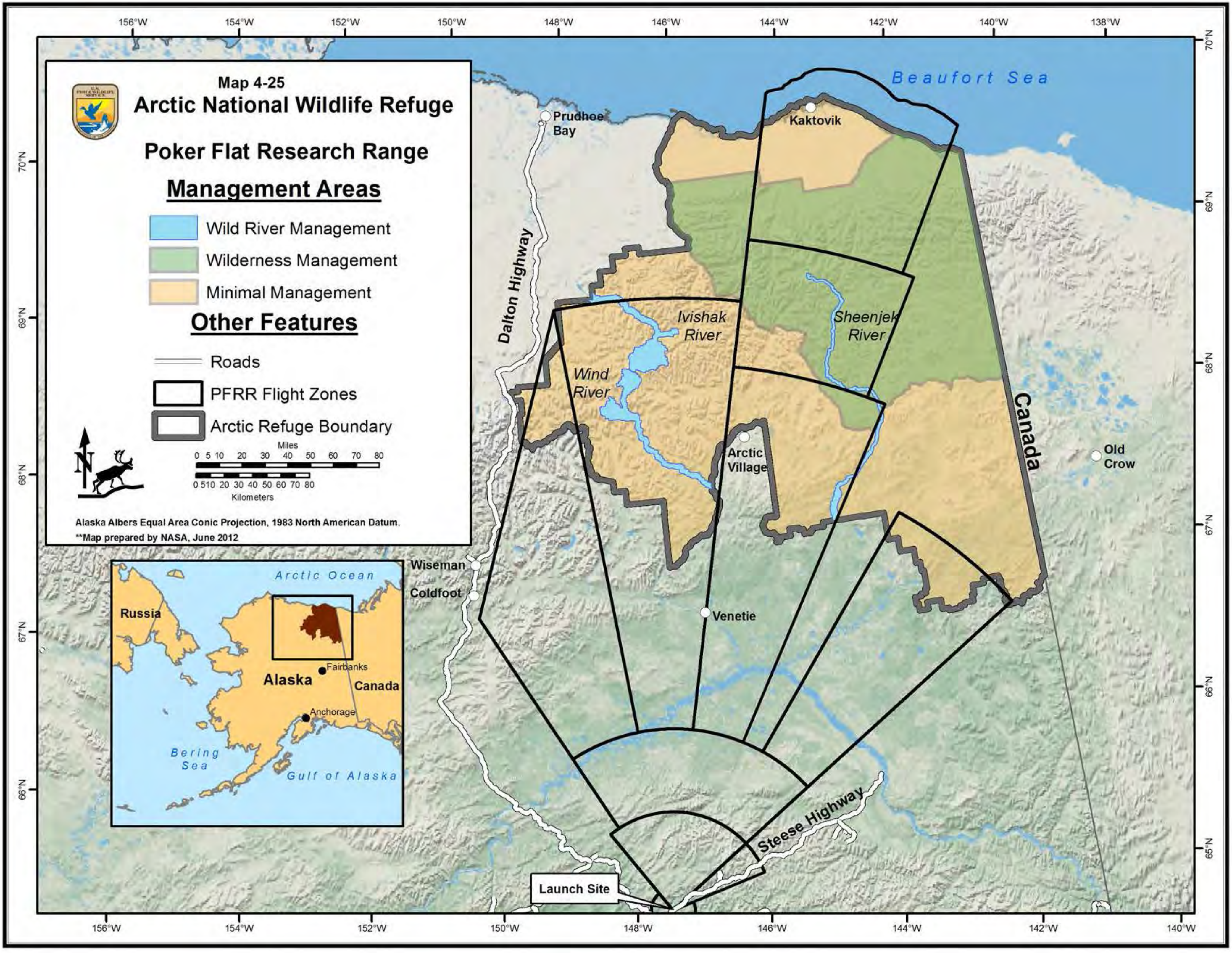
4.6.4 Relationship to Arctic Refuge

Poker Flat has been launching sounding rockets into the Brooks Range area since 1969, before ANILCA (1980) established the Refuge. The original Arctic National Wildlife Range was established in 1960. A number of past and current Poker Flat-launched sounding rockets have the potential to land within the boundaries of Arctic Refuge (Map 4-25); it is estimated that approximately 79-90 rocket motors and 45-55 payloads have landed in Arctic Refuge since the inception of Poker Flat. In the future, it is likely that a greater percentage of NASA missions would need to land in Arctic Refuge due to the trajectories of the higher performing rockets that are more frequently specified by researchers. Therefore, a special use permit is required from the Refuge for Poker Flat to conduct many of its launch and recovery operations. In support of issuing special use permits for rocket and payload impact and recovery, Arctic Refuge completed compatibility determinations in 1994 and 2004.

The University of Alaska-Fairbanks has applied to Arctic Refuge on an annual basis, and the Refuge has issued, a special use permit provided that certain conditions are met, including that Poker Flat cannot have planned landing locations in the Mollie Beattie Wilderness area; landings are prohibited on the remainder of the Refuge from 1 May through 30 September to avoid the high public use season; NASA will maintain a viable rocket component recovery program; and efforts are made to improve NASA’s technology to track and remove items from Refuge lands.

Current operations have not required planned landings in the designated Wilderness. As such, the current special use conditions do not adversely affect NASA’s ability to conduct its missions; most rocket hardware either lands well south or north of Mollie Beattie Wilderness. The Refuge plans to update the existing compatibility determination upon the signing of the record of decision for the Final EIS for the NASA Sounding Rockets Program at Poker Flat, which is expected to be completed in 2013. If future planned landings are proposed in designated Wilderness, a new compatibility determination would be required.

The Revised Plan’s Goal 6 (Chapter 2, Section 2.1.6), and its subsequent objectives, state that the effects of climate change on Refuge resources are to be evaluated through research and monitoring, and considered in management decisions. NASA missions may directly or indirectly contribute to our understanding of and capacity to predict and adapt to climate



Map 4-25
Arctic National Wildlife Refuge
Poker Flat Research Range
Management Areas
Wild River Management
Wilderness Management
Minimal Management
Other Features
Roads
PFRR Flight Zones
Arctic Refuge Boundary
Miles
0 5 10 20 30 40 50 60 70 80
0 5 10 20 30 40 50 60 70 80
Kilometers
Alaska Albers Equal Area Conic Projection, 1983 North American Datum.
**Map prepared by NASA, June 2012
Beaufort Sea
Prudhoe Bay
Kaktovik
Dalton Highway
Ivishak River
Sheenjek River
Wind River
Arctic Village
Canada
Old Crow
Wiseman
Coldfoot
Venetie
Steese Highway
Launch Site
Arctic Ocean
Russia
Alaska
Fairbanks
Canada
Anchorage
Bering Sea
Gulf of Alaska

change. Managers and scientists will maintain and enhance their involvement in broad-scale programs studying the effects of climate change in arctic and subarctic environments.

In addition to climate change, a full range of appropriate and compatible science-based activities would be considered and potentially implemented across Refuge lands and resources, including sounding rocket landings and recoveries in designated Wilderness. These missions could inform the management of lands under Minimal Management as wells as Wilderness stewardship actions taken by Refuge management. However, those missions with no direct or indirect connection to Refuge purposes, goals, objectives, policies, and guidelines would be unable to obtain authorization for landing and recovery in special land designations, and therefore could not be undertaken. Additionally, the impact of rockets and rocket parts in designated Wilderness, and the potential inability to recover them, would be contrary to the Wilderness Act's requirement to preserve Wilderness character.

Given that approximately five percent of NASA's missions launched from Poker Flat within the past 10 years have had direct climate change related research objectives, any future changes in the land management designations of Arctic Refuge (i.e., additional Wilderness) could present land use conflicts. However, the research conducted at Poker Flat has national importance. Additionally, NASA's increased commitment to locating and removing items from downrange lands, with highest priority assigned to designated Wilderness areas, would further reduce the potential effects on Wilderness character and wilderness characteristics. To that end, one way to facilitate Poker Flat's non-conforming use would be for Congress to include a special provision in any Wilderness establishing legislation that would allow the regulated use of the Wilderness area for rocket landings. The record of decision for the Revised Plan will identify whether the Service supports such a provision, should the decision select an alternative that recommends additional Wilderness areas.

5. Environmental Consequences

5.1 Introduction

The purpose of this chapter is to identify, describe, and compare potential environmental effects that could result from implementing the six management alternatives proposed in the Revised Comprehensive Conservation Plan (Plan, Revised Plan) for Arctic National Wildlife Refuge (Arctic Refuge, Refuge). The analysis was conducted for the Environmental Impact Statement (EIS) and to comply with the National Environmental Policy Act (NEPA). Effects on the physical and biological (biophysical) and socioeconomic (human) environments of the Refuge were considered. Existing conditions of the physical, biological, and socioeconomic environment are described in Chapter 4, and care was taken to ensure that the elements of the major issues—Wilderness, wild and scenic rivers, and visitor use management of the Kongakut River, as identified in Chapter 3—were addressed in the analysis contained in this chapter. Current management (Alternative A) provides the basis for comparing the possible environmental effects of Alternatives B through F (Table 5-2).

This chapter includes the following sections:

- Section 5.1 introduces the terms and concepts used throughout this chapter
- Section 5.2 describes the effects common to all alternatives (A – F) and those common to the five action alternatives (B – F). This includes:
    - the effects of the management policies and guidelines (Section 5.2.3)
    - the effects of the goals and objectives (Section 5.2.4)
    - the effects of the Revised Plan on reasonably foreseeable future actions (Section 5.2.5)
- Section 5.3 describes the direct, indirect, and cumulative effects of the No Action alternative, Alternative A
- Sections 5.4 through 5.9 describe the direct, indirect, and cumulative effects from each of the five action alternatives (B – F) as compared to Alternative A.
- Section 5.10 is the ANILCA Section 810 Analysis on the effects of the alternatives on subsistence uses and needs
- Section 5.11 is the analysis of the direct, indirect, and cumulative effects of each of the alternatives on low-income and minority populations in compliance with Executive Orders 12898 and 12948.
- Section 5.12 discloses irreversible and irretrievable commitments of resources
- Section 5.13 discusses the relationship between local short-term uses and the maintenance and enhancement of long-term productivity
- Section 5.14 discloses unavoidable adverse effects

5.1.1 Definitions

Possible effects of each alternative on the biophysical and human environments of the Refuge were compared using a set of general terms to describe the intensity, duration, scale, and nature of potential impacts. In this EIS, these terms are defined as follows:

5.1.1.1 Intensity of the Effects

- No effect – Impacts resulting from the specified management action would not affect resources on Refuge lands or public use opportunities.
- Negligible – Impacts resulting from the specified management action would have no measurable effect on resources on Refuge lands or public use opportunities.
- Minor – Impacts resulting from the specified management action can be reasonably expected to have detectable though limited effect on resources on Refuge lands or public use opportunities.
- Moderate – Impacts resulting from the specified management action can be reasonably expected to have detectable and apparent effect on resources on Refuge lands or public use opportunities.
- Major – Impacts resulting from the specified management action can be reasonably expected to have readily apparent and substantial effect on resources on Refuge lands or public use opportunities.

5.1.1.2 Duration of the Effects

- Short-term – Effects on resources on Refuge lands or public use opportunities that only occur during implementation of a management action.
- Medium-term – Effects on resources on Refuge lands or public use opportunities that occur during implementation of the management action and are expected to persist for some time into the future though not throughout the life of this Plan (not longer than 15 years).
- Long-term – Effects on resources on Refuge lands or public use opportunities that occur during implementation of the management action and are expected to persist throughout the life of this Plan and, most likely, longer (more than 15 years).

5.1.1.3 Scale of the Effects

- Site-specific – Positive or negative impacts occurring at a specific site that is relatively small in size (e.g., a trailhead or nest site).
- Local – Positive or negative impacts occurring throughout a specific area that is large in size (e.g., along an entire trail or throughout an entire home range.).
- Wilderness Study Area (WSA) – Positive or negative impacts occurring throughout one or more WSAs.
- Refuge-wide – Positive or negative impacts occurring throughout the Refuge but that generally do not affect resources or public use opportunities outside the Refuge.
- Regional – Positive or negative impacts occurring throughout or nearly throughout an area, including and much larger than the Refuge. For Arctic Refuge, this would include the Alaskan North Slope, the Brooks Range, and eastern interior Alaska.

5.1.1.4 Nature of the Effects

- Direct – Impacts result from the management action and occur at the same time and place as the action.
- Indirect – Impacts result from the management action but occur later in time and/or farther removed in distance but are still reasonably foreseeable.

- Positive – Impacts resulting from management actions maintain or enhance the quality and/or quantity of resources on Refuge lands or public use opportunities.
- Negative – Impacts resulting from management actions degrade the quality and/or quantity of resources on Refuge lands or public use opportunities.

5.1.2 Resource Categories

As described in Chapter 3, multiple elements combine to create each alternative: goals and objectives; management policies and guidelines; management categories; and issues. Alternative A would continue the management direction from the 1988 Plan and would not include the goals and objectives or management policies and guidelines discussed in the Revised Plan. In this chapter, we will describe the effects of each element of each alternative on the biophysical and human environments, and various resource categories within these environments. We also include a discussion of the scientific return and economic input of each alternative on the Poker Flat Research Range Sounding Rockets Program (see Section 5.1.4).

All resources, species, and public use opportunities on the Refuge are important, but many are not expected to undergo change (positive or negative) as a result of implementing any of the alternatives. For this reason, not all species, resources, or public uses in or related to Arctic Refuge are discussed in this chapter. Site-specific environmental effects of activities that would require NEPA documentation will be addressed in subsequent environmental assessment (EA) documents or EISs.

5.1.2.1 Resource Categories for the Biophysical Environment

For each major planning issue, we analyzed the possible effects of the proposed management alternatives on the physical and biological environments of the Refuge for the following broad categories of resources, which are discussed in detail in Chapter 4:

- Permafrost and soils
- Air quality
- Water quality and aquatic habitats
- Vegetation and terrestrial habitats
- Fish populations and natural diversity
- Bird populations and natural diversity
- Mammal populations and natural diversity

5.1.2.2 Resource Categories for the Human Environment

For each major planning issue, we analyzed the possible effects of the alternative on the human environment of the Refuge for the following categories:

- Local economy and commercial uses
- Cultural resources
- Subsistence
- Visitor services and recreation opportunities
- Wilderness characteristics
- Special designations – these include the Firth-Mancha and Shublik Springs Research Natural Areas (RNAs), the Neruokpuk Lakes Public Use Natural Area (PUNA), the Refuge's Marine Protected Area (MPA), and the Refuge's three existing wild rivers (Ivishak, Sheenjek, and Wind rivers)
- Public health and safety
- Refuge operations

5.1.2.3 Resource Categories for Poker Flat Research Range

The primary purpose of this section is to evaluate the potential effects of the Plan's alternatives on the scientific return and economic input of the Poker Flat Research Range (Poker Flat). Scientific return is described qualitatively and in broad terms. Economic input is discussed quantitatively.

Assumptions - The analysis of potential impacts in this section relies heavily on mission profiles (e.g., trajectories, planned impact points, etc.) from within the past 10 years. Although each future mission would present a specific case, it is expected that the next 10-15 years of activity at Poker Flat will closely resemble the recent past, thereby providing insight into potential impacts or use conflicts under each alternative.

Estimates of economic impacts in this chapter were obtained using the Regional Input-Output Modeling System developed by the Bureau of Economic Analysis (BEA 2011); its multipliers use a combination of national and regional data to estimate the potential economic impacts of an industry's activity on other industries within the region of impact that supplies resources to that industry. Multipliers are provided to estimate impacts on economic output, earnings, employment, and value added. Impacts from economic output are evaluated using the value added to the regional economy in terms of final goods and services directly comparable to gross domestic product, which is a widely used indicator of economic activity that represents the final value of all goods and services. The majority of Poker Flat employees reside in the Fairbanks North Star Borough (FNSB). Therefore, the FNSB is the region of impact for this socioeconomic analysis. Because no substantial economic impact from the Poker Flat facility occurs in the North Slope Borough, we have excluded that region from the model.

5.1.3 Cumulative Effects

At the end of each alternative, we discuss the anticipated cumulative effects on the biophysical and human environments. Cumulative effects include the incremental effects of the actions for an alternative when these are added to past, present, and reasonably foreseeable future actions. Cumulative effects can be the result of individually minor impacts, which can be major when added over time. If there are no direct or indirect effects of a proposed action, then there will be no cumulative effects. As the proposed action is U.S. Fish and Wildlife Service (Service) management of Arctic Refuge, few direct or indirect effects are not negligible or minor. Most effects of Service management are positive on most resources. Therefore, the cumulative effects analysis of each alternative is limited and in all cases only minor, if any, cumulative effects are anticipated. The cumulative effects discussion focuses on the three major issues: Wilderness, wild and scenic rivers, and the Kongakut River.

5.1.4 Reasonably Foreseeable Future Actions

In this section, we describe the reasonably foreseeable future actions considered in our analysis of cumulative effects. Reasonably foreseeable future actions include those Federal and non-Federal activities not yet undertaken, but sufficiently likely to occur, that we should take into account in reaching a decision (43 CFR 46.30). Reasonably foreseeable future actions include but are not limited to actions for which there are existing decisions, funding, or proposals identified by an agency. Reasonably foreseeable future actions do not include those actions that are highly speculative or indefinite. Each of the reasonably foreseeable actions currently under analysis are described briefly here and in more detail in Appendix C.

Gates of the Arctic National Park and Preserve, General Management Plan— In February 2010, Gates of the Arctic National Park and Preserve filed a Notice of Intent to prepare an EIS for an amendment to its 1986 General Management Plan and to conduct a wilderness study. The two planning processes overlap in their analyses of cumulative effects across the Arctic region.

National Petroleum Reserve–Alaska, Integrated Activity Plan and EIS— On March 30, 2012, the Bureau of Land Management (BLM) released a draft Integrated Activity Plan and EIS for the entire National Petroleum Reserve–Alaska (NPR-A). This document updates and replaces current plans for the northeastern and northwestern part of the NPR-A and would, for the first time, provide a plan for the southernmost part of the area. The draft plan incorporates the most current information and lays out management goals, objectives, and actions across the entire NPR-A. Other issues the plan considered are climate change, invasive species, raptor habitat, and the recent listing of polar bears as a threatened and endangered species. The final Integrated Activity Plan and EIS are scheduled to be released in November 2012 with a record of decision (ROD) by the end of the calendar year. The two planning efforts overlap in their analyses of cumulative effects across the Arctic region.

Eastern Interior Resource Management Plan— On February 24, 2012, the BLM released a draft Resource Management Plan for their Eastern Interior Planning Area. The draft plan establishes goals and objectives for managing resources, and it outlines the measures needed to achieve those goals and objectives. It identifies lands available for certain uses, along with any restrictions on those uses, and lands closed to certain uses. BLM's "Upper Black River Unit" is adjacent to the southeast boundary of Arctic Refuge and is currently not included in any existing land use plan. The two planning efforts overlap in their analyses of cumulative effects.

Polar Bear Conservation Plan—The Service is in the early planning stage of developing the Polar Bear Conservation Plan, in compliance with the Endangered Species Act and the Marine Mammal Protection Act. The plan will include a recovery plan and a conservation plan that will guide management and research activities now and into the future; it is scheduled to be completed in the fall/winter of 2013. Polar bears associated with Arctic Refuge are part of the southern Beaufort Sea stock. Arctic Refuge also includes substantial areas of polar bear critical habitat and numerous known den sites (see Chapter 4, Section 4.3.7).

Alaska Pipeline Project—The Alaska Pipeline Project would include a gas treatment plant near Prudhoe Bay, Alaska; a gas transmission pipeline that would connect the Point Thomson field (gas extraction location) to the gas treatment plant; and a transmission pipeline that would deliver the gas to market. A portion of the pipeline is expected to run adjacent to the westernmost border of Arctic Refuge, near the Atigun Gorge. Approvals for the project are expected in 2014, and the first gas extraction is expected to commence in 2020 at the earliest. The cumulative effects areas of the Alaska Pipeline Project and the Revised Plan overlap.

Point Thomson Project—The Point Thomson Project would develop the Thomson Sand Reservoir to extract gas condensate and oil for the purpose of commercial production. The project would be located on the North Slope of Alaska west of Arctic Refuge. The site would include three drilling pads, wells, infield roads, pipelines, a landing area, and a gravel mine. Two of the drilling pads would be located two and five miles from the western boundary of the Refuge: the central pad would be located five miles from the Refuge boundary and eight miles from the Canning River; the east pad would be located two miles from the Refuge boundary and five miles from the Canning River. A final EIS was released in July 2012. Selection of the preferred alternative has been deferred to the project's ROD, which will be issued after public notice of a Clean Water Act Section 404 permit application.

Poker Flat Research Range— The National Aeronautics and Space Administration (NASA) is currently preparing an EIS for its Sounding Rockets Program at the Poker Flat Research Range, and the Service is a cooperating agency for the NASA EIS. Downrange flight zones are the areas over which rockets are launched and within which spent stages and payloads impact the ground. Lands owned or managed by the Service, BLM, State of Alaska, Native Village of Venetie Tribal Government, Alaska Native organizations, and individuals are within these flight zones, including portions of Arctic Refuge. NASA's EIS will assess the impacts of the Sounding Rockets Program, including the effects of recovery versus abandonment of spent rocket parts, payloads, and other equipment. It will also discuss a variety of recovery initiatives. Upon completion of the EIS, NASA hopes the Service will issue limited authorizations for the Poker Flat Sounding Rockets Program so that it may continue.

Foothills West Transportation Access Project— The Foothills West Transportation Access Project (commonly referred to as the Foothills Project or Umiat Road Project) proposes to construct an all season gravel road from the Dalton Highway to Umiat, Alaska. The purpose of the project is to provide access to oil and gas resources both along the northwestern foothills of the Brooks Range and within the NPR-A. The road would provide exploration and development opportunities for the area and facilitate NPR-A development. The U.S. Army Corps of Engineers is currently developing an EIS for the project. The cumulative effects areas of the Foothills West Project and the Revised Plan overlap.

Barter Island Airport Improvements— Barter Island Airport is within Arctic Refuge and provides the only year-round access to the community of Kaktovik, Alaska. The Federal Aviation Administration and North Slope Borough plan to relocate the airport to the south side of Barter Island, about one mile southwest of Kaktovik, onto lands owned by the Kaktovik Iñupiat Corporation (KIC). The site is at the island's highest elevation and is therefore less susceptible to flooding. An EA was completed for this project in January 2009. Construction will begin after freeze-up in late 2012 and is expected to take three years to complete. Under the terms of a land exchange that granted Arctic Slope Regional Corporation the subsurface estate under KIC lands, the Refuge has input over the design and reclamation of the material sites that would be used for the project.

Beaufort Sea Oil and Gas Leases— The Bureau of Ocean Energy Management released a final Programmatic Environmental Impact Statement on June 26, 2012, which analyzes six oil and gas lease planning areas for the leasing period of 2012-2017. The proposed action includes a lease sale in 2017 for the Beaufort Sea Planning Area, including waters just north of Arctic Refuge, with proposed subsistence deferment areas near Kaktovik and an area on the far western border of the planning area. Any sale that takes place in 2017 will require an EIS be provided to the Bureau of Ocean Energy Management prior to any exploration activities in the lease area.

State Notice of Sale of North Slope Leases— On December 7, 2011, the State of Alaska Department of Natural Resources issued a Notice of Sale for 3,145 tracts of State land in the Beaufort Sea, the North Slope, and the North Slope foothills areas. These leases allow for the possibility of oil and gas exploration and development in the areas near Arctic Refuge, including four tracts adjacent to the Refuge boundary.

State of Alaska Predator Management— The Alaska Board of Game authorized intensive management of brown bear in Game Management Unit (GMU) 26B in order to lessen predatory pressure on the GMU's muskox population. GMU 26B contains both State-owned land and a portion of Arctic Refuge. With the exception of Refuge lands, the proposal as accepted by the Board of Game will allow 20 brown bears to be taken annually.

5.2 Effects Common to Alternatives

In this section, we describe the direct and indirect effects that are the same across the alternatives. As discussed in Chapter 3, Section 3.2, multiple elements combine to create each alternative. While we considered the full suite of elements for each alternative in this effects analysis, we found that the primary differences between the alternatives were the effects associated with the different approaches to the three planning issues: Wilderness, wild rivers, and Kongakut River visitor use management. The effects of the management policies and guidelines and the goals and objectives were the same across the five action alternatives (B-F) (see Sections 5.2.1 and 5.2.2). Similarly, the effects of the Revised Plan on the reasonably foreseeable future actions were the same across the alternatives.

Numerous management programs would continue regardless of the alternative selected. For example, we would continue to abide by the International Porcupine Caribou Herd Conservation Agreement, offer the six priority public uses identified in the National Wildlife Refuge System Improvement Act of 1997, and manage the Arctic Village Sheep Management Area. While these programs are not mentioned in the effects analysis, the Refuge is committed to implementing them. Please refer to Chapter 3, Section 3.2.1 for a description of the management programs that would continue under all the alternatives.

5.2.1 Effects of the Planning Issues Common to All Alternatives

5.2.1.1 Effects of the Wilderness Issue Common to All Alternatives

The administrative act of recommending an area for Wilderness designation would have no effect on Refuge resources or operations. Areas recommended for Wilderness would continue to be managed under the Minimal Management category (see Chapter 2, Section 2.3.3) as they are now. Therefore, the effects of the Wilderness issue under each of the six alternatives are the same, even though each alternative presents a different approach to this issue. If Congress were to designate any of Wilderness Study Areas (WSAs) as Wilderness, then the effects would vary across the alternatives, and it is these effects that are discussed in see Sections 5.3 to 5.9.

5.2.1.2 Effects of the Wild and Scenic River Issue Common to All Alternatives

The Wild and Scenic Rivers Act requires rivers determined suitable for designation as wild rivers be managed to maintain their free-flowing character, outstandingly remarkable values, and preliminary or recommended classification (i.e., wild, scenic, or recreational), whether or not they are recommended for designation. Under each alternative, the Refuge would use existing management tools to protect the values for rivers that are suitable but not recommended for designation. Therefore, wild and scenic river suitability determination adds a management commitment to Refuge staff across all alternatives, and the effects on Refuge operations would be negligible to minor, long-term, local, and negative. For a complete description of the effects of maintaining river values for suitable but not recommended rivers on each of the resource categories, please see the effects analysis of the wild and scenic river issue under Alternatives A (Section 5.3). For those alternatives that recommend suitable rivers (Alternatives B-E), additional effects are described.

General efforts to maintain wilderness characteristics and/or manage the Refuge as a naturally functioning ecosystem through the proposed goals, objectives, management policies, and guidelines would be the same for Alternatives B-F. These management tools would generally serve to maintain the free-flowing character of the Refuge's rivers and protect the outstandingly remarkable values of the four rivers found suitable for inclusion in the National Wild and Scenic Rivers System (NWSRS) (for more information, see the effects of the wild and scenic river issue under Alternative F, Section 5.9 of this chapter)).

For alternatives that recommend one or more rivers for inclusion in the NWSRS, additional effects would be incurred beyond baseline effects, and these are described in Sections 5.4 to 5.8.

5.2.1.3 Effects of the Kongakut River Visitor Management Issue Common to All Alternatives

Under all the alternatives, the Kongakut River would continue to be managed under the Wilderness Management category, including the statutory protections afforded by the Wilderness Act. Additionally, a set of management actions already in place and specific to the Kongakut River valley would continue to be used by Refuge staff and the Service under each of the six alternatives (see Chapter 3, Section 3.2.2.3, "Kongakut River Visitor Management" for a description of the management actions common to all the alternatives). In general, we believe existing management provides important protections to the biophysical and human environments in the Kongakut River valley; however, degradation of resources and visitor experience continues. For a complete description of the effects of current management, please see the effects analysis of the Kongakut River visitor use management issue under Alternative A (Section 5.3).

Assumptions - Under all alternatives, the current level of use in the Kongakut River valley is expected to continue, although some of the alternatives would freeze current use levels for up to four years and/or curb (but not halt) visitor impacts on resources. Because the Kongakut River flows through arctic habitats, physical damage (e.g., hardened campsites, trailing, etc.) may be irreparable, or at best take many years to recover. Under all the alternatives, degradation of the Kongakut Rivers's physical and experiential resources would continue, until focused, integrated strategies for mitigating such impacts are developed and implemented through step-down planning, but at variable rates, depending on the alternative (see Sections 5.3 to 5.9 for a discussion of these effects).

All the alternatives include a commitment to complete a Public Use Management Plan (Alternative A) or a Visitor Use Management Plan (VUMP) (Alternatives B-F). Step-down planning efforts would allow the Refuge to address visitor use concerns holistically, rather than drainage-by-drainage or area-by-area, thus limiting or avoiding visitor displacement, public use conflicts, and visitor impacts to other areas of the Refuge. As the step-down plan unfolds, it is likely to have impacts on visitor services and recreational opportunities, local economy and commercial services, and Refuge operations. The effects are likely to be minor to moderate, long-term, local, and positive for most environments affected by the Plan; however, the effects could also be minor to moderate, long-term, local, and negative to any commercial services potentially restricted or curtailed as a result of the step-down plan.

5.2.2 Effects of the Planning Issues on Resource Categories across All Alternatives

This section evaluates the effects that are common or consistent across all the alternatives.

5.2.2.1 Effects of the Planning Issues on the Biophysical Environment across All Alternatives

Permafrost and Soils Under All Alternatives

Under all alternatives, the effects of visitor use and construction of temporary facilities could result in local impacts to soils and permafrost. Damage could include destruction of soil structure by compaction, removal of the uppermost organic layers of soil, soil erosion, melting of permafrost, and ground subsidence due to thawing of buried ice and permafrost. Disturbance would be site-specific and restricted to areas receiving repeated use, such as base camps and aircraft accessible sites. It is anticipated these effects would be negligible to minor, site-specific, long-term, and negative.

Air quality Under All Alternatives

None of the actions or activities presented under any of the alternatives would affect air quality, and there would be no long-term or cumulative effects from Refuge management. Designation of more Wilderness, wild and scenic rivers, or different management scenarios for the Kongakut River would have no effect on air quality.

Water Quality and Aquatic Habitats Under All Alternatives

Under all alternatives, the effects of visitor use on water quality and aquatic habitats are anticipated to be negligible to minor, site-specific, and short-term. Possible negative impacts could arise from spills occurring during potential transfer and storage of fuels supporting boating, aircraft, or other public use activities. Permit stipulations for commercial operators limit storage of fuels on the Refuge. Scientific sampling equipment such as gauging stations could be installed in lands or waters not designated as Wilderness to monitor water quality and quantity in aquatic habitats.

Human waste accumulation could result in negligible to minor diminished water quality in site-specific locations for a short duration with no long-term effects. Water quality monitoring at the Refuge has not been conducted to identify impacts of human waste because it is expected that river water quality throughout the Refuge remains very clean compared to standards established by the Environmental Protection Agency for recreational waters. Damage to vegetation and terrestrial habitats can lead to erosion, which could indirectly result in moderate, long-term, site-specific and negative effects to water quality and aquatic habitats (see “Vegetation and Terrestrial Habitats Under All Alternatives”).

Vegetation and Terrestrial Habitats Under All Alternatives

Under all alternatives, direct effects of visitor use on vegetation include: 1) trampling; 2) damage to trees and shrubs; and 3) the possible introduction of invasive plants. Disturbances to vegetation would be site-specific and restricted to areas receiving repeated use, such as base camps and aircraft accessible sites. We anticipate these effects would be negligible to minor, site-specific, short-term, and negative.

The arctic and subarctic plant communities on the Refuge are slow growing and do not recover quickly from disturbance. Indirect effects of visitor use on vegetation include the effects of soil and snow compaction. Damage to the point that bare ground is exposed can result in erosion, which in turn could have minor to moderate, long-term, site-specific, and negative effects to vegetation and terrestrial habitats, as well as to water quality and aquatic habitats (see "Water Quality and Aquatic Habitats Under All Alternatives").

Fish Populations and Natural Diversity Under All Alternatives

The potential for human activities to affect fish abundance and distribution will vary, depending on the scale, location, and timing of the activity, and this would be true under all alternatives. None of the alternatives would adversely affect Yukon River salmon habitat or populations, or our international treaty obligations regarding fish.

Bird Populations and Natural Diversity Under All Alternatives

The potential for human activities to affect bird abundance and distribution will vary, depending on the scale, location, and timing of the activity, and this would be true under all alternatives. None of the alternatives would adversely affect our international treaty obligations regarding birds.

Mammal Populations and Natural Diversity Under All Alternatives

The potential for human activities such as hunting and trapping to affect mammal abundance and distribution will vary, depending on the scale, location, and timing of the activity, and this would be true under all alternatives. Effects would be managed through regulations, including hunting and trapping regulations, other State and Federal regulations, and any regulations proposed and promulgated as a result of Refuge step-down plans. Current and future regulations will have the same effects under all alternatives. Additionally, none of the alternatives would adversely affect the Porcupine caribou herd or our international agreement regarding this herd.

5.2.2.2 Effects of the Planning Issues on the Human Environment across All Alternatives

Local Economy and Commercial Uses Under All Alternatives

There are no similar or common effects on local economy and commercial uses. Effects on local economy and commercial uses vary across the alternatives.

Cultural Resources Under All Alternatives

Federal and State laws and regulations would continue to provide direction for the management of cultural resources. Inventorying and monitoring would continue as required. People using Refuge lands and waters for a variety of purposes might cause some damage to sites (intentionally or unintentionally). However, loss of cultural resources is primarily a result of natural forces, especially erosion, and is largely due to factors beyond our control. Negative effects could range from minor to major, long-term, and site-specific to local. If there are impacts to properties eligible for National Register of Historic Places inclusion, the impacts are, by definition, not negligible.

Subsistence Under All Alternatives

None of the alternatives would affect the opportunity for continued subsistence uses, nor would they restrict the availability of subsistence resources to federally qualified subsistence hunters.

Visitor Services and Recreation Opportunities Under All Alternatives

None of the alternatives would affect law enforcement and other Refuge staff response to known legal and special use permit violations or to identified natural resource concerns. The Service and the Refuge would continue to respond to such issues in the same manner as they do now.

Wilderness Characteristics Under All Alternatives

Under all alternatives, a management focus on less manipulation of the environment and promoting actions that facilitate solitude, self-discovery, self-reliance, remoteness, and primitive or unconfined recreational experiences would have negligible, indirect, long-term, Refuge-wide, positive effects on wilderness characteristics.

Special Designations Under All Alternatives

There would be no effects to the Neruokpuk Lakes PUNA, Firth-Mancha RNA, or Shublik Springs RNA as a result of Wilderness recommendation or designation. These three areas are already in designated Wilderness.

There would be no effects to the Neruokpuk Lakes PUNA, Firth-Mancha RNA, or the Refuge's three existing wild rivers as a result of wild river recommendation or designation.

Long-term, there would be no effect to the Neruokpuk Lakes PUNA, Firth-Mancha RNA, or Shublik Springs RNA as a result of Kongakut River visitor use management, nor would there be any direct effects to the Refuge's three existing wild rivers. However in the short-term, interim management could affect these special designations if commercial recreational guides elect to divert their operations from the Kongakut River to the PUNA, RNAs, or existing wild rivers (see "Special Designations" in Sections 5.4.3 and 5.5.3,).

Public Health and Safety Under All Alternatives

Under all alternatives, the Refuge manager is authorized in emergencies to take whatever prudent and reasonable actions are necessary to address public health and safety. In this regard, there are no differences between the alternatives, and there would be no adverse effect to public health and safety under any of the alternatives.

Refuge Operations Under All Alternatives

Based on the long-range planning and budget forecasts for the Department of the Interior (DOI) and the Service, appropriations and agency funding are expected to be flat or decreasing. The Service would be limited in operational funds, which would have a moderate to major effect on future staffing and operational capacities. Some needed positions would not be filled. Some programs would be reduced or eliminated based upon current program needs and priorities. The lack of staffing would result in an inability to ensure adequate resource management oversight, provision of visitor use activities, and planning for the future.

Under all five action alternatives, future step-down planning and the need to complete Minimum Requirement Analyses (MRAs) for all past and future management actions in designated Wilderness would result in moderate, short-term, Refuge-wide, and negative impacts to Refuge operations. Once completed, step-down plans and the monitoring protocols and other management controls that the plans would put in place, should increase staff efficiency and reduce the amount of time Refuge staff spend on resource concerns. Long-term, these effects would be minor to moderate, Refuge-wide, and positive.

5.2.2.3 Effects of the Planning Issues on Poker Flat Research Range across All Alternatives

Nothing in any of the alternatives would directly limit or curtail the Poker Flat Sounding Rockets Program. The administrative act of recommending Wilderness or wild rivers would have no effect on Poker Flat, nor would any of the management actions proposed for the Kongakut River. If Congress were to designate additional Wilderness or wild rivers, potential effects on Poker Flat would vary across alternatives, as discussed elsewhere in this chapter.

5.2.3 Effects of the Management Policies and Guidelines

For Alternative A, the Management Policies and Guidelines (guidelines) included in the 1988 Plan would continue to be used. Continuing management under the 1988 guidelines would not change the current situation; thus, any impacts on the biophysical or human environment resulting from current management would continue under Alternative A. However, all five of the action alternatives (B–F) would adopt new Arctic Refuge management policies and guidelines. This section evaluates the effects of the new guidelines and policies on resource categories. For an explanation of the differences between the management direction under Alternative A and that which would be adopted under Alternatives B-F, please refer to Table 3-2 in Chapter 3, Section 3.3.

As in the 1988 Plan, the Revised Plan assigns management direction to three categories—Minimal, Wild River, and Wilderness Management. None of the alternatives in this Revised Plan assign Refuge lands to the Intensive or Moderate Management categories. Lands recommended in this Plan for Wilderness or wild river status are managed in the Minimal Management category and would be assigned to the Wilderness or Wild River Management categories only if Congress designated those lands and waters as part of the National Wilderness Preservation System (NWPS) or the NWSRS.

5.2.3.1 Effects of the Management Policies and Guidelines on the Biophysical Environment

Those changes in the management policies and guidelines that have effects on the biophysical environment include:

1) an added emphasis on studying the effects of climate change on wildlife and ecosystems, including modeling future scenarios (Chapter 2, Section 2.4.10.1);
2) an increased focus on perpetuating the distinctive qualities of the Refuge's resources in their natural condition and retaining their wild character (Chapter 2, Section 2.4.11.1); and
3) an increased focus on maintaining the natural diversity of native species and maintaining functioning ecosystems without human interference.

By emphasizing the perpetuation of ecological processes, natural diversity, and the free function of natural communities in the Refuge, the management policies and guidelines would allow the Refuge to continue to serve as a natural laboratory of international importance and provide opportunities for scientific understanding of wildlife, ecology, geophysics, and the changing climate. We believe implementing the management policies and guidelines would have a positive effect on the biophysical environment. Habitat manipulation or other management actions may be authorized by the Refuge manager in cases of management emergencies (see Chapter 2, Section 2.4.2).

Effects of Guidelines on Permafrost and Soils

Perpetuating natural conditions, wild character, biological diversity, and maintaining intact ecosystem function (recognizing that ecosystems are dynamic) would allow natural vegetative cover to protect soils and permafrost from damage, and have negligible to minor, long-term, Refuge-wide, and positive effects on permafrost and soils. Implementing the guidelines could result in increased knowledge of climate change and improved ability to understand, predict, and manage for environmental responses to arctic climate change. However, the guidelines also direct the Service to generally avoid intervening with resources in the Refuge in response to climate change or naturally occurring events, unless the event is determined to be a management emergency. This approach could result in minor to moderate, short- to long-term, site-specific to local, and negative effects if events resulted in the degradation or loss of permafrost and soils. Climate change is not part of our management actions and we would not be able to mitigate for or minimize these effects.

Effects of Guidelines on Air Quality

Implementing the guidelines would have no effect on air quality. Episodes of reduced air quality currently come from long-range transport, such as from forest fires in interior Alaska and industry in Asia, or from industrial developments outside the Refuge. These sources are beyond the purview of the Revised Plan. Wildfires occur on the Refuge occasionally during the summer months and can negatively influence air quality. Ninety-eight percent of the Refuge (including designated Wilderness) is under the "Limited Management Option," meaning no suppression will occur unless a life-threatening situation or threats to communities exists. Some climate change models predict increased incidence of wildfires in boreal and arctic regions. Increased wildfire incidence would cause minor to moderate, regional, short-term, negative effects on air quality.

Effects of Guidelines on Water Quality and Aquatic Habitats

Perpetuating natural conditions, wild character, biological diversity, and maintaining intact ecosystem function (recognizing that ecosystems are dynamic) would allow natural vegetative cover to protect water quality and aquatic habitats, such as protecting soils from erosion. Effects would be negligible to minor, long-term, Refuge-wide, and positive for water quality and aquatic habitats. However, the guidelines direct the Service to generally avoid intervening with resources in the Refuge in response to climate change or naturally occurring events, unless the event is determined to be a management emergency. This approach could result in minor, short- to long-term, site-specific to local, and negative effects if events resulted in the degradation of water quality and aquatic habitats. Climate change is not part of our management actions and we would not be able to mitigate for or minimize these effects.

Effects of Guidelines on Vegetation and Terrestrial Habitats

Perpetuating native species in their natural diversity and maintaining intact ecosystem function could lessen damage to vegetation and terrestrial habitats resulting from administrative, development, and visitor use activities. Implementing the guidelines could result in increased knowledge of climate change and invasive species and an improved ability to understand, predict, and manage for the environmental responses of vegetation and terrestrial habitats. The effects would be negligible to minor, long-term, Refuge-wide, and positive for vegetation and terrestrial habitats. However, the guidelines also direct the Service to generally avoid intervening with resources in the Refuge in response to climate change or naturally occurring events, unless the event is determined to be a management emergency. This approach could result in minor, short- to long-term, site-specific to local, and negative effects if events and/or changing climate resulted in the degradation or loss of vegetation and terrestrial habitats. Climate change is not part of our management actions and we would not be able to mitigate for or minimize these effects.

Effects of Guidelines on Fish Populations and Natural Diversity

Perpetuating populations and native species in their natural diversity and maintaining intact ecosystem function (recognizing that ecosystems are dynamic) would allow fish populations and natural diversity to continue without human intervention. Effects would be negligible to minor, long-term, Refuge-wide, and positive for fish populations and natural diversity. However, the guidelines direct the Service to generally avoid intervening with resources in the Refuge in response to climate change or naturally occurring events, unless the event is determined to be a management emergency. This approach could result in changes to species presence, abundance, or distribution; the gradual loss or decline of some fish populations; or new species might move into the area. The effects could be positive, negative, or neutral, depending on what actually occurs and people's perceptions of these changes.

Effects of Guidelines on Bird Populations and Natural Diversity

Perpetuating populations and native species in their natural diversity and maintaining intact ecosystem function (recognizing that ecosystems are dynamic) would allow bird populations and natural diversity to continue without human intervention. Most bird species are migratory, and therefore beneficial effects could be expressed over a larger area than the Refuge. Effects would be negligible to minor, long-term, regional or greater, and positive for bird populations and natural diversity. However, the guidelines direct the Service to generally avoid intervening with resources in the Refuge in response to climate change or naturally occurring events, unless the event is determined to be a management emergency. This approach could result in changes to species presence, abundance, or distribution; the gradual loss or decline of some bird populations; or new species might move into the area. The effects could be positive, negative, or neutral, depending on what actually occurs and people's perceptions of these changes. Again, because most bird species are migratory, effects could be expressed over a larger area than the Refuge.

Effects of Guidelines on Mammal Populations and Natural Diversity

Perpetuating populations and native species in their natural diversity and maintaining intact ecosystem function (recognizing that ecosystems are dynamic) would allow mammal populations and natural diversity to continue without human intervention. Some mammal species range over large areas, and therefore beneficial effects could be expressed over a larger area than the Refuge. Effects would be negligible to minor, long-term, Refuge-wide to regional, and positive for mammal populations and natural diversity. However, the guidelines direct the Service to generally avoid intervening with resources in the Refuge in response to climate change or naturally occurring events, unless the event is determined to be a management emergency. This approach could result in changes to species presence, abundance, or distribution; the gradual loss or decline of some mammal populations; or new species might move into the area. The effects could be positive, negative, or neutral, depending on what actually occurs and people's perceptions of these changes. Again, because some mammal species are migratory or range over large areas, effects could be expressed over a larger area than the Refuge.

5.2.3.2 Effects of the Management Policies and Guidelines on the Human Environment

Those changes in the management guidelines that have effects on the human environment would include:

1) an increased emphasis on improving formal consultation and coordination with tribal governments, regional and village corporations, and local village councils regarding issues and programs that could affect Native people, their communities, and subsistence use (Chapter 2, Section 2.4.9.2);
2) an increased focus on ensuring local rural residents and the Federal Subsistence Regional Advisory Councils associated with the Refuge have a meaningful role and the opportunity to participate in the Federal Subsistence rule-making process (Chapter 2, Section 2.4.13);
3) a focus on managing recreation in a manner consistent with the Refuges special values (Chapter 1, Section 1.5) and with an increased emphasis on providing opportunities to experience wildness, adventure, freedom, independence, self-reliance, solitude, and discovery (Chapter 2, Section 2.4.15)
4) a focus on perpetuating the distinctive qualities of the Refuge's resources in their natural condition and retaining their wild character (Chapter 2, Section 2.4.11.1);

By focusing management on the special values of the Refuge and working more closely with local communities, the management policies and guidelines would maintain and enhance the human environment, especially subsistence opportunities and various recreational pursuits. In general, we believe the management policies and guidelines would have a positive effect on the human environment.

Effects of Guidelines on Local Economy and Commercial Uses

Implementing the management policies and guidelines could affect local economies or commercial uses to the extent that commercial services catering to recreationists seeking opportunities to experience independence, self-reliance, and solitude might be enhanced, and those more dependent on visitor use facilities and larger, supported groups could be reduced. These effects are likely to be negligible, long-term, Refuge-wide, and negative or positive, depending on whether there is net economic gain or loss to the economy. There would be no effect to local economies or commercial uses from such activities as mineral exploration or development or the commercial gathering of resources such as fish and timber. Such activities do not currently occur on the Refuge, and there would be no change in the management direction concerning such activities regardless of the alternative selected (A – F).

Effects of Guidelines on Cultural Resources

Improving communications, consultations, and cooperation with tribal governments, Native corporations, village councils, and Native organizations would help the Service better understand cultural resource issues and concerns, and would help us identify opportunities for mutual cooperation. Effects would be minor, long-term, Refuge-wide, and positive by ensuring the conservation and protection of cultural resources and the continuation of traditional Native use.

Effects of Guidelines on Subsistence

Perpetuating wildlife and plant populations and natural diversity, while maintaining intact ecosystem function would provide negligible, long-term, Refuge-wide, and positive effects on the availability of subsistence resources and the opportunity for continued subsistence use. However, the guidelines direct the Service to generally avoid intervening with resources in the Refuge in response to climate change or naturally occurring events, unless the event is determined to be a management emergency, including subsistence resources. This approach could result in the gradual loss or decline of subsistence resources, or result in them changing through time. The effects would likely be minor, long-term, Refuge-wide to regional, and negative.

An increased effort to improve communications, consultations and cooperation with local village residents, tribal governments, Native corporations, Native organizations, and Federal Subsistence Regional Advisory Councils associated with the Refuge would provide minor, long-term, Refuge-wide, positive effects since it would ensure local rural residents have a meaningful role and the opportunity to participate in the Federal subsistence rule-making process for the conservation and use of subsistence resources. New guidelines restricting the use of domestic goats, sheep, and camelids on the Refuge could help prevent the spread of disease, primarily to Dall's sheep, and indirectly lead to minor, long-term, Refuge-wide, positive effects on subsistence resource availability and access.

Effects of Guidelines on Visitor Services and Recreation Opportunities

Promoting minimal to no evidence of human modifications or changes upon the landscape, including signs, kiosks, visitor facilities, or roads would have negligible to minor, long-term, Refuge-wide effects. Effects could be seen either as positive or negative, depending on the perspectives and expectations of the Refuge user. By emphasizing recreational opportunities to experience wildness, adventure, freedom, independence, self-reliance, solitude, and discovery, visitor services catering to recreationists seeking such opportunities could be enhanced. Conversely, there could be a reduction in visitor services more dependent on visitor use facilities and larger, supported groups. These effects are likely to be negligible, long-term, Refuge-wide, and negative or positive, depending on the perspective of the Refuge user.

Visitor services and recreation opportunities dependent on select pack animals including domestic goats, sheep, and camelids (e.g., alpacas and llamas) would not be allowed on Arctic Refuge; straw and hay bedding would not be allowed for dog teams; and pelletized weed-free feed would be required for other types of pack animals (e.g., horses) (see Chapter 2, Sections 2.4.12.8 and 2.4.12.9). These policies would result in negligible, long-term, Refuge-wide, and negative effects to recreationists and commercial service providers using pack animals; however, these management provisions should also result in negligible to minor, long-term, Refuge-wide, and positive effects on wildlife populations, especially Dall's sheep.

Under the 1988 Plan, the Refuge could authorize helicopter landings through a special use permit; however, none have been issued on Arctic Refuge for recreational access. Thus, there would be no change in actual use of helicopters for recreational access by implementing any of the alternatives.

Effects of Guidelines on Wilderness Characteristics

Less manipulation of the environment and more promotion of actions that facilitate solitude, self-discovery, self-reliance, remoteness, and primitive or unconfined recreational experiences would provide minor, long-term, Refuge-wide, positive effects to wilderness characteristics.

Effects of Guidelines on Special Designations

The management policies and guidelines would adopt a management approach where natural systems prevail and there would be little direct management intervention, except for restoration of impaired sites. This could have indirect, negligible, long-term, local, and positive effects on the Refuge's specially designated areas under the five action alternatives (B – F).

Effects of Guidelines on Public Health and Safety

The management policies and guidelines direct the Refuge to avoid using signs, marked trails, roads, public use cabins, or other similar visitor facilities on the Refuge. While the use of these tools could increase safe travel through wild areas, this management approach is no different than under current management, and therefore there is no effect. It may be necessary when an emergency occurs on the Refuge to deviate from the Plan's policies and guidelines and undertake actions not normally allowed on the Refuge to ensure public health and safety.

Effects of Guidelines on Refuge Operations

In accordance with current national and regional Service policies, all Refuge management activities in designated Wilderness must be supported by an MRA whether or not any prohibited uses are proposed. Normally prohibited uses (e.g., motor vehicles, motorized equipment, helicopters, structures, installations, temporary roads, etc.) would be approved only where found to be the minimum necessary to manage the area as Wilderness. This change would increase the paperwork burden on Refuge staff, but would enhance Wilderness character. Effects on Refuge operations would likely be negligible, long-term, and negative for those management activities in designated Wilderness.

Nothing in the Revised Plan would affect the jurisdiction or responsibilities of the State with respect to fish and wildlife management. However, the management policies and guidelines would generally adopt a non-intervention approach to fish and wildlife management, with exceptions for management emergencies; this approach could conflict with State fish and wildlife management goals.

5.2.3.3 Effects of the Management Policies and Guidelines on Poker Flat Research Range

The new management policies and guidelines do not address NASA or Poker Flat by name and would have no direct effects on the Sounding Rockets Program. Because the new guidelines support naturally functioning ecosystems, retaining wilderness characteristics, and minimizing human imprints on the landscape, adopting the new guidelines would indirectly affect Poker Flat. In order to meet the guidelines, the Refuge would expect NASA to continue efforts to clean up past and future spent rocket parts throughout the Refuge. NASA would be considered an important partner in meeting the guidelines. Implementing the guidelines would result in minor, short- and long-term, Refuge-wide, and negative economic effects to NASA due to increased costs associated with clean-up efforts. On the other hand, implementing the guidelines would support increasing our knowledge of climate change and other scientific pursuits, and indirectly this could result in negligible to minor, long-term, Refuge-wide, and positive effects to the scientific return of Poker Flat and the Sounding Rockets Program.

5.2.4 Effects of the Goals and Objectives

The 1988 Plan did not include goals, objectives, or strategies for managing the Refuge. Because Alternative A is a continuation of current management, Alternative A would not include goals or objectives, consistent with current Refuge management. Continuing management under the 1988 Plan would not change the current situation; thus, any impacts on the biophysical or human environment resulting from current management would continue under Alternative A. However, all five of the action alternatives (B–F) would adopt new management goals and objectives for Arctic Refuge.

The Revised Plan contains a set of nine goals with associated objectives and strategies that would be implemented over the 15-year life of the Plan (see Chapter 2, Section 2.1). These goals, objectives, and strategies would allow the Refuge to more proactively direct staff, funding, and other resources towards management of the Refuge than we currently do under the 1988 Plan. The following sections evaluate the effects of the proposed goals and objectives on resource categories in the biophysical and human environments, including effects on the Poker Flat Research Range Sounding Rockets Program.

5.2.4.1 Effects of the Goals and Objectives on the Biophysical Environment

The proposed goals and objectives support naturally functioning ecosystems, retaining wilderness characteristics, and conducting collaborative research on a variety of resources within the Refuge and on climate change. Although public use is encouraged, visitors are also encouraged to minimize impacts on Refuge resources. In general, we anticipate implementing goals and objectives would have a positive effect on the biophysical environment.

Effects of Guidelines on Permafrost and Soils

Goals and objectives that encourage Refuge users to minimize impacts would have minor, long-term, local, and positive effects on soils and permafrost, while objectives focused on restoring damaged or impaired sites could have minor to moderate, long-term, site-specific, and positive effects on permafrost and soils. Implementing the goals and objectives would result in increased knowledge of climate change and an improved ability to understand, predict, and manage for environmental responses to arctic climate change. Therefore, goals and objectives focused on maintaining functioning ecosystems without human interference would indirectly provide negligible, long-term, Refuge-wide, and positive effects on permafrost and soils.

Effects of Guidelines on Air Quality

Implementing the goals and objectives would have no effect on air quality.

Effects of Guidelines on Water Quality and Aquatic Habitats

Goal 3 and its associated objectives focus specifically on research and studies that would increase our understanding of and appreciation for waters in the Refuge and the diverse aquatic habitats these waters support. Implementing this goal and its objectives would increase knowledge of aquatic habitats and their function in the Refuge. They would also improve our ability to respond to any water quality and aquatic habitat concerns identified by these studies. Indirectly then, Goal 3 and its objectives would have minor to moderate, long-term, Refuge-wide, and positive effects on water quality and aquatic habitats.

Multiple goals and objectives are aimed at perpetuating biological diversity and wilderness characteristics and maintaining intact ecosystem function, including water quality and aquatic habitats. These would result in negligible, long-term, Refuge-wide, and positive effects on water quality and aquatic habitats. Goals and objectives that encourage Refuge users to minimize impacts and those that would establish user capacities (Objective 3.5) would have negligible to minor, long-term, site-specific, and positive effects on water quality and aquatic habitats.

Effects of Guidelines on Vegetation and Terrestrial Habitats

Goals and objectives that encourage Refuge users to minimize impacts to vegetation would have negligible to minor, long-term, local, and positive effects, while objectives focused on restoring damaged or impaired sites would have minor to moderate, long-term, site-specific, and positive effects on vegetation and terrestrial habitats. Goals and objectives focused on long-term collaborative research on vegetation and habitats and maintaining intact ecosystem function would improve our ability to understand, predict, and manage vegetation and terrestrial habitats, resulting in indirect, negligible, long-term, Refuge-wide, and positive effects on vegetation and terrestrial habitats.

Effects of Guidelines on Fish Populations and Natural Diversity

Implementing those goals and objectives that would increase knowledge of aquatic habitats and their function in the Refuge and those that would improve our ability to respond to water quality and aquatic habitat concerns would provide negligible, indirect, long-term, Refuge-wide, and positive effects on fish populations and natural diversity. Similarly, goals and objectives requiring long-term collaborative research on fish populations and natural diversity and those focused on maintaining intact ecosystem function would indirectly provide negligible to minor, long-term, Refuge-wide, and positive effects on fish populations and natural diversity.

Effects of Guidelines on Bird Populations and Natural Diversity

Goals and objectives requiring long-term collaborative research on bird populations and natural diversity and those focused on maintaining intact ecosystem function would indirectly provide negligible to minor, long-term, Refuge-wide, and positive effects on bird populations and natural diversity.

Effects of Guidelines on Mammal Populations and Natural Diversity

Goals and objectives requiring long-term collaborative research on mammal populations and natural diversity and those focused on maintaining intact ecosystem function would indirectly provide negligible to minor, long-term, Refuge-wide, and positive effects on mammal populations and natural diversity.

5.2.4.2 Effects of the Goals and Objectives on the Human Environment

The proposed goals and objectives support naturally functioning ecosystems, retaining wilderness characteristics, and providing opportunities for wildlife-dependent and wilderness-associated recreational activities. Although public use is encouraged, visitors are also encouraged to minimize impacts on Refuge resources. In consultation with appropriate parties, the Refuge would provide for continued subsistence opportunities and document, conserve, and protect cultural resources. While on-site visitor contacts would be minimized, Refuge staff would provide outreach to those interested in the Refuge to enhance their understanding, appreciation, and stewardship of the Refuge and its resources. In general, we anticipate implementing the goals and objectives would have a positive effect on the human environment.

Effects of Goals and Objectives on Local Economy and Commercial Uses

Nothing in the goals and objectives would directly affect local economy and commercial uses as compared to the current situation; therefore, the goals and objectives would have no effect on local economy and commercial uses. Local economy and commercial uses could potentially be indirectly affected by goals and objectives requiring step-down plans that in turn result in changes to visitor or commercial services. Such effects would likely be negligible, long-term, Refuge-wide, and positive or negative, depending whether there is net economic gain or loss to the economy.

Effects of Goals and Objectives on Cultural Resources

Goal 8 and its associated objectives focus specifically on documenting, protecting, and conserving cultural resources in consultation with appropriate parties. Implementing this goal and its objectives would result in moderate, Refuge-wide to regional, long-term, positive effects on cultural resources.

Effects of Goals and Objectives on Subsistence

Goals and objectives that focus on perpetuating wildlife and plant populations, and natural diversity, while maintaining intact ecosystem function would provide negligible, long-term, Refuge-wide to regional, and positive effects on the availability of subsistence resources and the opportunity for continued subsistence use. Goal 4 and its associated objectives focus on improving communications, consultations, and cooperation with local village residents, tribal governments, Native corporations, Native organizations, and Federal Subsistence Regional Advisory Councils associated with the Refuge. Implementing this goal and its objectives would provide minor to moderate, Refuge-wide to regional, long-term, positive effects by ensuring the continuation of subsistence opportunities and providing local rural residents to have a meaningful role and the opportunity to participate in the Federal subsistence rule-making process for the conservation and use of subsistence resources.

Effects of Goals and Objectives on Visitor Services and Recreation Opportunities

Goals 5 and 9, and their associated objectives, focus on providing opportunities for wildlife-dependent and wilderness-associated recreation and on providing outreach to enhance understanding, appreciation, and stewardship of the Refuge. These goals and objectives encourage Refuge users (including Refuge staff) to minimize impacts, and signs, kiosks, and visitor facilities would be avoided in the Refuge.

Visitor use of the Refuge is higher in some areas than in other areas, and both biophysical resources and visitor experiences have changed or been impaired in specific high-use areas. Effects could worsen if visitation to popular locations continues to increase without active restoration of sites or management of visitor experiences. Effects could include the displacement of visitors and visitor services to other areas of the Refuge and/or the differential availability of certain recreation opportunities and the visitor services that cater to them. Objective 5.4 would require the Refuge to complete a Refuge-wide VUMP that would address visitor services and recreational opportunities holistically across the entire Refuge.

The effects of the goals and objectives on visitor services and recreation opportunities would be minor to moderate, Refuge-wide, and long-term. Effects could be seen either as positive or negative, depending upon the perspectives and expectations of the Refuge user. Refuge staff believes visitor services and recreational opportunities will ultimately be improved by implementing the Plan's goals and objectives.

Effects of Goals and Objectives on Wilderness Characteristics

Goal 2 and its associated objectives focus on perpetuating natural conditions and wilderness characteristics throughout the Refuge. Goal 5 and its objectives provide for wilderness-associated recreational opportunities including promoting opportunities for self-discovery, self-reliance, solitude, and primitive or unconfined recreational experiences. The goals and objectives would result in minor, long-term, Refuge-wide, positive effects to wilderness characteristics.

Effects of Goals and Objectives on Special Designations

Objective 3.5 prioritizes completing a Comprehensive River Management Plan (CRMP) for each of the Refuge's existing three designated wild rivers. Implementation would result in minor, long-term, local, and positive effects for the Ivishak, Sheenjek, and Wind wild river corridors. Objectives focused on water assessment and monitoring could also have minor, long-term, local, and positive effects on the Refuge's three designated wild rivers if they were to be included in the monitoring and assessment study.

Objective 3.1 prioritizes study of the Refuge's MPA. An increased understanding of natural variability in near shore ecosystems, the relationships between marine and terrestrial systems, and the potential impacts of climate change on lagoon ecosystems would improve our ability to manage the MPA and indirectly result in negligible to minor, long-term, local, and positive effects for the MPA.

The goals and objectives would have no effect on the Firth-Mancha or Shublik Spring RNAs or the Neruokpuk Lakes PUNA special designations.

Effects of Goals and Objectives on Public Health and Safety

Objective 5.3 (Chapter 2, Section 2.1.5) directs the Refuge to avoid using signs, marked trails, roads, public use cabins, or other similar visitor facilities on the Refuge. While the use of these tools could increase safe travel through wild areas, this management approach is no different than under current management, and therefore there is no effect. It may be necessary when an emergency occurs on the Refuge to deviate from the Plan's policies and guidelines and undertake actions not normally allowed on the Refuge to ensure public health and safety.

Effects of Goals and Objectives on Refuge Operations

The goals and objectives call for developing six step-down management plans; implementing a visitor use study, a traditional access study, and a national interest study; develop protocols and priorities for scientific research by cooperators; repeat baseline water quality studies, initiate study of the MPA; identify and determine the status of rare species; complete a cultural resource inventory and develop a cultural resource atlas and archive; review existing MRAs and complete new MRAs; and conduct environmental analyses as appropriate for proposed projects. The full set of goals and objectives outline priority projects and programs for managing the Refuge. Some work would be a continuation of existing activities being conducted under current management. New projects, studies, and programs would be in addition to ongoing commitments. Implementing the goals and objectives would result in moderate, short- to long-term, Refuge-wide effects to Refuge operations. In the short-term, the effects would be negative as current Refuge operation priorities would change and the staff would take on new work. However, in the long-term, the goals and objectives would allow the Refuge to more proactively direct staff, funding, and other resources towards management of the Refuge, and the completed programs and projects would improve staff knowledge, efficiency, and ability to manage resources in the Refuge. Thus long-term, the effects would be positive.

5.2.4.3 Effects of the Goals and Objectives on Poker Flat Research Range

Objective 5.4 includes restoring natural conditions and visitor experiences. Objective 2.7 focuses on restoring damaged or impaired sites, removing contaminants, and cleaning up debris across the Refuge. NASA is specifically mentioned in Objective 2.7 as a partner for removing spent rocket parts. Implementing the goals and objectives would result in minor, short- and long-term, Refuge-wide, negative economic effects to NASA due to costs associated with clean-up efforts. Goals 6 and 7 focus on the Refuge partnering and collaborating with other scientists on long-term climate change and ecological research. To the extent that NASA would continue to collaborate or contribute to these efforts, there would be negligible to minor, long-term, Refuge-wide to regional, positive effects on scientific return.

5.2.5 Effects of the Alternatives on Reasonably Foreseeable Future Actions

This section discusses the anticipated effects of the Revised Plan on the twelve reasonably foreseeable future actions identified in Section 5.1.4. The effects of the Revised Plan would be the same across all the alternatives, with the exception of Poker Flat, which is discussed in the analysis under each alternative. The effects of the proposed actions on Arctic Refuge are briefly mentioned in Appendix C and will be disclosed in the NEPA documents that have or will be prepared for each of the actions.

Gates of the Arctic National Park and Preserve, General Management Plan— None of the alternatives in the Revised Plan would be expected to adversely affect the General Management Plan because both conservation system units operate under the mandates of ANILCA and have similar management objectives. For those resources that are shared between the conservation system units, such as far-ranging wildlife populations, the Revised Plan's focus on perpetuating natural diversity and letting ecological systems prevail should be positive for the General Management Plan. It is possible that some commercial service providers could decide not to operate in Arctic Refuge in response to the Service's management policies, and they could be displaced to Gates of the Arctic. These effects would likely be negligible. The Service and National Park Service will continue to coordinate their respective planning efforts.

National Petroleum Reserve-Alaska, Integrated Activity Plan and EIS— Due to the distance to the Refuge, we do not expect any of the alternatives in the Revised Plan would have any effect on the Integrated Activity Plan and EIS. The Service and BLM will continue to coordinate their respective planning efforts.

Eastern Interior Resource Management Plan— None of the alternatives in the Revised Plan would be expected to affect the Resource Management Plan. It is possible that some commercial service providers could decide not to operate in Arctic Refuge in response to the Service's management policies, and they could be displaced to Eastern Interior lands managed by BLM. These effects would likely be negligible. The Service and the BLM will continue to coordinate their respective planning efforts.

Polar Bear Conservation Plan— None of the alternatives in the Revised Plan would be expected to affect the Polar Bear Conservation Plan.

Alaska Pipeline Project— None of the alternatives in the Revised Plan are expected to affect the Alaska Pipeline Project.

Point Thomson Project— None of the alternatives in the Revised Plan would be expected to have any direct or indirect effects on the Point Thomson Project. The Service and the U.S. Army Corps of Engineers will continue to coordinate our respective planning efforts.

Poker Flat Research Range— Effects of the Revised Plan's alternatives on the Poker Flat Sounding Rockets Program vary across alternatives and are described in each section of this chapter.

Foothills West Transportation Access Project— We do not expect the Revised Plan to have any impact on the Foothills West Transportation project.

Barter Island Airport Improvements— None of the alternatives in the Revised Plan would be expected to affect the Barter Island Airport Improvement project.

Beaufort Sea Oil and Gas Leases— The Revised Plan would not have any impact on the sale of oil and gas leases in the Beaufort Sea, nor would we expect any of the Plan's alternatives to affect any future oil and gas exploration and development activities stemming from the leases.

State Notice of Sale of North Slope Leases— None of the alternatives in the Revised Plan would affect the actions taken by the State of Alaska in regards to the sale of oil and gas leasing or any future oil and gas exploration and development activities stemming from the leases.

State of Alaska Predator Management Proposal 130— The Service does not expect any of approaches to the planning issues in the Revised Plan to affect this action. However, the management policies and guidelines that would be adopted under alternatives B–F would focus Refuge management on perpetuating natural diversity, letting ecological systems prevail, and generally avoiding responses to climate change. This management approach could adversely affect the State's efforts to achieve target wildlife population levels.

5.3 Effects of Alternative A (Current Management)

Alternative A is the continuation of current management. The impacts on resources described in this section are expected to occur if current management of the Refuge continues into the future. This section evaluates the implication or impacts on resource categories in each major issue: Wilderness, wild and scenic rivers, and Kongakut River visitor management.

5.3.1 Alternative A Introduction

Wilderness – Approximately 7.16 million acres of designated Wilderness would continue to be managed under Wilderness Management. No new areas would be recommended for Wilderness designation.

Wild and Scenic Rivers – Alternative A proposes to complete eligibility and suitability studies but not recommend any rivers for inclusion in the NWSRS. Even without a recommendation for designation, however, the Refuge would maintain the outstandingly remarkable values for the four suitable rivers (Atigun, Marsh Fork Canning, Hulahula, and Kongakut) using management tools under the 1988 Plan's Minimal and Wilderness Management categories, along with that Plan's management direction.

Kongakut River – Existing visitor use management actions for the Kongakut River would continue under Alternative A. This alternative stipulates that a Refuge-wide Public Use Management Plan be completed, and this step-down plan could modify current management actions on the Kongakut related to public use.

5.3.2 Effects on the Biophysical Environment from Alternative A

Wilderness – Under this alternative, none of the WSAs would be recommended for Wilderness designation, and these areas would continue to be managed under the Minimal Management category. Minimal Management already affords a high degree of administrative protection to the biophysical environment, and there would be no effect to any of the biophysical resource categories if additional Wilderness is not recommended.

Wild and Scenic Rivers – Although the four suitable rivers are not recommended for wild river designation under this alternative, their outstandingly remarkable values would be protected by the using existing management tools such as Minimal Management and Wilderness Management. In general, these protections would have negligible, short- to medium-term, site-specific to local, and positive effects on the biophysical environment. Six biophysical resource categories would be affected, as described in the following text.

Kongakut River – Existing visitor use management actions for the Kongakut River would continue under this alternative. While current management tools offer some protections to the biophysical environment in the river corridor, resource degradation and wildlife disturbance continues. Overall, continuing current management would result in minor, long-term, site-specific to local, and negative effects on the biophysical environment.

Permafrost and Soils Under Alternative A

Wilderness – No effects on permafrost and soils would occur if no new wilderness recommendations are made.

Wild and Scenic Rivers – Protecting the values associated with suitable rivers using management direction from the 1988 Plan would result in no effects to negligible, long-term, site-specific, and positive effects on permafrost and soils. Ongoing visitor use could still damage soils and permafrost in suitable river corridors, for example, at heavily used campsites, resulting in negligible to minor, short- to medium-term, site-specific, and negative effects.

Kongakut River – Visitor use in the Kongakut River valley continues to damage soils and permafrost, such as at heavily used access areas, resulting in negligible to minor, short-term, site-specific, and negative effects.

Water Quality and Aquatic Habitats Under Alternative A

Wilderness – Not recommending any new Wilderness areas would not affect water quality and aquatic habitats in areas outside designated Wilderness. Water bodies in designated Wilderness would continue to benefit from the high level of habitat protection that Wilderness affords.

Wild and Scenic Rivers – Protecting the values associated with suitable rivers using management direction from the 1988 Plan would result in no effects to negligible, long-term, site-specific, and positive effects on water quality and aquatic habitats. Ongoing visitor use could still damage aquatic habitats in suitable river corridors, resulting in negligible to minor, short- to medium-term, site-specific, and negative effects.

Kongakut River –Visitor use (hiking, hunting, and camping in the river corridor or floating the river) under current management would cause negligible, short-term, site-specific, negative impacts to water quality and aquatic habitats.

Vegetation and Terrestrial Habitats Under Alternative A

Wilderness – No effects on vegetation and habitat would occur if no new wilderness recommendations are made.

Wild and Scenic Rivers – Protecting the values associated with suitable rivers using management direction from the 1988 Plan would result in no effects to negligible, long-term, site-specific, and positive effects on vegetation and terrestrial habitats. Ongoing visitor use could still damage vegetation and terrestrial habitats in suitable river corridors (at heavily used campsites, for example), resulting in negligible to minor, short- to medium-term, site-specific, and negative effects.

Kongakut River – Visitor use in the Kongakut River valley continues to damage vegetation and terrestrial habitats, especially at heavily used sites, resulting in negligible to minor, short-term, site-specific, and negative effects.

Fish Populations and Natural Diversity Under Alternative A

Wilderness – No effects on fish populations and natural diversity would occur if no new Wilderness recommendations are made.

Wild and Scenic Rivers – While no rivers are recommended, river values would be protected using existing Minimal and Wilderness Management categories. This would have negligible, long-term, local, and positive effects.

Kongakut River –Direct effects from harvesting fish (especially Dolly Varden and arctic grayling) and disturbance by floaters are thought to be negligible, short-term, site-specific to local, and negative. Indirect impacts from substrate disturbance by foot traffic in and out of the river can lead to increased turbidity, especially in popular camping sites at the confluence of feeder streams. Effects are also thought to be negligible, short-term, site-specific to local, and negative to fish populations and natural diversity.

Bird Populations and Natural Diversity Under Alternative A

Wilderness – No effects on bird populations and natural diversity would occur if no new Wilderness recommendations are made.

Wild and Scenic Rivers – There would be negligible, long-term, local, and positive effects on bird populations and natural diversity under this alternative. Riparian areas tend to have higher density and diversity of birds compared to surrounding habitats, and river values would be protected using existing Minimal and Wilderness Management categories.

Kongakut River – Maintaining current management of the Kongakut River would result in negligible, short-term, site-specific, and negative impacts on bird populations, primarily through disturbance of breeding, feeding, and molting individuals.

Mammal Populations and Natural Diversity Under Alternative A

Wilderness – No effects on mammal populations would occur if no new Wilderness recommendations are made.

Wild and Scenic Rivers – There would be negligible, long-term, local, and positive effects on mammal populations and natural diversity under this alternative because river values would be protected using existing Minimal and Wilderness Management categories.

Kongakut River – Maintaining current management of the Kongakut River would result in minor, short-term, site-specific to local, and negative impacts on mammal populations through disturbance of migratory (caribou) and resident species.

5.3.3 Effects on the Human Environment from Alternative A

Wilderness – Under this alternative, none of the WSAs would be recommended for Wilderness designation, and these areas would continue to be managed under the Minimal Management category. Minimal Management already affords a high degree of administrative protection to the human environment. However, under Minimal Management there would be effects to cultural resources, visitor services and recreational opportunities, and wilderness characteristics.

Wild and Scenic Rivers – Although the four suitable rivers are not recommended for wild river designation under this alternative, their outstandingly remarkable values would be protected by using existing management tools such as Minimal Management and Wilderness Management. In general, these protections would have negligible, short- to medium-term, site-specific to local, and positive effects on the human environment. The resource categories that would be affected include: cultural resources; wilderness characteristics; and Refuge operations.

Kongakut River – Existing visitor use management actions for the Kongakut River would continue under this alternative. While current management tools offer some protections to the human environment in the river corridor, degradation of resources and visitor experience continues. Overall, continuing current management would result in moderate, long-term, local, and negative effects on the human environment. Current management would affect the following resource categories: local economy and commercial uses; cultural resources; visitor services and recreational opportunities; and wilderness characteristics.

Local Economy and Commercial Uses Under Alternative A

Wilderness – There would be no effect to the local economy or commercial uses. Commercial services would continue as currently managed.

Wild and Scenic Rivers – While no rivers would be recommended for inclusion in the NWSRS, the Refuge would protect outstandingly remarkable values using available management tools. There should be no measurable effect on local economy and commercial uses.

Kongakut River – Continuing current management on the Kongakut River could have effects on local economy and commercial uses. Because permits are currently issued non-competitively, commercial use of the Kongakut could increase. If use were to increase, it could be limited if found necessary to keep the use compatible with Refuge purposes. Additional commercial use in response to increasing visitor use would make a minor contribution to local economies. Visitors to the Kongakut often travel through Arctic Village or Kaktovik, resulting in an increase in business for local service providers. However, if experiential conditions continue to erode, at some point the Kongakut could cease to offer the experience its visitors are seeking, thus potentially displacing visitors whose standards for wilderness experience opportunities are not met by river conditions. Displacement could be to other areas in or outside the Refuge. If displacement is confirmed to be occurring in the Refuge, the economic and commercial opportunities would not be lost; but economic and commercial opportunities might be lost if displacement occurred outside the Refuge. Some guiding services have informed Refuge staff that the current conditions on the Kongakut (i.e., crowding, aircraft overflights, human waste accumulations, etc.) have already driven them either to stop operating in Arctic Refuge or to offer trips on other Arctic Refuge rivers, such as the Marsh Fork Canning or Hulahula Rivers. The concentration of visitors on the Kongakut has displaced, and may continue to displace, visitation elsewhere and may result in crowding and impacts to other Refuge rivers. If the current management strategy continues to be applied, short-term effects could be minor, local, and negative; while the long-term effects could be moderate, local to Refuge-wide, and negative.

Cultural Resources Under Alternative A

Wilderness – Not recommending additional Wilderness areas would not change ongoing effects to cultural resources. Ongoing damage or loss of cultural resources would continue, primarily as a result of erosion and other natural forces, and would be minor to major, long-term, site-specific, and negative.

Wild and Scenic Rivers – Public use would continue on the four rivers determined suitable for inclusion in the NWSRS but not recommended under this alternative. The effects of public use on cultural resources would likely be minor, long-term, site-specific, and negative. The Refuge could use existing Minimal and Wilderness Management categories to mitigate these effects. To comply with the Wild and Scenic Rivers Act, the Refuge would protect the Cultural outstandingly remarkable value on the Hulahula River. An increased management focus on cultural resources in this river corridor would result in minor, long-term, site-specific to local, and positive effects.

Kongakut River – Due to the level of visitation to the Kongakut River drainage by hikers and floaters, cultural resources in the area could be threatened by intentional or inadvertent disturbance. However, the Kongakut has received a relatively high level of visitation for at least two decades, and cultural resource damage might have already occurred. Since there has been no baseline resource inventory work conducted, the nature and extent of the damage is unknown. Continued effects are likely to range from minor to major, long-term, site-specific to local, and negative.

Subsistence Under Alternative A

Wilderness – There would be no effect to subsistence opportunities, uses, or resources under Alternative A. Traditional access and subsistence uses would continue to be allowed according to current regulations and policies.

Wild and Scenic Rivers – There would be no anticipated effect to subsistence opportunities, uses, or resources. Traditional access and subsistence uses would continue to be allowed according to current regulations and policies.

Kongakut River – There would be no effect to subsistence opportunities, uses, or resources. Subsistence use of the Kongakut is minimal and generally occurs outside the primary recreation seasons.

Visitor Services and Recreation Opportunities Under Alternative A

Wilderness –Visitor services and recreational opportunities outside the Refuge's designated Wilderness area would continue to be managed via Minimal Management, and the Refuge would continue to provide a variety of recreational opportunities for Refuge visitors. Continuing current management practices could affect visitor services and recreational opportunities in specific high use areas (e.g., the Atigun River area). With no active restoration of impaired sites or management of visitor experiences, visitors seeking certain recreational opportunities such as solitude and natural conditions could be displaced, indirectly resulting in the differential availability of certain visitor services. This could result in negligible to minor, long-term, site-specific to local, and negative effects to visitor services and recreational opportunities focused on solitude and natural conditions. However, Refuge staff could administratively decide to limit the number and types of visitor services in certain areas of the Refuge in order to preserve wilderness characteristics or improve recreational opportunities, thus minimizing impacts to visitors seeking wilderness-associated recreation.

No statutory protections from roads, facilities, installations, and recreational improvements, nor any statutory requirements to manage for wilderness characteristics, could result in negligible, long-term, local to Refuge-wide, negative effects to visitor services that cater to solitude and wilderness-associated opportunities and experiences.

Current management would not be expected to affect recreational opportunities for freedom, independence, exploration, challenge, self-reliance, and discovery. Additionally, routine law enforcement patrols and visitor use monitoring would continue on the Refuge as under current management, and there would be no effect to these programs under Alternative A.

Wild and Scenic Rivers – There would be no effect on visitor services and recreation opportunities under this alternative.

Kongakut River – Current management allows for nearly unrestricted recreational opportunities in the Kongakut River valley. There are no limits to the number of recreational guides or air operators offering services on the Kongakut River, nor are there any restrictions to private users. Current management contributes to perceptions of crowding and reduced visitor experience on the Kongakut River and is displacing use to other areas of the Refuge. The effects are moderate, short- and long-term, local to Refuge-wide, and negative.

Private airplanes may land on any suitable surface, whether vegetated or unvegetated. The lack of restrictions and/or limits may result in degradation of the Kongakut's physical resources and affect visitor experience. Because this river flows through arctic habitats, physical damage (e.g., hardened campsites, trailing, etc.) may be irreparable, or at best take many years to recover. Effects are minor to moderate, long-term, site-specific, and negative.

Visitor experience is affected by human waste accumulations, particularly at popular campsites, put-ins, and take-outs; decomposition could require years and possibly decades. These effects are moderate, long-term, site-specific to local, and negative.

Wilderness Characteristics Under Alternative A

Wilderness – Lands and waters outside designated Wilderness would not receive the protections afforded by the Wilderness Act. Non-Wilderness areas would continue to be managed in the administrative Minimal Management category, which includes most of the protections and prohibitions of designated Wilderness. Short-term, impacts are likely to be negligible to minor, Refuge-wide, and positive. However, Minimal Management is an administrative management category subject to change and does not have the enduring statutory protections afforded by designated Wilderness. Therefore, in the long-term, effects would be negligible to minor, Refuge-wide, and negative.

Wild and Scenic Rivers – Protecting outstandingly remarkable values on the Refuge's four suitable rivers using existing Minimal and Wilderness Management categories would have no effect to negligible, long-term, local, and positive effects on wilderness characteristics.

Kongakut River – Although the Kongakut River and its tributaries flow entirely in designated Wilderness, the river offers what might be the lowest quality Wilderness experience on the Refuge. During peak periods, visitors to the Kongakut are almost guaranteed to encounter at least one other group, to hear multiple airplanes daily, and to see visible impacts from previous visitors. For most visitors, this doesn't constitute a high-quality Wilderness experience. Current levels of visitation do not meet many people's standards about opportunities for solitude, resources in a natural condition, remoteness, natural quiet, or other key indicators of Wilderness character. Under current management, the quality of Wilderness recreational opportunities could continue to degrade. These effects are likely to be minor to moderate, long-term, local, and negative. However, the high level of freedom and unconfined recreation offered on the Kongakut may balance the degradation.

Special Designations Under Alternative A

Wilderness – There would be no effects to any of the Refuge's special designation areas under this alternative.

Wild and Scenic Rivers – There would be no effects to any of the Refuge's special designation areas under this alternative.

Kongakut River – There would be no effects to any of the Refuge's special designation areas under this alternative.

Public Health and Safety Under Alternative A

Wilderness – This alternative would have no effect on public health and safety. In emergencies, the Refuge manager is authorized to take whatever prudent and reasonable actions are necessary.

Wild and Scenic Rivers – This alternative would have no effect on public health and safety. In emergencies, the Refuge manager is authorized to take whatever prudent and reasonable actions are necessary.

Kongakut River – This alternative would have no effect on public health and safety. In emergencies, the Refuge manager is authorized to take whatever prudent and reasonable actions are necessary.

Refuge Operations Under Alternative A

Wilderness – Under this alternative, there would be no effect on Refuge operations because there would be no additional administrative tasks regarding designated Wilderness.

Wild and Scenic Rivers – Protecting the outstandingly remarkable values for the Refuge's four suitable rivers using existing Minimal and Wilderness Management categories would have from no effect to negligible, short- to medium-term, local, and negative effects on staff and Refuge operations. To maintain river values, staff would periodically conduct site assessments and monitoring in the corridors of the four suitable rivers.

Kongakut River – Under this alternative, there would be no effect on Refuge operations.

5.3.4 Effects on Poker Flat Research Range from Alternative A

It is anticipated that implementing Alternative A would not affect the continued launch of sounding rockets from Poker Flat nor their scientific return. NASA would continue to conduct its missions such that there are no planned impacts within Mollie Beattie Wilderness, and through the University of Alaska Fairbanks, secure permission for landing and recovery of rocket hardware within the remaining areas of Arctic Refuge on an as-needed basis. NASA would continue to follow the specific terms and conditions governing launch and recovery operations included in Refuge-issued authorizations.

Economic Input – Poker Flat's continued operations under this alternative would result in the following economic inputs to the Fairbanks North Star Borough (Table 5-1). The value added from Poker Flat operations accounts for less than one-tenth of 1 percent of the total gross domestic product, and approximately 1.3 percent of the professional, scientific, and technical services industry gross domestic product for the Fairbanks area of Alaska.

Table 5-1. Estimated economic effects from Poker Flat operations by activity

Annual Impacts (2010 Dollars)	Direct Economic Output	Value Added	Direct Earnings	Indirect Earnings
Normal Operations	$1,900,000	$1,900,000	$1,400,000	$640,000
Launch Activities	$310,000	$300,000	$210,000	$100,000
Maintenance Activities	$160,000	$150,000	$52,000	$24,000
Total	$2,400,000	$2,300,000	$1,600,000	$800,000

Additionally, alternatives under consideration in NASA's EIS for Poker Flat include varying degrees of spent stage and payload recovery; estimated to range from $20,500 to $321,000 in additional direct economic output and from $18,000 to $282,000 in value added per year. Depending on level of effort for both historic and future-launched items, annual recovery efforts could generate the equivalent of 0 to 4 full-time jobs in the area. Continued operations at Poker Flat would enable the full value of these recovery operations to contribute to the local economy.

5.3.5 Cumulative Effects of Alternative A

Under Alternative A, no new areas of the Refuge would be recommended for designation as Wilderness. There would be no foreseeable cumulative effects to the biophysical and human environments as a result of this alternative.

Four rivers would be suitable for wild river designation but would not be recommended for inclusion in the NWSRS. There would be negligible cumulative effects to the biophysical and human environments. Continuing current management under Minimal Management and Wilderness categories would protect the outstandingly remarkable values identified for these rivers.

Until completion of a Public Use Management Plan, management actions for the Kongakut River could result in overall negligible to minor cumulative effects to the biophysical and human environments. As visitor use increases, there is the potential for some minor cumulative effects to the biophysical and human environments, and particularly to visitor experience.

The effects of Alternative A would be cumulative to other effects in the planning region, including the effects of climate change, development activities, and management decisions made by others (such as the reasonably foreseeable future actions listed in Section 5.1.4). Cumulatively, Refuge management under Alternative A would have negligible to minor effects on the biophysical and human environments in the region.

5.4 Effects of Alternative B

This section evaluates the implications or impacts of Alternative B on resource categories for each major issue: Wilderness, wild and scenic rivers, and Kongakut River visitor management.

5.4.1 Alternative B Introduction

Wilderness –Alternative B recommends the qualified and suitable lands and waters of the Brooks Range WSA (5.82 million acres) for Wilderness designation. The administrative act of recommending the Brooks Range WSA would have no effect on any resource category. However, the effects analysis here considers the effects of Wilderness designation on the resource categories should Congress choose to designate the Brooks Range WSA as Wilderness.

Wild and Scenic Rivers – Alternative B recommends wild river designation for three of the Refuge's four suitable rivers: Marsh Fork Canning, Hulahula, and Kongakut. Rivers recommended for wild river status must be protected until Congress acts to designate or reject a recommendation for designation. Pending congressional action, the Service would use interim management prescriptions to manage each recommended river for the outstandingly remarkable values for which it was found eligible (see Appendix I, Section 4.4).

If Congress were to designate these rivers as wild, the interim management prescriptions would stay in effect until the Refuge completes a CRMP for each river. The river's CRMP would formalize the requirement to preserve the river's outstandingly remarkable values and other values found through inventory, in perpetuity. These rivers would be part of the NWSRS and be afforded the protections of the Wild and Scenic Rivers Act (see Appendix I, Section 4.5). The lower portion of the Hulahula River is owned by KIC. Those portions of the Hulahula River that flow through KIC lands would be recommended for wild river designation, and the corridor would be managed in partnership with KIC. For wild rivers or river segments within designated Wilderness, the more restrictive provisions of the Wild and Scenic Rivers Act and the Wilderness Act would apply.

Kongakut River – Alternative B proposes that Kongakut River management issues be addressed in a Visitor Use Management and/or Wilderness Stewardship step-down plan, which would, among other things, develop long-term monitoring protocols. Until the step-down plan(s) is completed, the Service would implement a variety of interim management actions to protect resources in the Kongakut River valley, including an interim cap on commercial recreation guides (see Chapter 3, Section 3.2.3.3).

5.4.2 Effects on the Biophysical Environment from Alternative B

Wilderness – If the Brooks Range WSA were designated as Wilderness, restrictions on activities that could damage Refuge resources may be less likely to change over time and may be more likely to be enforced, providing greater certainty of long-term protection for wildlife and habitats. The Brooks Range WSA is currently under Minimal Management, and this management category already affords a high degree of administrative protection to the biophysical environment. However, by protecting natural conditions, Wilderness designation could have minor, long-term, WSA-wide, positive effects on the value of the WSA for ecological research and monitoring.

Resource categories that could be affected by Wilderness designation of the Brooks Range WSA include: permafrost and soils; water quality and aquatic habitats; vegetation and terrestrial habitats; fish populations and natural diversity; bird populations and natural diversity; and mammal populations and natural diversity. Research on the biophysical environment could also be affected due to the need to complete MRAs for all Refuge management activities (see "Refuge Operations" in Section 5.4.3).

Wild and Scenic Rivers – Implementing interim management prescriptions for three of the Refuge's suitable rivers would result in negligible, medium-term, site-specific, and positive effects on biophysical resources within these river corridors. If these rivers were to be designated as wild rivers by Congress, the effects would be minor, long-term, local, and positive because designation would require the Refuge to develop CRMPs for each river. The CRMPs would include an inventory and assessment of biophysical resources in the wild river corridor as well as a monitoring program for ongoing assessment and protection of these resources. Six of the biophysical resource categories would be affected, as described in this section.

Kongakut River – Alternative B recommends interim management tools to address biophysical resource concerns in the Kongakut River valley until such time as a VUMP and/or Wilderness Stewardship Plan (WSP) are completed. While these management actions would curb effects to biophysical resources, the alternative would not eliminate such effects. These interim tools would have negligible to minor, long-term, local, and positive effects on biophysical resources. Six of the biophysical resource categories would be affected, as follows.

Permafrost and Soils Under Alternative B

Wilderness – Wilderness designation would have indirect, negligible to minor, long-term, WSA-wide, and positive effects to permafrost and soils because of the additional statutory protection Wilderness management provides regarding natural conditions.

Wild and Scenic Rivers – Interim management prescriptions to protect the free-flowing character and outstandingly remarkable values for those rivers that are suitable and recommended would result in negligible, medium-term, site-specific, and positive impacts to permafrost and soils in these river corridors. The CRMPs that would be prepared for the Marsh Fork Canning, Hulahula, and Kongakut Rivers if they are designated as wild rivers by Congress would include an inventory of current permafrost and soil conditions and a monitoring program for ongoing assessment and protection of these resources. The CRMP would also establish protocols to prevent and/or repair damage caused by visitor use. The resultant effects would be minor, site-specific to local, long-term, and positive.

Kongakut River – Refuge visitors have the potential to damage soils and permafrost by trampling, particularly at campsites and access points such as landing areas. Enhanced management of visitor use in the Kongakut River area under Alternative B would decrease site-specific impacts. Site-specific disturbances from visitors occur extensively up and down the Kongakut River corridor, so enhanced management would also decrease impacts at the local scale. This alternative would have negligible to minor, long-term, site-specific to local, positive impacts on permafrost and soils in the Kongakut River corridor.

Water Quality and Aquatic Habitats Under Alternative B

Wilderness – Wilderness designation of the Brooks Range WSA would provide long-term, statutory protection for wilderness characteristics, including aquatic habitats. Designation would result in negligible to minor, long-term, WSA-wide, positive effects to water quality and aquatic habitats.

Wild and Scenic Rivers – Interim management prescriptions to protect the free-flowing character and outstandingly remarkable values for those rivers that are suitable and recommended would result in negligible, medium-term, site-specific, and positive impacts to water quality and aquatic habitats in these river corridors. If the three recommended rivers were designated as wild rivers by Congress, CRMPs would be prepared for each river. The CRMPs would include an inventory of current water quality and aquatic habitat condition and a monitoring program for ongoing assessment and protection of these resources. The CRMP would also establish protocols to prevent and/or repair damage caused by visitor use. The effects of designation would be minor, site-specific to local, long-term, and positive.

Kongakut River – Water quality and aquatic habitats can be affected by increased visitor use through increased vegetation trampling and soil compaction, which increases the potential for runoff and sediment loading. Outreach about proper waste disposal and minimizing visitor impacts, along with monitoring the effectiveness of management actions, would have minor, long-term, local, and positive effects on water quality and aquatic habitats along the Kongakut River.

Vegetation and Terrestrial Habitats Under Alternative B

Wilderness – Although management strategies are similar for Wilderness Management and Minimal Management, Wilderness designation is a more permanent commitment to maintain natural conditions. Wilderness designation would likely have negligible to minor, long-term, WSA-wide, and positive effects on vegetation and terrestrial habitats because of the long-term, statutory protections designation would provide to Wilderness character.

Wild and Scenic Rivers – Interim management prescriptions to protect the free-flowing character and outstandingly remarkable values for those rivers that are suitable and recommended would result in negligible to minor, medium-term, site-specific, and positive impacts to vegetation and terrestrial habitats in these river corridors. If the three recommended rivers were designated as wild rivers by Congress, CRMPs would be prepared for each river. The CRMPs would include an inventory of current vegetation and terrestrial habitat condition and a monitoring program for ongoing assessment and protection of these resources. The CRMP would also establish protocols to prevent and/or repair visitor use damage, which would result in minor, long-term, site-specific to local, and positive effects to vegetation and terrestrial habitats.

Kongakut River – Refuge visitors may damage vegetation and habitats, particularly at campsites and access points such as landing areas. Potential damage includes the direct effects of trampling, breakage of trees and shrubs, the possible introduction of invasive plants, and the exclusion of wildlife from riparian and adjacent habitats. Indirect effects include soil and snow compaction as a result of trampling. Most disturbances to vegetation are site-specific and restricted to areas receiving repeated use, such as hunting camps near fixed-wing aircraft-accessible sites and campsites used by floaters. These areas are presently monitored and assessed for negative impacts. Disturbances are local in scale, as site-specific disturbances occur extensively along the Kongakut River corridor. The additional management proposed in Alternative B would have negligible to minor, long-term, site-specific to local, positive impacts on vegetation and terrestrial habitats in the Kongakut River drainage.

Fish Populations and Natural Diversity Under Alternative B

Wilderness – Wilderness designation provides long-term protections for fish populations and natural diversity through the statutory requirements of the Wilderness Act. Effects of designation of the Brooks Range WSA on fish populations and natural diversity would therefore be minor, long-term, WSA-wide, and positive.

Wild and Scenic Rivers –The Service would use interim management prescriptions to manage each recommended river for its free-flowing character and the outstandingly remarkable values for which it was found eligible. This would result in negligible, medium-term, local, and positive impacts to fish populations and natural diversity. If Congress were to designate recommended rivers, CRMPs would be prepared, resulting in minor, long-term, local, and positive effects to fish populations and natural diversity because of the assessment and monitoring programs that are required in the CRMPs for each river.

Kongakut River – Dolly Varden and grayling are popular fish sought by anglers on the Kongakut River. Harvest levels of these fish species are unknown and thought to be low. Providing outreach materials on proper catch-and-release techniques could lead to increased survival rates of released fishes, resulting in negligible, long-term, local, and positive effects. Enhanced management of visitors to the Kongakut, such as temporarily capping commercially guided recreation, would have positive effects by reducing substrate disturbance in and out of the river. This effect would indirectly result in negligible, short-term, local, and positive effects on fish populations and natural diversity.

Bird Populations and Natural Diversity Under Alternative B

Wilderness – If Congress were to designate the Brooks Range WSA as Wilderness, natural conditions would be maintained using the Wilderness Management category. This would likely have long-term, positive effects on bird populations in the Brooks Range WSA. Because most bird species are migratory, beneficial effects could be expressed over a larger area than the Brooks Range WSA. Under current management, disturbance to birds and alteration of their habitats is minimal. However, Wilderness designation, with its long-term commitment to maintaining natural conditions, could have negligible, long-term, regional or greater, and positive effects.

Wild and Scenic Rivers – There would be negligible, medium-term, local, and positive effects on bird populations and natural diversity under this alternative. The Service would use interim management prescriptions to manage each suitable and recommended river for the outstandingly remarkable values for which it was found eligible. Because riparian areas tend to have higher density and diversity of birds compared to surrounding habitats, maintaining river values should indirectly have positive effects on bird populations and natural diversity. If Congress were to designate recommended rivers, CRMPs would be prepared, resulting in minor, long-term, local, and positive effects to bird populations and natural diversity in these river corridors because of the assessment and monitoring programs that are required in the CRMPs.

Kongakut River – Enhanced management of human use of the Kongakut River valley would have negligible to minor, long-term, site-specific to local, and positive effects on bird populations and natural diversity. Monitoring visitor impacts on bird habitats would lead to the development of conservation measures to mitigate visitor impacts on birds if adverse effects are detected. Outreach materials would benefit birds by helping visitors reduce disturbance to nesting raptors and other species, and minimize impacts to bird habitats. Enhanced management of user groups on the river, such as by temporarily capping commercially guided recreation, would have positive effects by reducing disturbance to birds and bird habitat along the river.

Mammal Populations and Diversity Under Alternative B

Wilderness – Wilderness designation would result in minor, long-term, WSA-wide to regional, and positive effects in the Brooks Range WSA on mountain species like Dall's sheep and Alaska marmots because of the more permanent commitment to protect natural conditions in designated Wilderness, including mammal populations and habitats.

Wild and Scenic Rivers – There would be negligible, medium-term, local, and positive effects on mammal populations and natural diversity under this alternative. The Service would use interim management prescriptions to manage the free-flowing character of each recommended river and to maintain the outstandingly remarkable values for which each river was found eligible. This would indirectly affect mammal populations and natural diversity. If Congress were to designate recommended rivers, CRMPs would be prepared, resulting in minor, long-term, local, and positive effects to mammal populations and natural diversity in these river corridors because of the assessment and monitoring programs that would be included in the CRMPs.

Kongakut River – Enhanced management of human use of the Kongakut River valley would have negligible to minor, long-term, site-specific to local, and positive effects on mammal populations. Monitoring visitor impacts to habitats would lead to the development of conservation measures to mitigate visitor impacts on mammals if adverse effects are detected. Outreach materials would benefit mammals by helping visitors reduce disturbance to resident and migratory species, and minimize impacts to mammal habitats. Enhancing management of user groups on the river, such as by temporarily capping commercially guided recreation, would have positive effects by reducing disturbance to mammal populations and diversity along the river.

5.4.3 Effects on the Human Environment from Alternative B

Wilderness – Under current management, public use of the Refuge is managed similarly in designated Wilderness and in areas under Minimal Management. Most regulations on public use are derived from the area's status as a refuge and by State law. Public use is subject to Federal regulations implementing Federal laws (e.g., ANILCA, Refuge Administration Act), State laws (e.g., Alaska Statute 19.40.210, which prohibits off-road vehicles from the Dalton Highway), and State regulations (e.g., the State of Alaska hunting and fishing regulations). However, by protecting wilderness characteristics (both biophysical and experiential), Wilderness designation could have negligible to minor, long-term, WSA-wide, positive effects on the human environment.

If the Brooks Range WSA were to be designated as Wilderness, it would affect the following resource categories: local economy and commercial uses; cultural resources; subsistence; visitor services and recreational opportunities; wilderness characteristics; two of the Refuge's three designated wild rivers; Refuge operations; and Poker Flat.

Wild and Scenic Rivers – Alternative B would recommend three of the Refuge's rivers for inclusion in the NWSRS (Hulahula, Marsh Fork Canning, and Kongakut), and interim management prescriptions would be implemented for these rivers (see Appendix I, Section 4.4). The Atigun River would be protected using existing management tools available under the current Minimal Management category. If Congress were to designate any of the three recommended rivers, CRMPs would be developed and implemented for the continued protection of these rivers and their associated values. CRMPs and interim management prescriptions would lay out strategies that might affect the following resource categories: local economy and commercial uses; cultural resources; subsistence; visitor services and recreational opportunities; wilderness characteristics; special designations; and Refuge operations.

Kongakut River – Under this alternative, a VUMP would be initiated immediately upon approval of the Revised Plan. Until the VUMP takes effect, interim management tools would be implemented, including a temporary cap on commercial recreational guides. Effects of the interim management tools on the human environment would likely be moderate, long-term, local, and positive. Effects of the interim management tools would affect the following resource categories: local economy and commercial uses; cultural resources; subsistence; visitor services and recreational opportunities; wilderness characteristics; special designations; public health and safety; and Refuge operations.

Local Economy and Commercial Uses Under Alternative B

Wilderness – Designation of the Brooks Range WSA as Wilderness could affect commercial uses. In designated Wilderness, the Wilderness Act of 1964 and Service Wilderness policy prohibit commercial enterprises with few exceptions. Commercial services that help people access the Refuge to realize the recreational opportunities and wilderness characteristics of the area, such as guides and transportation companies, are allowed provided these uses are compatible with Refuge purposes, including Wilderness Act purposes. Other commercial enterprises, such as commercial filming, are limited in Wilderness by Service policy. Designation could potentially attract more wilderness-oriented visitors to the Refuge, resulting in increased business opportunities for recreation guides, air operators, and other commercial service providers in local communities. Effects would be negligible to minor, long-term, WSA-wide, and positive for recreational service providers.

Big-game hunting guides in guide use areas within the Brooks Range WSA could have to comply with stricter guidelines in order to minimize the effect of activities on Wilderness character. Because guide use areas are competitively awarded, effects would vary, depending on the guide. Effects could range from no effect to negligible to minor, long-term, WSA-wide, and negative or positive.

Wild and Scenic Rivers – Interim management provisions for suitable and recommended rivers are based on available management tools. In general, there would be no change to the management of the three suitable and recommended rivers, and therefore there would be no effects on local economy and commercial uses. However, if Refuge staff was to determine that one or more of the outstandingly remarkable values of these rivers was threatened and changes or restrictions to commercial services would mitigate the threat, then the Refuge could impose interim restrictions on commercial services. These restrictions would likely result in negligible, short-term to long-term, local, and negative effects to the local economy and commercial uses. If Congress were to designate the suitable and recommended rivers under this alternative, CRMPs would be developed. If the CRMPs were to limit or reduce the level of commercial use in order to protect outstandingly remarkable or other river values, there could be minor, long-term, local, and negative effects on the local economy and commercial uses.

Kongakut River – Limiting the number of guides and their use from 2013 to 2016 or until the VUMP is completed could limit the economic contribution of the river. Some service providers may decide not to offer a trip(s) on the Kongakut or may be unable to grow their business. Other commercial service providers may be unable to start a new business during the period of the cap. The effects would likely be minor, short-term, local, and negative.

A step-down VUMP would likely have effects on the local economy and commercial uses. Step-down planning would be done in conjunction with key stakeholders and the public. Depending on the nature of the changes and/or restrictions imposed by the VUMP, the effects could be minor to moderate, long-term, site-specific to Refuge-wide, and positive or negative for guides and commercial air operators operating on the Refuge. Should the plan limit or reduce the level of commercial use, minor to moderate negative effects would be anticipated to those guides adversely affected by such limits, and this could indirectly result in negligible to minor effects on local economies.

Cultural Resources Under Alternative B

Wilderness – Wilderness designation could indirectly have negligible, long-term, WSA-wide, and positive effects on cultural resources. By protecting natural conditions and wilderness characteristics, Wilderness could provide long-term protection for cultural resources and traditional lands, waters, and resources used by local residents and serve to perpetuate the conditions in which their cultures evolved. However, the intentional and unintentional losses of cultural resources would likely continue even within designated Wilderness, primarily as a result of erosion and other natural forces, resulting in similar effects as under Alternative A.

Wild and Scenic Rivers – Public use would continue on those rivers determined suitable for inclusion in the NWSRS. The effects of public use on cultural resources would likely be minor, long-term, site-specific, and negative. Interim management prescriptions could mitigate these effects because the Refuge would use the prescriptions to maintain river values. Under Alternative B, the Hulahula River is recommended for wild river designation. The Hulahula has a Cultural outstandingly remarkable value, and the Refuge is required to manage the river to maintain this value. Therefore, this river would have a higher level of protection for cultural resources. If Congress were to designate recommended rivers, CRMPs would be prepared, resulting in minor, long-term, local, and positive effects to cultural resources because of the assessment and monitoring programs that would be included in the CRMPs.

Kongakut River – Under Alternative B, cultural resource losses (intentional or unintentional) would likely continue in the Kongakut River valley. However, outreach emphasizing stewardship of cultural resources in the Kongakut River drainage could minimize potential impacts. Limiting the amount of guided use prior to completion of the VUMP should have negligible, short-term, local, positive effects on cultural resources. The VUMP would include a better understanding of the cultural resources of the area and their condition, and it would provide appropriate cultural resource management. The VUMP should result in negligible to minor, long-term, local, and positive effects to cultural resources as compared to Alternative A.

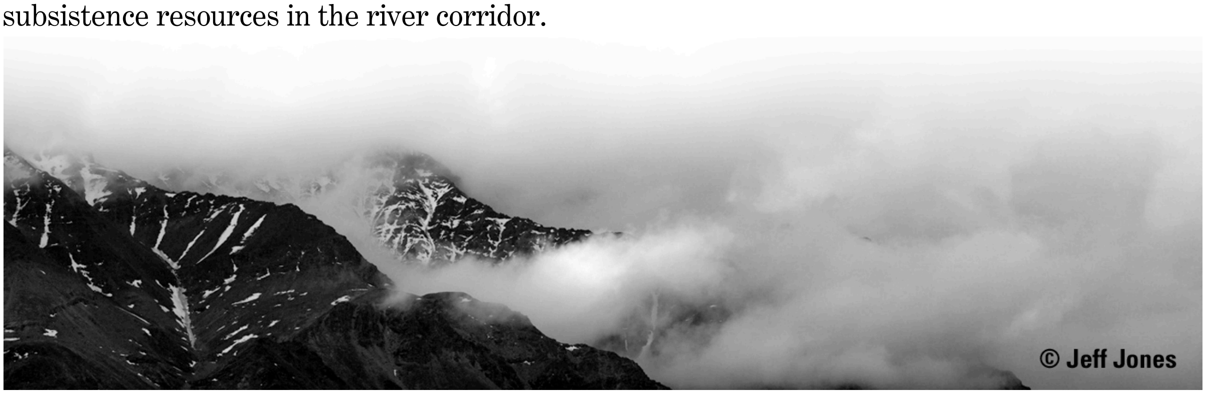
Subsistence Under Alternative B

Wilderness – Designation of the Brooks Range WSA would provide long-term, statutory protection to habitats and natural conditions, especially those found near Arctic Village and Venetie, thus indirectly serving to perpetuate the subsistence resources upon which local residents are so dependent. In general, subsistence uses in Wilderness would continue as they have under Minimal Management, and the harvest of subsistence resources would continue. Designation would not restrict subsistence use of resources in the Refuge, and the right of subsistence users to conduct traditional activities using traditional modes of transportation would continue. Effects of Wilderness designation to subsistence opportunities and resources would be negligible, long-term, WSA-wide, and positive.

The subsistence use of cabins would continue, although requests for construction or location of new cabins would receive greater scrutiny. Wilderness designation could also increase visitor use near Arctic Village's traditional and subsistence use areas, which could increase conflicts between locals and visitors. These effects would be expected to be negligible to minor, long-term, local, and negative.

Wild and Scenic Rivers – Under this alternative, interim management prescriptions combined with outreach regarding cultural and subsistence use in drainages recommended as wild rivers could improve understanding and reduce real and/or perceived conflict between local users and nonlocal visitors. The effects would likely be negligible, medium-term, local, and positive. If Congress were to designate the three rivers, CRMPs would be developed that establish user capacities for each river. The Refuge could then limit or control visitor use to ensure outstandingly remarkable and other river values are maintained, and this could indirectly result in fewer conflicts between subsistence users and visitors. CRMPs could therefore result in minor, long-term, and local effects that would be positive for subsistence resources and uses.

If Congress were to designate the entire extent of the Hulahula River as a wild river, the Service would partner with KIC regarding river management where it flows through KIC lands. The effects on subsistence could change as the process unfolds. Effects could range from negligible to moderate, short- to long-term, site-specific to local, and positive to negative, depending on the process, perceptions, and levels of protection afforded cultural and subsistence resources in the river corridor.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Kongakut River – Interim limits on guided use and outreach regarding cultural and subsistence use in the Kongakut River drainage could improve understanding, and reduce real and/or perceived conflict, between local users and nonlocal visitors. Voluntary actions by authorized guides and commercial air operators could also reduce the potential for conflicts among recreational visitors and subsistence users. The effects are likely to be minor, long-term, local, and positive.

Visitor Services and Recreation Opportunities Under Alternative B

Wilderness – Congressional designation of the Brooks Range WSA as Wilderness would have positive and negative effects on visitor services and recreational opportunities. Statutory protection of the area from roads, facilities, and recreational improvements would positively affect recreational opportunities for solitude, exploration, and freedom. Wilderness designation would potentially result in fewer installations and less visitor contact, which would enhance wilderness-associated recreational opportunities and experiences. Dalton Highway road access to the Brooks Range WSA would make it possible for visitors to reach designated Wilderness in an economically feasible manner without requiring aircraft support. Minimal Management already affords a high degree of wilderness-associated recreational opportunities and experiences, and so the effects of Wilderness designation would be negligible to minor, long-term, WSA-wide, and positive.

Because roads, facilities, recreational improvements, and commercial enterprises are not typically allowed in designated Wilderness, some visitor services could be directly and negatively impacted by Wilderness designation. No new cleared landing areas would be allowed in designated Wilderness, motorized generators and water pumps would not be allowed, and transportation and utility systems could only be authorized by Congress. Additionally, the Refuge might need to consider imposing limits on the number and types of visitor services in certain areas of the Refuge in order to preserve Wilderness character (should the area be designated as Wilderness). This would indirectly result in the loss of some recreational opportunities dependent on the impacted visitor services. These impacts are likely to be minor, long-term, specific to the WSA, and negative.

To preserve experiential opportunities associated with Wilderness character (such as opportunities for solitude), the Refuge may decide to have fewer routine law enforcement patrols and less visitor use monitoring on the ground in designated Wilderness areas. The resultant effects would likely be minor, temporary to short-term, local, and negative or positive, depending on the perception of the Refuge user. Fewer routine patrols and less on-the-ground visitor use monitoring could result in the failure to detect degraded or impaired sites in designated Wilderness, resulting in minor, long-term, site-specific, and negative effects.

Wild and Scenic Rivers – Interim management provisions for suitable and recommended rivers are based on available management tools. In general, there would be no change to the management of the three suitable and recommended rivers, and therefore there would be no effects on visitor services and recreational opportunities. However, if Refuge staff was to determine that one or more of the outstandingly remarkable values of these rivers was threatened and changes or restrictions on visitors would mitigate the threat, then the Refuge could impose interim restrictions on visitor services, which could in turn affect recreational opportunities. These restrictions would likely result in negligible, short-term to long-term, local, and negative effects to visitor services and recreational opportunities. However, if Congress were to designate any of the suitable and recommended rivers, the Refuge would be required to determine the user capacity of each designated river. If the number of visitors exceeds the determined user capacity, the Refuge might need to limit use. The effects would likely be minor to moderate, long-term, local, and positive or negative. Visitor experience could be enhanced by limiting use; however, some visitors might not be able to experience the river due to lack of river access. Any limitations on use of designated rivers could potentially displace visitors to other rivers in the Refuge.

Kongakut River – This alternative proposes to adopt management strategies based on a Refuge-wide Visitor Use Management step-down plan. As the step-down plan unfolds, it is likely to affect visitor services and recreational opportunities. Through the VUMP, Refuge managers will consider levels of use, timing and distribution of use, and activities and behaviors of visitors. Managers may use education, site management, regulation, enforcement, and/or rationing/allocation to manage visitor use at Arctic Refuge. The effects would likely vary, depending on the visitor, ranging from no effect to minor to moderate, long-term, local, and positive or negative. The effects of proposed visitor use management will be fully evaluated as part the step-down planning process.

Developing outreach materials with preferred practices and strategies for minimizing impacts would likely raise the level of awareness of commercial and private users. In turn, this could lead to higher quality experiences for all users by reducing the amount of physical and experiential impacts occurring on the river, including those associated with human waste. The effects of outreach actions would likely be minor, long-term, local, and positive.

Improving monitoring programs for physical and social conditions could better inform management about areas of concern, thus allowing management to take appropriate, responsive action before continued degradation occurs. The effects of improved monitoring on visitor services and recreational opportunities would be minor to moderate, long-term, local, and positive. However, site-specific monitoring and rehabilitation could result in Refuge staff contributing to crowding and other user impacts on the river. These effects are likely to be minor, short-term, local, and negative. Effects could be mitigated to some extent by timing Refuge activities to occur outside peak use.

Publishing schedules of past guided and non-guided visitor use (currently available from commercial permit client use reports) could increase visitor awareness regarding Kongakut River use periods but would likely do little to redistribute use across the season. Asking guides and commercial air operators to voluntarily limit their activities could have minor, short-term, local, and positive effects on visitor experiences.

Placing an interim cap on recreational guides would affect recreational opportunities and visitor services in the Kongakut River valley. Some service providers may decide not to offer a trip(s) on the Kongakut or may be unable to grow their business, while other commercial service providers might be unable to offer their services during the period of the cap. While recreational opportunities are not expected to decline, this alternative could be perceived by recreationists and visitor service providers as curtailing or limiting opportunities, and could result in displacing recreation and visitor services to other areas of the Refuge. Other people might perceive a cap on commercial guides as an opportunity to recreate independently in the Kongakut River valley. These effects would be minor, short-term, local, and positive or negative, depending on the perception of different individuals and groups.

Wilderness Characteristics Under Alternative B

Wilderness – Congressional designation of the Brooks Range WSA as Wilderness would have a positive effect on wilderness characteristics. Wilderness areas are protected from roads, facilities, recreational improvements, commercial enterprises, helicopters, and installations. These protections would enhance wilderness characteristics and people's experiences in the area. Additionally, the Service would more closely consider our own Refuge management activities and their effects through the MRA process. The Brooks Range WSA is currently under Minimal Management, and this management category already affords a high degree of administrative protection to wilderness characteristics. Wilderness designation would offer statutory protection to these characteristics and would represent a more permanent commitment to their protection. These effects would likely be minor, long-term, WSA-wide, and positive.

Wild and Scenic Rivers – Implementing interim management prescriptions for suitable and recommended rivers would have no effect to negligible, medium-term, local, and positive effects on wilderness characteristics. If Congress were to designate the Marsh Fork Canning, Hulahula, and Kongakut as wild rivers, a CRMP would be prepared for each river, resulting in minor to moderate, long-term, local, and positive effects to wilderness characteristics because of the assessment and monitoring programs that would be included in the CRMPs. In addition, the Refuge would establish user capacities and protect the outstandingly remarkable and other river values in the wild river corridor, which would have minor to moderate, long-term, local, and positive effects on wilderness characteristics. Beneficial effects on wilderness characteristics would also be realized for those portions of the Hulahula and Kongakut Rivers in designated Wilderness because the more restrictive provisions of the Wild and Scenic Rivers Act and the Wilderness Act would be applied to the management of these rivers.

Kongakut River – Interim limits on commercial recreation guides and their clients would minimize or lessen impacts on wilderness characteristics, but would not eliminate them. Activities would be frozen at current levels, thus curbing negative effects on wilderness characteristics, but ongoing impacts from continued use would not be affected. The effects of implementing an interim cap on guides would be minor, short-term, local, and positive for wilderness characteristics.

Working with air operators to disperse flight paths could reduce air traffic, therefore improving wilderness experiences for visitors. Because Arctic Refuge does not have jurisdiction over airspace, compliance with this request could not be enforced. To the extent we are able to achieve voluntary compliance with air operators, the effects to wilderness characteristics would likely be minor to moderate, short-term, local, and positive. Similarly, asking commercial guides and commercial air operators to minimize effects on Refuge visitors would have minor to moderate, short-term, local, and positive effects on wilderness characteristics, to the extent we are able to achieve compliance.

Improved monitoring of visitor experiences would: 1) tie observed conditions to management goals for biophysical resources; 2) help identify thresholds of acceptable changes in the biophysical environment; and 3) provide input on actions that could be taken to prevent negative Wilderness character indicator thresholds from being reached. Monitoring could result in improved management strategies for wilderness characteristics, and over the long-term, indirectly create moderate, local, and positive improvements to wilderness characteristics.

Visitors seeking solitude and other values associated with Wilderness might have already been displaced from the Kongakut River. Implementing interim Kongakut River visitor use management prescriptions and ultimately prescriptions from a VUMP could stop displacement and enhance wilderness characteristics enough that visitors seeking solitude would return to the Kongakut. Outreach efforts focused on minimal impact techniques and desired behaviors for visitors would likely result in minor, long-term, local, and positive effects on wilderness characteristics. Rehabilitating impacted sites could help restore the river to its natural condition, thus improving Wilderness character. The effects are likely to be minor, long-term, local, and positive.

Special Designations Under Alternative B

Wilderness –Wilderness designation would have negligible to minor, long-term, WSA-wide, and positive effects for the Ivishak, and Wind Rivers, as they are entirely in the Brooks Range WSA. Wild and Scenic Rivers Act protections are complimentary to the protections of the Wilderness Act, and for wild rivers within designated Wilderness, the more restrictive provisions of the Wild and Scenic Rivers Act and the Wilderness Act would apply.

Wild and Scenic Rivers – The Shublik Springs RNA is downstream from the Marsh Fork Canning River. There would be negligible to minor, long-term, local, and positive effects for the Shublik Springs RNA if the Marsh Fork Canning is designated as a wild river; the Marsh Fork would have added resource protections, and visitor experiences would be expected to improve. Similarly, protecting the free-flowing character and outstandingly remarkable and other values of the Hulahula and Kongakut Rivers would provide indirect, negligible, long-term, local, and positive effects on the MPA.

Kongakut River – There could be indirect, negligible, long-term, local, and positive effects to the MPA as a result of more proactive management of the Kongakut River. Some commercial recreation guides might elect to divert their operations from the Kongakut to one of the Refuge's three wild rivers (Ivishak, Sheenjek, and Wind Rivers) or to the Refuge's RNAs or PUNAs. Effects would range from no effect to negligible to minor, short- to medium term, local, and negative.

Public Health and Safety Under Alternative B

Wilderness –Wilderness recommendation or designation of the Brooks Range WSA would have no effect on public health and safety. Public health and safety would continue as under current management.

Wild and Scenic Rivers – Neither interim management prescriptions nor wild river designations for the Marsh Fork Canning, Hulahula, and Kongakut Rivers would have any effect on public health and safety.

Kongakut River – Developing a Visitor Use Management step-down plan and providing targeted messages to Refuge visitors would have no effect to negligible, long-term, Refuge-wide, and positive effects on public health and safety issues.

Refuge Operations Under Alternative B

Wilderness – Congressional designation of the Brooks Range WSA as Wilderness would affect overall Refuge operations, both in terms of paperwork and in terms of research. If the Brooks Range WSA is designated as Wilderness, Refuge management activities would be subject to an MRA process, and normally prohibited uses would be approved only if they are determined to be the minimum necessary to manage the area as Wilderness. New Wilderness designation could therefore increase the paperwork burden for Refuge staff. These effects would likely be negligible, long-term, WSA-wide, and negative.

Additionally, proposed research conducted as a Refuge management activity would be subject to an MRA to determine if it is necessary to accomplish the purposes of the Refuge, including Wilderness Act purposes, and that any normally prohibited uses are necessary to meet the minimum requirements for managing the area as Wilderness. The MRA process could negatively affect long-term research projects with established data collection protocols or research that might require permanent installations, such as climate change research. Decisions are made on a case-by-case basis, however, and it is possible that installations could be allowed. There is some uncertainty as to the extent that Wilderness designation would limit the ability to conduct research or monitoring necessary to affect conservation measures. We believe the effects would be negligible, long-term, WSA-wide, and negative.

Wilderness designation would not affect the jurisdiction or responsibilities of the State with respect to wildlife, although actions would need to be consistent with maintaining Wilderness character. For some State activities, an MRA might be required. We believe the effects would be negligible, long-term, WSA-wide, and negative.

Wild and Scenic Rivers – There would be no effect to negligible, medium-term, local, and negative effects to Refuge operations under interim management prescriptions. Overall, management of suitable and recommended rivers would continue as under current management. However, Refuge staff would likely conduct periodic monitoring and assessments of the river corridors to ensure outstandingly remarkable values are being maintained.

Should Congress designate suitable and recommended rivers, there would be effects to Refuge operations. There would be an additional workload for preparing a CRMP in the short term; the effects would be moderate, short-term, Refuge-wide, and negative. In the medium-term, monitoring and the potential for adjusting user limits would result in moderate, Refuge-wide, and negative effects through the expenditure of staff time and budget. However, once the CRMPs are completed and monitoring protocols and a system for managing the rivers are in place, there should be less strain on Refuge staff dealing with day-to-day issues. Thus, over the long-term, effects would be minor, Refuge-wide, and positive.

Kongakut River – This alternative would require additional staff time and budget to: 1) execute a revised monitoring program; 2) develop outreach materials; 3) compile and publish schedules of proposed launch dates; 4) establish, implement, and monitor an interim cap on commercial recreational guides; 5) conduct site-specific rehabilitation; and 6) develop and execute a step-down management plan. The effects are likely to be moderate, short- to medium term, Refuge-wide, and negative. Indirectly, limits placed on commercial guides could negatively affect the Service's relationship with these stakeholders in the short-term. Over the long-term, however, there should be less strain on Refuge staff dealing with day-to-day river management concerns, and more public buy-in on management of the Kongakut River, resulting in minor, long-term, Refuge-wide, and positive effects.

5.4.4 Effects on Poker Flat Research Range from Alternative B

Implementing Alternative B would have a major adverse effect on NASA's ability to launch sounding rockets from Poker Flat. As shown in Figure 5-1, the most commonly flown sounding rocket configurations within the past 10 years have been the Black Brant-class and Terrier-Orions, the trajectories of which would likely have a planned impact within the Brooks Range WSA. Assuming a launch rate of four rockets per year, designation of the Brooks Range WSA as Wilderness could eliminate NASA's ability to fly an expected 28 of the 30 Arctic Refuge-landing missions within the 15-year planning horizon of the Revised Plan because NASA is required to avoid landings in designated Wilderness.

Considering that at least half of its future missions at Poker Flat would be excluded by implementing this alternative, it is likely that NASA would discontinue funding Poker Flat's operations and maintenance all together.

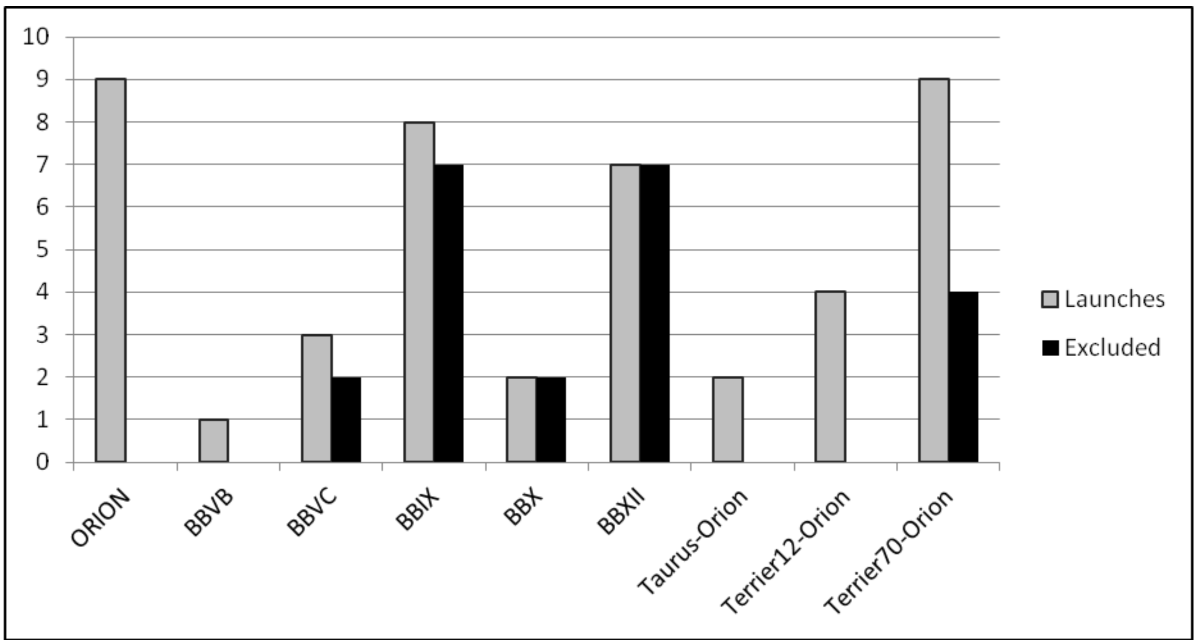


Figure 5-1. Sounding rockets launched from Poker Flat within last 10 years and those that would have been excluded if the Brooks Range WSA were designated as Wilderness

<u>*Scientific Return*</u> - The loss of NASA's ability to conduct Poker Flat-enabled science would have long-reaching adverse implications on the nation's ability to study and understand geospace at high latitudes. A large range of unexplained, critical phenomena can only be explored with in situ probes on sounding rockets, which gather vertical profiles of measured parameters and are essential for the study of the upper atmosphere and ionosphere. The information collected by Poker Flat-enabled missions is then available for use in applied fields, such as in the development of models of the upper atmosphere including upper atmospheric wind circulation; or the improvement of communications, navigation, and power systems.

Other commonly employed tools to study geospace, including orbiting satellites and ground-based observation stations, cannot collect the requisite data that is afforded by a sounding rocket launch. For example, in some cases, earth-orbiting satellites cannot gather adequate measurements as the satellites are traveling too fast or are too high. In other cases, measurements taken during sounding rocket flights are used to calibrate or verify remote measurements taken from orbiting or land-based instruments. In summary, NASA's inability to launch sounding rockets from Poker Flat would result in a loss of its ability to carry out a substantial number of unique scientific measurements at high latitudes, which would not only have a long term adverse effect on the entire NASA Sounding Rockets Program, but would also have indirect effects on a host of related technologies.

Effects could be mitigated, however, if Congress were to include a special provision in any Wilderness establishing legislation that would allow the regulated use of the Wilderness area for rocket landings. The ROD for the Revised Plan will identify whether the Service supports such a provision, should the decision select an alternative that recommends additional Wilderness areas.

Economic Input - The discontinuation of sounding rocket launches at Poker Flat would also have socioeconomic effects on the local area. Assuming four launches per year, the economic inputs summarized in Figure 5-1 would likely be lost, which would be a minor, long-term, regional, and negative impact. While it is possible that other government, commercial, or academic institutions might utilize Poker Flat, it is not known to what extent that might occur.

5.4.5 Cumulative Effects of Alternative B

The qualified and suitable lands and waters of the Brooks Range WSA (5.82 million acres) would be recommended for designation as Wilderness. There would be no cumulative effects related to the administrative act of recommending Wilderness. Should the Brooks Range WSA be designated Wilderness, the cumulative effects would be negligible to minor, long-term, WSA-wide, and positive, as designated Wilderness provides more permanent statutory protection to the biophysical and human environments. Refuge management activities within Wilderness would be subject to MRAs, and certain activities as discussed previously would be subject to a higher level of scrutiny.

Three rivers would be recommended for wild river designation: the Marsh Fork Canning, the Hulahula, and the Kongakut. If Congress were to include these rivers in the NWSRS, they would be afforded the protections of the Wild and Scenic Rivers Act. Permanent management prescriptions and river-specific CRMPs would be completed, which would include the ability to limit and control visitor use. The cumulative effects of these actions would present minor to moderate effects to the biophysical and human environments.

Cumulative effects as a result of management actions for the Kongakut river under this alternative would be minor due to increasing outreach, more proactively managing the area, and capping visitor use from commercial recreational guides until such time as a Refuge-wide VUMP is developed.

The effects of Alternative B would be cumulative to other effects in the planning region, including the effects of climate change, development activities, and management decisions made by others (such as the reasonably foreseeable future actions listed in Section 5.1.4). Cumulatively, Refuge management under Alternative B would have negligible to minor effects on the biophysical and human environments in the region.

5.5 Effects of Alternative C

This section evaluates the implication or impacts of Alternative C on resource categories for each major issue: Wilderness, wild and scenic rivers, and Kongakut River visitor management.

5.5.1 Alternative C Introduction

Wilderness – Alternative C recommends the qualified and suitable lands and waters of the Coastal Plain Wilderness Study Area (1.57 million acres) for Wilderness designation. The administrative act of recommending the Coastal Plain WSA would have no effect on any resource category. However, the effects analysis here considers the effects of Wilderness designation on the resource categories should Congress choose to designate the Coastal Plain WSA as Wilderness.

Wild and Scenic Rivers – Alternative C recommends Wild and Scenic Rivers Act protections for an 11-mile segment of the Atigun River, originating at the Refuge's westernmost boundary and extending to the river's confluence with the Sagavanirktok River. Rivers recommended for wild river status must be protected until Congress acts to designate or reject a recommendation for designation. Pending congressional action, the Service would use interim management prescriptions to manage the Atigun River for the outstandingly remarkable values for which it was found eligible (see Appendix I, Section 4.4). If Congress were to designate this 11-mile segment of the Atigun River as wild, the Refuge would prepare a CRMP. The river's CRMP would formalize the requirement to preserve the river's outstandingly remarkable values and other values found through inventory, in perpetuity. The river would become part of the NWSRS and be afforded the protections of the Wild and Scenic Rivers Act (see Appendix I, Section 4.5).

For the three rivers determined suitable but not recommended for wild river designation (Marsh Fork Canning, Hulahula, and Kongakut), the Refuge would maintain outstandingly remarkable values using the management tools available under the Wilderness and Minimal Management categories, goals, objectives, management policies, and guidelines (see Chapter 2).

Kongakut River – Alternative C proposes Kongakut River management identical to that described in Alternative B (see Section 5.4.1).

5.5.2 Effects on the Biophysical Environment from Alternative C

Wilderness –If the Coastal Plain WSA were designated as Wilderness, restrictions on activities that could damage Refuge resources may be less likely to change over time and may be more likely to be enforced, providing greater certainty of long-term protection for wildlife and habitats. The Coastal Plain WSA is currently under Minimal Management, and this management category already affords a high degree of administrative protection to the biophysical environment. However, by protecting natural conditions, Wilderness designation could have minor, long-term, WSA-wide, positive effects on the value of the WSA for ecological research and monitoring.

Resource categories that could be affected by Wilderness designation of the Coastal Plain WSA include: permafrost and soils; water quality and aquatic habitats; vegetation and terrestrial habitats; fish populations and natural diversity; bird populations and natural diversity; and mammal populations and natural diversity. Research on the biophysical environment could also be affected due to the need to complete MRAs for all Refuge management activities (see "Refuge Operations" in Section 5.5.3).

Wild and Scenic Rivers – Implementing interim management prescriptions for the Atigun River would result in negligible, medium-term, site-specific, and positive effects on biophysical resources in this river corridor. However, if the Atigun River was designated a wild river by Congress, the effects would be minor, long-term, local, and positive because designation would require the Refuge to develop a CRMP for the Atigun River. The CRMP would include an inventory and assessment of biophysical resources in the wild river corridor as well as a monitoring program for ongoing assessment and protection of these resources. Six of the biophysical resource categories would be affected, as described in this section.

Kongakut River – Alternative C recommends interim management tools to address the biophysical resource concerns of the Kongakut River valley until such time as a VUMP and/or WSP are completed. While these management actions would curb effects to biophysical resources, the alternative would not eliminate such effects. These interim tools would have negligible to minor, long-term, local, and positive effects on biophysical resources. Six of the biophysical resource categories would be affected, as follows.

Permafrost and Soils Under Alternative C

Wilderness –Wilderness designation would have indirect, negligible to minor, long-term, WSA-wide, and positive effects to permafrost and soils because of the additional statutory protection Wilderness management provides regarding natural conditions.

Wild and Scenic Rivers – Interim management prescription would be implemented for the portion of the Atigun River recommended for wild river status. Interim prescriptions would maintain or improve (through rehabilitation) current permafrost and soil conditions. Interim prescriptions would therefore have negligible, medium-term, site-specific, positive effects. If Congress were to designate the Atigun River as a wild river, a CRMP would be prepared. The CRMP would also establish protocols to prevent and/or repair damage caused by visitor use. The resultant effects would be minor, long-term, site-specific to local, and positive on permafrost and soils.

Kongakut River – Refuge visitors have the potential to damage soils and permafrost by trampling, particularly at campsites and access points such as landing areas. Enhanced management of visitor use in the Kongakut River area under Alternative C would decrease site-specific impacts to permafrost and soils. Site-specific disturbances from visitors occur extensively up and down the Kongakut River corridor, so enhanced management would also decrease impacts at the local scale. This alternative would have negligible to minor, long-term, site-specific to local, positive impacts on permafrost and soils in the Kongakut River corridor.

Water Quality and Aquatic Habitats Under Alternative C

Wilderness – Wilderness designation of the Coastal Plain WSA would provide a long-term, statutory protection for wilderness characteristics, including aquatic habitats. Designation would result in minor, long-term, WSA-wide, and positive effects to water quality and aquatic habitats.

Wild and Scenic Rivers – Interim management prescriptions to protect the free-flowing character and outstandingly remarkable values of the Atigun River would maintain or improve (through rehabilitation) current water quality and aquatic habitat conditions. Interim prescriptions would therefore have negligible, medium-term, site-specific, positive effects to water quality and aquatic habitats. If Congress were to designate the Atigun River as a wild river, a CRMP would be prepared. The CRMP would include an inventory of current water quality and aquatic habitat condition and a monitoring program for ongoing assessment and protection of these resources. The CRMP would also establish protocols to prevent and/or repair damage caused by visitor use. The effects of designation would be minor, long-term, site-specific to local, and positive on water quality and aquatic habitats.

Kongakut River – Water quality and aquatic habitats can be affected by increased visitor use through increased vegetation trampling and soil compaction, which increases the potential for runoff and sediment loading. Outreach about proper waste disposal and minimizing visitor impacts, along with monitoring the effectiveness of management actions, would have minor, long-term, local, and positive effects on water quality and aquatic habitats along the Kongakut River.

Vegetation and Terrestrial Habitats Under Alternative C

Wilderness – Although management strategies are similar for Wilderness Management and Minimal Management, Wilderness designation is a more permanent commitment to maintain natural conditions. Wilderness designation would likely have negligible to minor, long-term, WSA-wide, and positive effects on vegetation and terrestrial habitats because of the long-term, statutory protections designation would provide to Wilderness character.

Wild and Scenic Rivers –Interim management prescriptions would be implemented to protect the free-flowing character and outstandingly remarkable values of the Atigun River. Interim prescriptions would maintain or improve (through rehabilitation) current vegetation and terrestrial habitat conditions. Interim prescriptions would therefore have negligible to minor, medium-term, site-specific, and positive impacts to vegetation and terrestrial habitats in the Atigun River corridor. If Congress were to designate the Atigun River, a CRMP would be prepared and implemented. The CRMPs would include an inventory of current vegetation and terrestrial habitat condition and a monitoring program for ongoing assessment and protection of these resources. The CRMP would also establish protocols to prevent and/or repair visitor use damage, which would result in minor, long-term, site-specific to local, and positive effects to vegetation and terrestrial habitats.

Kongakut River – Refuge visitors may damage vegetation and habitats, particularly at campsites and access points such as landing areas. Potential damage includes the direct effects of trampling, breakage of trees and shrubs, the possible introduction of invasive plants, and the exclusion of wildlife from riparian and adjacent habitats. Indirect effects include soil and snow compaction as a result of trampling. Most disturbances to vegetation are site-specific and restricted to areas receiving repeated use, such as hunting camps near fixed-wing aircraft-accessible sites and campsites used by floaters. These areas are presently monitored and assessed for negative impacts. Disturbances are local in scale, as site-specific disturbances occur extensively along the Kongakut River corridor. The additional management proposed in Alternative C would have negligible to minor, long-term, site-specific to local, and positive impacts on vegetation and terrestrial habitats in the Kongakut River drainage.

Fish Populations and Natural Diversity Under Alternative C

Wilderness – Many rivers and streams occur in the Coastal Plain WSA. While this WSA is smaller than the others, the concentration of fish populations and natural diversity are highest. Wilderness designation provides long-term protections for fish populations and natural diversity through the statutory requirements of the Wilderness Act. Effects of designation of the Coastal Plain WSA on fish populations and natural diversity would therefore be minor to moderate, long-term, WSA-wide, and positive.

Wild and Scenic Rivers – The interim management prescriptions implemented to maintain the free-flowing character and outstandingly remarkable values of the Atigun River would result in negligible, medium-term, local, and positive impacts to fish populations and natural diversity. If Congress were to designate the Atigun River, a CRMP would be prepared and implemented, resulting in minor, long-term, local, and positive effects to fish populations and natural diversity because of the assessment and monitoring programs the CRMP would develop for all the river's values.

Kongakut River – Dolly Varden and grayling are popular fish sought by anglers on the Kongakut River. Harvest levels of these fish species are unknown and thought to be low. Providing outreach materials on proper catch-and-release techniques could lead to increased survival rates of released fishes, resulting in negligible, long-term, local, and positive effects. Enhanced management of visitors to the Kongakut, such as temporarily capping commercially guided recreation, would have positive effects by reducing substrate disturbance in and out of the river. This effect would indirectly result in negligible, short-term, local, and positive effects on fish populations and natural diversity.

Bird Populations and Natural Diversity Under Alternative C

Wilderness – If Congress were to designate the Coastal Plain WSA as Wilderness, natural conditions would be maintained using the more permanent commitments of the Wilderness Management category. This would likely have long-term, positive effects on bird populations in the Coastal Plain WSA. While the Coastal Plain WSA is smaller than the other study areas, the concentration of bird populations and natural diversity are highest. Additionally, because most bird species are migratory, beneficial effects could be expressed over a larger area than the WSA. Under current management, disturbance to birds and alteration of their habitats is minimal. However, Wilderness designation, because of its greater long-term commitment to maintaining natural conditions, could have minor to moderate, long-term, regional or greater, and positive effects on bird populations and natural diversity.

Wild and Scenic Rivers – There would be negligible, medium-term, local, and positive effects on bird populations and natural diversity under this alternative. An interim management prescription to maintain the outstandingly remarkable values of the Atigun River would be implemented. Because riparian areas tend to have higher density and diversity of birds compared to surrounding habitats, maintaining river values should indirectly have positive effects on bird populations and natural diversity. If Congress were to designate the Atigun River, a CRMP would be prepared and implemented, resulting in minor, long-term, local, and positive effects to bird populations and natural diversity because of the long-term assessment and monitoring programs of all the river's values that are required in the CRMPs.

Kongakut River – Enhanced management of human use of the Kongakut River valley would have negligible to minor, long-term, site-specific to local, and positive effects on bird populations and natural diversity. Monitoring visitor impacts to bird habitats would lead to development of conservation measures to mitigate visitor impacts on birds if adverse effects are detected. Outreach materials would benefit birds by helping visitors reduce disturbance to nesting raptors and other species, and minimize impacts to bird habitats. Enhanced management of user groups on the river, such as by temporarily capping commercially guided recreation, would have positive effects by reducing disturbance to birds and bird habitat along the river.

Mammal Populations and Natural Diversity Under Alternative C

Wilderness – Wilderness designation of the Coastal Plain WSA would have positive effects on mammal populations and natural diversity in the WSA, including caribou, muskoxen, polar bears, and microtines that use the coastal plain seasonally or year round. Positive effects would vary from minor to moderate, long-term, WSA-wide to regional, and positive because of the more permanent commitment to protect natural conditions in designated Wilderness, including mammal populations and habitats.

Wild and Scenic Rivers – There would be negligible, medium-term, local, and positive impacts to mammal populations and natural diversity under this alternative. Interim management prescriptions to protect the free-flowing character and outstandingly remarkable values of the Atigun River would indirectly result in positive effects for mammal populations and their habitats within the river corridor. If Congress were to designate the Atigun River, a CRMP would be prepared and implemented, resulting in minor, long-term, local, and positive effects to mammal populations and natural diversity because of the long-term assessment and monitoring programs of all the river's values that would be included in the CRMP.

Kongakut River – Enhanced management of human use of the Kongakut River valley would have negligible to minor, long-term, site-specific to local, and positive effects on mammal populations. Monitoring visitor impacts to habitats would lead to development of conservation measures to mitigate visitor impacts on mammals if adverse effects are detected. Outreach materials would benefit mammals by helping visitors reduce disturbance to resident and migratory species, and minimize impacts to mammal habitats. Enhancing management of user groups on the river, such as by temporarily capping commercially guided recreation, would have positive effects by reducing disturbance to mammal populations and diversity along the river.

5.5.3 Effects on the Human Environment from Alternative C

Wilderness – The Coastal Plain WSA is currently managed under Minimal Management. Under current management, public use of the Refuge is managed similarly in designated Wilderness and in areas under Minimal Management. Most restrictions on public use are derived from the area's status as a refuge and its regulations. Public use is subject to Federal regulations implementing Federal laws (e.g., ANILCA, Refuge Administration Act, etc.), State laws (e.g., Alaska Statute 19.40.210, which prohibits off-road vehicles from the Dalton Highway), and State regulations (e.g., the State of Alaska hunting and fishing regulations). However, by protecting wilderness characteristics (both biophysical and experiential), Wilderness designation could have negligible to minor, long-term, WSA-wide, positive effects on the human environment.

If the Coastal Plain WSA were to be designated as Wilderness, it would affect the following resource categories: local economy and commercial uses; cultural resources; subsistence;

visitor services and recreational opportunities; wilderness characteristics; the Refuge's MPA; and Refuge operations.

Wild and Scenic Rivers – Alternative C would recommend the Atigun River as a wild river. The outstandingly remarkable values of the Marsh Fork Canning, Hulahula, and Kongakut Rivers would be protected under current Minimal Management and Wilderness designations. If Congress were to designate the Atigun River, a CRMP would be developed for the continued protection of the river. In general, these effects would be minor, long-term, local, and positive for the human environment in the Atigun River corridor. CRMPs and interim management prescriptions would lay out strategies that might affect the following resource categories: local economy and commercial uses; subsistence; cultural resources; visitor services and recreational opportunities; wilderness characteristics; and refuge operations.

Kongakut River – Under this alternative, a VUMP would be initiated immediately upon approval of the Revised Plan. Until the VUMP takes effect, interim management tools would be implemented, including a temporary cap on commercial recreational guides. Effects of the interim management tools on the human environment would likely be moderate, long-term, local, and positive. Effects of the interim management tools would affect the following resource categories: local economy and commercial uses; cultural resources; subsistence; visitor services and recreational opportunities; special designations; public health and safety; wilderness characteristics; and Refuge operations.

Local Economy and Commercial Uses Under Alternative C

Wilderness – Designation of the Coastal Plain WSA as Wilderness could affect commercial uses. In designated Wilderness, the Wilderness Act of 1964 and Service Wilderness policy prohibit commercial enterprises with few exceptions. Commercial services that help people access the Refuge to realize the recreational opportunities and wilderness characteristics of the area, such as guides and transportation companies, are allowed provided these uses are compatible with Refuge purposes, including Wilderness Act purposes. Commercial filming is limited in Wilderness by Service policy. Designation could potentially attract more wilderness-oriented visitors to the Refuge, resulting in increased business prospects for recreation guides, air operators, and other commercial service providers in local communities. Effects would be negligible to minor, long-term, WSA-wide, and positive for recreational service providers.

Big-game hunting guides in guide use areas within the Coastal Plain WSA could have to comply with stricter guidelines in order to minimize the effect of activities on Wilderness character. Because guide use areas are competitively awarded, effects would vary, depending on the guide. Effects could range from no effect to negligible to minor, long-term, WSA-wide, and negative or positive.

Wild and Scenic Rivers – Interim management provisions for the Atigun River, which are based on available management tools (see Appendix I, Section 4.4), would not affect local economy and commercial uses. However, if Refuge staff was to determine that one or more of the outstandingly remarkable values of the river was threatened and changes or restrictions to commercial services would mitigate the threat, then the Refuge could impose interim restrictions on commercial services. These restrictions would likely result in negligible, short-term to long-term, local, and negative effects to the local economy and commercial uses. If Congress were to designate the Atigun River as a wild river, Refuge staff would prepare a river-specific CRMP. If the CRMP were to limit or reduce the level of commercial use in order to protect the river's values, there could be negligible to minor, long-term, local, and negative effects on local economy and commercial uses.

Kongakut River – Limiting the number of guides and their use from 2013 to 2016 or until the VUMP is completed could limit the economic contribution of the river. Some service providers may decide not to offer a trip(s) on the Kongakut or may be unable to grow their business. Other commercial service providers may be unable to start a new business during the period of the cap. The effects would likely be minor, short-term, local, and negative.

A step-down VUMP would likely have effects on the local economy and commercial uses. Step-down planning would be done in conjunction with key stakeholders and the public. Depending on the nature of the changes and/or restrictions imposed by the VUMP, the effects could be minor to moderate, long-term, site-specific to Refuge-wide, and positive or negative for guides and commercial air operators operating on the Refuge. Should the plan limit or reduce the level of commercial use, minor to moderate negative effects would be anticipated to those guides adversely affected by such limits, and this could indirectly result in negligible to minor effects on local economies.

Cultural Resources Under Alternative C

Wilderness –Wilderness designation could indirectly have negligible, long-term, WSA-wide, and positive effect on cultural resources. By protecting natural conditions and wilderness characteristics, Wilderness could provide long-term protection for cultural resources and traditional lands, waters, and resources used by local residents and serve to perpetuate the natural conditions in which their cultures evolved. However, the intentional and unintentional losses of cultural resources would likely continue even within designated Wilderness, primarily as a result of erosion and other natural forces, resulting in similar effects as under Alternative A.

Wild and Scenic Rivers – Public use would continue on those rivers determined suitable for inclusion in the NWSRS. The effects of public use on cultural resources would likely be minor, long-term, site-specific, and negative. Interim management prescriptions for the Atigun River could mitigate these effects in this river corridor because the Refuge would use the prescriptions to maintain the river's values. If Congress were to designate the Atigun River as a wild river, a CRMP would be prepared, resulting in minor, long-term, local, and positive effects to cultural resources because of the assessment and monitoring programs that would be included in the CRMP.

Under Alternative C, the Refuge would use existing management tools to maintain the Cultural outstandingly remarkable value on the Hulahula River, rather than interim management prescriptions or the higher level of protection offered by a CRMP. Effects would range from no effect to negligible to minor, long-term, site-specific, and positive.

Kongakut River – Under Alternative C, cultural resource losses (intentional or unintentional) would likely continue in the Kongakut River valley. However, outreach emphasizing stewardship of cultural resources in the Kongakut River drainage would likely minimize potential impacts. Limiting the amount of guided use prior to completion of the VUMP should have negligible, short-term, local, positive effects on cultural resources. The VUMP would include a better understanding of the cultural resources of the area and their condition, and it would provide appropriate cultural resource management. The VUMP should result in negligible to minor, long-term, local, and positive effects to cultural resources as compared to Alternative A.

Subsistence Under Alternative C

Wilderness – Wilderness designation of the Coastal Plain WSA would provide long-term, statutory protection to habitats and natural conditions, especially those found near Kaktovik, thus indirectly serving to perpetuate the subsistence resources upon which local residents are so dependent. In general, subsistence uses in designated Wilderness would continue as they have under Minimal Management, and the harvest of subsistence resources would continue. Designation would not restrict subsistence use of resources in the Refuge, and the right of subsistence users to conduct traditional activities using traditional modes of transportation would continue. Effects of Wilderness designation to subsistence opportunities and resources would be negligible, long-term, WSA-wide, and positive.

The subsistence use of cabins would continue, although requests for construction or location of new cabins would receive greater scrutiny. Wilderness designation could also increase visitor use near Kaktovik's traditional and subsistence use areas, which could increase conflicts between locals and visitors. These effects would be expected to be negligible to minor, long-term, local, and negative.

Wild and Scenic Rivers – Under this alternative, interim management prescriptions for the Atigun River combined with outreach regarding cultural and subsistence use in the drainage could improve understanding and reduce real and/or perceived conflict between local users and nonlocal visitors. The effects would likely be negligible, medium-term, local, and positive. If Congress were to designate the Atigun River, a CRMP would be developed that would establish user capacities for the river corridor. The Refuge could then limit or control visitor use to ensure outstandingly remarkable and other river values are maintained, and this could indirectly result in fewer conflicts between subsistence users and visitors. The Atigun River CRMP would therefore result in minor, long-term, and local effects that would positive for subsistence resources and uses.

Kongakut River – Interim limits on guided use and outreach regarding cultural and subsistence use in the Kongakut River drainage could improve understanding and reduce real and/or perceived conflict between local users and nonlocal visitors. Voluntary actions by authorized guides and commercial air operators could also reduce the potential for conflicts among recreational visitors and subsistence users. The effects are likely to be minor, long-term, local, and positive.

Visitor Services and Recreation Opportunities Under Alternative C

Wilderness – Wilderness designation of the Coastal Plain WSA would have positive and negative effects on visitor services and recreational opportunities. Statutory protection of the area from roads, facilities, and recreational improvements would positively affect recreational opportunities for solitude, exploration, and freedom. Wilderness designation would potentially result in fewer installations and less visitor contact, which would enhance wilderness-associated recreational opportunities and experiences. Minimal Management already affords a high degree of wilderness-associated recreational opportunities and experiences, and so the effects of Wilderness designation would be negligible to minor, long-term, WSA-wide, and positive.

Because roads, facilities, recreational improvements, and commercial enterprises are not typically allowed in designated Wilderness, some visitor services could be directly and negatively impacted by Wilderness designation. No new cleared landing areas would be allowed in designated Wilderness, motorized generators and water pumps would not be allowed, and transportation and utility systems could only be authorized by Congress. Additionally, the Refuge might need to consider imposing limits on the number and types of visitor services in certain areas of the Refuge in order to preserve Wilderness character (should the area be designated as Wilderness). This would indirectly result in the loss of some recreational opportunities dependent on the impacted visitor services. These impacts are likely to be minor to moderate, long-term, specific to the Coastal Plain WSA, and negative.

To preserve experiential opportunities associated with Wilderness character (such as opportunities for solitude), the Refuge may decide to have fewer routine law enforcement patrols and less visitor use monitoring on the ground in designated Wilderness areas. The resultant effects would likely be minor, temporary to short-term, local, and negative or positive, depending on the perception of the Refuge user. Fewer routine patrols and less on-the-ground visitor use monitoring could result in the failure to detect degraded or impaired sites in designated Wilderness, resulting in minor, long-term, site-specific, and negative effects.

Wild and Scenic Rivers – Interim management provisions for the Atigun River, which are based on available management tools, would generally have no effect on visitor services and recreational opportunities. However, if Refuge staff was to determine that one or more of the outstandingly remarkable values of the river was threatened and changes or restrictions to visitors would mitigate the threat, then the Refuge could impose interim restrictions on visitor services, which in turn could affect recreational opportunities. These restrictions would likely result in negligible, short-term to long-term, local, and negative effects to visitor services and recreational opportunities. Congressional designation of the Atigun as a wild river could attract more visitors. If the number of visitors exceeds the determined user capacity of the river corridor, the Refuge might need to limit use. Effects would likely be minor to moderate, long-term, local, and positive or negative. Visitor experience could be enhanced by limiting use; however, some visitors might not be able to experience the river if access is limited. Any limitations on use of the Atigun River could potentially displace visitors to other Refuge rivers.

Kongakut River – This alternative proposes to adopt management strategies based on a Refuge-wide Visitor Use Management step-down plan. As the step-down plan unfolds, it is likely to affect visitor services and recreational opportunities. Through the VUMP, Refuge managers will consider levels of use, timing and distribution of use, and activities and behaviors of visitors. Managers may use education, site management, regulation, enforcement, and/or rationing/allocation to manage visitor use at Arctic Refuge. The effects would likely vary, depending on the visitor, ranging from no effect to minor to moderate, long-term, local, and positive or negative. The effects of proposed visitor use management will be fully evaluated in the step down planning process.

Developing outreach materials with preferred practices and strategies for minimizing impacts would likely raise the level of awareness of commercial and private users. In turn, this could lead to higher quality experiences for all users by reducing the amount of physical and experiential impacts occurring on the river, including those associated with human waste. The effects of outreach actions would likely be minor, long-term, local, and positive.

Improving monitoring programs for physical and social conditions could better inform management about areas of concern, thus allowing management to take appropriate, responsive action before continued degradation occurs. The effects of improved monitoring on visitor services and recreational opportunities would be minor to moderate, long-term, local, and positive. However, site-specific monitoring and rehabilitation could result in Refuge staff contributing to crowding and other user impacts on the river. These effects are likely to be minor, short-term, local, and negative. Effects could be mitigated to some extent by timing Refuge activities to occur outside peak use.

Publishing schedules of past guided and non-guided visitor use (currently available from commercial permit client use reports) could increase visitor awareness regarding Kongakut River use periods but would likely do little to redistribute use across the season. Asking guides and commercial air operators to voluntarily limit their activities could have minor, short-term, local, and positive effects on visitor experiences.

Placing an interim cap on recreational guides would affect recreational opportunities and visitor services in the Kongakut River valley. Some service providers may decide not to offer a trip(s) on the Kongakut or may be unable to grow their business, while other commercial service providers might be unable to offer their services during the period of the cap. While recreational opportunities are not expected to decline, this alternative could be perceived by recreationists and visitor service providers as curtailing or limiting opportunities, and could result in displacing recreation and visitor services to other areas of the Refuge. Other people might perceive a cap on commercial guides as an opportunity to recreate independently in the Kongakut River valley. These effects would be minor, short-term, local, and positive or negative, depending on the perception of different individuals and groups.

Wilderness Characteristics Under Alternative C

Wilderness – Congressional designation of the Coastal Plain WSA as Wilderness, would have a positive effect on wilderness characteristics. Wilderness areas are protected from roads, facilities, recreational improvements, commercial enterprises, helicopters, and installations. These protections would enhance wilderness characteristics and people's experiences in the area. Additionally, the Service would more closely consider our own Refuge management activities and their effects through the MRA process. The Coastal Plain WSA is currently under Minimal Management, and this management category already affords a high degree of administrative protection to wilderness characteristics. Wilderness designation would offer statutory protection to these characteristics and would represent a more permanent commitment to their protection. These effects would likely be minor, long-term, WSA-wide, and positive.

Wild and Scenic Rivers – Interim management prescriptions for the Atigun River would have no effect to negligible, medium-term, local, and positive effects on wilderness characteristics. If Congress were to designate the Atigun River as a wild river, a CRMP would be prepared, resulting in minor, long-term, local, and positive effects to wilderness characteristics because of the assessment and monitoring programs that would be included in the CRMP. In addition, the Refuge would establish user capacities and protect the outstandingly remarkable and other river values in the wild river corridor, which would have minor to moderate, long-term, local, and positive effects on wilderness characteristics.

Kongakut River – Interim limits on commercial recreation guides and their clients would minimize or lessen impacts on wilderness characteristics, but would not eliminate them. Activities would be frozen at current levels, thus curbing negative effects on wilderness characteristics, but ongoing impacts from continued use would not be affected. The effects of implementing an interim cap on guides would be minor, short-term, local, and positive for wilderness characteristics.

Working with air operators to disperse flight paths could reduce air traffic, therefore improving wilderness experiences for visitors. Because Arctic Refuge does not have jurisdiction over airspace, compliance with this request could not be enforced. To the extent we are able to achieve voluntary compliance with air operators, the effects to wilderness characteristics would likely be minor to moderate, short-term, local, and positive. Similarly, asking commercial guides and commercial air operators to minimize effects on Refuge visitors would have minor to moderate, short-term, local, and positive effects on wilderness characteristics, to the extent we are able to achieve compliance.

Improved monitoring of visitor experiences would: 1) tie observed conditions to management goals for biophysical resources; 2) help identify thresholds of acceptable changes in the biophysical environment; and 3) provide input on actions that could be taken to prevent negative Wilderness character indicator thresholds from being reached. Monitoring could result in improved management strategies for wilderness characteristics, and over the long-term, indirectly create moderate, local, and positive improvements to wilderness characteristics.

Visitors seeking solitude and other values associated with Wilderness might have already been displaced from the Kongakut. Implementing interim Kongakut River visitor use management prescriptions and ultimately prescriptions from a VUMP could stop displacement and enhance wilderness characteristics enough that visitors seeking solitude would return to the Kongakut. Outreach efforts focused on minimal impact techniques and desired behaviors for visitors would likely result in minor, long-term, local, and positive effects on wilderness characteristics. Rehabilitating impacted sites could help restore the river to its natural condition, thus improving Wilderness character. The effects are likely to be minor, long-term, local, and positive.

Special Designations Under Alternative C

Wilderness – Wilderness designation of the Coastal Plain WSA would have minor, long-term, WSA-wide, and positive effects on those portions of the MPA in the WSA because Wilderness designation would provide statutory protection to the Wilderness character of the MPA.

Wild and Scenic Rivers – There would be no effects to any special designations under this alternative.

Kongakut River – There would be negligible, long-term, local, and positive effects to the MPA as a result of more proactive management of the Kongakut River. Some commercial recreation guides might elect to divert their operations from the Kongakut to one of the Refuge's three wild rivers (Ivishak, Sheenjek, and Wind Rivers) or to the Refuge's RNAs or PUNAs. Effects would range from no effect to negligible to minor, short- to medium term, local, and negative.

Public Health and Safety Under Alternative C

Wilderness – Neither Wilderness recommendation nor designation would not have any effect on public health and safety. Public health and safety would continue as under current management.

Wild and Scenic Rivers – Neither interim management prescriptions nor wild river designation of the Atigun River would have any effect on public health and safety.

Kongakut – Developing a Visitor Use Management step-down plan and providing targeted messages to Refuge visitors would have no effect to negligible, long-term, Refuge-wide, and positive effects on public health and safety issues.

Refuge Operations Under Alternative C

Wilderness – Congressional designation of the Coastal Plain WSA as Wilderness would affect overall Refuge operations, both in terms of paperwork and in terms of research. If the Coastal Plain WSA were to be designated as Wilderness, Refuge management activities would be subject to an MRA process, and normally prohibited uses would be approved only if they are determined to be the minimum necessary to manage the area as Wilderness. New Wilderness designation could therefore increase the paperwork burden for Refuge staff. These effects would likely be minor, long-term, WSA-wide, and negative.

Additionally, proposed research conducted as a Refuge management activity would be subject to an MRA to determine if it is necessary to accomplish the purposes of the Refuge, including Wilderness Act purposes, and that any normally prohibited uses are necessary to meet the minimum requirements for managing the area as Wilderness. The MRA process could negatively affect long-term research projects with established data collection protocols or research that might require permanent installations, such as climate change research. Decisions are made on a case-by-case basis, however, and it is possible that installations could be allowed. There is some uncertainty as to the extent that Wilderness designation would limit the ability to conduct research or monitoring necessary to affect conservation measures. We believe the effects would be negligible to minor, long-term, WSA-wide, and negative.

Wilderness designation would not affect the jurisdiction or responsibilities of the State with respect to wildlife, although actions would need to be consistent with maintaining Wilderness character. For some State activities, an MRA would be required if Congress were to designate the Coastal Plain WSA as Wilderness. We believe the effects would be negligible, long-term, WSA-wide, and negative.

Wild and Scenic Rivers – There would be no effect to negligible, medium-term, local, and negative effects to Refuge operations under an interim management prescription for the Atigun River. Overall, management of the Atigun River would continue as under current management. However, Refuge staff would likely conduct periodic monitoring and assessments of the river corridor to ensure outstandingly remarkable values are being maintained.

Should Congress include the Atigun River in the NWSRS, there would be effects to Refuge operations. There would be an additional workload to prepare a CRMP in the short-term; the effects would be moderate, short-term, Refuge-wide, and negative. In the medium-term, monitoring and the potential for adjusting user limits would result in minor to moderate, Refuge-wide, and negative effects through the expenditure of staff time and budget. However, once the CRMP is completed and monitoring protocols and a system for managing the river are in place, there should be less strain on Refuge staff dealing with day-to-day issues. Thus, over the long-term, effects would be minor, Refuge-wide, and positive.

Kongakut River – This alternative would require additional staff time and budget to 1) execute a revised monitoring program; 2) develop outreach materials; 3) compile and publish schedules of proposed launch dates; 4) establish, implement, and monitor an interim cap on commercial recreational guides; 5) conduct site-specific rehabilitation; and 6) develop and execute a step-down management plan. The effects are likely to be moderate, short- to medium-term, Refuge-wide, and negative. Indirectly, limits placed on commercial guides could negatively affect the Service's relationship with these stakeholders in the short-term. Over the long-term, however, there should be less strain on Refuge staff dealing with day-to-day river management concerns, and more public buy-in on management of the Kongakut River, resulting in minor, long-term, Refuge-wide, and positive effects.

5.5.4 Effects on Poker Flat Research Range from Alternative C

The service does not expect that implementing Alternative C would have an adverse impact on the continued launch of sounding rockets from Poker Flat. In general, planned impact locations within Arctic Refuge are not further north of the Ivishak River; water landings in the Beaufort Sea/Arctic Ocean are generally not closer than 220 miles (350 kilometers) north of Barter Island.

As designation of the Coastal Plain WSA would likely restrict the future installation of certain infrastructure and the onset of commercial activities within the area, it could benefit the Sounding Rockets Program. The future year-round presence of high value infrastructure and additional people within the Poker Flat flight corridor could place further restrictions on allowable missions due to mandatory flight safety considerations. Implementing Alternative C could alleviate this possibility.

5.5.5 Cumulative Effects of Alternative C

The qualified and suitable lands and waters of the Coastal Plain WSA (1.55 million acres) would be recommended for Wilderness designation. There would be no cumulative effects related to the administrative act of recommending Wilderness. Should the Coastal Plain WSA be designated Wilderness, the cumulative effects would be negligible to minor, long-term, WSA-wide, and positive, since designated Wilderness provides more permanent statutory protection to the biophysical and human environments. Management activities within Wilderness would be subject to MRAs, and certain activities discussed previously would be subject to a higher level of scrutiny.

An 11-mile segment of the Atigun River would be recommended for designation as a wild river. The cumulative effect of this action would be a positive effect for long-term protection of the Atigun River. The three suitable rivers not recommended for inclusion in the NWSRS would be managed using existing management tools under the Minimal Management and Wilderness Management categories. This alternative would result in a minor cumulative effect to the biophysical and human environments for the foreseeable future.

Cumulative effects as a result of management actions for the Kongakut River under this alternative would be minor as a result of increasing outreach, more proactively managing the area, and capping visitor use from commercial recreation guides until such time as a Refuge-wide VUMP is developed.

The effects of Alternative C would be cumulative to other effects in the planning region, including the effects of climate change, development activities, and management decisions made by others (such as the reasonably foreseeable future actions listed in Section 5.1.4). Cumulatively, Refuge management under Alternative C would have negligible to minor effects on the biophysical and human environments in the region.

5.6 Effects of Alternative D

This section evaluates the implication or impacts of Alternative D on resource categories for each major issue: Wilderness, wild and scenic rivers, and Kongakut River visitor management.

5.6.1 Alternative D Introduction

Wilderness –Alternative D recommends designating the qualified and suitable lands and waters in the Brooks Range WSA (5.82 million acres) and Porcupine Plateau WSA (4.92 million acres) as Wilderness. The administrative act of recommending these WSAs would have no effect on any resource category. However, the effects analysis here considers the effects of Wilderness designation on the resource categories should Congress choose to designate the Brooks Range and Porcupine Plateau WSAs as Wilderness.

Wild and Scenic Rivers – Alternative D recommends all four suitable rivers for inclusion in the National Wild and Scenic River System: Atigun, Marsh Fork Canning, Hulahula, and Kongakut. The Hulahula River would be segmented at the boundary of Refuge and KIC lands. Those portions of the Hulahula River on KIC lands would not be recommended. Rivers recommended for wild river status must be protected until Congress acts to designate or reject a recommendation for designation. Pending congressional action, the Service would use interim management prescriptions to manage each recommended river for the outstandingly remarkable values for which it was found eligible (see Appendix I, Section 4.4).

If Congress were to designate these four rivers as wild, the Refuge would prepare a CRMP for each river. The CRMPs would formalize the requirement to preserve each river's outstandingly remarkable and other values found through inventory, in perpetuity. These rivers would be part of the NWSRS and be afforded the protections of the Wild and Scenic Rivers Act (see Appendix I, Section 4.5). For wild rivers or river segments within designated Wilderness, the more restrictive provisions of the Wild and Scenic Rivers Act and the Wilderness Act would apply.

Kongakut River – Alternative D proposes Kongakut River management issues be addressed in a Visitor Use Management and/or Wilderness Stewardship step-down plan, that would, among other things, develop long-term monitoring protocols. Until the step-down plan(s) is completed, the Service would implement a variety of interim management actions to protect resources in the Kongakut River valley (see Chapter 3, Section 3.2.5.3).

5.6.2 Effects on the Biophysical Environment from Alternative D

Wilderness – If the Brooks Range and Porcupine Plateau WSAs were to be designated as Wilderness, restrictions on activities that could damage Refuge resources would be less likely to change over time and might be more likely to be enforced, which would provide greater certainty of long-term protection for wildlife and habitats. The Brooks Range and Porcupine Plateau WSAs are currently under Minimal Management, and this management category already affords a high degree of administrative protection to the biophysical environment. However, by protecting natural conditions, Wilderness designation could have minor, long-term, WSA-wide, positive effects on the value of the WSAs for ecological research and monitoring.

Resource categories that could be affected by Wilderness designation of the Brooks Range WSA include: permafrost and soils; water quality and aquatic habitats; vegetation and terrestrial habitats; fish populations and natural diversity; bird populations and natural diversity; and mammal populations and natural diversity. Research on the biophysical environment could also be affected due to the need to complete MRAs for all Refuge management activities (see "Refuge Operations" in Section 5.6.3).

Wild and Scenic Rivers – Alternative D recommends wild and scenic river designation for all four suitable rivers, but only those portions of the Hulahula River flowing through Refuge lands would be recommended. Implementing interim management prescriptions for the four suitable rivers would result in negligible, medium-term, site-specific, and positive effects on biophysical resources within these river corridors. If these rivers were to be designated as wild rivers by Congress, the effects would be minor, long-term, local, and positive because designation would require the Refuge to develop CRMPs for each river. The CRMPs would include an inventory and assessment of biophysical resources in the wild river corridor as well as a monitoring program for ongoing assessment and protection of these resources. Six of the biophysical resource categories would be affected, as described in this section.

Kongakut River – Alternative D recommends interim management tools to address biophysical resource concerns in the Kongakut River valley until such time as a VUMP and/or WSP are completed. These interim tools would have negligible to minor, long-term, site-specific to local, and positive effects on biophysical resources. Six of the biophysical resource categories would be affected, as follows.

Permafrost and Soils Under Alternative D

Wilderness – Wilderness designation would have indirect, negligible to minor, long-term, WSA-wide, and positive effects on permafrost and soils because of the additional statutory protection Wilderness management provides regarding natural conditions.

Wild and Scenic Rivers – Interim management prescriptions to protect the free-flowing character and outstandingly remarkable values for those rivers that are suitable and recommended would result in negligible, medium-term, site-specific, and positive impacts to permafrost and soils in these river corridors. The CRMPs that would be prepared for the Atigun, Marsh Fork Canning, Hulahula, and Kongakut Rivers, if they were to be designated as wild rivers by Congress, would include an inventory of current permafrost and soil conditions and a monitoring program for ongoing assessment and protection of these resources. The CRMPs would also establish protocols to prevent and/or repair damage caused by visitor use. The resultant effects would be minor, site-specific to local, long-term, and positive.

Kongakut River – Refuge visitors have the potential to damage soils and permafrost by trampling, particularly at campsites and access points such as landing areas. Enhanced management of visitor use in the Kongakut River area under Alternative D would decrease site-specific impacts. Site-specific disturbances from visitors occur extensively up and down the Kongakut River corridor, so enhanced management would also decrease impacts at the local scale. This alternative would have negligible to minor, long-term, site-specific to local, and positive impacts on permafrost and soils in the Kongakut River corridor.

Water Quality and Aquatic Habitats Under Alternative D

Wilderness – Wilderness designation of the Brooks Range and Porcupine Plateau WSAs would provide long-term, statutory protection for wilderness characteristics, including aquatic habitats. Designation would result in minor, long-term, WSA-wide, and positive effects.

Wild and Scenic Rivers – Interim management prescriptions to protect the free-flowing character and outstandingly remarkable values of the four recommended rivers would result in negligible, medium-term, site-specific, and positive impacts to water quality and aquatic habitats in these river corridors. If Congress were to include these four rivers in the NWSRS, CRMPs would be prepared for each river. The CRMPs would include an inventory of current water quality and aquatic habitat condition and a monitoring program for ongoing assessment and protection of these resources. The CRMP would also establish protocols to prevent and/or repair damage caused by visitor use. The effects of designation would be minor, long-term, site-specific to local, and positive on water quality and aquatic habitats.

Kongakut River – Water quality and aquatic habitats can be affected by increased visitor use through increased vegetation trampling and soil compaction, which increases the potential for runoff and sediment loading. Outreach about proper waste disposal and minimizing visitor impacts, along with monitoring the effectiveness of management actions, would have minor, long-term, local, and positive effects on water quality and aquatic habitats along the Kongakut River.

Vegetation and Terrestrial Habitats Under Alternative D

Wilderness – Although management strategies are similar for Wilderness Management and Minimal Management, Wilderness designation is a more permanent commitment to maintain natural conditions. Wilderness designation would likely have a negligible to minor, long-term, WSA-wide, and positive effects on vegetation and terrestrial habitats because of the long-term statutory protections designation would provide to Wilderness character.

Wild and Scenic Rivers – Interim management prescriptions to protect the free-flowing character and outstandingly remarkable values of the four suitable and recommended rivers would result in negligible to minor, medium-term, site-specific, and positive impacts to vegetation and terrestrial habitats in these river corridors. If Congress were to designate the four rivers as wild, CRMPs would be prepared for each river. The CRMPs would include an inventory of current vegetation and terrestrial habitat condition and a monitoring program for ongoing assessment and protection of these resources. The CRMP would also establish protocols to prevent and/or repair visitor use damage, which would result in minor, long-term, site-specific to local, and positive effects on vegetation and terrestrial habitats.

Kongakut River – Refuge visitors may damage vegetation and habitats, particularly at campsites and access points such as landing areas. Potential damage includes direct effects of trampling, breakage of trees and shrubs, the possible introduction of invasive plants, and the exclusion of wildlife from riparian and adjacent habitats on vegetation. Indirect effects include soil and snow compaction as a result of trampling. Most disturbances to vegetation are site-specific and restricted to areas receiving repeated use, such as hunting camps near fixed-wing aircraft-accessible sites and campsites used by floaters along major rivers. Disturbances are local in scale, as site-specific disturbances occur extensively along the Kongakut River corridor. The additional management proposed in Alternative D would have negligible to minor, long-term, site-specific to local, and positive impacts on vegetation and terrestrial habitats in the Kongakut River drainage.

Fish Populations and Natural Diversity Under Alternative D

Wilderness – Wilderness designation provides long-term protections for fish populations and natural diversity through the statutory requirements of the Wilderness Act. Effects of designation of the Brooks Range and Porcupine Plateau WSAs on fish populations and natural diversity would therefore be minor, long-term, throughout the WSAs, and positive.

Wild and Scenic Rivers – The Service would use interim management prescriptions to manage each suitable and recommended river for its free-flowing character and the outstandingly remarkable values for which it was found eligible. This would result in negligible, medium-term, local, and positive impacts to fish populations and natural diversity. If Congress were to designate the recommended rivers, CRMPs would be prepared, resulting in minor, long-term, local, and positive effects to fish populations and natural diversity because of the assessment and monitoring programs that would be included in the CRMPs.

Kongakut River – Dolly Varden and grayling are popular fish sought by anglers on the Kongakut River. Harvest levels of these fish species are unknown and thought to be low. Providing outreach materials on proper catch-and-release techniques could lead to increased survival rates of released fishes, resulting in negligible, long-term, local, positive effects.

Bird Populations and Natural Diversity Under Alternative D

Wilderness – If Congress were to designate the Brooks Range and Porcupine Plateau WSAs as Wilderness, natural conditions would be maintained using the Wilderness Management category. This would have long-term, positive effects on bird populations in the two WSAs. Because most bird species are migratory, beneficial effects could be expressed over a larger area than the WSAs. Under current management, disturbance to birds and alteration of their habitats is minimal. However, Wilderness designation, with its long-term commitment to maintaining natural conditions, could have negligible to minor, long-term, regional or greater, and positive effects.

Wild and Scenic Rivers – There would be negligible, medium-term, local, and positive effects on bird populations and natural diversity under this alternative. The Service would use interim management prescriptions to manage each suitable and recommended river for the outstandingly remarkable values for which it was found eligible. Because riparian areas tend to have higher density and diversity of birds compared to surrounding habitats, maintaining river values should indirectly have positive effects on bird populations and natural diversity. If Congress were to include the four recommended rivers in the NWSRS, CRMPs would be prepared for each river, resulting in minor, long-term, local, and positive effects on bird populations and natural diversity in these river corridors because of the assessment and monitoring programs that are required in the CRMPs.

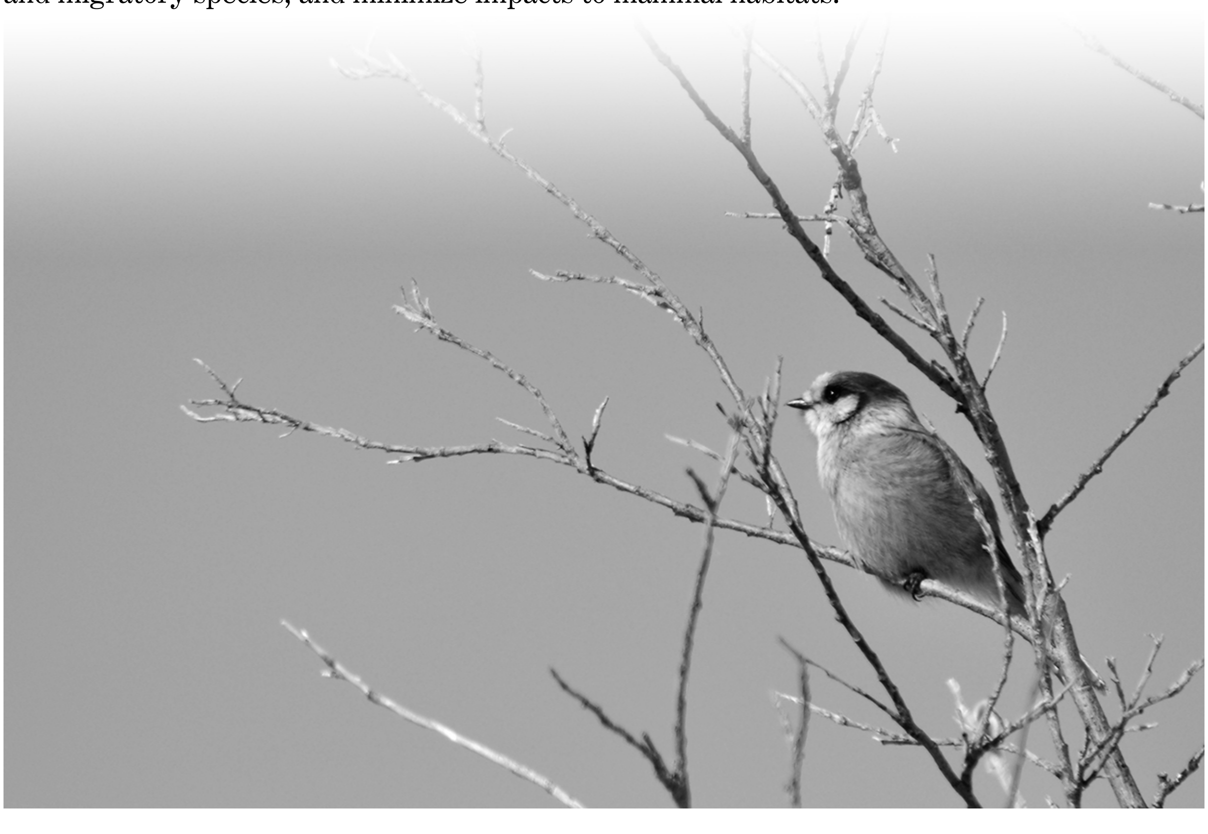
Kongakut River – Enhanced management of human use of the Kongakut River valley would have negligible to minor, long-term, site-specific to local, and positive effects on bird populations and natural diversity. Monitoring visitor impacts on bird habitats would lead to the development of conservation measures to mitigate visitor impacts on birds if adverse effects are detected. Outreach materials would benefit birds by helping visitors reduce disturbance to nesting raptors and other species, and minimize impacts to bird habitats.

Mammal Populations and Natural Diversity Under Alternative D

Wilderness – Wilderness designation would result in minor to moderate, long-term, WSA-wide to regional, and positive effects for a variety of mammals including Dall's sheep, moose, grizzly bears, black bears, wolves, wolverines, and caribou because of the more permanent commitment to protect natural conditions in designated Wilderness, including mammal populations and habitats.

Wild and Scenic Rivers – There would be negligible, medium-term, local, and positive effects on mammal populations and natural diversity under this alternative. The Service would use interim management prescriptions to manage the free-flowing character of each suitable and recommended river and to maintain the outstandingly remarkable values for which each river was found eligible. This would indirectly affect mammal populations and natural diversity. If Congress were to designate recommended rivers, CRMPs would be prepared, resulting in minor, long-term, local, and positive effects to mammal populations and natural diversity in these river corridors because of the assessment and monitoring programs that would be included in the CRMPs.

Kongakut River – Enhanced management of human use of the Kongakut River valley would have negligible to minor, long-term, site-specific to local, and positive effects on mammal populations. Monitoring impacts to habitats by visitors would lead to the development of conservation measures to mitigate visitor impacts on mammals if adverse effects are detected. Outreach materials would benefit mammals by helping visitors reduce disturbance to resident and migratory species, and minimize impacts to mammal habitats.



5.6.3 Effects on the Human Environment from Alternative D

Wilderness – Under current management, public use of the Refuge is managed similarly in designated Wilderness and in areas under Minimal Management. Most regulations on public use are derived from the area's status as a refuge and by State law. Public use is subject to Federal regulations implementing Federal laws (e.g., ANILCA, Refuge Administration Act), State laws (e.g., Alaska Statute 19.40.210, which prohibits off-road vehicles from the Dalton Highway), and State regulations (e.g., the State of Alaska hunting and fishing regulations). However, by protecting wilderness characteristics (both biophysical and experiential), Wilderness designation could have negligible to minor, long-term, WSA-wide, positive effects on the human environment.

If the Brooks Range and Porcupine Plateau WSAs were to be designated as Wilderness, it would affect the following resource categories: local economy and commercial uses; cultural resources; subsistence; visitor services and recreational opportunities; wilderness characteristics; all three of the Refuge's designated wild rivers; Refuge operations; and Poker Flat.

Wild and Scenic Rivers – Alternative D recommends the Atigun, Marsh Fork Canning, and Kongakut Rivers, plus those portions of the Hulahula River managed by the Refuge, for inclusion in the NWSRS. Interim management prescriptions would be implemented for these rivers to maintain the outstandingly remarkable values associated with each river (see Appendix I, Section 4.4). If Congress were to designate any of the rivers as wild, CRMPs would be developed and implemented for the continued protection of the rivers and their associated values. CRMPs and interim management prescriptions would lay out strategies that might affect the following resource categories: local economy and commercial uses; subsistence; cultural resources; visitor services and recreational opportunities; special designations; and wilderness characteristics.

Kongakut River – Under Alternative D, a VUMP would be initiated immediately upon approval of the Revised Plan. Until the VUMP takes effect, interim management tools would be implemented. The interim management tools would result in minor to moderate, long-term, local, and positive effects on the human environment. Interim management tools would affect the following resource categories: local economy and commercial uses; cultural resources; subsistence; visitor services and recreational opportunities; wilderness characteristics; and Refuge operations.

Local Economy and Commercial Uses Under Alternative D

Wilderness – Designation of the Brooks Range and Porcupine Plateau WSAs as Wilderness could affect commercial uses. In designated Wilderness, the Wilderness Act of 1964 and Service Wilderness policy prohibit commercial enterprises with few exceptions. Commercial services that allow people to access the Refuge to realize the recreational or other wilderness purposes of the area, such as guides and transportation companies, are allowed. Other commercial enterprises, such as commercial filming, are limited in Wilderness by Service policy. Designation could potentially attract more wilderness-oriented visitors to the Refuge, resulting in increased business opportunities for recreation guides, commercial air operators, and other commercial service providers in local communities. Effects would be negligible to minor, long-term, WSA-wide, and positive for recreational service providers.

Big-game hunting guides in guide use areas within the Brooks Range and Porcupine Plateau WSA could have to comply with stricter guidelines in order to minimize the effect of activities on Wilderness character. Because guide use areas are competitively awarded, effects would vary, depending on the guide. Effects could range from no effect to negligible to minor, long-term, WSA-wide, and negative or positive.

Wild and Scenic Rivers – Interim management provisions for suitable and recommended rivers are based on available management tools. In general, there would be no change to the management of the four suitable and recommended rivers, and therefore there would be no effects on local economy and commercial uses. However, if Refuge staff was to determine that one or more of the outstandingly remarkable values of these rivers was threatened and changes or restrictions to commercial services would mitigate the threat, then the Refuge could impose interim restrictions on commercial services. These restrictions would likely result in negligible, short-term to long-term, local, and negative effects to the local economy and commercial uses. If Congress were to designate the suitable and recommended rivers under this alternative, CRMPs would be developed. If the CRMPs were to limit or reduce the level of commercial use in order to protect outstandingly remarkable or other river values, there could be minor, long-term, local, and negative effects on the local economy and commercial uses.

Kongakut River – A step-down VUMP would likely have effects on the local economy and commercial uses. Step-down planning would be done in conjunction with key stakeholders and the public. Depending on the nature of the changes and/or restrictions imposed by the VUMP, the effects could be minor to moderate, long-term, site-specific to Refuge-wide, and positive or negative for guides and air operators operating on the Refuge. Should the plan limit or reduce the level of commercial use, minor to moderate negative effects would be anticipated to those guides adversely affected by such limits, and this could indirectly result in negligible to minor effects on local economies.

Cultural Resources Under Alternative D

Wilderness – Wilderness designation could indirectly have negligible, long-term, WSA-wide, and positive effects on cultural resources. By protecting natural conditions and wilderness characteristics, Wilderness could provide long-term protection for cultural resources and traditional lands, waters, and resources used by local residents and serve to perpetuate the conditions in which their cultures evolved. However, the intentional and unintentional losses of cultural resources would likely continue even within designated Wilderness, primarily as a result of erosion and other natural forces, resulting in similar effects as under Alternative A.

Wild and Scenic Rivers – Public use would continue on those rivers determined suitable and recommended for inclusion in the NWSRS. The effects of public use on cultural resources would likely be minor, long-term, site-specific, and negative. Interim management prescriptions could mitigate these effects because the refuge would use the prescriptions to maintain river values. Under Alternative C, those portions of the Hulahula River that flow through Refuge-managed lands would be recommended for wild river designation. The Hulahula River has a Cultural outstandingly remarkable value, and the Refuge is required to manage the river to maintain this value. Therefore, this river would have a higher level of protection for cultural resources. If Congress were to designate the recommended rivers, CRMPs would be prepared, resulting in minor, long-term, local, and positive effects to cultural resources because of the assessment and monitoring programs that would be included in the CRMPs.

Kongakut River – Under Alternative D, cultural resource losses (intentional or unintentional) would likely continue in the Kongakut River valley. However, outreach emphasizing stewardship of cultural resources in the Kongakut River drainage could minimize potential impacts. Additionally, the VUMP would include a better understanding of the cultural resources of the area and their condition, and it would provide appropriate cultural resource management. The VUMP should result in negligible to minor, long-term, local, and positive effects to cultural resources as compared to Alternative A.

Subsistence Under Alternative D

Wilderness – Designation of the Brooks Range and Porcupine Plateau WSAs would provide long-term, statutory protection to habitats and natural conditions, especially those found south of the Brooks Range, thus indirectly serving to perpetuate the subsistence resources upon which local residents are so dependent. In general, subsistence uses in Wilderness would continue as they have under Minimal Management, and the harvest of subsistence resources would continue. Designation would not restrict subsistence use of resources in the Refuge, and the right of subsistence users to conduct traditional activities using traditional modes of transportation would continue. Effects of Wilderness designation on subsistence opportunities and resources would be negligible, long-term, WSA-wide, and positive.

The subsistence use of cabins would continue, although requests for construction or location of new cabins would receive greater scrutiny. Wilderness designation could also increase visitor use near the south side village traditional and subsistence use areas, which could increase conflicts between locals and visitors. These effects would be expected to be negligible to minor, long-term, local, and negative.

Wild and Scenic Rivers – Under this alternative, interim management prescriptions combined with outreach regarding cultural and subsistence use in drainages recommended as wild rivers could improve understanding and reduce real and/or perceived conflict between local users and nonlocal visitors. The effects would likely be negligible, medium-term, local, and positive. If Congress were to designate the four suitable and recommended rivers, CRMPs would be developed that establish user capacities for each river. The Refuge could then limit or control visitor use to ensure outstandingly remarkable and other river values are maintained, and this could indirectly result in fewer conflicts between subsistence users and visitors. CRMPs could therefore result in minor, long-term, and local effects that would be positive for subsistence resources and uses.

Kongakut River – Outreach regarding cultural and subsistence use in the Kongakut River drainage could improve understanding and reduce real and/or perceived conflict between local users and nonlocal visitors. Voluntary actions by authorized guides and commercial air operators could also reduce the potential for conflicts among recreational visitors and subsistence users. The effects would likely be minor, long-term, local, and positive.

Visitor Services and Recreation Opportunities Under Alternative D

Wilderness – Congressional designation of the Brooks Range and Porcupine Plateau WSAs as Wilderness would affect visitor services and recreational opportunities. Statutory protection of the area from roads, facilities, and recreational improvements would positively affect recreational opportunities for solitude, exploration, and freedom. Wilderness designation would potentially result in fewer installations and less visitor contact, which would enhance wilderness-associated recreational opportunities and experiences. Dalton Highway road access to the Brooks Range WSA would make it possible for visitors to reach designated Wilderness in an economically feasible manner without requiring aircraft support. Minimal Management already affords a high degree of wilderness-associated recreational opportunities and experiences, and so the effects of Wilderness designation would be minor, long-term, WSA-wide to Refuge-wide, and positive.

Because roads, facilities, recreational improvements, and commercial enterprises are not typically allowed in designated Wilderness, some visitor services could be directly and negatively impacted by Wilderness designation. No new cleared landing areas would be allowed in designated Wilderness, motorized generators and water pumps would not be allowed, and transportation and utility systems could only be authorized by Congress. Additionally, the Refuge might need to consider imposing limits on the number and types of visitor services in certain areas of the Refuge in order to preserve Wilderness character (should the area be designated as Wilderness). This would indirectly result in the loss of some recreational opportunities dependent on the impacted visitor services. These impacts are likely to be minor, long-term, WSA-wide to Refuge-wide, and negative.

To preserve experiential opportunities associated with Wilderness character (such as opportunities for solitude), the Refuge may decide to have fewer routine law enforcement patrols and less visitor use monitoring on the ground in designated Wilderness areas. The resultant effects would likely be minor, temporary to short-term, local, and negative or positive, depending on the perception of the Refuge user. Fewer routine patrols and less on-the-ground visitor use monitoring could result in the failure to detect degraded or impaired sites in designated Wilderness, resulting in minor, long-term, site-specific, and negative effects.

Wild and Scenic Rivers – Interim management provisions for suitable and recommended rivers are based on available management tools. In general, there would be no change to the management of the four suitable and recommended rivers, and therefore there would be no effects on visitor services and recreational opportunities. However, if Refuge staff was to determine that one or more of the outstandingly remarkable values of these rivers was threatened and changes or restrictions to visitors would mitigate the threat, then the Refuge could impose interim restrictions on visitor services, which in turn could affect recreational opportunities. These restrictions would likely result in negligible, short-term to long-term, local, and negative effects to visitor services and recreational opportunities. If Congress were to designate any of the suitable and recommended rivers, the Refuge would be required to determine the user capacity of each designated river. If the number of visitors exceeds the determined user capacity, the Refuge might need to limit use. The effects would likely be minor to moderate, long-term, local, and positive or negative. Visitor experience could be enhanced by limiting use; however, some visitors might not be able to experience the river due to lack of river access. Any limitations on use of the designated rivers could potentially displace visitors to other rivers in the Refuge.

Kongakut River – This alternative proposes to adopt management strategies based on a Refuge-wide Visitor Use Management step-down plan. As the step-down plan unfolds, it is likely to affect visitor services and recreational opportunities. Through the VUMP, Refuge managers will consider levels of use, timing and distribution of use, and activities and behaviors of visitors. Managers may use education, site management, regulation, enforcement, and/or rationing/allocation to manage visitor use at Arctic Refuge. The effects would likely vary, depending on the visitor, ranging from no effect to minor to moderate, long-term, local, and positive or negative. The effects of proposed visitor use management will be fully evaluated as part the step-down planning process.

Developing outreach materials with preferred practices and strategies for minimizing impacts would likely raise the level of awareness of commercial and private users. In turn, this could lead to higher quality experiences for all users by reducing the amount of physical and experiential impacts occurring on the river, including those associated with human waste. The effects of outreach actions would likely be minor, long-term, local, and positive.

Improving monitoring programs for physical and social conditions could better inform management about areas of concern, thus allowing management to take appropriate responsive action before continued degradation occurs. The effects of improved monitoring on visitor services and recreational opportunities would be minor to moderate, long-term, local, and positive. However, site-specific monitoring and rehabilitation could result in Refuge staff contributing to crowding and other user impacts on the river. These effects are likely to be minor, short-term, local, and negative. Effects could be mitigated to some extent by timing Refuge activities to occur outside peak use.

Publishing schedules of past guided and non-guided visitor use (currently available from commercial permit client use reports) could increase visitor awareness regarding Kongakut River use periods but would likely do little to redistribute use across the season. Asking guides and commercial air operators to voluntarily limit their activities could have minor, short-term, local, and positive effects on visitor experiences.

Wilderness Characteristics Under Alternative D

Wilderness – Congressional designation of the Brooks Range and Porcupine Plateau WSAs as Wilderness would have a positive effect on wilderness characteristics. Wilderness areas are protected from roads, facilities, recreational improvements, commercial enterprises, helicopters, and installations. These protections would enhance wilderness characteristics and people's experiences in the area. Additionally, the Service would more closely consider our own Refuge management activities and their effects through the MRA process. The Brooks Range WSA is currently under Minimal Management, and this management category already affords a high degree of administrative protection to wilderness characteristics. Wilderness designation would offer statutory protection to these characteristics and would represent a more permanent commitment to their protection. These effects would likely be moderate, long-term, Refuge-wide, and positive.

Wild and Scenic Rivers – Implementing interim management prescriptions would have no effect to negligible, medium-term, local, and positive effects on wilderness characteristics. However, designation of additional wild rivers would result in minor to moderate, long-term, local, and positive effects because Wild and Scenic Rivers Act protections are complimentary to the protections of the Wilderness Act. For wild rivers or segments thereof in designated

Wilderness, the more restrictive provisions of the Wild and Scenic Rivers Act and the Wilderness Act would apply. In addition, the Refuge would have the ability to limit and control public use by establishing user capacities, which in turn would enhance wilderness characteristics. The effects would be minor to moderate, long-term, local, and positive.

Kongakut River – Working with operators to disperse flight paths could reduce air traffic, therefore improving wilderness experiences for visitors. Because Arctic Refuge does not have jurisdiction over airspace, compliance with this request could not be enforced. To the extent we are able to achieve voluntary compliance with air operators, the effects to wilderness characteristics would likely be minor to moderate, short-term, local, and positive. Similarly, asking guides and commercial air operators to minimize effects on Refuge visitors would have minor to moderate, short-term, local, and positive effects on wilderness characteristics, to the extent we are able to achieve compliance.

Improved monitoring of visitor experiences would: 1) tie observed conditions to management goals for biophysical resources; 2) help identify thresholds of acceptable changes in the biophysical environment; and 3) provide input on actions that could be taken to prevent negative Wilderness character indicator thresholds from being reached. Monitoring could result in improved management strategies for wilderness characteristics, and over the long-term, indirectly create moderate, local, and positive improvements to wilderness characteristics.

Visitors seeking solitude and other values associated with Wilderness might have already been displaced from the Kongakut River. Implementing interim Kongakut River visitor use management prescriptions and ultimately prescriptions from a VUMP could stop displacement and enhance wilderness characteristics enough that visitors seeking solitude would return to the Kongakut. Outreach efforts focused on minimal impact techniques and desired behaviors for visitors would likely result in minor, long-term, local, and positive effects on wilderness characteristics. Rehabilitating impacted sites could help restore the river to its natural condition, thus improving wilderness characteristics. The effects are likely to be minor, long-term, local, and positive.

Special Designations Under Alternative D

Wilderness – Wilderness designation would have negligible to minor, long-term, WSA-wide, and positive effects to the Refuge's existing three wild rivers as a result of Wilderness designation. The lower portion of the Sheenjek River, and all of the Ivishak, and Wind wild river corridors are in the Brooks Range and Porcupine Plateau WSAs. Wild and Scenic Rivers Act protections are complimentary to the protections of the Wilderness Act, and for wild rivers within designated Wilderness, the more restrictive provisions of the Wild and Scenic Rivers Act and the Wilderness Act would apply.

Wild and Scenic Rivers – The Shublik Springs RNA is downstream from the Marsh Fork Canning River. There would be negligible to minor, long-term, local, and positive effects for Shublik Springs if the Marsh Fork is designated as a wild river; the Marsh Fork would have added resource protections, and visitor experiences would be expected to improve. Similarly, protecting the free-flowing character and outstandingly remarkable and other values of the Hulahula and Kongakut Rivers would indirectly result in negligible, long-term, local, and positive effects on the MPA.

Kongakut River – There would be negligible, long-term, local, and positive effects to the MPA as a result of more proactive management of the Kongakut River.

Public Health and Safety Under Alternative D

Wilderness – Neither Wilderness recommendation nor designation would have any effect on public health and safety. Public health and safety would continue as under current management.

Wild and Scenic Rivers – Implementing interim management prescriptions or wild river designation would have no effect on public health and safety.

Kongakut River –Developing a Visitor Use Management step-down plan and providing targeted messages to Refuge visitors would have no effect to negligible, long-term, Refuge-wide, and positive effects on public health and safety issues.

Refuge Operations Under Alternative D

Wilderness – Congressional designation of the Brooks Range and Porcupine Plateau WSAs as Wilderness would affect overall Refuge operations, both in terms of paperwork and in terms of research. If the Brooks Range and Porcupine Plateau WSAs were designated as Wilderness, Refuge management activities would be subject to an MRA process, and normally prohibited uses would be approved only if they are determined to be the minimum necessary to manage the area as Wilderness. New Wilderness designation could therefore increase the paperwork burden for Refuge staff. These effects would likely be minor, long-term, WSA-wide, and negative.

Additionally, proposed research conducted as a Refuge management activity would be subject to an MRA to determine if it is necessary to accomplish the purposes of the Refuge, including Wilderness Act purposes, and that any normally prohibited uses are necessary to meet the minimum requirements for managing the area as Wilderness. The MRA process could negatively affect long-term research projects with established data collection protocols or research that might require permanent installations, such as climate change research. Decisions are made on a case-by-case basis, however, and it is possible that installations could be allowed. There is some uncertainty as to the extent that Wilderness designation would limit the ability to conduct research or monitoring necessary to affect conservation measures. We believe the effects would be negligible, long-term, WSA-wide to Refuge-wide, and negative.

Wilderness designation would not affect the jurisdiction or responsibilities of the State with respect to wildlife, although actions would need to be consistent with maintaining Wilderness character. For some State activities, an MRA might be required. We believe the effects would be negligible, long-term, WSA-wide, and negative.

Wild and Scenic Rivers – There would be no effect to negligible, medium-term, local, and negative effects to Refuge operations under interim management prescriptions. Overall, management of suitable and recommended rivers would continue as under current management. However, Refuge staff would likely conduct periodic monitoring and assessments of the river corridors to ensure outstandingly remarkable values are being maintained.

Should Congress designate the suitable and recommended rivers as wild rivers, there would be effects to Refuge operations. There would be an additional workload for preparing CRMPs in the short term; the effects would be moderate, short-term, Refuge-wide, and negative. In the medium term, monitoring and the potential for adjusting user limits would result in minor to moderate, Refuge-wide, and negative effects through the expenditure of staff time and budget. However, once the CRMPs are completed and monitoring protocols and a system for managing the rivers are in place, there should be less strain on Refuge staff dealing with day-to-day issues. Thus over the long-term, effects would be minor, Refuge-wide, and positive.

Kongakut River – This alternative would require additional staff time and budget to: 1) execute a revised monitoring program; 2) develop outreach materials; 3) compile and publish schedules of proposed launch dates; 4) conduct site-specific rehabilitation; and 5) develop and execute a step-down management plan. The effects are likely to be moderate, short- to medium-term, Refuge-wide, and negative. Over the long-term, however, there should be less strain on Refuge staff dealing with day-to-day river management concerns, resulting in minor, long-term, Refuge-wide, and positive effects.

5.6.4 Effects on Poker Flat Research Range from Alternative D

Impacts on the scientific return and economic inputs of the Sounding Rockets Program would be similar in type but likely greater in magnitude to those discussed under Alternative B. Although there have been no planned impacts within the Porcupine Plateau WSA within the past 10 years of Poker Flat launches, the potential cannot be discounted. Therefore, it is possible that a currently unquantified number of moderate range launches could be eliminated in addition to those affected by designation of the Brooks Range WSA. Accordingly, of all the alternatives under consideration, this alternative would likely have the greatest adverse effects on sounding rocket-provided scientific return and economic input.

Effects could be mitigated, however, if Congress were to include a special provision in any Wilderness establishing legislation that would allow the regulated use of the Wilderness area for rocket landings. The ROD for the Revised Plan will identify whether the Service supports such a provision, should the decision select an alternative that recommends additional Wilderness areas.

5.6.5 Cumulative Impacts of Alternative D

The qualified and suitable lands and waters of the Brooks Range WSA (5.82 million acres) and Porcupine Plateau WSA (4.92 million acres) would be recommended for designation as Wilderness. There would be no cumulative effects related to the administrative act of recommending Wilderness. Should the Brooks Range and Porcupine Plateau WSAs be designated Wilderness, the cumulative effects would be minor, long-term, WSA-wide, and positive because designated Wilderness provides more permanent statutory protection to the biophysical and human environments. Refuge management activities within Wilderness would be subject to MRAs, and certain activities as discussed previously would be subject to a higher level of scrutiny.

All four suitable rivers would be recommended for wild and scenic river designation: the Atigun, Marsh Fork Canning, and Kongakut Rivers, along with those portions of the Hulahula River that flow through Service-managed lands. If Congress were to include these rivers in the NWSRS, they would be afforded the protections of the Wild and Scenic Rivers Act. Permanent management prescriptions and river-specific CRMPs would be completed, which could include the ability to limit and control visitor use. The cumulative effects of these actions would present minor to moderate effects to the biophysical and human environments.

Cumulative effects as a result of management actions for the Kongakut River under this alternative would be minor as a result of increasing outreach and more proactively managing the area.

The effects of Alternative D would be cumulative to the effects of climate change, development activities, and management decisions made by others throughout the region (such as through the reasonably foreseeable future actions listed in Section 5.1.4). Cumulatively, Refuge management under Alternative D would have minor effects on the biophysical and human environments in the region.

5.7 Effects of Alternative E

This section evaluates the implication or impacts of Alternative E on resources categories for each major issue: Wilderness, wild and scenic rivers, and Kongakut River visitor management.

5.7.1 Alternative E Introduction

Wilderness – Alternative E recommends designating the qualified and suitable lands and waters in three Wilderness Study Areas (nearly 12.28 million acres) as Wilderness. The administrative act of recommending these WSAs would have no effect on any resource category. However, the effects analysis here considers the effects of Wilderness designation on the resource categories should Congress choose to designate the Brooks Range and Porcupine Plateau WSAs as Wilderness.

Wild and Scenic Rivers – Alternative E recommends all four of the Refuge's suitable rivers for inclusion in the NWSRS: Atigun, Marsh Fork Canning, Hulahula, and Kongakut. Rivers recommended for wild river status must be protected until Congress acts to designate or reject a recommendation for designation. Pending congressional action, the Service would use interim management prescriptions to manage each recommended river for the outstandingly remarkable values for which it was found eligible (see Appendix I, Section 4.4).

If Congress were to designate these four rivers as wild, the Refuge would prepare a CRMP for each river. The CRMPs would formalize the requirement to preserve each river's outstandingly remarkable and other values found through inventory, in perpetuity. These rivers would become part of the NWSRS and be afforded the protections of the Wild and Scenic Rivers Act (see Appendix I, Section 4.5). The lower portion of the Hulahula River is owned by KIC. Those portions of the Hulahula River that flow through KIC lands would be recommended for wild river designation, and the corridor would be managed in partnership with KIC. For wild rivers or river segments within designated Wilderness, the more restrictive provisions of the Wild and Scenic Rivers Act and the Wilderness Act would apply.

Kongakut River – Alternative E proposes Kongakut River management identical to that described in Alternative D (see Section 5.6.1).

5.7.2 Effects on the Biophysical Environment from Alternative E

Wilderness – If the three WSAs were to be designated as Wilderness, restrictions on activities that could damage Refuge resources would be less likely to change over time and might be more likely to be enforced, which would provide greater certainty of long-term protection for wildlife and habitats. The Brooks Range, Porcupine Plateau, and Coastal Plain WSAs are currently under Minimal Management, and this management category already affords a high degree of administrative protection to the biophysical environment. However, by protecting natural conditions, Wilderness designation could have minor, long-term, WSA-wide, positive effects on the value of the WSAs for ecological research and monitoring.

Resource categories that could be affected by Wilderness designation of the Brooks Range WSA include: permafrost and soils; water quality and aquatic habitats; vegetation and terrestrial habitats; fish populations and natural diversity; bird populations and natural diversity; and mammal populations and natural diversity. Research on the biophysical environment could also be affected due to the need to complete MRAs for all Refuge management activities (see “Refuge Operations” in Section 5.7.3).

Wild and Scenic Rivers – Alternative E recommends wild river designation for all four of the Refuge’s suitable rivers. Implementing interim management prescriptions for the four suitable rivers would result in negligible, medium-term, site-specific, and positive effects on biophysical resources within these river corridors. If these rivers were to be designated as wild rivers by Congress, the effects would be minor, long-term, local, and positive because designation would require the Refuge to develop CRMPs for each river. The CRMPs would include an inventory and assessment of biophysical resources in the wild river corridor as well as a monitoring program for ongoing assessment and protection of these resources. Six of the biophysical resource categories would be affected, as described in this section.

Kongakut River – Alternative E recommends interim management tools to address biophysical resource concerns in the Kongakut River valley until such time as a VUMP and/or WSP are completed. These interim tools would have negligible to minor, long-term, site-specific to local, and positive effects on biophysical resources. Six of the biophysical resource categories would be affected, as follows.

Permafrost and Soils Under Alternative E

Wilderness – Wilderness designation would have indirect, negligible to minor, long-term, Refuge-wide, and positive effects on permafrost and soils because of the additional statutory protection Wilderness management provides regarding natural conditions.

Wild and Scenic Rivers – Interim management prescriptions to protect the free-flowing character and outstandingly remarkable values for those rivers that are suitable and recommended would result in negligible, medium-term, site-specific, and positive impacts to permafrost and soils in these river corridors. The CRMPs that would be prepared for each of the four suitable rivers (if they were to be designated as wild rivers by Congress) would include an inventory of current permafrost and soil condition and a monitoring program for ongoing assessment and protection of these resources. The CRMPs would also establish protocols to prevent and/or repair damage caused by visitor use. The resultant effects would be minor, long-term, site-specific to local, and positive.

Kongakut River – Refuge visitors have the potential to damage soils and permafrost by trampling, particularly at campsites and access points such as landing areas. Enhanced management of visitor use in the Kongakut River area under Alternative E would decrease these site-specific impacts. Site-specific disturbances from visitors occur extensively up and down the Kongakut River corridor, so enhanced management would also decrease impacts at the local scale. This alternative would have negligible to minor, long-term, site-specific to local, and positive impacts on permafrost and soils in the Kongakut River corridor.

Water Quality and Aquatic Habitats Under Alternative E

Wilderness – Wilderness designation of the three WSAs would provide long-term, statutory protection for wilderness characteristics, including aquatic habitats. Designation of the Brooks Range, Coastal Plain, and Porcupine Plateau WSAs would result in minor, long-term, Refuge-wide, and positive effects.

Wild and Scenic Rivers – Interim management prescriptions to protect the free-flowing character and outstandingly remarkable values of the four recommended rivers would result in negligible, medium-term, site-specific, positive effects to water quality and aquatic habitats in these river corridors. If Congress were to designate these four rivers as wild rivers, CRMPs would be prepared for each river. The CRMPs would include an inventory of current water quality and aquatic habitat condition and a monitoring program for ongoing assessment and protection of these resources. The CRMP would also establish protocols to prevent and/or repair damage caused by visitor use. The effects of designation would be minor, long-term, site-specific to local, and positive on water quality and aquatic habitats.

Kongakut River – Water quality and aquatic habitats can be affected by increased visitor use through increased vegetation trampling and soil compaction, which increases the potential for runoff and sediment loading. Outreach about proper waste disposal and minimizing other visitor impacts, along with monitoring the effectiveness of management actions, would have minor, long-term, local, and positive effects on water quality and aquatic habitats along the Kongakut River.

Vegetation and Terrestrial Habitats Under Alternative E

Wilderness – Although management strategies are similar for Wilderness Management and Minimal Management, Wilderness designation is a more permanent commitment to maintain natural conditions. Wilderness designation would likely have a negligible to minor, long-term, Refuge-wide, and positive effects on vegetation and terrestrial habitats because of the long-term statutory protections designation would provide to Wilderness character.

Wild and Scenic Rivers – Interim management prescriptions to protect the free-flowing character and outstandingly remarkable values of the four suitable and recommended rivers would result in negligible to minor, medium-term, site-specific, and positive impacts to vegetation and terrestrial habitats in these river corridors. If Congress were to include the four suitable and recommended rivers in the NWSRS, CRMPs would be prepared for each river. The CRMPs would include an inventory and assessment of current vegetation and terrestrial habitat condition and a monitoring program for ongoing assessment and protection of these resources. The CRMPs would also establish protocols to prevent and/or repair visitor use damage, which would result in minor, long-term, site-specific to local, and positive effects on vegetation and terrestrial habitats.

Kongakut River – Refuge visitors may damage vegetation and habitats, particularly at campsites and access points such as landing areas. Potential damage includes direct effects of trampling, breakage of trees and shrubs, the possible introduction of invasive plants, and the exclusion of wildlife from riparian and adjacent habitats. Indirect effects include soil and snow compaction as a result of trampling. Most disturbances to vegetation are site-specific and restricted to areas receiving repeated use, such as hunting camps near fixed-wing aircraft-accessible sites and campsites used by floaters along major rivers. Disturbances are local in scale, as site-specific disturbances occur extensively along the Kongakut River corridor. The additional management proposed in Alternative E would have negligible to minor, long-term, site-specific to local, and positive impacts on vegetation and terrestrial habitats in the Kongakut River drainage.

Fish Populations and Natural Diversity Under Alternative E

Wilderness – Many rivers and streams occur in the Coastal Plain WSA. While this WSA is smaller than the others, the concentration of fish populations and natural diversity are highest. Wilderness designation provides long-term protections for fish populations and natural diversity through the statutory requirements of the Wilderness Act. Effects of designation of the Brooks Range, Coastal Plain, and Porcupine Plateau WSAs on fish populations and natural diversity would therefore be minor to moderate, long-term, Refuge-wide, and positive.

Wild and Scenic Rivers – The Service would use interim management prescriptions to manage each suitable and recommended river for its free-flowing character and the outstandingly remarkable values for which it was found eligible. This would result in negligible, medium-term, local, and positive impacts to fish populations and natural diversity. If Congress were to designate the recommended rivers, CRMPs would be prepared, resulting in minor, long-term, local, and positive effects to fish populations and natural diversity because of the assessment and monitoring programs that would be included in the CRMPs.

Kongakut River – Dolly Varden and grayling are popular fish sought by anglers on the Kongakut River. Harvest levels of these fish species are unknown and thought to be low. Providing outreach materials on proper catch-and-release techniques could lead to increased survival rates of released fishes resulting in negligible, long-term, local, positive effects.

Bird Populations and Natural Diversity Under Alternative E

Wilderness – If Congress were to designate the Brooks Range, Coastal Plain, and Porcupine Plateau WSAs as Wilderness, natural conditions would be maintained using the Wilderness Management category. This would have long-term, positive effects on bird populations across the Refuge. Because most bird species are migratory, beneficial effects could be expressed over a larger area than the WSAs. Under current management, disturbance to birds and alteration of their habitats is minimal. However, Wilderness designation, with its long-term commitment to maintaining natural conditions, could have minor to moderate, long-term, regional or greater, and positive effects.

Wild and Scenic Rivers – There would be negligible, medium-term, local, and positive effects on bird populations and natural diversity under this alternative. The Service would use interim management prescriptions to manage each suitable and recommended river for the outstandingly remarkable values for which it was found eligible. Because riparian areas tend to have higher density and diversity of birds compared to surrounding habitats, maintaining river values should indirectly have positive effects on bird populations and natural diversity. If Congress were to designate the four suitable and recommended rivers as wild rivers, CRMPs would be prepared for each river, resulting in minor, long-term, local, and positive effects on bird populations and natural diversity in these river corridors because of the assessment and monitoring programs that are required in the CRMPs.

Kongakut River – Enhanced management of human use of the Kongakut River valley would have negligible to minor, long-term, site-specific to local, and positive effects on bird populations and natural diversity. Monitoring visitor impacts on bird habitats would lead to the development of conservation measures to mitigate visitor impacts on birds if adverse effects are detected. Outreach materials would benefit birds by helping visitors reduce disturbance to nesting raptors and other species, and minimize impacts to bird habitats.

Mammal Populations and Natural Diversity Under Alternative E

Wilderness – Wilderness recommendations would result in moderate, long-term, Refuge-wide to regional, and positive effects for a variety of mammals because of the more permanent commitment to protect natural conditions in designated Wilderness, including mammal populations and habitats.

Wild and Scenic Rivers – There would be negligible, medium-term, local, and positive effects on mammal populations and natural diversity under this alternative. The Service would use interim management prescriptions to manage the free-flowing character of each suitable and recommended river and to maintain the outstandingly remarkable values for which each river was found eligible. This would indirectly affect mammal populations and natural diversity. If Congress were to designate recommended rivers as wild, CRMPs would be prepared, resulting in minor, long-term, local, and positive effects to mammal populations and natural diversity in these river corridors because of the assessment and monitoring programs that would be included in the CRMPs.

Kongakut River – Enhanced management of human use of the Kongakut River valley would have negligible to minor, long-term, site-specific to local, and positive effects on mammal populations. Monitoring impacts to habitats by visitors would lead to the development of conservation measures to mitigate visitor impacts on mammals if adverse effects are detected. Outreach materials would benefit mammals by helping visitors reduce disturbance to resident and migratory species, and minimize impacts to mammal habitats.

5.7.3 Effects on the Human Environment from Alternative E

Wilderness – Under current management, public use of the Refuge is managed similarly in designated Wilderness and in areas under Minimal Management. Most regulations on public use are derived from the area's status as a refuge and by State law. Public use is subject to Federal regulations implementing Federal laws (e.g., ANILCA, Refuge Administration Act), State laws (e.g., Alaska Statute 19.40.210, which prohibits off-road vehicles from the Dalton Highway), and State regulations (e.g., the State of Alaska hunting and fishing regulations). However, by protecting wilderness characteristics (both biophysical and experiential), Wilderness designation could have negligible to minor, long-term, WSA-wide, positive effects on the human environment.

If the three WSAs were to be designated as Wilderness, it would affect the following resource categories: local economy and commercial uses; cultural resources; subsistence; visitor services and recreational opportunities; wilderness characteristics; all three of the Refuge's designated wild rivers; Refuge operations; and Poker Flat.

Wild and Scenic Rivers – Alternative E recommends the Refuge's four suitable rivers: Atigun, Marsh Fork Canning, Hulahula, and Kongakut Rivers. Interim management prescriptions would be implemented for these rivers to maintain the outstandingly remarkable values associated with each of the rivers (see Appendix I, Section 4.4). If Congress were to designate any of the rivers as wild, CRMPs would be developed and implemented for the continued protection of the rivers and their associated values. CRMPs and interim management prescriptions would lay out strategies that might affect the following resource categories: local economy and commercial uses; subsistence; cultural resources; visitor services and recreational opportunities; special designation; wilderness characteristics; and refuge operations.

Kongakut – Under Alternative E, a VUMP would be initiated immediately upon approval of the Revised Plan. Until the VUMP takes effect, interim management tools would be implemented. The interim management tools would result in minor to moderate, long-term, local, and positive effects on the human environment. Interim management tools would affect the following resource categories: local economy and commercial uses; cultural resources; subsistence; visitor services and recreational opportunities; public health and safety; special designation; wilderness characteristics; and Refuge operations.

Local Economy and Commercial Uses Under Alternative E

Wilderness – Designation of the Brooks Range, Coastal Plain, and Porcupine Plateau WSAs could affect commercial uses. In designated Wilderness, the Wilderness Act of 1964 and Service Wilderness policy prohibit commercial enterprises with few exceptions. Commercial services that allow people to access the Refuge to realize the recreational or other wilderness purposes of the area, such as guides and transportation companies, are allowed. Other commercial enterprises, such as commercial filming, are limited in Wilderness by Service policy. Designation could potentially attract more wilderness-oriented visitors to the Refuge, resulting in increased business prospects for recreation guides, commercial air operators, and other commercial service providers in local communities. Effects would be negligible to minor, long-term, Refuge-wide, and positive for recreational service providers.

Big-game hunting guides in guide use areas within the Refuge could have to comply with stricter guidelines in order to minimize the effect of activities on Wilderness character. Because guide use areas are competitively awarded, effects would vary, depending on the guide. Effects could range from no effect to negligible to minor, long-term, Refuge-wide, and negative or positive.

Wild and Scenic Rivers – Interim management provisions for suitable and recommended rivers are based on available management tools. In general, there would be no change to the management of the four suitable and recommended rivers, and therefore there would be no effects on local economy and commercial uses. However, if Refuge staff was to determine that one or more of the outstandingly remarkable values of these rivers was threatened and changes or restrictions to commercial services would mitigate the threat, then the Refuge could impose interim restrictions on commercial services. These restrictions would likely result in negligible, short-term to long-term, local, and negative effects to the local economy and commercial uses. If Congress were to designate the suitable and recommended rivers under this alternative, CRMPs would be developed. If the CRMPs were to limit or reduce the level of commercial use in order to protect outstandingly remarkable or other river values, there could be minor, long-term, local, and negative effects on the local economy and commercial uses.

Kongakut River – A step-down VUMP would likely have effects on the local economy and commercial uses. Step-down planning would be done in conjunction with key stakeholders and the public. Depending on the nature of the changes and/or restrictions imposed by the VUMP, the effects could be minor to moderate, long-term, site-specific to Refuge-wide, and positive or negative for guides and air operators operating on the Refuge. Should the plan limit or reduce the level of commercial use, minor to moderate negative effects would be anticipated to those guides adversely affected by such limits, and this could indirectly result in negligible to minor effects on local economies.

Cultural Resources Under Alternative E

Wilderness – Wilderness designation could indirectly have negligible, long-term, Refuge-wide, and positive effects on cultural resources. By protecting natural conditions and wilderness characteristics, Wilderness could provide long-term protection for cultural resources and traditional lands, waters, and resources used by local residents and serve to perpetuate the conditions in which their cultures evolved. However, the intentional and unintentional losses of cultural resources would likely continue even within designated Wilderness, primarily as a result of erosion and other natural forces, resulting in similar effects as under Alternative A.

Wild and Scenic Rivers – Public use would continue on those rivers determined suitable and recommended for inclusion in the NWSRS. The effects of public use on cultural resources would likely be minor, long-term, site-specific, and negative. Interim management prescriptions could mitigate these effects because the refuge would use the prescriptions to maintain river values. Under Alternative C, the entire extent of the Hulahula River would be recommended for wild river designation. The Hulahula River has a Cultural outstandingly remarkable value, and the Refuge is required to manage the river to maintain this value. Therefore, this river would have a higher level of protection for cultural resources. If Congress were to designate the recommended rivers, CRMPs would be prepared, resulting in minor, long-term, local, and positive effects to cultural resources because of the assessment and monitoring programs that would be included in the CRMPs.

Kongakut River – Under Alternative E, cultural resource losses (intentional or unintentional) would likely continue in the Kongakut River valley. However, outreach emphasizing stewardship of cultural resources in the Kongakut River drainage could minimize potential impacts. Additionally, the VUMP would include a better understanding of the cultural resources of the area and their condition, and it would provide appropriate cultural resource management. The VUMP should result in negligible to minor, long-term, local, and positive effects to cultural resources as compared to Alternative A.

Subsistence Under Alternative E

Wilderness – Designation of the three WSAs as Wilderness would provide long-term, statutory protection to habitats and natural conditions throughout the Refuge, thus indirectly serving to perpetuate the subsistence resources upon which local residents are so dependent. In general, subsistence uses in Wilderness would continue as they have under Minimal Management, and the harvest of subsistence resources would continue. Designation would not restrict subsistence use of resources in the Refuge, and the right of subsistence users to conduct traditional activities using traditional modes of transportation would continue. Effects of Wilderness designation on subsistence opportunities and resources would be negligible, long-term, Refuge-wide, and positive.

The subsistence use of cabins would continue, although requests for construction or location of new cabins would receive greater scrutiny. Wilderness designation could increase visitor use near traditional and subsistence use areas, which could increase conflicts between locals and visitors. These effects would be expected to be negligible to minor, long-term, local, and negative.

Wild and Scenic Rivers – Under this alternative, interim management prescriptions, combined with outreach regarding cultural and subsistence use in drainages recommended as wild rivers, could improve understanding and reduce real and/or perceived conflict between local users and nonlocal visitors. The effects would likely be negligible, medium-term, local, and positive. If Congress were to designate the four suitable and recommended rivers as wild rivers, CRMPs would be developed that establish user capacities for each river. The Refuge could then limit or control visitor use to ensure outstandingly remarkable and other river values are maintained, and this could indirectly result in fewer conflicts between subsistence users and visitors. CRMPs could therefore result in minor, long-term, and local effects that would be positive for subsistence resources and uses.

If Congress were to designate the entire extent of the Hulahula River as a wild river, the Service would partner with KIC regarding river management where it flows through KIC lands. The effects on subsistence could change as the process unfolds. Effects could range from negligible to moderate, short- to long-term, site-specific to local, and positive to negative, depending on the process, perceptions, and levels of protection afforded cultural and subsistence resources in the river corridor.

Kongakut River – Outreach regarding cultural and subsistence use in the Kongakut River drainage could improve understanding and reduce real and/or perceived conflict between local users and nonlocal visitors. Voluntary actions by authorized guides and commercial air operators could also reduce the potential for conflicts among recreational visitors and subsistence users. The effects would likely be minor, long-term, local, and positive.

Visitor Services and Recreation Opportunities Under Alternative E

Wilderness – Congressional designation of the Brooks Range, Coastal Plain, and Porcupine Plateau WSAs as Wilderness would affect visitor services and recreational opportunities. Statutory protection of the area from roads, facilities, and recreational improvements would positively affect recreational opportunities for solitude, exploration, and freedom. Wilderness designation would potentially result in fewer installations and less visitor contact, which would enhance wilderness-associated recreational opportunities and experiences. Dalton Highway road access to the Brooks Range WSA would make it possible for visitors to reach designated Wilderness in an economically feasible manner without requiring aircraft support. Minimal Management already affords a high degree of wilderness-associated recreational opportunities and experiences, and so the effects of Wilderness designation would be minor, long-term, Refuge-wide, and positive.

Because roads, facilities, recreational improvements, and commercial enterprises are not typically allowed in designated Wilderness, some visitor services could be directly and negatively impacted by Wilderness designation. No new cleared landing areas would be allowed in designated Wilderness, motorized generators and water pumps would not be allowed, and transportation and utility systems could only be authorized by Congress. Additionally, the Refuge might need to consider imposing limits on the number and types of visitor services in certain areas of the Refuge in order to preserve Wilderness character (should the area be designated as Wilderness). This would indirectly result in the loss of some recreational opportunities dependent on the impacted visitor services. These impacts are likely to be moderate, long-term, Refuge-wide to regional, and negative.

To preserve experiential opportunities associated with Wilderness character (such as opportunities for solitude), the Refuge may decide to have fewer routine law enforcement patrols and less visitor use monitoring on the ground in designated Wilderness areas. The resultant effects would likely be minor, temporary to short-term, local, and negative or positive, depending on the perception of the Refuge user. Fewer routine patrols and less on-the-ground visitor use monitoring could result in the failure to detect degraded or impaired sites in designated Wilderness, resulting in minor, long-term, site-specific, and negative effects.

Wild and Scenic Rivers – Interim management provisions for suitable and recommended rivers are based on available management tools. In general, there would be no change to the management of the four suitable and recommended rivers, and therefore there would be no effects on visitor services and recreational opportunities. However, if Refuge staff was to determine that one or more of the outstandingly remarkable values of these rivers was threatened and changes or restrictions to visitors would mitigate the threat, then the Refuge could impose interim restrictions on visitor services, which in turn could affect recreational opportunities. These restrictions would likely result in negligible, short-term to long-term, local, and negative effects to the local economy and commercial uses. If Congress were to include any of the suitable and recommended rivers in the NWSRS, the Refuge would be required to determine the user capacity of each designated river. If the number of visitors exceeds the determined user capacity of a specific river corridor, the Refuge might need to limit use. The effects would likely be minor to moderate, long-term, local, and positive or negative. Visitor experience could be enhanced by limiting use; however some visitors might not be able to experience the river due to lack of river access. Any limitations on use of the designated rivers could potentially displace visitors to other rivers in the Refuge.

Kongakut River – This alternative proposes to adopt management strategies based on a Refuge-wide Visitor Use Management step-down plan. As the step-down plan unfolds, it is likely to affect visitor services and recreational opportunities. Through the VUMP, Refuge managers will consider levels of use, timing and distribution of use, and activities and behaviors of visitors. Managers may use education, site management, regulation, enforcement, and/or rationing/allocation to manage visitor use at Arctic Refuge. The effects would likely vary, depending on the visitor, ranging from no effect to minor to moderate, long-term, local, and positive or negative. The effects of proposed visitor use management will be fully evaluated as part the step-down planning process.

Developing outreach materials with preferred practices and strategies for minimizing impacts would likely raise the level of awareness of commercial and private users. In turn, this could lead to higher quality experiences for all users by reducing the amount of physical and experiential impacts occurring on the river, including those associated with human waste. The effects of outreach actions would likely be minor, long-term, local, and positive.

Improving monitoring programs for physical and social conditions could better inform management about areas of concern, thus allowing management to take appropriate responsive action before continued degradation occurs. The effects of improved monitoring on visitor services and recreational opportunities would be minor to moderate, long-term, local, and positive. However, site-specific monitoring and rehabilitation could result in Refuge staff contributing to crowding and other user impacts on the river. These effects are likely to be minor, short-term, local, and negative. Effects could be mitigated to some extent by timing Refuge activities to occur outside peak use.

Publishing schedules of past guided and non-guided visitor use (currently available from commercial permit client use reports) could increase visitor awareness regarding Kongakut River use periods but would likely do little to redistribute use across the season. Asking guides and commercial air operators to voluntarily limit their activities could have minor, short-term, local, and positive effects on visitor experiences.

Wilderness Characteristics Under Alternative E

Wilderness – Congressional designation of the three WSAs as Wilderness would have a positive effect on wilderness characteristics. Wilderness areas are protected from roads, facilities, recreational improvements, commercial enterprises, helicopters, and installations. These protections would enhance wilderness characteristics and people's experiences in the area. Additionally, the Service would more closely consider our own Refuge management activities and their effects through the MRA process. The Brooks Range WSA is currently under Minimal Management, and this management category already affords a high degree of administrative protection to wilderness characteristics. Wilderness designation would offer statutory protection to these characteristics and would represent a more permanent commitment to their protection. These effects would likely be moderate, long-term, Refuge-wide, and positive.

Wild and Scenic Rivers – Implementing interim management prescriptions for suitable and recommended rivers would have no effect to negligible, medium-term, local, and positive effects on wilderness characteristics. If Congress were to designate the Atigun, Marsh Fork Canning, Hulahula, and Kongakut as wild rivers, a CRMP would be prepared for each river, resulting in minor to moderate, long-term, local, and positive effects to wilderness characteristics because of the assessment and monitoring programs that would be included in the CRMPs. In addition, the Refuge would establish user capacities and protect the outstandingly remarkable and other river values in the wild river corridor, which would have minor to moderate, long-term, local, and positive effects on wilderness characteristics. Beneficial effects on wilderness characteristics would also be realized for those portions of the Hulahula and Kongakut Rivers in designated Wilderness because the more restrictive provisions of the Wild and Scenic Rivers Act and the Wilderness Act would be applied to the management of these rivers.

Kongakut River – Working with operators to disperse flight paths could reduce air traffic, therefore improving wilderness experiences for visitors. Because Arctic Refuge does not have jurisdiction over airspace, compliance with this request could not be enforced. To the extent we are able to achieve voluntary compliance with air operators, the effects to wilderness characteristics would likely be minor to moderate, short-term, local, and positive. Similarly, asking guides and commercial air operators to minimize effects on Refuge visitors would have minor to moderate, short-term, local, and positive effects on wilderness characteristics, to the extent we are able to achieve compliance.

Improved monitoring of visitor experiences would: 1) tie observed conditions to management goals for biophysical resources; 2) help identify thresholds of acceptable changes in the biophysical environment; and 3) provide input on actions that could be taken to prevent negative Wilderness character indicator thresholds from being reached. Monitoring could result in improved management strategies for wilderness characteristics, and over the long-term, indirectly create moderate, local, and positive improvements to wilderness characteristics.

Visitors seeking solitude and other values associated with Wilderness might have already been displaced from the Kongakut River. Implementing interim Kongakut River visitor use management prescriptions and ultimately prescriptions from a VUMP could stop displacement and enhance wilderness characteristics enough that visitors seeking solitude would return to the Kongakut. Outreach efforts focused on minimal impact techniques and desired behaviors for visitors would likely result in minor, long-term, local, and positive effects on wilderness characteristics. Rehabilitating impacted sites could help restore the river to its natural condition, thus improving wilderness characteristics. The effects are likely to be minor, long-term, local, and positive.

Special Designations Under Alternative E

Wilderness – Wilderness designation of the Coastal Plain WSA would have minor, long-term, WSA-wide, and positive effects on those portions of the MPA in the WSA because Wilderness designation would provide statutory protection to the Wilderness character of the MPA.

Wilderness designation of the Brooks Range and Porcupine Plateau WSAs would have negligible to minor, long-term, WSA-wide, and positive effects to the Refuge's existing three wild rivers as a result of Wilderness designation. The lower portion of the Sheenjek River, and all of the Ivishak, and Wind wild river corridors are in these two WSAs. Wild and Scenic Rivers Act protections are complimentary to the protections of the Wilderness Act, and for wild rivers within designated Wilderness, the more restrictive provisions of the Wild and Scenic Rivers Act and the Wilderness Act would apply.

Wild and Scenic Rivers – The Shublik Springs RNA is downstream from the Marsh Fork Canning River. There would be negligible to minor, long-term, local, and positive effects for Shublik Springs if the Marsh Fork is designated as a wild river; the Marsh Fork would have added resource protections, and visitor experiences would be expected to improve. Similarly, protecting the free-flowing character and outstandingly remarkable and other values of the Hulahula and Kongakut Rivers would result in indirect, negligible, long-term, local, and positive effects on the MPA.

Kongakut River –There would be negligible, long-term, local, and positive effects to the MPA as a result of more proactive management of the Kongakut River.

Public Health and Safety Under Alternative E

Wilderness – Neither Wilderness recommendation nor designation would have any effect on public health and safety. Public health and safety would continue as under current management.

Wild and Scenic Rivers – Implementing interim management prescriptions or wild river designation would have no effect on public health and safety.

Kongakut River – Developing a Visitor Use Management step-down plan and providing targeted messages to Refuge visitors would have no effect to negligible, long-term, Refuge-wide, and positive effects on public health and safety issues.

Refuge Operations Under Alternative E

Wilderness – Congressional designation of the Brooks Range, Coastal Plain, and Porcupine Plateau WSAs as Wilderness would affect overall Refuge operations, both in terms of paperwork and in terms of research. If the Brooks Range WSA is designated as Wilderness, Refuge management activities would be subject to an MRA process, and normally prohibited uses would be approved only if they are determined to be the minimum necessary to manage the area as Wilderness. New Wilderness designation could therefore increase the paperwork burden for Refuge staff. These effects would likely be minor, long-term, Refuge-wide, and negative.

Additionally, proposed research conducted as a Refuge management activity would be subject to an MRA to determine if it is necessary to accomplish the purposes of the Refuge, including Wilderness Act purposes, and that any normally prohibited uses are necessary to meet the minimum requirements for managing the area as Wilderness. The MRA process could negatively affect long-term research projects with established data collection protocols or research that might require permanent installations, such as climate change research. Decisions are made on a case-by-case basis, however, and it is possible that installations could be allowed. There is some uncertainty as to the extent that Wilderness designation would limit the ability to conduct research or monitoring necessary to affect conservation measures. We believe the effects would be negligible to minor, long-term, regional, and negative.

Wilderness designation would not affect the jurisdiction or responsibilities of the State with respect to wildlife, although actions would need to be consistent with maintaining Wilderness character. For some State activities, an MRA might be required. We believe the effects would be negligible, long-term, Refuge-wide, and negative.

Wild and Scenic Rivers – There would be no effect to negligible, medium-term, local, and negative effects to Refuge operations under interim management prescriptions. Overall, management of suitable and recommended rivers would continue as under current management. However, Refuge staff would likely conduct periodic monitoring and assessments of the river corridors to ensure outstandingly remarkable values are being maintained.

Should Congress designate the suitable and recommended rivers as wild rivers, there would be effects to Refuge operations. There would be an additional workload for preparing CRMPs in the short term; the effects would be moderate, short-term, Refuge-wide, and negative. In the medium term, monitoring and the potential for adjusting user limits would result in minor to moderate, Refuge-wide, and negative effects through the expenditure of staff time and budget. However, once the CRMPs are completed and monitoring protocols and a system for managing the rivers are in place, there should be less strain on Refuge staff dealing with day-to-day issues. Thus over the long-term, effects would be minor, Refuge-wide, and positive.

Kongakut River – This alternative would require additional staff time and budget to: 1) execute a revised monitoring program; 2) develop outreach materials; 3) compile and publish schedules of proposed launch dates; 4) conduct site-specific rehabilitation; and 5) develop and execute a step-down management plan. The effects are likely to be moderate, short- to medium-term, Refuge-wide, and negative. Over the long-term, however, there should be less strain on Refuge staff dealing with day-to-day river management concerns, resulting in minor, long-term, Refuge-wide, and positive effects.

5.7.4 Effects on Poker Flat Research Range from Alternative E

Impacts on the Sounding Rockets Program would be the same as under Alternative D. It is not expected that the additional designation of the Coastal Plain WSA provided under this alternative would have a measurable positive effect on the program given that all rocket configurations having the capability to either overfly or land within the vicinity of the coastal plain (e.g., Black Brant X and XII) would also require authorization for spent rocket motors to impact within one of the lower latitude WSAs, thereby precluding their flight.

Effects could be mitigated, however, if Congress were to include a special provision in any Wilderness establishing legislation that would allow the regulated use of the Wilderness area for rocket landings. The ROD for the Revised Plan will identify whether the Service supports such a provision, should the decision select an alternative that recommends additional Wilderness areas.

5.7.5 Cumulative Impacts of Alternative E

The qualified and suitable lands and waters in the Brooks Range WSA (5.82 million acres), Porcupine Plateau WSA (4.92 million acres), and Coastal Plain WSA (1.55 million acres) would be recommended for designation as Wilderness. There would be no cumulative effects related to the administrative act of recommending Wilderness. Should the three WSAs be designated Wilderness, the cumulative effects would be minor, long-term, Refuge-wide, and positive because designated Wilderness provides more permanent statutory protection to the biophysical and human environments. Refuge management activities within Wilderness would be subject to MRAs, and certain activities as discussed previously would be subject to a higher level of scrutiny.

All four suitable rivers would be recommended for wild and scenic river designation: the Atigun, Marsh Fork Canning, Hulahula, and Kongakut Rivers. If Congress were to include these rivers in the NWSRS, they would be afforded the protections of the Wild and Scenic Rivers Act. Permanent management prescriptions and river-specific CRMPs would be completed, which could include the ability to limit and control visitor use. The cumulative effects of these actions would present minor to moderate effects to the biophysical and human environments.

Cumulative effects as a result of management actions for the Kongakut River under this alternative would be minor as a result of increasing outreach and more proactively managing the area.

The effects of Alternative E would be cumulative to the effects of climate change, development activities, and management decisions made by others throughout the region (such as through the reasonably foreseeable future actions listed in Section 5.1.4). Cumulatively, Refuge management under Alternative E would have minor effects on the biophysical and human environments in the region.

5.8 Effects of Alternative F

This section evaluates the implication or impacts Alternative F on resources categories for each major issue: Wilderness, wild and scenic rivers, and Kongakut River visitor management.

5.8.1 Alternative F Introduction

Wilderness – Under this alternative, approximately 7.16 million acres of the Refuge would continue to be managed under the Wilderness Management category, and no new areas would be recommended for Wilderness designation.

Wild and Scenic Rivers – Under this alternative, no new rivers would be recommended for inclusion in the NWSRS. The suitability study (Appendix I) preliminarily determined four of the Refuge's rivers are suitable for wild river designation: Atigun, Marsh Fork Canning, Hulahula, and Kongakut Rivers. Even without a recommendation for designation, the outstandingly remarkable values for the four suitable rivers would be protected by using existing management tools under the Minimal Management and Wilderness Management categories, and using tools from the goals, objectives, management policies, and guidelines (see Chapter 2).

Kongakut River – Alternative F proposes Kongakut River management issues be addressed in a Visitor Use Management and/or Wilderness Stewardship step-down plan, that would, among other things, develop long-term monitoring protocols. Until the step-down plan(s) is completed, the Service would implement a variety of interim management actions to protect resources in the Kongakut River valley (see Chapter 3, Section 3.2.5.3).

5.8.2 Effects on the Biophysical Environment from Alternative F

Wilderness – Under this alternative, none of the WSAs would be recommended for Wilderness designation, and these areas would continue to be managed under the Minimal Management category. Minimal Management already affords a high degree of administrative protection to the biophysical environment, and there would be no effect to any of the biophysical resource categories if additional Wilderness is not recommended. However, Minimal Management in combination with the goals, objectives, management policies, and guidelines that would be adopted under Alternative F would have negligible, long-term, Refuge-wide, positive effects on the value of the WSAs for ecological research and monitoring.

Wild and Scenic Rivers – Although the four suitable rivers are not recommended for wild river designation under this alternative, their outstandingly remarkable values would be protected by using management tools under Minimal Management, Wilderness Management, the goals and objectives, and the management policies and guidelines. In general, these protections would have negligible, long-term, local, and positive effects on the biophysical environment. Six of the biophysical resource categories would be affected, as described in this section.

Kongakut River – Alternative F recommends interim management tools to address biophysical resource concerns in the Kongakut River valley until such time as a VUMP and/or WSP are completed. These interim tools would have negligible to minor, long-term, site-specific to local, and positive effects on biophysical resources. Six of the biophysical resource categories would be affected, as follows.

Permafrost and Soils Under Alternative F

Wilderness – No effects on permafrost and soils would occur if no new wilderness recommendations are made.

Wild and Scenic Rivers – Protecting the values associated with suitable rivers using existing management tools would result in negligible, long-term, site-specific, and positive effects to permafrost and soils. However, ongoing visitor use could still damage soils and permafrost in the corridors of suitable rivers (at heavily used campsites, for example), resulting in negligible to minor, short- to medium-term, site-specific, and negative effects.

Kongakut River – Refuge visitors have the potential to damage soils and permafrost by trampling, particularly at campsites and access points such as landing areas. Enhanced management of visitor use in the Kongakut River area under Alternative F would decrease these site-specific impacts. Site-specific disturbances from visitors occur extensively up and down the Kongakut River corridor, so enhanced management would also decrease impacts at the local scale. This alternative would have negligible to minor, long-term, site-specific to local, and positive impacts on permafrost and soils in the Kongakut River corridor.

Water Quality and Aquatic Habitats Under Alternative F

Wilderness – There would be no effect on water quality and aquatic habitats from not recommending new Wilderness areas. Water bodies in both Minimal Management and designated Wilderness would continue to benefit from the habitat protections these management categories afford.

Wild and Scenic Rivers – Protecting the values associated with suitable rivers using existing management tools would result in negligible, long-term, site-specific, and positive effects to water quality and aquatic habitats. Ongoing visitor use could still damage aquatic habitats in the corridors of suitable rivers, however, resulting in negligible to minor, short- to medium-term, site-specific, and negative effects.

Kongakut River – Water quality and aquatic habitats can be affected by increased visitor use through increased vegetation trampling and soil compaction, which increases the potential for runoff and sediment loading. Outreach about proper waste disposal and minimizing other visitor impacts, along with monitoring the effectiveness of management actions, would have negligible to minor, long-term, local, and positive effects on water quality and aquatic habitats along the Kongakut River.

Vegetation and Terrestrial Habitats Under Alternative F

Wilderness – No effects on vegetation and terrestrial habitats would occur if no new wilderness recommendations are made.

Wild and Scenic Rivers – Protecting the values associated with suitable rivers using existing management tools would result in negligible to minor, long-term, site-specific, and positive effects to vegetation and terrestrial habitats. Ongoing visitor use, however, could still damage vegetation and terrestrial habitats in the corridors of suitable rivers (at heavily used campsites, for example), resulting in negligible to minor, short- to medium-term, site-specific, and negative effects.

Kongakut River – Refuge visitors may damage vegetation and habitats, particularly at campsites and access points such as landing areas. Potential damage includes direct effects of trampling, breakage of trees and shrubs, the possible introduction of invasive plants, and the exclusion of wildlife from riparian and adjacent habitats. Indirect effects include soil and snow compaction as a result of trampling. Most disturbances to vegetation are site-specific and restricted to areas receiving repeated use, such as hunting camps near fixed-wing aircraft-accessible sites and campsites used by floaters along major rivers. Disturbances are local in scale, as site-specific disturbances occur extensively along the Kongakut River corridor. The additional management proposed in Alternative F would have negligible to minor, long-term, site-specific to local, and positive impacts on vegetation and terrestrial habitats in the Kongakut River drainage.

Fish Populations and Natural Diversity Under Alternative F

Wilderness – No effects on fish populations and natural diversity would occur if no new Wilderness recommendations are made.

Wild and Scenic Rivers – Protecting the values associated with suitable rivers using existing management tools would result in negligible, long-term, local, and positive effects to fish populations and natural diversity.

Kongakut River – Dolly Varden and grayling are popular fish sought by anglers on the Kongakut River. Harvest levels of these fish species are unknown and thought to be low. Providing outreach materials on proper catch-and-release techniques could lead to increased survival rates of released fishes resulting in negligible, long-term, local, positive effects.

Bird Populations and Natural Diversity Under Alternative F

Wilderness – No effects on bird populations and natural diversity would occur if no new Wilderness recommendations are made.

Wild and Scenic Rivers – There would be negligible, long-term, local, and positive effects on bird populations and natural diversity under this alternative. Riparian areas tend to have higher density and diversity of birds compared to surrounding habitats, and river values would be protected using existing management tools.

Kongakut River – Enhanced management of human use of the Kongakut River valley would have negligible to minor, long-term, site-specific to local, and positive effects on bird populations and natural diversity. Monitoring visitor impacts on bird habitats would lead to the development of conservation measures to mitigate visitor impacts on birds if adverse effects are detected. Outreach materials would benefit birds by helping visitors reduce disturbance to nesting raptors and other species, and minimize impacts to bird habitats.

Mammal Populations and Natural Diversity Under Alternative F

Wilderness – No effects on mammal populations and natural diversity would occur if no new Wilderness recommendations are made.

Wild and Scenic Rivers – There would be negligible, long-term, local, and positive effects on mammal populations and natural diversity under this alternative because river values would be protected using existing management tools.

Kongakut River – Enhanced management of human use of the Kongakut River valley would have negligible to minor, long-term, site-specific to local, and positive effects on mammal populations. Monitoring impacts to habitats by visitors would lead to development of conservation measures to mitigate visitor impacts on mammals if adverse effects are detected. Outreach materials would benefit mammals by helping visitors reduce disturbance to resident and migratory species, and minimize impacts to mammal habitats.

5.8.3 Effects on the Human Environment from Alternative F

Wilderness – Under current management, public use of the Refuge is managed similarly in designated Wilderness and in areas under Minimal Management. Most regulations on public use are derived from the area's status as a refuge and by State law. Public use is subject to Federal regulations implementing Federal laws (e.g., ANILCA, Refuge Administration Act), State laws (e.g., Alaska Statute 19.40.210, which prohibits off-road vehicles from the Dalton Highway), and State regulations (e.g., the State of Alaska hunting and fishing regulations).

General efforts to maintain wilderness characteristics and/or manage the Refuge as a naturally functioning ecosystem through the proposed goals, objectives, management policies, and guidelines would have negligible, long-term, Refuge-wide, and positive effects on the human environment.

Wild and Scenic Rivers – Although the four suitable rivers are not recommended for wild river designation under this alternative, their outstandingly remarkable values would be protected by using the management tools under Minimal Management, Wilderness Management, the goals and objectives, and the management policies and guidelines. In general, these protections would have negligible, long-term, local, and positive effects on the human environment. The following resource categories would be affected: cultural resources; visitor services; special designation; public health; wilderness characteristics; and Refuge operations.

Kongakut river – Under Alternative F, a VUMP would be initiated immediately upon approval of the Revised Plan. Until the VUMP takes effect, interim management tools would be implemented. The interim management tools would result in minor to moderate, long-term, local, and positive effects on the human environment. Interim management tools would affect the following resource categories: local economy and commercial uses; cultural resources; subsistence; visitor services and recreational opportunities; wilderness characteristics; and Refuge operations.

Local Economy and Commercial Uses Under Alternative F

Wilderness – There would be no effect to the local economy or commercial uses. Commercial services would continue as they have and would not be restricted in any way.

Wild and Scenic Rivers – While no rivers would be recommended for inclusion in the NWSRS, the Refuge would protect outstandingly remarkable values using available management tools. There should be no measurable effect on local economy and commercial uses.

Kongakut river – A step-down VUMP would likely have effects on the local economy and commercial uses. Step-down planning would be done in conjunction with key stakeholders and the public. Depending on the nature of the changes and/or restrictions imposed by the VUMP, the effects could be minor to moderate, long-term, site-specific to Refuge-wide, and positive or negative for guides and air operators operating on the Refuge. Should the plan limit or reduce the level of commercial use, minor to moderate negative effects would be anticipated to those guides adversely affected by such limits, and this could indirectly result in negligible to minor effects on local economies.

Cultural Resources Under Alternative F

Wilderness – Not recommending additional Wilderness areas would not change ongoing effects to cultural resources. Ongoing damage or loss of cultural resources would continue, primarily as a result of erosion and other natural forces, and would be minor to major, long-term, site-specific, and negative, as under Alternative A.

Wild and Scenic Rivers – Public use would continue on the four rivers determined suitable for inclusion in the NWSRS but not recommended under this alternative. The effects of public use on cultural resources would likely be minor, long-term, site-specific, and negative. The Refuge could use Minimal Management and Wilderness Management categories as well as tools from the goals, objectives, management policies, and guidelines to mitigate these effects. To comply with the Wild and Scenic Rivers Act, the Refuge would protect the Cultural outstandingly remarkable value on the Hulahula River. An increased management focus on cultural resources in this river corridor would result in minor, long-term, site-specific to local, and positive effects.

Kongakut River – Under Alternative F, cultural resource losses (intentional or unintentional) would likely continue in the Kongakut River valley. However, outreach emphasizing stewardship of cultural resources in the Kongakut River drainage could minimize potential impacts. Additionally, the VUMP would include a better understanding of the cultural resources of the area and their condition, and it would provide appropriate cultural resource management. The VUMP should result in negligible to minor, long-term, local, and positive effects to cultural resources as compared to Alternative A.

Subsistence Under Alternative F

Wilderness – There would be no effect to subsistence opportunities, uses, or resources under Alternative F. Traditional access and subsistence uses would continue to be allowed according to current regulations and policies.

Wild and Scenic Rivers – There would be no anticipated effect to subsistence opportunities, uses, or resources. Traditional access and subsistence uses would continue to be allowed according to current regulations and policies.

Kongakut River – Outreach regarding cultural and subsistence use in the Kongakut River drainage could improve understanding and reduce real and/or perceived conflict between local users and nonlocal visitors. Voluntary actions by authorized guides and commercial air operators could also reduce the potential for conflicts among recreational visitors and subsistence users. The effects would likely be minor, long-term, local, and positive.

Visitor Services and Recreation Opportunities Under Alternative F

Wilderness – Visitor services and recreational opportunities outside the Refuge's designated Wilderness area would continue to be managed via Minimal Management, and the Refuge would continue to provide a variety of recreational opportunities for Refuge visitors. Continuing current management practices could affect visitor services and recreational opportunities in specific high use areas (e.g., the Atigun River area). With no active restoration of impaired sites or management of visitor experiences, visitors seeking certain recreational opportunities such as solitude and natural conditions could be displaced, indirectly resulting in the differential availability of certain visitor services. This could result in negligible to minor, long-term, site-specific to local, and negative effects to visitor services and recreational opportunities focused on solitude and natural conditions. However, the goals and objectives that would be adopted under this alternative calls for the restoration of wilderness characteristics at impaired and degraded sites. Additionally, Refuge staff could administratively decide to limit the number and types of visitor services in certain areas of the Refuge in order to preserve wilderness characteristics or improve recreational opportunities, thus minimizing impacts to visitors seeking wilderness-associated recreation.

No statutory protections from roads, facilities, installations, and recreational improvements, nor any statutory requirements to manage for wilderness characteristics, could result in negligible, long-term, local to Refuge-wide, negative effects to visitor services that cater to solitude and wilderness-associated opportunities and experiences. However, Refuge staff could administratively decide to limit the number and types of visitor services in certain areas of the Refuge in order to preserve wilderness characteristics or improve recreational opportunities, thus minimizing impacts to visitors seeking wilderness-associated recreation.

Minimal Management in concert with the goals, objectives, management policies, and guidelines would not be expected to affect recreational opportunities for solitude, independence, self-reliance, freedom, exploration, adventure, challenge, exploration, and discovery. Additionally, routine law enforcement patrols and visitor use monitoring would continue on the Refuge as under current management, and there would be no effect to these programs under Alternative F.

Wild and Scenic Rivers – There would be no effect on visitor services and recreation opportunities under this alternative.

Kongakut River – This alternative proposes to adopt management strategies based on a Refuge-wide Visitor Use Management step-down plan. As the step-down plan unfolds, it is likely to affect visitor services and recreational opportunities. Through the VUMP, Refuge managers will consider levels of use, timing and distribution of use, and activities and behaviors of visitors. Managers may use education, site management, regulation, enforcement, and/or rationing/allocation to manage visitor use at Arctic Refuge. The effects would likely vary, depending on the visitor, ranging from no effect to minor to moderate, long-term, local, and positive or negative. The effects of proposed visitor use management will be fully evaluated as part the step-down planning process.

Developing outreach materials with preferred practices and strategies for minimizing impacts would likely raise the level of awareness of commercial and private users. In turn, this could lead to higher quality experiences for all users by reducing the amount of physical and experiential impacts occurring on the river, including those associated with human waste. The effects of outreach actions would likely be minor, long-term, local, and positive.

Improving monitoring programs for physical and social conditions could better inform management about areas of concern, thus allowing management to take appropriate responsive action before continued degradation occurs. The effects of improved monitoring on visitor services and recreational opportunities would be minor to moderate, long-term, local, and positive. However, site-specific monitoring and rehabilitation could result in Refuge staff contributing to crowding and other user impacts on the river. These effects are likely to be minor, short-term, local, and negative. Effects could be mitigated to some extent by timing Refuge activities to occur outside peak use.

Publishing schedules of past guided and non-guided visitor use (currently available from commercial permit client use reports) could increase visitor awareness regarding Kongakut River use periods but would likely do little to redistribute use across the season. Asking guides and commercial air operators to voluntarily limit their activities could have minor, short-term, local, and positive effects on visitor experiences.

Wilderness Characteristics Under Alternative F

Wilderness – Lands and waters outside designated Wilderness would not receive the protections afforded by the Wilderness Act. Non-Wilderness areas would continue to be managed under the administrative Minimal Management category, which includes most of the protections and prohibitions of designated Wilderness. Short-term, impacts are likely to be negligible to minor, Refuge-wide, and positive. However, Minimal Management is an administrative management category subject to change and does not have the enduring statutory protections afforded by designated Wilderness. Therefore, in the long-term, effects would be negligible to minor, Refuge-wide, and negative.

Wild and Scenic Rivers – Protecting outstandingly remarkable values on the Refuge's four suitable rivers using existing Minimal and Wilderness Management categories would have no effect to negligible, long-term, local, and positive effects on wilderness characteristics.

Kongakut River – Working with operators to disperse flight paths could reduce air traffic, therefore improving wilderness experiences for visitors. Because Arctic Refuge does not have jurisdiction over airspace, compliance with this request could not be enforced. To the extent we are able to achieve voluntary compliance with air operators, the effects to wilderness characteristics would likely be minor to moderate, short-term, local, and positive. Similarly, asking guides and commercial air operators to minimize effects on Refuge visitors would have minor to moderate, short-term, local, and positive effects on wilderness characteristics, to the extent we are able to achieve compliance.

Improved monitoring of visitor experiences would: 1) tie observed conditions to management goals for biophysical resources; 2) help identify thresholds of acceptable changes in the biophysical environment; and 3) provide input on actions that could be taken to prevent negative Wilderness character indicator thresholds from being reached. Monitoring could result in improved management strategies for wilderness characteristics, and over the long-term, indirectly create moderate, local, and positive improvements to wilderness characteristics.

Visitors seeking solitude and other values associated with Wilderness might have already been displaced from the Kongakut. Implementing interim Kongakut River visitor use management prescriptions and ultimately prescriptions from a VUMP could stop displacement and enhance wilderness characteristics enough that visitors seeking solitude would return to the Kongakut.

Outreach efforts focused on minimal impact techniques and desired behaviors for visitors would likely result in minor, long-term, local, and positive effects on wilderness characteristics. Rehabilitating impacted sites could help restore the river to its natural condition, thus improving wilderness characteristics. The effects are likely to be minor, long-term, local, and positive.

Special Designations Under Alternative F

Wilderness – There would be no effects to any special designations under this alternative.

Wild and Scenic Rivers – There would be no effects to any of the Refuge's special designation areas under this alternative.

Kongakut River – There would be negligible, long-term, local, and positive effects to the MPA as a result of more proactive management of the Kongakut River.

Public Health and Safety Under Alternative F

Wilderness – Maintaining the current extent of designated Wilderness would have no effect on public health and safety.

Wild and Scenic Rivers – There would be no effect on public health and safety.

Kongakut River – Developing a Visitor Use Management step-down plan and providing targeted messages to Refuge visitors would have no effect to negligible, long-term, Refuge-wide, and positive effects on public health and safety issues.

Refuge Operations Under Alternative F

Wilderness – Under this alternative, there would be no effect on Refuge operations because there would be no additional administrative tasks regarding designated Wilderness.

Wild and Scenic Rivers – Protecting the outstandingly remarkable values for the Refuge's four suitable rivers using existing Minimal and Wilderness Management categories would have from no effect to negligible, short- to medium-term, local, and negative effects on staff and Refuge operations. To maintain river values, staff would periodically conduct site assessments and monitoring in the corridors of the four suitable rivers.

Kongakut River –This alternative would require additional staff time and budget to: 1) execute a revised monitoring program; 2) develop outreach materials; 3) compile and publish schedules of proposed launch dates; 4) conduct site-specific rehabilitation; and 5) develop and execute a step-down management plan. The effects are likely to be moderate, short- to medium-term, Refuge-wide, and negative. Over the long-term, however, there should be less strain on Refuge staff dealing with day-to-day river management concerns, resulting in minor, long-term, Refuge-wide, and positive effects.

5.8.4 Effects on Poker Flat Research Range from Alternative F

Implementing Alternative F would not be expected to affect the continued launch of sounding rockets from Poker Flat nor their scientific return. NASA would continue to conduct its missions such that there are no planned impacts within Mollie Beattie Wilderness, and through the University of Alaska Fairbanks, secure permission for landing and recovery of rocket hardware within the remaining areas of Arctic Refuge on an as-needed basis. NASA would continue to follow the specific terms and conditions governing launch and recovery operations included in Refuge-issued authorizations.

Economic Input – Poker Flat's continued operations under this alternative would result in the same economic inputs to the Fairbanks North Star Borough as under Alternative A (see Table 5-1). The value added from Poker Flat operations accounts for less than one-tenth of 1 percent of the total gross domestic product, and approximately 1.3 percent of the professional, scientific, and technical services industry gross domestic product for the Fairbanks area of Alaska.

5.8.5 Cumulative Impacts of Alternative F

Under Alternative F, no new areas of the Refuge would be recommended for designation as Wilderness. There would be no foreseeable cumulative effects to the biophysical and human environments as a result of this alternative.

Four rivers would be suitable for wild river designation but would not be recommended for inclusion in the NWSRS. There would be negligible cumulative effects to the biophysical and human environments. Continuing current management under Minimal Management and Wilderness categories, in combination with the goals, objectives, management policies, and guidelines, would protect the outstandingly remarkable values identified for these rivers.

Cumulative effects as a result of management actions for the Kongakut River under this alternative would be minor as a result of increasing outreach and more proactively managing the area.

The effects of Alternative F would be cumulative to the effects of climate change, development activities, and management decisions made by others throughout the region (such as through the reasonably foreseeable future actions listed in Section 5.1.4). Cumulatively, Refuge management under Alternative F would have minor effects on the biophysical and human environments in the region.


Photo by Dave Prestipino

5.9 Summary of Environmental Consequences

The following table provides a summary and comparison of impacts across the alternatives in each resource category for the major issues: Wilderness, Wild and Scenic Rivers, and Kongakut River visitor management. The effects are described by intensity, duration, scale, and nature of the impacts. The table does not include effects common across all the alternatives or those common across all the action alternatives (i.e., effects of the new management policies and guidelines or the goals and objectives).

Table 5-2. Environmental effects

Issues	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F
Resource Category: Permafrost and Soils						
Wilderness	No effect	Negligible to minor, long-term, WSA-wide, positive	Negligible to minor, long-term, WSA-wide, positive	Negligible to minor, long-term, WSA-wide, positive	Negligible to minor, long-term, Refuge-wide, positive	No effect
Wild and Scenic Rivers	Negligible to minor, short- to medium-term, site-specific, negative	Interim Management: Negligible, medium-term, site-specific, positive Designated (CRMPs): Minor, long-term, site-specific to local, positive	Interim Management: Negligible, medium-term, site-specific, positive Designated (CRMPs): Minor, long-term, site-specific to local, positive	Interim Management: Negligible, medium-term, site-specific, positive Designated (CRMPs): Minor, long-term, site-specific to local, positive	Interim Management: Negligible, medium-term, site-specific, positive Designated (CRMPs): Minor, long-term, site-specific to local, positive	Management Tools: Negligible, long-term, site-specific, positive Ongoing Visitor Use: Negligible to minor, short- to medium-term, site-specific, negative
Kongakut	Negligible to minor, short-term, site-specific, negative	Negligible to minor, long-term, site-specific to local, positive	Negligible to minor, long-term, site-specific to local, positive	Negligible to minor, long-term, site-specific to local, positive	Negligible to minor, long-term, site-specific to local, positive	Negligible to minor, long-term, site-specific to local, positive
Resource Category: Water Quality and Aquatic Habitats						
Wilderness	No effect	Negligible to minor, long-term, WSA-wide, positive	Minor, long-term, WSA-wide, positive	Minor, long-term, WSA-wide, positive	Minor, long-term, Refuge-wide, positive	No effect

Issues	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F
Wild and Scenic Rivers	Negligible to minor, short- to medium-term, site-specific, negative	Interim Management: Negligible, medium-term, site-specific, positive Designated (CRMPs): Minor, long-term, site-specific to local, positive	Interim Management: Negligible, medium-term, site-specific, positive Designated (CRMPs): Minor, long-term, site-specific to local, positive	Interim Management: Negligible, medium-term, site-specific, positive Designated (CRMPs): Minor, long-term, site-specific to local, positive	Interim Management: Negligible, medium-term, site-specific, positive Designated (CRMPs): Minor, long-term, site-specific to local, positive	Management Tools: Negligible, long-term, site-specific, positive Ongoing Visitor Use: Negligible to minor, short- to medium-term, site-specific, negative
Kongakut	Negligible, short-term, site-specific, negative	Minor, long-term, local, positive	Minor, long-term, local, positive	Minor, long-term, local, positive	Minor, long-term, local, positive	Negligible to minor, long-term, local, positive
Resource Category: Vegetation and Terrestrial Habitat						
Wilderness	No effect	Negligible to minor, long-term, WSA-wide, positive	Negligible to minor, long-term, WSA-wide, positive	Negligible to minor, long-term, WSA-wide, positive	Negligible to minor, long-term, Refuge-wide, positive	No effect
Wild and Scenic Rivers	Negligible to minor, short- to medium-term, site-specific, negative	Interim Management: Negligible to minor, medium-term, site-specific, positive Designated (CRMPs): Minor, long-term, site-specific to local, positive	Interim Management: Negligible to minor, medium-term, site-specific, positive Designated (CRMPs): Minor, long-term, site-specific to local, positive	Interim Management: Negligible to minor, medium-term, site-specific, positive Designated (CRMPs): Minor, long-term, site-specific to local, positive	Interim Management: Negligible to minor, medium-term, site-specific, positive Designated (CRMPs): Minor, long-term, site-specific to local, positive	Management Tools: Negligible to minor, long-term, site-specific, positive Ongoing Visitor Use: Negligible to minor, short- to medium-term, site-specific, negative

Issues	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F
Kongakut	Negligible to minor, short-term, site specific, negative	Negligible to minor, long-term, site-specific to local, positive	Negligible to minor, long-term, site-specific to local, positive	Negligible to minor, long-term, site-specific to local, positive	Negligible to minor, long-term, site-specific to local, positive	Negligible to minor, long-term, site-specific to local, positive
Resource Category: Fish Populations and Natural Diversity						
Wilderness	No effect	Minor, long-term, WSA-wide, positive	Minor to moderate, long-term, WSA-wide, positive	Minor, long-term, WSA-wide, positive	Minor to moderate, long-term, Refuge-wide, positive	No effect
Wild and Scenic Rivers	Negligible, long-term, local, positive	Interim Management: Negligible, medium-term, local, positive Designated (CRMPs): Minor, long-term, local, positive	Interim Management: Negligible, medium-term, local, positive Designated (CRMPs): Minor, long-term, local, positive	Interim Management: Negligible, medium-term, local, positive Designated (CRMPs): Minor, long-term, local, positive	Interim Management: Negligible, medium-term, local, positive Designated (CRMPs): Minor, long-term, local, positive	Negligible, long-term, local, positive
Kongakut	Fish Harvest: Negligible, short-term, site-specific to local, negative Other Visitor Use: Negligible, short-term, site-specific to local, negative	Outreach: Negligible, long-term, local, positive Interim Cap: Negligible, short-term, local, positive	Outreach: Negligible, long-term, local, positive Interim Cap: Negligible, short-term, local, positive	Outreach: Negligible, long-term, local, positive	Outreach: Negligible, long-term, local, positive	Outreach: Negligible, long-term, local, positive
Resource Category: Bird Populations and Natural Diversity						
Wilderness	No effect	Negligible, long-term, regional or greater, positive	Minor to moderate, long-term, regional or greater, positive	Negligible to minor, long-term, regional or greater, positive	Minor to moderate, long-term, regional or greater, positive	No effect

Issues	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F
Wild and Scenic Rivers	Negligible, long-term, local, positive	<u>Interim Management</u>: Negligible, medium-term, local, positive <u>Designated (CRMPs):</u> Minor, long-term, local, positive	<u>Interim Management</u>: Negligible, medium-term, local, positive <u>Designated (CRMPs):</u> Minor, long-term, local, positive	<u>Interim Management</u>: Negligible, medium-term, local, positive <u>Designated (CRMPs):</u> Minor, long-term, local, positive	<u>Interim Management</u>: Negligible, medium-term, local, positive <u>Designated (CRMPs):</u> Minor, long-term, local, positive	Negligible, long-term, local, positive
Kongakut	Negligible, short-term, site-specific, negative	Negligible to minor, long-term, site-specific to local, positive	Negligible to minor, long-term, site-specific to local, positive	Negligible to minor, long-term, site-specific to local, positive	Negligible to minor, long-term, site-specific to local, positive	Negligible to minor, long-term, site-specific to local, positive
Resource Category: Mammal Populations and Natural Diversity						
Wilderness	No effect	Minor, long-term, WSA-wide to regional, positive	Minor to moderate, long-term, WSA-wide to regional, positive	Minor to moderate, long-term, WSA-wide to regional, positive	Moderate, long-term, Refuge-wide to regional, positive	No effect
Wild and Scenic Rivers	Negligible, long-term, local, positive	<u>Interim Management</u>: Negligible, medium-term, local, positive <u>Designated (CRMPs):</u> Minor, long-term, local, positive	<u>Interim Management</u>: Negligible, medium-term, local, positive <u>Designated (CRMPs):</u> Minor, long-term, local, positive	<u>Interim Management</u>: Negligible, medium-term, local, positive <u>Designated (CRMPs):</u> Minor, long-term, local, positive	<u>Interim Management</u>: Negligible, medium-term, local, positive <u>Designated (CRMPs):</u> Minor, long-term, local, positive	Negligible, long-term, local, positive
Kongakut	Minor, short-term, site-specific to local, negative	Negligible to minor, long-term, site-specific to local, positive	Negligible to minor, long-term, site-specific to local, positive	Negligible to minor, long-term site-specific to local, positive	Negligible to minor, long-term, site-specific to local, positive	Negligible to minor, long-term, site-specific to local, positive

Issues	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F
Resource Category: Local Economy and Commercial Uses						
Wilderness	No effect	Recreation Services: Negligible to minor, long-term, WSA-wide, positive Big-Game Hunt Guides: No effect to negligible to minor, long-term, WSA-wide, negative or positive	Recreation Services: Negligible to minor, long-term, WSA-wide, positive Big-Game Hunt Guides: No effect to negligible to minor, long-term, WSA-wide, negative or positive	Recreation Services: Negligible to minor, long-term, WSA-wide, positive Big-Game Hunt Guides: No effect to negligible to minor, long-term, WSA-wide, negative or positive	Recreation Services: Negligible to minor, long-term, Refuge-wide, positive Big-Game Hunt Guides: No effect to negligible to minor, long-term, Refuge-wide, negative or positive	No effect
Wild and Scenic Rivers	No effect	Interim Management: No effect to negligible, short- to long-term, local, negative Designated (CRMPs): Minor, long-term, local, negative	Interim Management: No effect to negligible, short- to long-term, local, negative Designated (CRMPs): Negligible to minor, long-term, local, negative	Interim Management: No effect to negligible, short- to long-term, local, negative Designated (CRMPs): Minor, long-term, local, negative	Interim Management: No effect to negligible, short- to long-term, local, negative Designated (CRMPs): Minor, long-term, local, negative	No effect

Issues	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F
Kongakut	In short-term: Minor, local, negative In long-term: Moderate, local to Refuge-wide, negative	Step-down Planning: Minor to moderate, long-term, site-specific to Refuge-wide, positive or negative Interim Cap: Minor, short-term, local, negative	Step-down Planning: Minor to moderate, long-term, site-specific to Refuge-wide, positive or negative Interim Cap: Minor, short-term, local, negative	Step-down Planning: Minor to moderate, long-term, site-specific to Refuge-wide, positive or negative	Step-down Planning: Minor to moderate, long-term, site-specific to Refuge-wide, positive or negative	Step-down Planning: Minor to moderate, long-term, site-specific to Refuge-wide, positive or negative
Resource Category: Cultural Resources						
Wilderness	Minor to major, long-term, site-specific, negative[1]	Same as Alternative A	Same as Alternative A	Same as Alternative A	Same as Alternative A	Same as Alternative A
Wild and Scenic Rivers	Minor to major, long-term, site-specific to local, negative[1] Hulahula River: Minor, long-term, site-specific to local, positive	Same as Alternative A Hulahula River: Minor, long-term, local, positive	Same as Alternative A Hulahula River: No effect to negligible to minor, long-term, site-specific, positive	Same as Alternative A Hulahula River: Minor, long-term, local, positive	Same as Alternative A Hulahula River: Minor, long-term, local, positive	Same as Alternative A Hulahula River: Minor, long-term, site-specific to local, positive

[1] These effects are largely due to erosion and other natural forces, not human use. For more information, please see Chapter 4, Section 4.4.1, and "Cultural Resources Under All Alternatives" in Chapter 5, Section 5.2.2.2.

Issues	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F
Kongakut	Minor to major, long-term, site-specific to local, negative[2]	Same as Alternative A Step-down Planning: Negligible to minor, long-term, local, positive Interim Cap: Negligible, short-term, local, positive	Same as Alternative A Step-down Planning: Negligible to minor, long-term, local, positive Interim Cap: Negligible, short-term, local, positive	Same as Alternative A Step-down Planning: Negligible to minor, long-term, local, positive	Same as Alternative A Step-down Planning: Negligible to minor, long-term, local, positive	Same as Alternative A Step-down Planning: Negligible to minor, long-term, local, positive
Resource Category: Subsistence						
Wilderness	No effect	Use and Resources: Negligible, long-term, WSA-wide, positive Related Concerns: Negligible to minor, long-term, local, negative	Use and Resources: Negligible, long-term, WSA-wide, positive Related Concerns: Negligible to minor, long-term, local, negative	Use and Resources: Negligible, long-term, WSA-wide, positive Related Concerns: Negligible to minor, long-term, local, negative	Use and Resources: Negligible, long-term, Refuge-wide, positive Related Concerns: Negligible to minor, long-term, local, negative	No effect

[2] These effects are largely due to erosion and other natural forces, not human use. For more information, please see Chapter 4, Section 4.4.1, and “Cultural Resources Under All Alternatives” in Chapter 5, Section 5.2.2.2.

Issues	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F
Wild and Scenic Rivers	No effect	<u>Interim Management</u>: Negligible, medium-term, local, positive <u>Designated (CRMPs):</u> Minor, long-term, local, positive <u>Joint Management of Hulahula River</u>: Negligible to moderate, short- to long-term, site-specific to local, positive to negative	<u>Interim Management</u>: Negligible, medium-term, local, positive <u>Designated (CRMPs):</u> Minor, long-term, local, positive	<u>Interim Management</u>: Negligible, medium-term, local, positive <u>Designated (CRMPs):</u> Minor, long-term, local, positive	<u>Interim Management</u>: Negligible, medium-term, local, positive <u>Designated (CRMPs):</u> Minor, long-term, local, positive <u>Joint Management of Hulahula River</u>: Negligible to moderate, short- to long-term, site-specific to local, positive to negative	No effect
Kongakut	No effect	Minor, long-term, local, positive	Minor, long-term, local, positive	Minor, long-term, local, positive	Minor, long-term, local, positive	Minor, long-term, local, positive

Issues	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F
Resource Category: Visitor Services and Recreation Opportunities						
Wilderness	Recreation Opportunities: Negligible to minor, long-term, site-specific to local, negative Visitor Services: Negligible, long-term, local to Refuge-wide, negative Law Enforcement and Monitoring: No effect	Recreation Opportunities: Negligible to minor, long-term, WSA-wide, positive Visitor Services: Minor, long-term, WSA-wide, negative Law Enforcement and Monitoring: Minor, temporary to short-term, local, negative or positive	Recreation Opportunities: Negligible to minor, long-term, WSA-wide, positive Visitor Services: Minor to moderate, long-term, WSA-wide, negative Law Enforcement and Monitoring: Minor, temporary to short-term, local, negative or positive	Recreation Opportunities: Minor, long-term, WSA-wide to Refuge-wide, positive Visitor Services: Minor, long-term, WSA-wide to Refuge-wide, negative Law Enforcement and Monitoring: Minor, temporary to short-term, local, negative or positive	Recreation Opportunities: Minor, long-term, Refuge-wide, positive Visitor Services: Moderate, long-term, Refuge-wide to regional, negative Law Enforcement and Monitoring: Minor, temporary to short-term, local, negative or positive	Recreation Opportunities: Negligible to minor, long-term, site-specific to local, negative Visitor Services: Negligible, long-term, local to Refuge-wide, negative Law Enforcement and Monitoring: No effect
Wild and Scenic Rivers	No effect	Interim Management: No effect to negligible, short- to long-term, local, negative Designated (CRMPs): Minor to moderate, long-term, local, positive or negative	Interim Management: No effect to negligible, short- to long-term, local, negative Designated (CRMPs): Minor to moderate, long-term, local, positive or negative	Interim Management: No effect to negligible, short- to long-term, local, negative Designated (CRMPs): Minor to moderate, long-term, local, positive or negative	Interim Management: No effect to negligible, short- to long-term, local, negative Designated (CRMPs): Minor to moderate, long-term, local, positive or negative	No effect

Issues	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F
Kongakut	Management Tools: Moderate, short- and long-term, local to Refuge-wide, negative Aircraft Landings: Minor to moderate, long-term, site-specific, negative Visitor Experiences: Moderate, long-term, site-specific to local, negative	Step-Down Planning: No effect to minor to moderate, long-term, local, positive or negative Outreach: Minor, long-term, local, positive Monitoring: Minor to moderate, short-term or long-term, local, positive or negative Publishing Schedules: Minor, short-term, local, positive Interim Cap: Minor, short-term, local, positive or negative	Step-Down Planning: No effect to minor to moderate, long-term, local, positive or negative Outreach: Minor, long-term, local, positive Monitoring: Minor to moderate, short-term or long-term, local, positive or negative Publishing Schedules: Minor, short-term, local, positive Interim Cap: Minor, short-term, local, positive or negative	Step-Down Planning: No effect to minor to moderate, long-term, local, positive or negative Outreach: Minor, long-term, local, positive Monitoring: Minor to moderate, short-term or long-term, local, positive or negative Publishing Schedules: Minor, short-term, local, positive	Step-Down Planning: No effect to minor to moderate, long-term, local, positive or negative Outreach: Minor, long-term, local, positive Monitoring: Minor to moderate, short-term or long-term, local, positive or negative Publishing Schedules: Minor, short-term, local, positive	Step-Down Planning: No effect to minor to moderate, long-term, local, positive or negative Outreach: Minor, long-term, local, positive Monitoring: Minor to moderate, short-term or long-term, local, positive or negative Publishing Schedules: Minor, short-term, local, positive
Resource Category: Wilderness Characteristics						
Wilderness	In short-term: Negligible to minor, Refuge-wide, positive In long-term: Negligible to minor, Refuge-wide, negative	Minor, long-term, WSA-wide, positive	Minor, long-term, WSA-wide, positive	Moderate, long-term, Refuge-wide, positive	Moderate, long-term, Refuge-wide, positive	In short-term: Negligible to minor, Refuge-wide, positive In long-term: Negligible to minor, Refuge-wide, negative

Issues	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F
Wild and Scenic Rivers	No effect to negligible, long-term, local, positive	Interim Management: No effect to negligible, medium-term, local, positive Designated (CRMPs): Minor to moderate, long-term, local, positive	Interim Management: No effect to negligible, medium-term, local, positive Designated (CRMPs): Minor to moderate, long-term, local, positive	Interim Management: No effect to negligible, medium-term, local, positive Designated (CRMPs): Minor to moderate, long-term, local, positive	Interim Management: No effect to negligible, medium-term, local, positive Designated (CRMPs): Minor to moderate, long-term, local, positive	No effect to negligible, long-term, local, positive
Kongakut	Minor to moderate, long-term, local, negative	Working with Operators: Minor to moderate, short-term, local, and positive Monitoring: Moderate, long-term, local, positive Outreach: Minor, long-term, local, positive Rehabilitation: Minor, long-term, local, positive Interim Cap: Minor, short-term, local, positive	Working with Operators: Minor to moderate, short-term, local, and positive Monitoring: Moderate, long-term, local, positive Outreach: Minor, long-term, local, positive Rehabilitation: Minor, long-term, local, positive Interim Cap: Minor, short-term, local, positive	Working with Operators: Minor to moderate, short-term, local, and positive Monitoring: Moderate, long-term, local, positive Outreach: Minor, long-term, local, positive Rehabilitation: Minor, long-term, local, positive	Working with Operators: Minor to moderate, short-term, local, and positive Monitoring: Moderate, long-term, local, positive Outreach: Minor, long-term, local, positive Rehabilitation: Minor, long-term, local, positive	Working with Operators: Minor to moderate, short-term, local, and positive Monitoring: Moderate, long-term, local, positive Outreach: Minor, long-term, local, positive Rehabilitation: Minor, long-term, local, positive

Issues	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F
Resource Category: Special Designations						
Wilderness	PUNA: No effect Shublik RNA: No effect Firth RNA: No effect MPA: No effect Wild Rivers: No effect	PUNA: No effect Shublik RNA: No effect Firth RNA: No effect MPA: No effect Wild Rivers: Negligible to minor, long-term, WSA-wide, positive	PUNA: No effect Shublik RNA: No effect Firth RNA: No effect MPA: Minor, long-term, WSA-wide, positive Wild Rivers: No effect	PUNA: No effect Shublik RNA: No effect Firth RNA: No effect MPA: No effect Wild Rivers: Negligible to minor, long-term, WSA-wide, positive	PUNA: No effect Shublik RNA: No effect Firth RNA: No effect MPA: Minor, long-term, WSA-wide, positive Wild Rivers: Negligible to minor, long-term, WSA-wide, positive	PUNA: No effect Shublik RNA: No effect Firth RNA: No effect MPA: No effect Wild Rivers: No effect
Wild and Scenic Rivers	PUNA: No effect Shublik RNA: No effect Firth RNA: No effect MPA: No effect Wild Rivers: No effect	PUNA: No effect Shublik RNA: Negligible to minor, long-term, local, positive Firth RNA: No effect MPA: Negligible, long-term, local, positive Wild Rivers: No effect	PUNA: No effect Shublik RNA: No effect Firth RNA: No effect MPA: No effect Wild Rivers: No effect	PUNA: No effect Shublik RNA: Negligible to minor, long-term, local, positive Firth RNA: No effect MPA: Negligible, long-term, local, positive Wild Rivers: No effect	PUNA: No effect Shublik RNA: Negligible to minor, long-term, local, positive Firth RNA: No effect MPA: Negligible, long-term, local, positive Wild Rivers: No effect	PUNA: No effect Shublik RNA: No effect Firth RNA: No effect MPA: No effect Wild Rivers: No effect

Issues	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F
Kongakut	PUNA: No effect Shublik RNA: No effect Firth RNA: No effect MPA: No effect Wild Rivers: No effect	PUNA: No effect to negligible, short-term, local, negative Shublik RNA: No effnkbect to negligible, short-term, local, negative Firth RNA: No effect to negligible, short-term, local, negative MPA: Negligible, long-term, local, positive Wild Rivers: No effect to negligible to minor, short- to medium-term, local, negative	PUNA: No effect to negligible, short-term, local, negative Shublik RNA: No effect to negligible, short-term, local, negative Firth RNA: No effect to negligible, short-term, local, negative MPA: Negligible, long-term, local, positive Wild Rivers: No effect to negligible to minor, short- to medium-term, local, negative	PUNA: No effect Shublik RNA: No effect Firth RNA: No effect MPA: Negligible, long-term, local, positive Wild Rivers: No effect	PUNA: No effect Shublik RNA: No effect Firth RNA: No effect MPA: Negligible, long-term, local, positive Wild Rivers: No effect	PUNA: No effect Shublik RNA: No effect Firth RNA: No effect MPA: Negligible, long-term, local, positive Wild Rivers: No effect
Resource Category: Public Health and Safety						
Wilderness	No effect	No effect	No effect	No effect	No effect	No effect
Wild and Scenic Rivers	No effect	No effect	No effect	No effect	No effect	No effect
Kongakut	No effect	No effect to negligible, long-term, Refuge-wide, positive	No effect to negligible, long-term, Refuge-wide, positive	No effect to negligible, long-term, Refuge-wide, positive	No effect to negligible, long-term, Refuge-wide, positive	No effect to negligible, long-term, Refuge-wide, positive

Issues	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F
			Resource Category: Refuge Operations			
Wilderness	No effect	Paperwork: Negligible, long-term, WSA-wide, negative Research: Negligible, long-term, WSA-wide, negative State Operations: Negligible, long-term, WSA-wide, negative	Paperwork: Minor, long-term, WSA-wide, negative Research: Negligible to minor, long-term, WSA-wide, negative State Operations: Negligible, long-term, WSA-wide, negative	Paperwork: Minor, long-term, WSA-wide, negative Research: Negligible to minor, long-term, WSA-wide to Refuge-wide, negative State Operations: Negligible, long-term, WSA-wide, negative	Paperwork: Minor, long-term, Refuge-wide, negative Research: Negligible to minor, long-term, Refuge-wide to regional, negative State Operations: Negligible, long-term, Refuge-wide, negative	No effect
Wild and Scenic Rivers	No effect to negligible, short- to medium-term, local, negative	Interim Management: No effect to negligible, medium-term, local, negative Designation – in short term: Moderate, Refuge-wide, negative Designation – in long term: Minor, Refuge-wide, positive	Interim Management: No effect to negligible, medium-term, local, negative Designation – in short term: Moderate, Refuge-wide, negative Designation – in long term: Minor, Refuge-wide, positive	Interim Management: No effect to negligible, medium-term, local, negative Designation – in short term: Moderate, Refuge-wide, negative Designation – in long term: Minor, Refuge-wide, positive	Interim Management: No effect to negligible, medium-term, local, negative Designation – in short term: Moderate, Refuge-wide, negative Designation – in long term: Minor, Refuge-wide, positive	No effect to negligible, short- to medium-term, local, negative

Issues	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F
Kongakut	No effect	In short-term: Moderate, short- to medium-term, Refuge-wide, negative In long-term: Minor, Refuge-wide, positive	In short-term: Moderate, short- to medium-term, Refuge-wide, negative In long-term: Minor, Refuge-wide, positive	In short-term: Moderate, short- to medium-term, Refuge-wide, negative In long-term: Minor, Refuge-wide, positive	In short-term: Moderate, short- to medium-term, Refuge-wide, negative In long-term: Minor, Refuge-wide, positive	In short-term: Moderate, short- to medium-term, Refuge-wide, negative In long-term: Minor, Refuge-wide, positive
Poker Flat Research Range						
Wilderness	Scientific Return: No effect Economic Input: No effect	Scientific Return: Major, long-term, regional, negative Economic Input: Minor, long-term, regional, negative	Scientific Return: Negligible, long-term, regional, positive Economic Input: No effect	Scientific Return: Major, long-term, regional, negative (Alternative with greatest impacts) Economic Input: Minor, long-term, regional, negative	Scientific Return: Major, long-term, regional, negative Economic Input: Minor, long-term, regional, negative	Scientific Return: No effect Economic Input: No effect
Wild and Scenic Rivers	No effect	No effect	No effect	No effect	No effect	No effect
Kongakut	No effect	No effect	No effect	No effect	No effect	No effect

5.10 Section 810 Evaluation

ANILCA Section 810 requires that when the Refuge contemplates "whether to withdraw, reserve, lease, or otherwise permit the use, occupancy, or disposition of public lands," it must evaluate the effects of such uses on subsistence uses and needs. If the Refuge determines that a significant restriction is likely to occur, they must follow the Section 810 notice and hearing requirements. The Refuge may proceed with an action that would significantly restrict subsistence uses only if it first determines:

- such a significant restriction of subsistence uses is necessary, and consistent with sound management principles for the utilization of the public lands;
- the proposed activity would involve the minimal amount of public lands necessary to accomplish the purposes of such use, occupancy, or other disposition; and
- reasonable steps would be taken to minimize adverse effects upon subsistence uses and resources resulting from such actions.

A finding that the proposed action or other alternatives may significantly restrict subsistence uses imposes additional requirements, including provisions for notices to the State and appropriate regional and local subsistence committees, a hearing in the vicinity of the area involved, the making of a determination as required by ANILCA Section 810(a)(3), or prohibition of the action.

The evaluation and findings required by ANILCA Section 810 are considered in this analysis. To determine if a significant restriction of subsistence uses and needs may result from any one of the alternatives discussed in this Plan, including their cumulative effects, the following three factors were considered:

- A reduction in subsistence uses due to factors such as direct impacts on the resource, adverse impacts on habitat, or increased competition for the resources.
- A reduction in the subsistence uses due to changes in availability of resources caused by an alteration in their distribution, migration, or location.
- A reduction in subsistence uses due to limitations on the access to harvestable resources such as physical or legal barriers.

This Plan and its alternatives do not propose any types of uses or developments that would pose risks to subsistence resources or subsistence uses of the Refuge. No proposed or foreseen significant restriction of subsistence uses and needs is envisioned for any of the alternatives. Referring to the goals, objectives, management policies, and guidelines in Chapter 2, the various subsistence activities or uses currently allowed will not change from present management under any of proposed alternatives. Fishing, hunting, trapping, and berry picking is allowed under all land management categories (i.e., Wilderness Management, Wild River Management, Minimal Management, Moderate Management, and Intensive Management). Collection of house logs and firewood and collection of plant materials is also allowed under all five management categories (see Chapter 2, Sections 2.3, 2.4, and 2.5).

The establishment and use of temporary facilities directly related to the taking of fish and wildlife may be allowed under each of the five management categories as they have been since the 1988 Plan was implemented. Caches, camps, shelters, lean-tos, and other temporary facilities will be allowed in either Wilderness or Minimal Management lands. Subsistence users will not need a special use permit for use of temporary facilities, with the exception of tent platforms left in place for more than a year; such tent platforms have required a special use permit since the 1988 Plan was implemented. Tent platforms left in place for more than one year by subsistence users may be authorized under a five-year renewable permit in which no administrative processing fees will be required.

The legislated purposes of the Refuge require maintaining high-quality habitats and healthy populations and natural diversity of fish and wildlife; maintaining water quality; fulfilling international treaty obligations; and providing a continued opportunity for subsistence use. While the alternatives contain slightly different approaches to meeting these purposes, none favor activities or projects that would have direct negative impacts or would disproportionately impose adverse cumulative effects on subsistence uses. The management policies and guidelines that would be adopted under Alternatives B-F direct the Service to generally avoid intervening with resources in the Refuge in response to climate change or naturally occurring events, unless the event is determined to be a management emergency. This approach could result in the gradual loss or decline of subsistence resources, or result in them changing through time. The effects would likely be minor, long-term, and Refuge-wide to regional, and they could be mitigated according to our management emergency policy (see Chapter 2, Section 2.4.2). Climate change is not part of any of the proposed management actions in the Revised Plan, and there would be limits to what the Service could do to minimize resultant effects.

There would be no effect to subsistence uses or resources, and traditional access and subsistence use opportunities would continue according to current regulations and policies. Current traditional methods and patterns of motorized and non-motorized access would not be affected by Wilderness designation. On Refuge lands in Alaska, including Wilderness areas, Section 811(b) of ANILCA authorizes the use of snowmobiles, motorboats, dog teams, and other means of surface transportation traditionally employed by local rural residents engaged in subsistence activities. Subsistence uses in designated Wilderness and wild river corridors would continue as they have under current Minimal Management, and the Refuge's subsistence purpose would continue to be met.

Chapter 4 describes the environment of Arctic Refuge in detail, including subsistence and other human uses. Chapter 5 (this chapter) describes anticipated effects of each alternative on the environment, including effects to subsistence and other uses. This Plan and its alternatives propose a number of future step-down management plans, monitoring programs, and other proposed activities. As required by ANILCA Section 810 and NEPA, the Refuge will continue to evaluate the effects of each proposed action or activities on subsistence activities or uses to ensure compliance with ANILCA and NEPA.

The Refuge will also continue to work with the Federal Subsistence Board, Federal Subsistence Regional Advisory Councils, local fish and game advisory committees, the Alaska Department of Fish and Game, local tribes and Native organizations, local Native corporations, and other appropriate local sources to determine whether a proposed activity would significantly restrict subsistence activities or uses. If the Refuge determines that a proposal or activity would likely result in adverse effects to subsistence activities or uses, the Refuge would follow the requirements identified in Section 810 and the Service's tribal consultation policies before making a final decision on the proposed action.

The United States, Alaska Native tribes, and Alaska Native Claims Settlement Act (ANCSA) Native corporations have a unique legal and political relationship to provide regular and meaningful involvement in the decision making process regarding issues affecting cultural and subsistence resources, subsistence and traditional uses, or other activities that may have implications to tribes or Native corporations . In recognition of this special relationship, we added Objective 4.1 Formal Consultation (Chapter 2, Section 2.1.4) and embedded language requiring either formal or informal consultation, or collaboration, or cooperation with local Native communities in all of the subsistence, cultural and other objectives which may have tribal or Native corporation implications. In addition to formal consultation with federally recognized tribal governments and ANCSA Native corporations, the Refuge will, whenever practicable and reasonable, collaborate and partner with Native organizations, subsistence advisory groups, and universities to accomplish agreed upon subsistence and cultural projects and studies.

The Service has determined in this Section 810(a) evaluation that none of the alternatives or the cumulative effects of the Revised Plan would significantly restrict subsistence use or the availability of resources in Arctic Refuge, nor would they increase competition for resources or restrict access to harvestable resources. Opportunities for continued subsistence use would be maintained.

5.11 Environmental Justice

A Federal agency is required to identify and address, as appropriate, any disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations (Executive Order 12898, February 11, 1994, amended January 30, 1995, by Executive Order 12948). This includes health risks and other impacts for people who rely principally on fish or wildlife for subsistence. Subsistence activities are a way of obtaining food or natural materials and an important mechanism for maintaining cultural values, family traditions, kinships, sharing practices, and relationships to the land.

Iñupiat and Gwich'in people and their ancestors have maintained this connection to the land for thousands of years. Much of Arctic Refuge's legacy exists today largely because they have nurtured it so well. ANILCA recognizes this important connection between Native people and the land for continued cultural and subsistence purposes. Arctic Refuge's vision and management goals also share this Native perspective and values towards the land and nature (see Chapter 1, Section 1.6).

As described in Chapter 4, Section 4.4.3, communities associated with Arctic Refuge are rural, contain many low-income households, and maintain subsistence lifestyles in a mixed, subsistence cash-income economy with high levels of unemployment. Continued traditional and cultural uses of the land and waters contribute to the physical and spiritual well-being of individuals and communities helping to maintain their close relationship to the land and sustain their profound "sense of place." The nature of the proposed action (the revision of the Refuge's management plan), is very different from the proposals often associated with environmental justice issues (such as the siting of pollution-causing facilities). None of the alternatives evaluated in the Revised Plan would place a disproportionate weight of any adverse effects on low-income and/or minority populations.

Maintaining high-quality habitats and healthy populations and natural diversity of fish and wildlife; maintaining water quality; fulfilling international treaty obligations; and providing opportunities for subsistence are legislated purposes of the Refuge. The Service cannot compromise these values and their associated uses under any management alternative. While the alternatives contain slightly different approaches to meeting Refuge purposes, none favor activities or projects that would have direct negative impacts toward low-income and/or minority populations, and none of the alternatives evaluated in this Revised Plan would disproportionately impose adverse cumulative effects on communities in or adjacent to Arctic Refuge. The management policies and guidelines that would be adopted under Alternatives B-F direct the Service to generally avoid intervening with resources in the Refuge in response to climate change or naturally occurring events, unless the event is determined to be a management emergency. This approach could result in the gradual loss, decline, or change in subsistence resources upon which local low-income and minority residents depend. However, the effects could be mitigated according to our management emergency policy (see Chapter 2, Section 2.4.2). Climate change is not part of any of the proposed management actions in the Revised Plan, and there would be limits to what the Service could do to minimize resultant effects. None of the alternatives, management prescriptions, or objectives would increase the pathways of potential contaminants entering into the water supply and subsistence food resources.

5.11.1 Effects of Alternative A

Alternative A does not propose any changes to current management. No new areas would be recommended for Wilderness designation, and no new wild rivers would be recommended for designation. Visitor use management along the Kongakut River would continue under current management. Recreation-related commercial services are allowed across the entire Refuge with the exception of the big-game guide use area ARC 12 that surrounds Arctic Village. This commercial hunting guide use area would remain vacant to reduce potential user conflict with subsistence users. Private and commercial activities would continue to be reviewed, managed, and regulated with respect to ANILCA, Refuge establishing purposes, and other existing laws, regulations, and policies.

Arctic Refuge covers a vast area that is very remote and rugged, making visitor access into and out of the area quite challenging. Visitor access is primarily by commercial air operators or private aircraft and is further limited by the number of suitable landing sites. All commercial service providers are required to obtain special use permits, which contain stipulations to protect resources in the Refuge and minimize conflicts with subsistence users and other Refuge visitors. Although subsistence activities take place throughout wide areas of the Refuge, they tend to be concentrated along the coast and coastal plain regions in the north, and near Arctic Village and Venetie and several major rivers drainages in the south. Subsistence access is primarily by boat in the summer and snowmachine in the winter.

Commercial service providers and visitors operating in areas of high subsistence use could result in a perception of conflict or competition for resources with subsistence users. Simultaneous visits by general hunters (nonlocal), commercially guided hunters, and recreation groups in some high-use areas have led to reported erosion of visitor experiences, increases in user conflicts, and physical impacts such as human waste accumulations, trash, and site-hardening at commonly used campsites. To minimize perceived crowding, user conflicts, and impacts to resources, commercial recreational river guides are required to limit their trip frequency to one trip per river drainage at a time, as well as commercial guided group size limits of seven for land activities and 10 for water-based activities. The number of commercial hunting guides, and the areas they are authorized to provide services in, are also limited, as are the number of hunting clients they may guide. For subsistence users, These management actions are viewed as favorable for subsistence users because they would minimize impacts to resources, crowding, user conflicts, and potential competition for important subsistence resources.

To minimize potential impacts from contaminants to resources, Refuge users resources, Refuge staff requires commercial service providers to bury human waste at least six to eight inches deep and at least 200 feet away from springs, lakes, and streams, and the Service recommends non-guided Refuge users and visitors do the same. Temporary fuel caches are only allowed in designated areas from May 1 through September 30 and must be approved in advance by the Refuge manager with the specific location identified. Approved fuel caches must be located above the high water line of any water course, be less than 60 gallons, be stored in containers approved for gasoline, and be labeled with the permittee's name, address, and type of fuel. These visitor use management actions are generally viewed favorably for reducing potential impacts to resources by visitors and subsistence users.

The number of big-game hunting guide units would remain the same, as would limits on the number of hunting clients authorized for each guide area. Big-game hunting guide unit ARC 12 that surrounds Arctic Village would remain vacant; this includes the Arctic Village Sheep Management Area that is reserved for local federally qualified subsistence users. In recognizing the importance of Native and non-Native rural residents subsistence needs, ANILCA established a rural priority for the subsistence uses of fish and wildlife over other consumptive users in times of scarcity. These provisions are viewed favorably by subsistence users in helping to ensure continued subsistence opportunities on Federal lands.

In addition, and weather permitting, commercial air operators are asked to follow the FAA advisory to maintain a minimum altitude of 2,000 feet above the ground whenever possible, to avoid intentional low flights over camps, people, or wildlife, and to minimize interference with Refuge visitors or subsistence users. Federal law also prohibits all all aircraft operations from harassing wildlife. Subsistence users support these management actions, which help reduce user conflict and ensure subsistence opportunity.

To further minimize potential conflicts with subsistence users, commercial service providers are required to: a) review Refuge land status maps to determine the location of private lands and avoid these lands or obtain permission to use these lands from the landowner; b) warn clients that they cannot trespass or camp on any patented or selected Native allotments or conveyed Native corporation lands; c) inform clients that general sheep hunting in the Arctic Village Sheep Management Area is closed to all sheep hunting except for subsistence use; and d) encourage clients hunting on the coastal plain to avoid the coastal areas frequented by subsistence hunters.

These management stipulations were incorporated to conserve resources on the Refuge, reduce crowding, reduce potential visitor and local user conflicts, and ensure Refuge purposes (including the continued opportunity for subsistence use) are being met. This alternative does not propose any new changes to how visitors, commercially supported users, or non-commercially supported users currently visit the Refuge. Therefore, no changes in effects to the local economy, commercial uses, cultural resources, visitor services, recreational opportunities, wilderness characteristics, public health and safety, or Refuge operations are expected. Under current management actions and visitor use trends, guided commercial use on the Refuge is expected to continue near current levels. Non-guided use on the Refuge is expected to continue to gradually increase. The popularity and levels of recreational visitor use on the Refuge is expected to continue into the future with associated site-specific minor impacts to local physical resources. No new impacts to subsistence activities are expected to occur. There will continue to be a potential for trespass on Native allotments and Native corporation lands, and a potential for conflict with visitors and local users at important high use subsistence areas. However, with current management stipulations and increased education and outreach to all users, the overall impact to subsistence resources and subsistence activities would likely be local, long-term, and minor in scale.

This alternative does not impose any disproportionately high or adverse human health or environmental effects on minority populations and low-income populations. This alternative does not include health risks and other impacts for people who rely principally on fish or wildlife for subsistence.

5.11.2 Effects of Alternative B

The general management stipulations stated in Alternative A would continue in Alternative B. Alternative B would recommend the Brooks Range WSA for Wilderness designation. If approved by Congress, this designation would provide further long-term protection for the lands and waters, wildlife, and other resources in this region of the Refuge on which subsistence users depend. Wilderness designation would serve to perpetuate the natural conditions so essential for continuing a subsistence way of life. However, should the population of a subsistence species decline, Wilderness status would require a stronger justification for consideration of some management actions such as predator control. This could be viewed as a negative effect if an important subsistence wildlife population were to decline substantially; however, the effects could be mitigated according to our management emergency policy (see Chapter 2, Section 2.4.2). In recognizing the importance of Native and non-Native rural residents' subsistence needs, ANILCA established a rural priority for the subsistence uses of fish and wildlife over other consumptive users in times of scarcity. These provisions are viewed favorably by subsistence users in helping to ensure continued subsistence opportunities on Federal lands.

Current traditional methods and patterns of motorized and non-motorized access would not be affected by Wilderness designation. The use of temporary structures such as tent camps, tent frames, and fish drying racks would continue. Subsistence use of cabins would continue, although requests for construction or location of new cabins would receive greater scrutiny. Some subsistence users would view Wilderness designation on their homeland as complementary to their subsistence and cultural perspective; others would view Wilderness designation as a foreign concept and at variance with their traditional beliefs. The subsistence user groups most affected by the Brooks Range WSA-wide designation would be the south side Gwich'in villages of Arctic Village and Venetie. The Gwich'in Nation, through a resolution adopted at their Arctic Village meeting in 1988 and reaffirmed at biannual meetings ever since, continues to support wilderness review and designation for the 1002 Area of Arctic

Refuge. This resolution stresses the importance of protecting the land, waters, and traditional and customary ways of life for future generations. In 2010, the Gwich'in Steering Committee supported a wilderness review for all Refuge lands not yet designated as Wilderness.

In the Brooks Range WSA, there are 29 conveyed Native allotments, each 40–160 acres in size, for a total of 3,658.92 acres. The Native allotments were selected and conveyed based on their subsistence importance. Current and foreseeable subsistence-related use is consistent with Refuge purposes and the purposes of Wilderness. Sales to private parties could potentially result in commercial or other development that could detract from the wilderness characteristics and subsistence use of the immediate area. The Refuge would continue its policy of offering to purchase inholdings when owners have decided to sell and acquisition funds are available. If acquired, the Service would manage these lands in accordance with Refuge purposes and ANILCA, including the continued opportunity for subsistence use. The continued use of these lands for all subsistence users would be viewed as a positive effect.

In the Brooks Range WSA, 190,000 acres around Arctic Village, Old John Lake, and adjacent high use areas were found not suitable for Wilderness recommendation. This determination was made after conducting Wilderness eligibility and suitability reviews and consulting with leaders from the Native Village of Venetie Tribal Government and the Arctic Village Council. The area would be difficult to manage as Wilderness because of its proximity to an active village with supporting infrastructure such as a busy airport and the community electrical generation complex. The area also has a high concentration of private inholdings, frequent use of motorized vehicles such as motorboats and snowmachines, and includes the village's high use areas for activities such as firewood and house log cutting. These boundaries were determined in consultation with Native leaders and elders in Venetie and Arctic Village who support excluding the 190,000 acres from wilderness recommendations.

Designation of the Brooks Range WSA could potentially increase visitor interest and use for this region of the Refuge, which includes large portions of Arctic Village's and Venetie's traditional and subsistence use areas. This could increase competition for local resources between local subsistence users and visitors. However, as in Alternative A, the number of big-game guides and use areas would remain the same, as would the limits on the number of hunting clients authorized for each guide area. Big-game guide use area ARC 12 that surrounds Arctic Village would remain vacant; this includes the Arctic Village Sheep Management Area where hunting is reserved for local federally qualified subsistence users. Continuing these management stipulations and increasing education and outreach to all users would minimize potential and perceived conflicts and competition with local subsistence users.

Alternative B recommends wild river designation for the Hulahula, Kongakut, and Marsh Fork Canning rivers. Of these suitable rivers, only the Hulahula River has a cultural outstandingly remarkable value. If Congress were to designate any of the recommended rivers in this alternative, a CRMP would be developed for each river, and the river plan would identify strategies to provide protection for the river's outstandingly remarkable and other river-related values. These river plans might affect commercial services, visitor services, cultural resources, local economies, recreational opportunities, and wilderness opportunities. Overall, there would be a positive effect for further protection of the cultural outstandingly remarkable value for the Hulahula River, and traditional access and subsistence use opportunities would continue to be permitted according to current regulations and policies. However, effects on subsistence could vary as the CRMP process unfolds. If Congress were to designate the entire extent of the Hulahula River as a wild river, the Service would partner with KIC regarding river management where it flows through KIC lands. KIC and the

Service could have different perceptions as to what is needed in the CRMP to protect cultural and subsistence resources on the lower extent of the river. The Service and KIC would need to work together to achieve effective protections.

In general, subsistence uses in designated Wilderness and along wild river corridors would continue as they have under Minimal Management, and the subsistence purpose would continue to be met. Pathways of potential contaminants into water supplies and subsistence foods resources by human waste accumulation or fuel caches would be mitigated by ongoing management practices and current regulations. No new impacts to subsistence activities are expected to occur under this alternative. However, there will continue to be a potential for trespass on Native allotments and Native corporation lands as well as a potential for conflict with visitors and nonlocal users at important high use subsistence use areas. With current management stipulations and increased education and outreach to all users, the overall impact to cultural and subsistence resources and subsistence activities would likely be minor, long-term, local, and positive.

Alternative B proposes that Kongakut River visitor use management issues be addressed in a Visitor Use Management and/or Wilderness Stewardship step-down plan (i.e., VUMP and/or WSP). It would also establish several new programs to protect resources in the Kongakut River valley. An interim cap would be set on commercial recreation guides running from 2013 until 2016, or when the required VUMP is completed. The Service would develop outreach materials for the public with targeted messages explaining preferred visitor practices and strategies for minimizing impacts, such as proper waste disposal, avoiding wildlife impacts, and alleviating crowding among groups. The Service would provide the public with schedules of proposed guided trip launch dates and past visitor use activity patterns. Rehabilitation of heavily impacted sites would be conducted when necessary. The Service would revise the current monitoring program of physical and social conditions to evaluate the effectiveness of management actions. Efforts would be increased to enforce compliance of special use permit conditions and existing visitor use regulations. We would work with commercial guides to encourage them to voluntarily modify their use of the river throughout the season, especially during heavy use periods (late June and mid-August). We would also work with commercial air operators to disperse commuting flight paths in and out of the Kongakut valley, subject to safe aircraft operation, inclement weather conditions, and takeoff and landing approach requirements. More proactive management of commercial and visitor use, including recreational and commercially guided hunting, would be beneficial to subsistence users and would potentially minimize conflicts and competition for subsistence related resources.

This alternative does not impose any disproportionately high and adverse human health or environmental effects on minority populations or low-income populations. This alternative does not include health risks and other impacts for people who rely principally on fish or wildlife for subsistence.

5.11.3 Effects of Alternative C

The general management stipulations stated in Alternative A would continue in Alternative C. This alternative would recommend the Coastal Plain WSA be designated as Wilderness. If approved by Congress, Wilderness designation would provide further long-term protection for the lands, wildlife, and other resources in this region of the Refuge on which subsistence users depend. Wilderness designation would serve to perpetuate the current natural conditions so important for a subsistence way of life. However, should the population of a subsistence species decline, Wilderness status would require a stronger justification for consideration of some management actions such as predator control. This could be viewed as a negative effect if an important subsistence wildlife population were to decline substantially; however, the effects could be mitigated according to our management emergency policy (see Chapter 2, Section 2.4.2). In recognizing the importance of Native and non-Native rural residents subsistence needs, ANILCA established a rural priority for the subsistence uses of fish and wildlife over other consumptive users in times of scarcity. These provisions are viewed favorably by subsistence users in helping to ensure continued subsistence opportunities on Federal lands.

Current traditional methods and patterns of motorized and non-motorized access would not be affected by Wilderness designation. The use of temporary structures such as tent camps, tent frames, and fish drying racks would continue. Subsistence use of cabins would continue, although requests for construction or location of new cabins would receive greater scrutiny. Some subsistence users would view Wilderness designation on their homeland as complementary to their subsistence and cultural perspective; others would view Wilderness designation as a foreign concept and at variance with their traditional beliefs. The subsistence user group that would be most affected by the Wilderness designation of the Coastal Plain WSA would be the north side Iñupiat village of Kaktovik.

Comments received from several members of the Native Village of Kaktovik Tribal Government, representatives of Arctic Slope Regional Corporation (ASRC), and various public speakers during public scoping meetings and public hearings on the Revised Plan opposed Wilderness designation for the Coastal Plain WSA. They believe future economic development opportunities, such as oil and gas development in the 1002 Area (if opened by Congress) would be impacted. Other Native representatives recommended designation of the coastal plain as Wilderness because of its importance for a variety of subsistence resources, including the calving and nursery grounds for the Porcupine caribou herd. The Gwich'in Nation, through a resolution adopted at Arctic Village in 1988 and reaffirmed at biannual meetings ever since, continues to support Wilderness review and designation for the 1002 Area of Arctic National Wildlife Refuge. The Gwich'in Nation's resolution stresses the importance of protecting the land and waters and the traditional and customary ways of life for future generations. Gwich'in elders and tribal leaders describe the caribou calving and nursery ground of Arctic Refuge's coastal plain as a "Sacred Place Where Life Begins."

Several members from the Native Village of Kaktovik and ASRC opposed Wilderness designation because they believe it would impact subsistence use and access, particularly regarding all-terrain vehicle use for access to resources and to Native allotments. Current traditional methods and patterns of motorized and non-motorized access would not be affected by Wilderness designation. Traditional access and subsistence uses would continue to be permitted according to ANILCA and current regulations and policies.

The Coastal Plain WSA contains 28 Native allotments, each 40–160 acres in size, for a total of 1,359.55 acres. These allotments were selected and conveyed due to their important past subsistence use. Current and foreseeable subsistence-related use is consistent with Refuge purposes and the purposes of Wilderness. Sales to private parties could potentially result in commercial or other development that could detract from the wilderness characteristics and subsistence uses of the immediate area. The Refuge would continue its policy of offering to purchase inholdings where the owners have decided to sell and acquisition funds become available. If acquired, the Service would manage these lands in accordance with Refuge purposes and ANILCA, including the continued opportunity for subsistence use.

There is a 30,000-acre area of lagoon waters near Kaktovik that is not being recommended for Wilderness designation due to its proximity to an active village. The lagoon is heavily used by village residents and is near supporting village infrastructure such as a busy airport, community electrical generation complex, the military Barter Island Long Range Radar Site, and a Borough landfill. A number of Native allotments are in the area around the lagoon, and frequently there are motorized vehicles such as motorboats and snowmachines in and around the lagoon. The exclusion area boundaries were determined in consultation with Native leaders and elders from the Native Village of Kaktovik Tribal Government who support excluding this area from wilderness recommendation.

Alternative C recommends wild river designation for Atigun River. If Congress were to designate this river, a CRMP would be developed that would identify strategies to provide protection for the river's outstandingly remarkable and other river-related values. This could result in impacts to commercial services, visitor services, cultural resources, local economies, recreational opportunities, and wilderness opportunities. There would be no anticipated effect to subsistence uses or resources. Traditional access and subsistence use opportunities would continue to be permitted according to current regulations and policies.

In general, subsistence uses in designated Wilderness and wild river corridors would continue as they have under Minimal Management, and the Refuge's subsistence purpose would continue to be met. Pathways of potential contaminants into water supplies and subsistence foods resources by human waste accumulation or fuel caches would be mitigated by ongoing management practices and current regulations. No new impacts to subsistence activities are expected to occur. However, there will continue to be a potential for trespass on Native allotments and Native corporation lands, as well as a potential for conflict with visitors and nonlocal users at important high use subsistence use areas. With current management stipulations and increased education and outreach to all users, the overall impact to cultural and subsistence resources and subsistence activities would likely be minor, long-term, local, and positive.

Alternative C proposes that Kongakut River visitor use management issues be addressed in a Visitor Use Management and/or Wilderness Stewardship step-down plan (i.e., VUMP and/or WSP). It would also establish several new programs to protect resources in the Kongakut River valley. An interim cap would be set on commercial recreation guides running from 2013 until 2016, or when the required VUMP is completed. The Service would develop outreach materials for the public with targeted messages explaining preferred visitor practices and strategies for minimizing impacts, such as proper waste disposal, avoiding wildlife impacts, and alleviating crowding among groups. The Service would provide the public with schedules of proposed guided trip launch dates and past visitor use activity patterns. Rehabilitation of heavily impacted sites would be conducted when necessary. The Service would revise the current monitoring program of physical and social conditions to evaluate the effectiveness of management actions. Efforts would be increased to enforce compliance of special use permit conditions and existing visitor use regulations. We would work with commercial guides to encourage them to voluntarily modify their use of the river throughout the season, especially during heavy use periods (late June and mid-August). We would also work with commercial air operators to disperse commuting flight paths in and out of the Kongakut valley, subject to safe aircraft operation, inclement weather conditions, and takeoff and landing approach requirements. More proactive management of commercial and visitor use, including recreational and commercially guided hunting, would be beneficial to subsistence users and would potentially minimize conflicts and competition for subsistence related resources.

This alternative does not impose any disproportionately high or adverse human health or environmental effects on minority populations and low-income populations. This alternative would not impose any disproportional economic effects on minority or low-income populations because neither Wilderness designation nor oil and gas development of the 1002 Area are reasonably foreseeable future actions. This alternative does not include health risks and other impacts for people who rely principally on fish or wildlife for subsistence.

5.11.4 Effects of Alternative D

The general management stipulations stated in Alternative A would continue in Alternative D. This alternative would recommend Wilderness designation of the Brooks Range and Porcupine Plateau WSAs. If approved by Congress, Wilderness designation would provide further long-term protection for the lands, wildlife, and other resources on which subsistence users depend. Wilderness designation would serve to perpetuate the natural conditions in which subsistence cultures evolved. However, should the population of a subsistence species decline, Wilderness status would require a stronger justification for consideration of some management actions such as predator control. This could be viewed as a negative effect if an important subsistence wildlife population were to decline substantially; however, the effects could be mitigated according to our management emergency policy (see Chapter 2, Section 2.4.2). In recognizing the importance of Native and non-Native rural residents subsistence needs, ANILCA established a rural priority for the subsistence uses of fish and wildlife over other consumptive users in times of scarcity. These provisions are viewed favorably by subsistence users in helping to ensure continued subsistence opportunities on Federal lands.

Current methods and patterns of motorized and non-motorized access would not be affected. The use of temporary structures such as tent camps, tent frames, and fish drying racks would continue. Subsistence use of cabins would continue, although requests for construction or location of new cabins would receive greater scrutiny. Some subsistence users would view the Wilderness designation on their homeland as complementary to their cultural perspective; others would view Wilderness as a foreign concept and at variance with their traditional beliefs. The subsistence user groups most affected by the Brooks Range and Porcupine WSA designations would be the south side Gwich'in communities of Arctic Village, Venetie, Fort Yukon, and Chalkyitsik.

The Gwich'in Nation, through a resolution adopted at Arctic Village in 1988 and reaffirmed at biannual meetings ever since, continues to support Wilderness review and designation for the 1002 Area of Arctic Refuge. The resolution stresses the importance of protecting the land and traditional and customary ways of life for future generations. In 2010, the Gwich'in Steering Committee supported a wilderness review for all Refuge lands not yet designated as Wilderness. Alternative D would provide further long-term protection for a large portion of their traditional homelands in Arctic Refuge boundaries south of the Brooks Range, which would be viewed as a positive subsistence and cultural benefit. However, there would be no further protection for the Porcupine caribou herd's calving and nursery grounds on the coastal plain associated with the 1002 Area, which would be viewed as a negative effect for the Gwich'in people.

In the Brooks Range and Porcupine WSAs, there are 41 conveyed Native allotments, each 40–160 acres in size, for a total of 4,738.54 acres. The Native allotments were selected and conveyed based on their past subsistence importance. Current and foreseeable subsistence-related use is consistent with Refuge purposes and the purposes of Wilderness. Sales to private parties could potentially result in commercial or other development that could detract from the wild character and subsistence use of the immediate area. The Refuge would continue its policy of offering to purchase inholdings when owners have decided to sell and acquisition funds are available. If acquired, the Service would manage these lands in accordance with Refuge purposes and ANILCA, including the continued opportunity for subsistence use.

Under Alternative D, 190,000 acres around Arctic Village, Old John Lake, and adjacent high use areas were found not suitable for Wilderness recommendation. This determination was made after conducting Wilderness eligibility and suitability reviews and consulting with leaders from the Native Village of Venetie Tribal Government and the Arctic Village Council. The area would be difficult to manage as Wilderness because of its proximity to an active village with supporting infrastructure such as a busy airport and the community electrical generation complex. The area also has a high concentration of private inholdings, frequent use of motorized vehicles such as motorboats and snowmachines, and includes the village's high use areas for activities such as firewood and house log cutting. These boundaries were determined in consultation with Native leaders and elders in Venetie and Arctic Village who support excluding this area from wilderness recommendations.

Alternative D recommends wild river designation for the Kongakut, Hulahula, Marsh Fork Canning, and Atigun rivers. Only those portions of the Hulahula River on Refuge lands would be recommended for designation. The Hulahula River was identified as have as having outstandingly remarkable cultural values. If Congress were to designate any of the recommended rivers in this alternative, a CRMP would be developed for each river, and the river plans would identify strategies to provide further protection for each river's outstandingly remarkable and other river-related values. This could result in impacts to commercial services, visitor services, cultural resources, local economies, recreational opportunities, and wilderness opportunities. There would be no anticipated effect to subsistence uses or resources. Traditional access and subsistence use opportunities would continue to be permitted according to current regulations and policies.

In general, subsistence uses in designated Wilderness and wild river corridors would continue as they have under Minimal Management, and the subsistence purpose would continue to be met. Pathways of potential contaminants into water supplies and subsistence foods resources by human waste accumulation or fuel caches would be mitigated by ongoing management practices and current regulations. No new impacts to subsistence activities are expected to occur. However, there will continue to be a potential for trespass on Native allotments and Native corporation lands, as well as a potential for conflict with visitors and nonlocal users at important high use subsistence use areas. With current management stipulations and increased education and outreach to all users, the overall impact to cultural and subsistence resources and subsistence activities would likely be minor, long-term, local, and positive.

Alternative D proposes that Kongakut River management issues be addressed through step-down planning (i.e., a VUMP and/or WSP). Among other things, the step-down plan(s) would develop long-term monitoring protocols. Until the step-down plan(s) is completed, the Service would revise the river's current monitoring program of physical and social conditions to evaluate the effectiveness of management actions. Alternative D would also establish several new interim programs to protect resources in the Kongakut River valley. The Service would work with commercial guides to encourage them to voluntarily modify their use of the river throughout the season, especially during heavy use periods (late June and mid-August). We would also work with commercial air operators to disperse commuting flight paths in and out of the Kongakut valley, subject to safe aircraft operation, inclement weather conditions, and takeoff and landing approach requirements. The Service would develop outreach materials for the public with targeted messages explaining preferred visitor practices and strategies for minimizing impacts, such as proper waste disposal, avoiding wildlife impacts, and alleviating crowding among groups. The Service would also provide the public with schedules of proposed guided trip launch dates and past visitor use activity patterns. Rehabilitation of heavily impacted sites would be conducted when necessary, and efforts would be increased to enforce compliance of special use permit conditions and existing visitor use regulations. More proactive management of commercial and visitor use, including recreational and commercially guided hunting, would be beneficial to subsistence users and would potentially minimize conflicts and competition for subsistence related resources.

This alternative does not impose any disproportionately high or adverse human health or environmental effects on minority populations and low-income populations. This alternative does not include health risks and other impacts for people who rely principally on fish or wildlife for subsistence.

5.11.5 Effects of Alternative E

The general management stipulations stated in Alternative A would continue in Alternative E. This alternative would recommend the Brooks Range, Porcupine Plateau, and the Coastal Plain WSAs for Wilderness designation. If approved by Congress, Wilderness designation would provide further long-term protection for the lands, wildlife, and other resources on which subsistence users depend. Wilderness designation would serve to perpetuate the natural conditions in which subsistence cultures evolved. However, should the population of a subsistence species decline, Wilderness status would require a stronger justification for consideration of some management actions such as predator control. This could be viewed as a negative effect if an important subsistence wildlife population were to decline substantially; however, the effects could be mitigated according to our management emergency policy (see Chapter 2, Section 2.4.2). In recognizing the importance of Native and non-Native rural residents subsistence needs, ANILCA established a rural priority for the subsistence uses of fish and wildlife over other consumptive users in times of scarcity. These provisions are viewed favorably by subsistence users in helping to ensure continued subsistence opportunities on Federal lands.

Current methods and patterns of motorized and non-motorized access would not be affected. The use of temporary structures such as tent camps, tent frames, and fish drying racks would continue. Subsistence use of cabins would continue, although requests for construction or location of new cabins would receive greater scrutiny. Some subsistence users would view Wilderness designation on their homeland as complementary to their cultural perspective; others would view Wilderness as a foreign concept and at variance with their traditional beliefs. In general, subsistence uses in Wilderness would continue as they have under Minimal Management, and the subsistence purpose would continue to be met. The subsistence user groups most affected by this alternative would be the Iñupiat village of Kaktovik in the northern region and the Gwich'in communities of Arctic Village, Venetie, Fort Yukon, and Chalkyitsik to the south.

Including the coastal plain in the Wilderness recommendations would be viewed as having a negative effect by Iñupiat tribal leaders, ASRC, KIC, and some members of the Native community because it would impact future economic development opportunities such as oil and gas development in the 1002 Area. Gwich'in Nation representatives recommend designation of the coastal plain as Wilderness because of its importance for a variety of subsistence resources, including the calving and nursery grounds for the Porcupine caribou herd. They describe the Refuge's coastal plain as a "Sacred Place Where Life Begins."

The Gwich'in Nation, through a resolution adopted at Arctic Village in 1988 and reaffirmed at biannual meetings ever since, continues to support Wilderness review and designation for the 1002 Area of Arctic Refuge. The resolution stresses the importance of protecting the land and traditional and customary ways of life for future generations. In 2010, the Gwich'in Steering Committee supported a wilderness review for all Refuge lands not yet designated as Wilderness. This alternative would have a positive effect for the Gwich'in people, providing the most long-term protection over the greatest portion of their traditional homelands in Arctic Refuge and helping to perpetuate the natural conditions and subsistence resources so essential to the Gwich'in way of life. Iñupiat leaders, while supporting continued protection of subsistence resources and subsistence use, view Wilderness designation of the 1002 Area as being detrimental to future economic development opportunities and traditional subsistence use opportunities.

In the Brooks Range, Porcupine Plateau, and Coastal Plain WSAs, there are 69 conveyed Native allotments, each 40–160 acres in size, for a total of 6,098.09 acres. The Native allotments were selected and conveyed based on their past subsistence importance. Current and foreseeable subsistence-related use is consistent with Refuge purposes and the purposes of Wilderness. Sales to private parties could potentially result in commercial or other development that could detract from the wilderness characteristics and subsistence use of the immediate area. The Refuge would continue its policy of offering to purchase inholdings when owners have decided to sell and acquisition funds are available. If acquired, the Service would manage these lands in accordance with Refuge purposes and ANILCA, including the continued opportunity for subsistence use.

Under Alternative E, 190,000 acres around Arctic Village, Old John Lake, and adjacent high use areas, and a 30,000-acre area of lagoon waters near Kaktovik, would not be recommended for Wilderness designation. These areas were determined to be not suitable for Wilderness after conducting Wilderness eligibility and suitability reviews and consulting with leaders from the Native Village of Venetie Tribal Government and the Arctic Village Council, as well as with Native leaders and elders from the Native Village of Kaktovik Tribal Government. These areas would be difficult to manage as Wilderness because of their proximities to active villages with supporting infrastructure such airports and community electrical generation complexes. These areas also have a high a concentration of private inholdings and motorized vehicles such as motorboats and snowmachines frequently are used in these areas.

Alternative E recommends wild river designation for the Kongakut, Hulahula, Marsh Fork, and Atigun rivers. The Hulahula River was identified as having an outstandingly remarkable cultural value. If Congress were to designate any of the recommended rivers in this alternative, a CRMP would be developed for each river. The river plans would identify strategies to protect each river's outstandingly remarkable and other river-related values. This could result in impacts to commercial services, visitor services, cultural resources, local economies, recreational opportunities, and wilderness opportunities. Overall, there would be a positive effect for further protection of the cultural outstandingly remarkable value for the Hulahula River, and traditional access and subsistence use opportunities would continue to be permitted according to current regulations and policies. However, effects on subsistence could vary as the CRMP process unfolds. If Congress were to designate the entire extent of the Hulahula River as a wild river, the Service would partner with KIC regarding river management where it flows through KIC lands. KIC and the Service could have different perceptions as to what is needed in the CRMP to protect cultural and subsistence resources on the lower extent of the river. The Service and KIC would need to work together to achieve effective protections.

In general, subsistence uses in designated Wilderness and wild river corridors would continue as they have under Minimal Management, and the subsistence purpose would continue to be met. Pathways of potential contaminants into water supplies and subsistence foods resources by human waste accumulation or fuel caches would be mitigated by ongoing management practices and current regulations. No new impacts to subsistence activities are expected to occur. However, there will continue to be a potential for trespass on Native allotments and Native corporation lands, as well as a potential for conflict with visitors and nonlocal users at important high use subsistence use areas. With current management stipulations and increased education and outreach to all users, the overall impact to cultural and subsistence resources and subsistence activities would likely be minor, long-term, local, and positive.

Alternative E proposes that Kongakut River management issues be addressed through step-down planning (i.e., a VUMP and/or WSP). Among other things, the step-down plan(s) would develop long-term monitoring protocols. Until the step-down plan(s) is completed, the Service would revise the river's current monitoring program of physical and social conditions to evaluate the effectiveness of management actions. Alternative E would also establish several new interim programs to protect resources in the Kongakut River valley. The Service would work with commercial guides to encourage them to voluntarily modify their use of the river throughout the season, especially during heavy use periods (late June and mid-August). We would also work with commercial air operators to disperse commuting flight paths in and out of the Kongakut valley, subject to safe aircraft operation, inclement weather conditions, and takeoff and landing approach requirements. The Service would develop outreach materials for the public with targeted messages explaining preferred visitor practices and strategies for minimizing impacts, such as proper waste disposal, avoiding wildlife impacts, and alleviating crowding among groups. The Service would also provide the public with schedules of proposed guided trip launch dates and past visitor use activity patterns. Rehabilitation of heavily impacted sites would be conducted when necessary, and efforts would be increased to enforce compliance of special use permit conditions and existing visitor use regulations. More proactive management of commercial and visitor use, including recreational and commercially guided hunting, would be beneficial to subsistence users and would potentially minimize conflicts and competition for subsistence related resources.

This alternative does not impose any disproportionately high or adverse human health or environmental effects on minority populations and low-income populations. This alternative would not impose any disproportional economic effects on minority or low-income populations because neither Wilderness designation nor oil and gas development of the 1002 Area are reasonably foreseeable future actions. This alternative does not include health risks and other impacts for people who rely principally on fish or wildlife for subsistence.

5.11.6 Effects of Alternative F

The general management stipulations stated in Alternative A would continue in Alternative F. No new areas would be recommended for Wilderness designation, and no new wild rivers would be recommended for designation.

Alternative F proposes that Kongakut River management issues be addressed through step-down planning (i.e., a VUMP and/or WSP). Among other things, the step-down plan(s) would develop long-term monitoring protocols. Until the step-down plan(s) is completed, the Service would revise the river's current monitoring program of physical and social conditions to evaluate the effectiveness of management actions. Alternative F would also establish several new interim programs to protect resources in the Kongakut River valley. The Service would work with commercial guides to encourage them to voluntarily modify their use of the river throughout the season, especially during heavy use periods (late June and mid-August). We would also work with commercial air operators to disperse commuting flight paths in and out of the Kongakut valley, subject to safe aircraft operation, inclement weather conditions, and takeoff and landing approach requirements. The Service would develop outreach materials for the public with targeted messages explaining preferred visitor practices and strategies for minimizing impacts, such as proper waste disposal, avoiding wildlife impacts, and alleviating crowding among groups. The Service would also provide the public with schedules of proposed guided trip launch dates and past visitor use activity patterns. Rehabilitation of heavily impacted sites would be conducted when necessary, and efforts would be increased to enforce compliance of special use permit conditions and existing visitor use regulations. More proactive management of commercial and visitor use, including recreational and commercially guided hunting, would be beneficial to subsistence users and would potentially minimize conflicts and competition for subsistence related resources.

In general, subsistence uses would continue as they have under Minimal Management, and the Refuge's subsistence purpose would continue to be met. Pathways of potential contaminants into water supplies and subsistence foods resources by human waste accumulation or fuel caches would be mitigated by ongoing management practices and current regulations. No new impacts to subsistence activities are expected to occur. However, there will continue to be a potential for trespass on Native allotments and Native corporation lands, and a potential for conflict with visitors and nonlocal users at important high use subsistence use areas. With current management stipulations and increased education and outreach to all users, overall impacts to cultural and subsistence resources and subsistence activities would likely be minor, long-term, local, and positive.

This alternative does not impose any disproportionately high or adverse human health or environmental effects on minority populations and low-income populations. This alternative does not include health risks and other impacts for people who rely principally on fish or wildlife for subsistence.

5.11.7 Conclusion

Neither current management, nor any of the actions proposed in alternatives B–F, would significantly affect subsistence resources, subsistence access, or subsistence use. These alternatives do not impose any disproportionately high or adverse human health or environmental effects on minority or low-income populations. This analysis does not include a health risk assessment for people who rely principally on subsistence resources.

5.12 Irreversible and Irretrievable Commitment of Resources

The irreversible commitment of resources means that nonrenewable resources are consumed or destroyed. Examples would be the destruction of cultural resources by management activities and mineral extraction that consumes nonrenewable minerals.

The irretrievable commitment of resources represents tradeoffs (opportunities forgone) in the use and management of natural resources. Irretrievable commitment of resources can include the expenditure of funds, loss of production, or restrictions on resource use.

None of the actions proposed in any of the alternatives would constitute an irreversible or irretrievable commitment of resources. The only resources likely to continue to be lost under any alternative are those cultural resources that are being damaged or destroyed due to natural processes, including erosion. Those actions proposed that would result in gathering more cultural resources information through working cooperatively with partners and actual surveys of areas of the Refuge subject to frequent human use (e.g., along the Kongakut River) would result in lessening of these effects through better protection of known resources and/or documenting resources before they are lost.

In Alternatives C and E, there is a recommendation for the Coastal Plain WSA to be designated as Wilderness. If this area were to be designated as Wilderness by Congress, there would be a loss of potential oil and gas production. As oil and gas development is currently not allowed by law, there would be no change in the current status of the legal opportunity to exploit the resource. Under a Wilderness designation, the oil and gas resources would remain and could be available if needed at some time in the future.

5.13 Relationship Between Local Short-term Uses and Maintenance and Enhancement of Long-term Productivity

Based on current management (Alternative A) and Alternatives B–F, the Refuge would be managed for its four ANILCA purposes and, in areas encompassed by the former Range, the original purpose of preserving unique wildlife, wilderness, and recreational values. Alternatives B–E recommend designating progressively more Wilderness and wild rivers, ensuring long-term preservation of lands and waters in the Refuge through statutory protections. Wilderness recommendations would have no effects. Should lands or rivers be designated, there could be minor positive effects to the biophysical and human environments over the planning period of this Revised Plan.

Alternatives C and E recommend designating the Coastal Plain WSA as Wilderness. This would enhance the long-term productivity of Refuge lands for the purposes for which the Refuge was established. While designation could result in precluding future oil and gas development and its attendant impacts, it might not. Congress has the authority and legal flexibility to designate Wilderness, open the 1002 Area to oil and gas production, or do both; it depends on the action Congress takes.

5.14 Unavoidable Adverse Effects

Management actions proposed in Alternatives A–F would not result in any unavoidable adverse effects. As noted, cultural resources would continue to degrade due to natural processes and, to a much lesser extent, unintentional or intentional damage by Refuge users. Those actions proposed that would result in gathering more cultural resources information through working cooperatively with partners and actual surveys of areas of the Refuge subject to frequent human use (e.g., along the Kongakut River) would result in lessening these effects through better protection of known resources and/or documenting resources before they are lost.

Wilderness and wild river recommendations or designation would cause no unavoidable adverse effects. More proactively managing the Kongakut River would produce no unavoidable adverse effects.

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6. Implementation and Monitoring

6.1 Introduction

The Arctic National Wildlife Refuge (Arctic Refuge, Refuge) Revised Comprehensive Conservation Plan (Plan, Revised Plan) will be implemented through the goals, objectives, management guidelines and policies, and specific actions described in Chapters 2 and 3. The Refuge will also use various step-down management plans described in Section 6.3 to implement the Revised Plan. Each step-down plan has its own focus, and each identifies and directs the implementation of specific actions, techniques, and tools designed to achieve the objectives outlined in this Plan (Service Manual 602 FW 1.5).

The vision and goals adopted in the Revised Plan are intended to guide management of Arctic Refuge for the next 15 years. The objectives and management actions adopted in the Plan are the concrete steps that the Refuge would take to reach those goals, and they serve an integral role in implementation. The intent is for these objectives to be a measure of real progress toward goals for Arctic Refuge. Because opportunities and needs for new objectives will most likely arise, the U.S. Fish and Wildlife Service (Service) considers these objectives dynamic and responsive to changing environmental and social conditions and management situations, such as those anticipated from accelerating climate change or infrastructure development in local communities. Implementation is also dependent on future Service budgets and regional funding allocations. Plan adjustments and amendments might be needed depending on the nature of unfolding concerns or opportunities (Section 6.7).

Implementing this Plan will require the Refuge to coordinate closely with partners throughout the region and with the State. We will also need to identify new partnership opportunities as they arise (Section 6.4) to carry out strategies for accomplishing objectives. The Plan's objectives identify numerous monitoring activities that would directly or indirectly provide feedback on the effects of the Revised Plan on Refuge resources and operations (Section 6.6). The Plan is scheduled for full revision in 15 years.

6.2 Current Step-Down Plans

Step-down plans deal with specific management topics. They describe strategies and implementation schedules and provide details necessary to implement goals and objectives in this Plan.

6.2.1 Fire Management Plan

Service wildland fire management planning is a complex activity incorporating: interagency fire management obligations and coordination at local, regional, and national levels; the mission of the Service and the National Wildlife Refuge System (Refuge System); and local Refuge management. It must also be consistent with overall Refuge System planning processes.

Every unit managed by the Service that has burnable vegetation must have an approved Fire Management Plan (FMP), unless exempted in writing by the regional director. An approved FMP ensures consistency with the Comprehensive Conservation Plan and other management plans, and allows a manager to consider a wide range of management responses to wildfires and to conduct prescribed fires.

FMPs are intended to be dynamic and reflect current situations and policies; therefore, to remain up-to-date, FMPs must be reviewed each year using a nationally established annual review process. Plans must be revised when substantial changes occur or substantial changes in management are proposed. Minor plan revisions may be accomplished through an amendment added to the plan and signed by the line officer and servicing fire management officer. Major scheduled revisions to fire management plans will follow the 15-year Comprehensive Conservation Plan revision cycle to provide consistency in objectives and management strategy formulation. Without a current FMP, prescribed fires cannot be conducted, and response to unplanned ignitions can only consider suppression strategies. Preparedness and prevention activities can continue in the interim period as outlined in the expired plan. An Arctic FMP was completed in 2007, approved in 2008, and has been reviewed annually since then. A major revision of the FMP will be completed within one year of approval of the Revised Plan and thereafter in conjunction with future Comprehensive Conservation Plan revisions.

6.3 Future Step-Down Plans

The following sections provide more detail on the step-down plans mentioned in this Plan's objectives (Section 2.1); included is an estimated schedule for their completion (Table 6-1).

6.3.1 Visitor Use Management Plan

The Visitor Use Management Plan (VUMP) is a step-down plan that will develop a visitor management framework to protect, and restore where necessary, desired conditions and visitor experience opportunities of Arctic Refuge and preserve its wilderness characteristics. The planning process will help managers decide the specific conditions and visitor experiences that will be available to the public across the Refuge. The VUMP will develop condition goals, indicators, and standards, which will help measure the success of plan implementation; the visitor plan will also identify thresholds that trigger management actions to ensure management goals are maintained.

The VUMP will address visitor use issues identified during the Revised Plan's public involvement phases, and additional public involvement will be conducted during the development of the visitor plan. We will assess visitor use issues and information needs such as levels of use, timing and distribution of use, and activities and behaviors of visitors. Managers may use outreach, site management, regulation, enforcement, and rationing or allocation to manage visitor use at Arctic Refuge.

The VUMP would begin immediately upon implementation of the Revised Plan and be completed within three to five years. Since the visitor plan will comprehensively address visitor use throughout the Refuge and across special designations (e.g., designated Wilderness), the effort will be coordinated with the Wilderness Stewardship Plan (WSP) through concurrent scoping, preplanning, data collecting, public involvement, and planning decisions. Additionally, the VUMP will be coordinated with and/or inform other planning efforts, including Comprehensive River Management Plans (CRMPs) and the Ecological Inventory and Monitoring Plan (I&M Plan). The Refuge manager has identified the Visitor Use Management and Wilderness Stewardship plans as the highest priority for step-down planning.

The VUMP would be reviewed every three to five years, coincident with Refuge staff review of the Revised Plan. We will consider public comments, local and State government recommendations, research studies, and other sources, to determine if revisions to the VUMP are necessary. If major changes are proposed, public meetings may be held, and new environmental analyses may be necessary. Thereafter, the VUMP will be fully reviewed and revised every 15 years, coincident with Refuge comprehensive planning (see Section 6.6).

6.3.2 Wilderness Stewardship Plan

The Wilderness Stewardship Plan (WSP) is a step-down management plan that provides detailed strategies and implementation schedules for meeting the broader Wilderness goals and objectives identified in the Revised Plan. Service policy requires that refuges develop a WSP for all congressionally designated Wilderness areas. A WSP is used to guide the preservation, stewardship, and use of a particular Wilderness area (Service Manual 610 FW 3).

The WSP will identify adverse impacts on Wilderness character and develop indicators and standards for measuring the condition of Wilderness. Additionally, the plan will identify thresholds that will trigger management actions to reduce or prevent impacts. It will evaluate ongoing and needed monitoring and research, and appropriate and compatible uses and commercial services in Wilderness. It will also contain Minimum Requirement Analyses (MRAs) needed for Refuge management activities. Wilderness is a composite resource with physical, ecological, and experiential components. Therefore, many of the issues the WSP will address will be coordinated with other planning efforts addressing similar issues such as the VUMP, CRMP, and the Ecological Inventory and Monitoring Plan (I&M Plan). The Refuge will coordinate the Wilderness Stewardship and Visitor Use Management planning processes (Objective 5.4) through concurrent scoping, preplanning, data collecting, public involvement, and planning decisions.

The WSP for Arctic Refuge would begin immediately upon approval of the Revised Plan and would be conducted with the VUMP through concurrent scoping, preplanning, data collecting, public involvement, and planning decisions (Table 6-1). The WSP will be completed in three to five years. The Refuge manager has identified the concurrent WSP and VUMP as the highest planning priority.

6.3.3 Ecological Inventory & Monitoring Plan

The Ecological Inventory & Monitoring Plan (I&M Plan) is a step-down plan that will guide an annual program for collection of data on species of management concern to the Refuge (Service Manual 701 FW 2). Service policy requires each refuge to develop an I&M Plan to document selection of species to survey, field protocols, analyses, data management, reporting, and, where appropriate, measurable thresholds for initiating specific management actions. The I&M Plan is effectively a compilation of approved and current survey procedures.

Refuge staff prepared a draft I&M Plan in 2000, but it was not finalized. Alaska Region policy mirrors national policy by requiring development of an I&M Plan for each refuge. The policy further requires that each plan be reviewed at two-year intervals by the Refuge and at 5-8-year intervals by the regional office. The I&M Plan is a “living document” that is subject to revision based on these reviews.

Arctic Refuge will begin drafting an I&M Plan upon approval of the Revised Plan. The draft I&M Plan will be subject to peer review through an ecological review of the Refuge’s biological program three years after approval of the Revised Plan, and will be finalized within four years of approval of the Revised Plan.

A Research Plan will be developed concurrently with the I&M Plan and will be incorporated as an appendix to the I&M Plan. The Research Plan will identify and prioritize research needs, partnership opportunities, and potential funding resources. Research projects will address specific biological hypotheses. For example, while monitoring projects will identify species population trends, research projects will investigate the causes of observed trends and may support development of conservation measures for the Refuge. The Research Plan will be completed within four years of approval of the Revised Plan, after completion of the ecological review.

The Refuge manager has identified the I&M and Research Plans as the second-highest priority step-down planning effort.

6.3.4 Land Protection Plan

A Land Protection Plan (LPP) is a step-down plan that focuses on private lands within the Refuges boundaries with the goal of identifying and conserving high-quality habitat on those lands. It provides a framework for Refuge and private landowner cooperation. Land conservation measures will be pursued only with landowners who are willing to work with the Service, and LPPs do not obligate the Refuge or landowners to undertake any of the measures identified in the plan. The Refuge must consider management goals, priorities, and availability of funds when approached by private landowners with land conservation proposals. An LPP for Arctic Refuge is scheduled to be initiated within one to two years of approval of the Revised Plan and will likely take two years to complete. The Refuge manager has identified the LPP as the third planning priority.

6.3.5 Comprehensive River Management Plans

Comprehensive River Management Plans (CRMPs) apply only to rivers included in the National Wild and Scenic Rivers System. A CRMP is a step-down plan that: includes a detailed description of the river's outstandingly remarkable values; addresses development of lands and facilities; defines the goals and desired conditions for protecting river values; addresses user capacities; addresses water quality issues and in-stream flow requirements; reflects a collaborative approach with all stakeholders; identifies regulatory authorities of other governmental agencies that assist in protecting river values; and includes a monitoring strategy to maintain desired conditions (Wild and Scenic Rivers Act 16 U.S.C. 1271-1287).

A CRMP for each of the three currently designated wild rivers in Arctic Refuge is number four on the Refuge manager's priority list; they are scheduled to be initiated within five years of approval of the Revised Plan. CRMPs will also be completed within three years of designation for any river(s) recommended suitable through the Plan and subsequently designated by Congress. CRMPs will be consistent with Refuge-wide management objectives identified in the Visitor Use Management and Wilderness Stewardship step-down plans. The Refuge manager has identified developing CRMPs as the fourth planning priority, along with Land Protection planning (Section 6.3.4).

6.3.6 Integrated Cultural Resources Management Plan

An Integrated Cultural Resource Management Plan (ICRMP) is a step-down plan that will assist Refuge staff in meeting legal requirements to protect and manage the cultural resources of the Refuge. It provides a ready reference to cultural resource laws and regulations, the Service Manual and the Cultural Resource Management Handbook. The ICRMP outlines a program for implementing Section 110 of the National Historic Preservation Act and Section 14 of the Archaeological Resources Protection Act requirements to determine the nature and extent of cultural resources on the Refuge and evaluate them for eligibility to the National Register of Historic Places. The plan will identify funding needs and possible timetables for completion of identified work.

The ICRMP for Arctic Refuge is scheduled to begin within three years of approval of the Revised Plan with tribal consultations and an overview of literature, authorities, responsibilities, and compliance requirements. The Plan will be completed within six years of approval of the Revised Plan. This plan is fifth on the Refuge manager's step-down plan priority list. The ICRMP will be consistent with CRMPs, protecting cultural values of the Refuge's Wild and Scenic Rivers, however, most of the work on the ICRMP will be conducted in the Services regional office.

Table 6-1. Timeline for start and completion dates of future step-down plans of Arctic Refuge.

Future Step-Down Plans	Priority	Start Date	Estimated Completion Date
Visitor Use Management Plan (VUMP)[1]	1	2013	2018
Wilderness Stewardship Plan (WSP)[1]	1	2013	2018
Ecological Inventory and Monitoring Plan (I&M Plan) and Research Plan[2]	2	2013	2017
Land Protection Plan (LPP)	3	2013	2016
Comprehensive River Management Plans (CRMPs)	4	2017	2020
Integrated Cultural Resources Management Plan (ICRMP)	5	2015	2018

[1] These plans will be done concurrently and could be combined into a single planning effort.
[2] The Research Plan is an appendix to the I&M Plan and not a separate planning effort.

6.4 Partnership Opportunities

Partnerships with other organizations are among the ways the Service fulfills its mission of "working with others to conserve, protect and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people."

Arctic Refuge is a dynamic ecosystem. Many of the resources in the Refuge are of regional, State, national, and international importance. The Service recognizes that the public, organizations, and other governmental agencies have interests in the Refuge and the work of the Service. Successful implementation of many Refuge programs requires involvement from these interested parties. Partnerships are among the best ways for the Refuge to accomplish its work and fulfill its mission. We seek opportunities with others to do that work, including but not limited to the following:

- State of Alaska – Alaska Department of Fish and Game (ADFG), Alaska Department of Natural Resources (ADNR), Board of Fisheries, Board of Game, Alaska State Troopers and Division of Wildlife Protection, and the State Historic Preservation Office
- Tribal Governments
- Native organizations such as Doyon, Arctic Slope Regional Corporation (ASRC), Kaktovik Iñupiat Corporation (KIC), Council of Athabascan Tribal Governments (CATG), and Tanana Chiefs Conference (TCC)
- Local village and city councils
- Local municipalities and cities
- North Slope Borough
- Other Federal agencies – such as the U.S. Geological Survey (USGS), the National Oceanic and Atmospheric Administration (NOAA), the National Park Service (NPS), the Bureau of Land Management (BLM), the National Aeronautics and Atmospheric Administration (NASA), the U.S. Coast Guard, and Department of Homeland Security
- Other branches of the U.S. Fish and Wildlife Service
- Landscape Conservation Cooperatives (LCCs)
- Canadian Partners including Parks Canada, Canadian Wildlife Service, and Environment Yukon
- Arctic Borderlands Ecological Knowledge Cooperative
- Migratory Bird Co-management Council
- Various co-management committees and groups
- Universities and museums
- Non-governmental organizations
- Local businesses
- Commercial recreation and hunting interests
- Nanuuq Commission (MMPA)
- Kaktovik Whaling Captains' Association (Eskimo Whaling Commission)

6.5 Implementation Schedule

The Refuge is committed to implementing the projects and studies identified in the Plan's objectives (Chapter 2, Section 2.1). These projects and studies are summarized in Table 6-2 along with their associated timelines. Ongoing efforts, such as outreach, monitoring and research activities, or partnerships, are not included. For more details, refer to the Refuge's goals and objectives.

Table 6-2. Projects and studies to be implemented by Arctic Refuge.

Date	Activities	Objective[1]	Comments
2012	Initiate water resource inventory and assessment	3.3	Complete in 2013
	Incorporate patrols of at-risk cultural sites into law enforcement patrols	8.2	
	Establish legal protection for water quality and quantity	3.2	Annually until Federal water rights reservations are adjudicated by the State of Alaska
	Evaluate potential effects of climate change on Refuge resources	6.1	Complete in 2017, revise periodically thereafter
2013	Develop Wilderness checklist for Refuge operations	2.1	
	Establish partnerships for village harvest monitoring program	4.4	
	Develop protocols and priorities for scientific research by cooperators	7.3	
	Develop Refuge land status map with 17(b) easements	5.6	
	Interview and document elders and residents in preparation for traditional access study	4.6	
	Compile subsistence use data	4.5	
	Train staff about Wilderness and wild and scenic rivers	2.3	Repeat as needed
	Revise the Visitor Study	5.8	Monitoring intervals to be determined through VUMP/WSP
2014	Implement village harvest monitoring program	4.4	Annually thereafter
	Conduct cultural resource training	8.2	
	Conduct archival research and compile cultural inventories, reports, and data	8.3	

Date	Activities	Objective[1]	Comments
	Complete an environmental analysis of the Lake Peters administrative cabins project	2.5	
	Conduct wild river assessment/inventories of the Refuge's three designated rivers (preplanning for CRMPs)	3.5	Through 2017
2015	Conduct ecological review	1.4	Implement by 2017
	Begin surveys, interviews, and research for Cultural Resource Atlas	8.4	
2016	Evaluate permit process for scientific permits	7.3	
2017	Conduct water quality and quantity sampling	3.4	
	Identify and determine status of rare species	1.8	
	Develop Cultural Resource Atlas and archive	8.4	
	Expand Refuge Information Technician (RIT) program to Venetie/Fort Yukon	4.3	
	Review existing MRAs	2.2	Review again in 2022 and 2027
	Complete field component of the Lake Peters administrative cabin project, if approved	2.5	
2018	Conduct traditional access study	4.6	Could take until 2020
2022	Complete an administrative history of Arctic Refuge	8.5	
	Complete Cultural Resource Atlas and Archive	8.4	
	Implement necessary changes to the Long-term Ecological Monitoring Program	1.9	
2024	Revise the National Interest Study	9.4	

[1] This column identifies the number of the objective in which we make a commitment for the activity. Please refer to Chapter 2, Section 2.1 for a complete description of goals and objectives.

6.6 Monitoring and Evaluation

Monitoring helps Refuge staff track the progress of Plan implementation. In this Plan, objectives specify numerous monitoring programs. These programs use various methods and strategies, including but not limited to surveys, inventories, censuses, and strategic frameworks. While the results from these monitoring programs pertain directly to the program areas requiring the monitoring, the data collected will also provide feedback on the Revised Plan. The Refuge monitoring programs listed in this section will indirectly monitor the impact of the Revised Plan on Refuge management, operations, and resources.

- Ecological inventory and monitoring: status and trends of populations, species, communities and ecosystems
- Baseline water quality study on coastal plain and of designated wild rivers
- Impact of climate change on Refuge resources, including vulnerable species and ecological communities
- Marine Protected Areas
- Monitoring of visitor use impacts and experience on the Kongakut River
- Aircraft impacts monitoring
- Community harvest monitoring
- Cultural resource monitoring
- Subsistence uses
- Wilderness characteristics
- Visitor Study
- National Interest Study
- Additional monitoring programs would come out of the following step-down planning efforts
  - Visitor Use Management Plan
  - Wilderness Stewardship Plan
  - Ecological Inventory and Monitoring Plan
  - Comprehensive River Management Plans

The Service will maintain flexibility in implementing the Plan to account for changing environmental conditions, policies, budgets, technologies, and opportunities for partnerships that might occur during the life of the Plan. The Service will evaluate monitoring results and amend or revise the Plan accordingly to improve wildlife conservation and Refuge management (Section 6.7).

6.7 Plan Amendment and Revision

Periodic review and change of the Plan will be necessary. As knowledge of Refuge resources, users, and uses improves, changes in management may be identified. Fish and wildlife populations, user groups, adjacent land users, and other management considerations change with time, often in unforeseen ways. Challenges may also be encountered in trying to implement the Plan.

Revisions are a necessary part of the adaptive management approach used by the Service. This means that objectives and strategies to reach goals can be adjusted. Most of the resulting changes will fine-tune the Plan. These changes will be addressed in the more detailed Refuge step-down and annual work plans. An appropriate level of public involvement and environmental analysis will be conducted for any proposed change.

To enable Refuge users; adjacent landowners; local, State, and Federal agencies; and other interested parties to express their views on how the Refuge is being managed, the Refuge might periodically hold meetings or use other techniques, such as comment cards and surveys, to solicit comments for evaluation purposes. By encouraging continuing public input, the Refuge will be better able to serve the public, determine potential problems before they occur, and take immediate action to resolve existing problems.

Every three to five years, Refuge staff will review public comments, local and State government recommendations, research studies, and other sources to determine if revisions to the Plan are necessary. If major changes are proposed, public meetings may be held, and new environmental analyses may be necessary. The Plan will be fully reviewed and revised every 15 years.

Literature Cited

Adamczewski, J. Z., W. M. Kerr, E. F. Lammerding, and P. F. Flood. 1994. Digestion of low protein grass hay by muskoxen and cattle. Journal of Wildlife Management 58:679-685.

Adams, F. J., T. L. Tanner, and M. A. Nelson. 2005. Harvest and biological characteristics of the subsistence fishery in Arctic Village, Alaska, 2001-2003. U.S. Fish and Wildlife Service, Alaska Fisheries Data Series 2005-18, Fairbanks, Alaska, USA.

Alaska Department of Commerce, Community and Economic Development. 2010. Community database online. Division of Community and Regional Affairs. <http://www.commerce.state.ak.us/dca/commdb/CF_BLOCK.htm>. Accessed February 22, 2010.

Alaska Department of Commerce, Community and Economic Development. 2011. Community profiles. Division of Community and Regional Affairs. <http://www.commerce.state.ak.us/dca/commdb/CF_COMDB.htm>. Accessed February 24, 2011.

Alaska Department of Fish and Game [ADFG]. 1984. State of Alaska resource management recommendation for the Arctic National Wildlife Refuge and surrounding area. Alaska Department of Fish and Game, Anchorage, Alaska, USA.

Alaska Department of Fish and Game [ADFG]. 1985. Data for Kaktovik 1985. Community subsistence information system (CSIS). <http://www.adfg.alaska.gov/sb/CSIS/>. Accessed February 24, 2011.

Alaska Department of Fish and Game [ADFG]. 1986. Data for Kaktovik 1986. Community subsistence information system (CSIS). <http://www.adfg.alaska.gov/sb/CSIS/>. Accessed February 24, 2011.

Alaska Department of Fish and Game [ADFG]. 1992. Data for Kaktovik 1992. Community subsistence information system (CSIS). <http://www.adfg.alaska.gov/sb/CSIS/>. Accessed February 24, 2011.

Alaska Department of Fish and Game [ADFG]. 2000. Subsistence in Alaska: a year 2000 update. Alaska Department of Fish and Game, Division of Subsistence, Juneau, USA.

Alaska Department of Fish and Game [ADFG]. 2005. Alaska subsistence fisheries 2003 annual report. Alaska Department of Fish and Game, Division of Subsistence, Juneau, USA.

Alaska Department of Fish and Game [ADFG]. 2006. Our wealth maintained: a strategy for conserving Alaska's diverse wildlife and fish resources. Alaska Department of Fish and Game, Juneau, USA <http://www.sf.adfg.state.ak.us/statewide/ngplan/NG_outline.cfm>. Accessed April 26, 2010.

Alaska Department of Fish and Game [ADFG]. 2009. Catalog of waters important for spawning, rearing or migration of anadromous fishes. Alaska Department of Fish and Game, Juneau, USA.

Alaska Department of Labor and Workforce Development. 2007. Alaska population projections 2007–2030. Research Analysis Section, Juneau, USA. <http://laborstats.alaska.gov>. Accessed March 3, 2010.

Alaska Department of Labor and Workforce Development. 2010. 2010 Census Demographic Profiles. Research Analysis Section, Juneau, AK, USA. <http://live.laborstats.alaska.gov/cen/dparea.cfm>. Accessed February 8, 2012.

Alaska Department of Natural Resources, Office of History and Archaeology. 2001. Alaska heritage resources survey. Database located at the Office of History and Archaeology. Anchorage, USA.

Alaska Department of Natural Resources. 2008. The barter or sale of handicrafts. Office of Subsistence Management, Anchorage, USA.

Alaska Department of Transportation and Public Facilities. 2010. Chalkyitsik: airport improvements. Reference No: 40277. State of Alaska capital project summary. Juneau, USA.

Alaska Division of Geological and Geophysical Surveys. 1987. Physical environment of the Arctic National Wildlife Refuge. Unpublished report. Alaska Department of Natural Resources, Division of Geological and Geophysical Surveys.

Alaska Exotic Plant Information Clearinghouse (AKEPIC). 2011. Alaska exotic plant information clearinghouse database. Alaska Natural Heritage Program, University of Alaska, Anchorage, USA. < http://aknhp.uaa.alaska.edu/maps/akepic/>. Accessed July 27, 2012.

Alaska Federation of Natives. 2010. The right to subsist. Federal protection of subsistence in Alaska. Alaska Federation of Natives, Anchorage, USA <http://www.nativefederation.org/documents/CompleteSubsBinder4-8-10.pdf> Accessed February 24, 2011.

Alaska Shorebird Group [ASG]. 2008. Alaska shorebird conservation plan. Version II. Alaska Shorebird Group, Anchorage, USA. <http://alaska.fws.gov/mbsp/mbm/shorebirds/plans.htm>. Accessed April 26, 2010

Alexander, H. L. 1987. Putu: a fluted point site in Alaska: publication No. 17. Department of Archaeology, Simon Frazer University, Burnaby, British Columbia, Canada.

Alt, K. T. 1969. Taxonomy and ecology of the inconnu (*Stenodus leucichthys nelma*) in Alaska. Biological Papers of the University of Alaska 12:1-61. College, USA.

Alt, K. T. 1974. A life history study of sheefish and whitefish in Alaska. Job R-ll-C. Movements, age and growth, spawning ecology, population dynamics, and utilization of sheefish in the middle Yukon River and Norton Sound streams. Federal Aid in Fish Restoration, Annual Report of Progress, Project F-9-6. Alaska Department of Fish and Game, Juneau, Alaska, USA.

Alt, K. T. 1976. Sport Fish Investigations of Alaska: Inventory and cataloging of North Slope waters. Alaska Fish and Game, Division of Sport Fish, Annual Performance Report. Project F-9-8, Vol. 17, G-I, Juneau, USA.

Alt, K. T. 1979. Contributions to the life history of the humpback whitefish in Alaska. Transactions of the American Fisheries Society 108:156-160.

Alt, K. T. 1980. A life history study of sheefish and whitefish in Alaska. Alaska Department of Fish and Game, Division of Sport Fish, Annual Performance Report, 1980-1981, Project F-9-12, Vol. 21, R-II, Juneau, USA.

American Ornithologists' Union [AOU]. 1998. Check-list of North American Birds. 7th edition and supplements. American Ornithologists' Union, Washington, D.C., USA.

Amstrup, S. C. 2002. Polar bears. Pages 65 -70 *in* D. C. Douglas, P. E. Reynolds, and E. B. Rhodes, editors. Arctic Refuge coastal plain terrestrial wildlife research summaries. U.S. Geological Survey, Biological Resources Division, Biological Science Report USGS/BRD/BSR-2002-0001.

Amstrup, S. C., G. M. Durner, T. L. McDonald, and W. R. Johnson. 2006. Estimating potential effects of hypothetical oil spills on polar bears. Final Report to U.S. Minerals Management Service. U.S. Geological Survey, Alaska Science Center, Anchorage, USA.

Amstrup, S. C., T. L. McDonald and I. Stirling. 2001. Polar bears in the Beaufort Sea: a 30 year mark-recapture case history. Journal of Agricultural, Biological and Environmental Statistics 2:221-234.

Amstrup, S. C., I. Stirling, and J. W. Lentfer. 1986. Past and present status of polar bears in Alaska. Wildlife Society Bulletin 14:241-254.

Andersen, D. 1993. Trapping in Alaska and the European Economic Community import ban on furs taken with leghold traps. Technical Paper No. 223. Alaska Department of Fish and Game, Division of Subsistence. Juneau, USA.

Andersen, D., and G. Jennings. 2001. The 2000 harvest of migratory birds in ten Upper Yukon River communities, Alaska. Final Report No. 1 to U.S. Fish and Wildlife Service under Cooperative Agreement No. 701801J252.

Andersen, D. B., C. L. Brown, R. J. Walker, and K. Elkin. 2004. Traditional ecological knowledge and contemporary subsistence harvest of non-salmon fish in the Koyukuk River drainage, Alaska. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper Number 282, Fairbanks, USA.

Anderson, C. G. 1999. Arctic fox *Alopex lagopus*. Pages 147-148 *in* D.E. Wilson and S. Ruff, editors. 1999. The Smithsonian Book of North American Mammals. Smithsonian Institution Press, Washington, D.C., USA.

Anderson, D. D. 1968. A Stone age campsite at the gateway to America. Scientific American 218:24-33.

Anderson, D. D. 1970. Akmak: an early archaeological assemblage from Northwest Alaska. Acta Arctica 16:1-180.

Andrews, E. F. 1977. Report on the cultural resources of the Doyon Region, Central Alaska. Volumes I and II. Cooperative Park Studies Unit, University of Alaska, Fairbanks, USA.

Andriyashev, A. P. 1954. Fishes of the northern seas of the U.S.S.R. Keys to the fauna of the U.S.S.R. No. 53, Israel Program for Scientific Translations.

Anras, M. L. B., P. M. Cooley, R. A. Bodaly, L. Anras, and R. J. P. Fudge. 1999. Movement and habitat use by lake whitefish in a boreal lake: Integrating acoustic telemetry and geographic information systems. Transactions of the American Fisheries Society 128:939-952.

Arctic Climate Impact Assessment. 2005. Arctic climate impact assessment. Cambridge University Press, Cambridge, England, United Kingdom. <http://www.acia.uaf.edu/pages/scientific.html>. Accessed July 27, 2012.

Arctic Climate Impact Assessment. 2004. Impacts of a warming arctic: arctic climate impact assessment. Cambridge University Press, Cambridge, England, United Kingdom. <http://amap.no/acia/>. Accessed August 6, 2012.

Arctic Refuge. 1976. Arctic National Wildlife Refuge, Annual Narrative Report - 1972. Arctic Refuge, Fairbanks, Alaska, USA.

Arctic Refuge. 1977. Arctic National Wildlife Refuge, Annual Narrative Report - 1975. Arctic Refuge, Fairbanks, Alaska, USA.

Arctic Refuge. 1979. Arctic National Wildlife Refuge, Annual Narrative Report - 1978. Arctic Refuge, Fairbanks, Alaska, USA.

Arctic Refuge. 1980. Arctic National Wildlife Refuge, Annual Narrative Report - 1979. Arctic Refuge, Fairbanks, Alaska, USA.

Arctic Refuge. 1984. Arctic National Wildlife Refuge, Annual Narrative Report - 1983. Arctic Refuge, Fairbanks, Alaska, USA.

Arctic Refuge. 1985. Arctic National Wildlife Refuge, Annual Narrative Report - 1984. Arctic Refuge, Fairbanks, Alaska, USA.

Arctic Refuge. 1986. Arctic National Wildlife Refuge, Annual Narrative Report - 1985. Arctic Refuge, Fairbanks, Alaska, USA.

Arctic Refuge. 1987. Arctic National Wildlife Refuge, Annual Narrative Report - 1986. Arctic Refuge, Fairbanks, Alaska, USA.

Arctic Refuge. 1988. Arctic National Wildlife Refuge, Annual Narrative Report - 1987. Arctic Refuge, Fairbanks, Alaska, USA.

Arctic Refuge. 1989. Arctic National Wildlife Refuge, Annual Narrative Report - 1988. Arctic Refuge, Fairbanks, Alaska, USA.

Arctic Refuge. 1990. Arctic National Wildlife Refuge, Annual Narrative Report - 1989. Arctic Refuge, Fairbanks, Alaska, USA.

Arctic Refuge. 1993. Arctic National Wildlife Refuge draft river management plan and environmental assessment. Arctic Refuge, Fairbanks, Alaska, USA.

Arctic Refuge. 2008a. Use of Arctic National Wildlife Refuge by Toolik Lake people: 1997-2005. Unpublished report. Arctic Refuge, Fairbanks, Alaska, USA.

Arctic Refuge. 2008b. Strategies for minimizing your impacts. <http://arctic.fws.gov/camping.htm>. Accessed February 1, 2011.

Arctic Refuge. 2010. Summary of recreational impact monitoring efforts for the Kongakut River, Arctic National Wildlife Refuge. Unpublished report. Arctic Refuge, Fairbanks, Alaska, USA.

Arctic Refuge. 2011. Arctic National Wildlife Refuge public use summary. Arctic Refuge, Fairbanks, Alaska, USA. <http://arctic.fws.gov/pdf/pureportap2011.pdf>. Accessed February 2, 2010.

Armstrong, R. H., and J. E. Morrow. 1980. The Dolly Varden char, *Salvelinus malma*. Pages 99-140 *in* U. K. Balon, editor. Charrs: salmonid fishes of the genus *Salvelinus*. Dr. W. Junk Publishers, The Hague, Netherlands.

Arthur, S. M., and P. A. Del Vecchio. 2009. Effects of oil field development on calf production and survival in the Central Arctic Herd. Alaska Department of Fish and Game, Federal Aid in Wildlife Restoration, Final Research Technical Report. Grants W-27-5 and W-33-1 through W-33-4. Project 3.46. Juneau, Alaska, USA.

Arthur, S. M., K. R. Whitten, F. J. Mauer, and D. Cooley. 2003. Modeling the decline of the Porcupine caribou herd, 1989-1998: the importance of survival vs. recruitment. Rangifer Special Issue 14:123-130.

Arvey, W. D. 1991. Stock status of anadromous Dolly Varden in waters of Alaska's North Slope. Alaska Department of Fish and Game, Fishery Manuscript Number 91-3.

Attanasi, E. D., 2005, Economics of 1998 U.S. Geological Survey's 1002 area regional assessment: an economic update: U.S. Geological Survey Open-File Report 2005-1359.

Bacon, J. J., T. R Hepa, H. K Brower, M. Pederson, T. P. Olemaun, J. C. George, and B. G. Corrigan. 2009. Estimates of subsistence harvest for villages on the North Slope of Alaska, 1994-2003. Draft report, North Slope Borough Department of Wildlife Management, Barrow, Alaska, USA.

Balascio, N. L., D. S. Kaufman, J. P. Briner, and W. F. Manley. 2005a. Equilibrium-line altitudes during the last glacial maximum across the Brooks Range, Alaska. Journal of Quaternary Science 20:821-838.

Balascio, N.L., D.S. Kaufman, J.P. Briner, and W.F. Manley. 2005b. Late pleistocene glacial geology of the Okpilak-Kongakut Rivers region, northeastern Brooks Range, Alaska. Arctic, Antarctic, and Alpine Research 37:416-424.

Ballard, W. B., E. H. Follmann, D. G. Ritter, M. D. Robards, and M. A. Cronin. 2001. Rabies and canine distemper in an arctic fox population in Alaska. Journal of Wildlife Diseases 37:133-137.

Barber, V. A., G. P. Juday, T. Osterkamp, R. D'Arrigo, E. Berg, B. Buckley, L. Hinzman, H. Huntington, M. T. Jorgenson, D. Mcguire, B. Riordan, A. Whiting, G. Wiles, and M. Wilmking. 2009. A synthesis of recent climate warming effects on terrestrial ecosystems of Alaska. Pages 110-139 *in* F. H. Wagner, editor. Climate Warming in Western North America: Evidence and Environmental Effects. University of Utah Press, Salt Lake City, Utah, USA.

Barry, R. G. 1979. Study of climatic effects on fast ice extent and its seasonal decay along the Beaufort-Chukchi coasts. Pages 272-375 *in* Environmental Assessment of the Alaskan Continental Shelf, Vol. 2: Physical Science Studies, Final Report. National Oceanic and Atmospheric Administration, Boulder, Colorado, USA.

Bart, J., B. Andres, S. Brown, G. Donaldson, B. Harrington, V. Johnston, S. Jones, R.I.G. Morrison, and S. Skagen. 2005. The program for regional and international shorebird monitoring (PRISM). Pages 893–901 *in* C. J. Ralph and T. D. Rich, editors. Bird conservation implementation and integration in the Americas: Proceedings of the third international Partners in Flight conference, 20–24 March 2002, Asilomar, California. Volume 2, U.S. Forest Service General Technical Report PSWGTR-191. Southwest Research Station, Albany, California, USA.

Bart, J., S. Brown, B. Harrington, and R. I. G. Morrison. 2007. Population trends of North American shorebirds: population declines or shifting distributions? Journal of Avian Biology 38:73-82.

Bartlett, H. 2007. 2007 Kongakut River: familiarization and evaluation float trip report. Unpublished report. U. S. Fish and Wildlife Service, Arctic Refuge, Fairbanks, Alaska, USA.

Barton, L. R. 1984. A catalog of Yukon River salmon spawning escapement surveys. Technical Data Report 121. Alaska Department of Fish and Game, Juneau, Alaska, USA.

Batzli, G. O., and F. A. Pitelka. 1983. Nutritional ecology of microtine rodents: food habits of lemmings near Barrow, Alaska. Journal of Mammalogy 64:648-655.

Bayha, K., S. Lyons, and M. L. Harle. 1997. Strategic plan for Water Resources Branch. WRB-97-1. U.S. Fish and Wildlife Service, Division of Realty, Anchorage, Alaska, USA.

Bureau of Economic Analysis (BEA). 2011.

Bee, J. W. 1958. Birds found on the Arctic Slope of northern Alaska. University Kansas Museum of Natural History Publication 10:163-211.

Bee, J. W., and E. R. Hall. 1956. Mammals of northern Alaska on the arctic slope. University of Kansas Museum of Natural History, Miscellaneous publications.

Beechey, F. W. 1831. Narrative of a voyage to the Pacific and Bering’s Strait. Henry Colburn and Richard Bently, London, England.

Bendock, T. 1977. Beaufort Sea estuarine fishery study. Final Report of the Principal Investigators, Outer Continental Shelf Environmental Assessment Program, Volume 4. National Oceanic and Atmospheric Administration, Anchorage, Alaska, USA.

Bendock, T. 1980. Inventory and cataloging of Arctic area waters. Alaska Department of Fish and Game, Division of Sport Fish, Annual Performance Report, 1979-1980, Project F-9-12, Vol. 21, G-I-I, Juneau, Alaska, USA.

Bendock, T. 1982. Inventory and cataloging of Arctic area waters. Alaska Department of Fish and Game, Division of Sport Fish, Annual Performance Report, 1981-1982, Project F-9-14, Vol. 23, G-I-I, Juneau, Alaska, USA.

Bendock, T. 1984. Inventory and cataloging of Arctic area waters. Alaska Department of Fish and Game, Division of Sport Fish, Annual Performance Report, 1983-1984, Project F-9-15, Vol. 24, G-I-I, Juneau, Alaska, USA.

Bendock, T. N., and J. M. Burr. 1984. Freshwater fish distributions in the Central Arctic Coastal Plain (Ikpikpuk River to Colville River). Unpublished report. Alaska Department of Fish and Game, Division of Sport Fish.

Bendock, T. N., and J. M. Burr. 1985. Inventory and cataloging of Arctic area waters. Alaska Department of Fish and Game, Division of Sport Fish, Annual Performance Report, 1984-1985, Project F-9-17, Vol. 26, G-I-I, Juneau, Alaska, USA.

Best, T. L. 1999a. Alaskan Hare. *Lepus othus.* Pages 702-703 *in* Wilson, D. E. and S. Ruff, editors. 1999. The Smithsonian Book of North American Mammals. Smithsonian Institution Press. Washington, D.C., USA.

Best, T. L. 1999b. Arctic Hare. *Lepus arcticus.* Pages 697-698 *in* Wilson, D.E. and S. Ruff, editors. 1999. The Smithsonian Book of North American Mammals. Smithsonian Institution Press. Washington, D.C., USA.

Bidgood, B. F. 1974. Reproductive potential of two lake whitefish (*Coregonus clupeaformis*) populations. Journal of the Fisheries Research Board of Canada 31:1631-1639.

Bird, K. J. 1999. Assessment overview. Chapter AO *in* ANWR assessment team. The oil and gas resource potential of the 1002 area, Arctic National Wildlife Refuge, Alaska. U.S. Geological Survey Open-File Report 98-34.

Bishop, F. G. 1971. Observations on spawning habits and fecundity of the Arctic grayling. The Progressive Fish Culturist. 33:12-19.

Blazina-Joyce, R. 1989. A dendrochronological analysis of Neets'aii Gwich'in caribou pounds and associated structures in northeastern Alaska. Thesis, Northern Arizona University, Flagstaff, Arizona, USA.

Bockheim, J. G., J. D. O'Brien, J. S. Munroe, and K. M. Hinkel. 2003. Factors affecting the distribution of *Populus balsamifera* on the North Slope of Alaska, U.S.A. Arctic, Antarctic, and Alpine Research 35:331-340.

Bodaly, R. A. 1986. Biology, exploitation and culture of coregonid fishes in Canada. Advances in Limnology 22:1-30.

Boreal Partners in Flight Working Group. 1999. Landbird conservation plan for Alaska biogeographic regions, Version 1.0. Unpublished report. U.S. Fish and Wildlife Service, Anchorage, Alaska, USA. <http://alaska.usgs.gov/science/biology/bpif/conservation/index.php>. Accessed April 15, 2010.

Bowers, P. M. 1982. The Lisburne Site: analysis and cultural history of a multi-component workshop in the Iteriak Valley, Arctic Foothills, Northern Alaska. Anthropological Papers of the University of Alaska 20(1-2): 79-112.

Bowers, P. M. 1999. AMS Dating of the Area 22 American Paleo Arctic Tradition Microblade component at the Lisburne Site, Arctic Alaska. Current Research in the Pleistocene 16:12-14.

Bowyer, R. T., and D .M. Leslie, Jr. 1992. *Ovis dalli.* Mammalian Species 393:1-7.

Boyle, B., A. W. Brackney, and D. Sowards. 2002. Distribution and abundance of fall staging snow geese on the coastal plain of the Arctic National Wildlife Refuge 1997-2001. Unpublished report. U.S. Fish and Wildlife Service, Arctic National Wildlife Refuge, Fairbanks, Alaska, USA.

Brabets, T. P., B. Wang, and R. H. Meade. 2000. Environmental and hydrologic overview of the Yukon River basin, Alaska and Canada. U.S. Geological Survey Water-Resources Investigations Report 99-4204, Anchorage, Alaska, USA.

Brackney, A. W. 1988. Distribution and abundance of fall staging snow geese on the coastal plain of the Arctic National Wildlife Refuge, 1986 and 1987. Unpublished report. U.S. Fish and Wildlife Service, Arctic National Wildlife Refuge, Fairbanks, Alaska, USA.

Brackney, A. W. 1989. Distribution, abundance, and productivity of fall staging snow geese on the coastal plain of the Arctic National Wildlife Refuge, 1988. Unpublished report. U.S. Fish and Wildlife Service, Arctic National Wildlife Refuge, Fairbanks, Alaska, USA.

Brackney, A. W. 1990. Distribution and abundance of fall staging snow geese on coastal plain of the Arctic National Wildlife Refuge, 1989. Unpublished report. U.S. Fish and Wildlife Service, Arctic National Wildlife Refuge, Fairbanks, Alaska, USA.

Brackney, A. W. 2008. Vital statistics on the Arctic National Wildlife Refuge, Alaska. Unpublished report. U.S. Fish and Wildlife Service, Arctic National Wildlife Refuge, Fairbanks, Alaska, USA.

Brackney, A. W., and J. W. Hupp. 1993. Autumn diet of lesser snow geese staging in Northeastern Alaska. Journal of Wildlife Management 57:55-61.

Brackney, A. W., R. M. Platte, and J. M. Morton. 1987. Migratory bird use of the coastal lagoon system of the Beaufort Sea coastline within the Arctic National Wildlife Refuge, Alaska, 1985. Arctic National Wildlife Refuge Progress Report Number FY86-15. Arctic National Wildlife Refuge, Fairbanks, Alaska. Pages 422-450 *in* 1985 update report baseline study of the fish, wildlife and their habitats. Vol. 1, Sect. 1002C, Anchorage, Alaska, USA.

Bradford, M. J., A. von Finster, and P. A. Milligan. 2009. Freshwater life history, habitat, and the production of Chinook salmon from the upper Yukon Basin. Pages 19-38 *in* C.C. Krueger and C.E. Zimmerman, editors. Pacific salmon: ecology and management of western Alaska’s populations. American Fisheries Society, Symposium 70, Bethesda, Maryland, USA.

Breeser, S. W., D. F. Stearns, M. W. Smith, R. L. West, and J. B. Reynolds. 1988. Observations of movements and habitat preferences of burbot in an Alaskan glacial river system. Transactions of the American Fisheries Society 117:506-509.

Brower, C. D., A. Carperter, M. L. Branigan, W. Calvert, T. Evans, A. S. Fischback, J. A. Nagy, S. Schliebe and I. Stirling. 2002. The polar bear management agreement for the Southern Beaufort Sea: an evaluation of the first ten years of a unique conservation agreement. Arctic 55:362-372.

Brower, H. K., and T. R. Hepa. 1998. Subsistence hunting activities and the Inupiat Eskimo. Cultural Survival Quarterly 22:37-39.

Brower, H. K., T. P. Olemaun, and T. R. Hepa. 2000. North Slope Borough subsistence harvest documentation project: data for Kaktovik, Alaska for the period December 1, 1994 to November 30, 1995. Department of Wildlife Management, North Slope Borough, Barrow, Alaska, USA.

Brown, R. J. 2006. Humpback whitefish *Coregonus pidschian* of the upper Tanana River drainage. U.S. Fish and Wildlife Service, Alaska Fisheries Technical Report No. 90, Fairbanks, Alaska, USA.

Brown, R. J. 2008. Life history and demographic characteristics of Arctic cisco, Dolly Varden, and other fish species in the Barter Island region of northern Alaska. U.S. Fish and Wildlife Service, Alaska Fisheries Technical Report No. 101, Fairbanks, Alaska, USA.

Brown, R. J., N. Bickford, and K. Severin. 2007a. Otolith trace element chemistry as in indicator of anadromy in Yukon River drainage Coregonine fishes. Transactions of the American Fisheries Society 136:678-690.

Brown, R. J., C. Brown, N. M. Braem, W. K. Carter III, N. Legere, and L. Slayton. 2011. Whitefish and whitefish fisheries in the Yukon and Kuskokwim River drainages in Alaska: a review with recommendations for future research. Fisheries Resources Monitoring Program, draft report. U.S. Fish and Wildlife Service and Alaska Department of Fish and Game, Fairbanks, Alaska, USA.

Brown, R. J., and C. Fleener. 2001. Beaver dam influence on fish in lentic and lotic habitats in the Black River drainage, Alaska. U.S. Fish and Wildlife Service, Office of Subsistence Management, Fisheries Resource Monitoring Program, Final Report (Study No. 00-004). U.S. Fish and Wildlife Service, Fairbanks Fishery Research Office, Fairbanks, Alaska, USA.

Brown, S., J. Bart, R. B. Lanctot, J. Johnson, S. Kendall, D. Payer, and J. Johnson. 2007b. Shorebird abundance and distribution on the coastal plain of the Arctic National Wildlife Refuge. Condor 109:1-14.

Brown, S., C. Hickey, B. Harrington, and R. Gill, editors. 2001. United States shorebird conservation plan. Second edition. Manomet Center for Conservation Sciences. Massachusetts, USA. <http://www.fws.gov/shorebirdplan/USShorebird/PlanDocuments.htm>. Accessed April 15, 2010.

Bryan, J. E. 1973. The influence of pipeline development on freshwater fishery resources of northern Yukon Territory, aspects of research conducted in 1971 and 1972. Pacific Region Department of the Environment, Northern Operations Branch Fisheries Service, Task Force on Northern Oil Development Report No. 73-6 (Information Canada Catalog No. R72-9773).

Bryan, J. E., and D. A. Kato. 1975. Spawning of lake whitefish, *Coregonus clupeaformis*, and round whitefish, *Prosopium cylindraceum*, in Aishihik Lake and East Aishihik River, Yukon Territory. Journal of the Fisheries Research Board of Canada 32:283-288.

Buck , L. C., and B. M. Barnes. 1999. Annual cycle of body composition and hibernation in free-living arctic ground squirrels. Journal of Mammalogy 80:430-442.

Buklis, L. S., and L. H. Barton. 1984. Yukon River fall chum salmon biology and stock status. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage, Alaska, USA.

Bureau of Economic Analysis (BEA). 2011. Regional Input-Output Modeling System (RIMS II) Multipliers, Table 1.5 Total multipliers for output, earnings, employment, and value added by detailed industry, NASA Poker Flat Region of Influence (Type II). Regional Product Division, Bureau of Economic Analysis, Washington, D.C.

Busher, W. H., and T. Hamazaki. 2005. Subsistence and personal use salmon harvests in the Alaska portion of the Yukon River drainage, 2003. Regional Information Report 3A04-33. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage, Alaska, USA.

Busher, W. H., T. Hamazaki, and A. M. Marsh. 2007. Subsistence and personal use salmon harvests in the Alaska portion of the Yukon River drainage, 2005. Fishery Data Series No. 07-52. Alaska Department of Fish and Game, Division of Commercial Fisheries. Anchorage, Alaska, USA.

Caikoski, J. R. 2008. Units 24A East, 25A, 26B and 26C Dall sheep. Pages 177-196 *in* P. Harper editor. Dall sheep management report of survey and inventory activities 1 July 2004-30 June 2007. Alaska Department of Fish and Game. Project 6.0. Juneau, Alaska, USA.

Caikoski, J. R. 2009. Porcupine Caribou Herd Calving and Post-Calving Surveys, June-July 2009. 14 Aug 2009 memorandum to R. Nowlin, Management Coordinator, Alaska Department of Fish and Game, Region III, Fairbanks, Alaska, USA.

Cameron, R. D. and K. R. Whitten. 1979. Seasonal movements and sexual aggregation of caribou determined by aerial survey. Journal of Wildlife Management 43:626-633.

Cameron, R, D., W. T. Smith, R. G. White, and B. Griffith. 2002. The Central Arctic Caribou Herd. Pages 38-45 *in* D. C. Douglas, P. E. Reynolds, and E. B. Rhode, editors. Arctic Refuge coastal plain terrestrial wildlife research summaries. U.S. Geological Survey, Biological Resources Division, Biological Sciences Report. USGS/BRD BSR-2002-0001.

Campbell, J.M. 1961. The Tuktu complex of Anaktuvuk Pass. Anthropological Papers of the University of Alaska 9(1):69-80.

Carlson, M. L., and M. Shephard. 2007. The spread of invasive exotic plants in Alaska: is establishment of exotics accelerating? Pages 117-133 *in* T. B. Harrington and S. H. Reichard, editors. Meeting the Challenge: Invasive Plants in Pacific Northwestern Ecosystems. U.S. Forest Service, Pacific Northwest Research Station General Technical Report 694, Portland, Oregon, USA.

Carroll, G. 2007. Unit 26A, Teshekpuk caribou herd. Pages 262-283 *in* P. Harper, editor. Caribou management report of survey and inventory activities 1 July 2004-30 June 2006. Alaska Department of Fish and Game. Project 3.0. Juneau, Alaska, USA.

Carter, L. D. 1988. Loess and deep thermokarst basins in arctic Alaska. Pages 706-711 *in* K. Senneset, editor. Proceedings of the Fifth International Conference on Permafrost, Trondheim, Norway.

Carter, W. K. 1966. Archaeological survey of Eskimo, or earlier, material in the vicinity of Point Barrow, Alaska: final report. Office of Naval Research and Arctic Institute of North America, Contract number ONR-110, 31 January.

Carter, W. K. 2010. Life history and spawning movements of broad whitefish in the middle Yukon River. M.S. Thesis, University of Alaska Fairbanks, Fairbanks, Alaska, USA.

Case, D. S., and D. A. Voluck. 2002. Alaska Natives and American Laws. Second Edition. University of Alaska Press, Fairbanks, Alaska, USA.

Case, R. L., and L. Buckland. 1998. Reproductive characteristics of grizzly bears in the Kugluktuk area, Northwest Territories, Canada. Ursus 10:41-47.

Caudill, J., and E. Carver. 2007. Banking on Nature 2006: the economic benefits to local communities of National Wildlife Refuge visitation. U.S. Fish and Wildlife Service, Division of Economics, Washington, D.C., USA.

Caulfield, R. A. 1983. Subsistence land use in upper Yukon-Porcupine communities. Alaska Technical Paper Number 16. Alaska Department of Fish and Game, Subsistence Division.

Chang-Kue, K. J. T., and E. F. Jessop. 1997. Broad whitefish radio tagging studies in the lower Mackenzie River and adjacent coastal region, 1982-1993. Pages 117-146 *in* R.F. Tallman and J.D. Reist, editors. The proceedings of the broad whitefish workshop: the biology, traditional knowledge and scientific management of broad whitefish (*Coregonus nasus* (Pallas)) in the lower Mackenzie River. Canadian Technical Report of Fisheries and Aquatic Sciences 2193, Winnipeg, Manitoba, Canada.

Chen, L. 1969. The biology and taxonomy of the burbot *Lota lota*, in interior Alaska. Biological Papers of the University of Alaska No. 11.

Chesemore, D. L. 1968. Occurrence of moose near Barrow, Alaska. Journal of Mammalogy 49:528-529.

Childers, J. M., C. E. Sloan, and J. P. Meckel. 1973. Hydrologic reconnaissance of streams and springs in eastern Brooks Range, Alaska--July 1972. U.S. Geological Survey, Water Resources Division Basic Data Report. U.S. Geological Survey, Water Resources Division Anchorage, Alaska, USA.

Childers, J. M., C. E. Sloan, J. P. Meckel, and J. W. Nauman. 1977. Hydrologic reconnaissance of the eastern north slope, Alaska, 1975. U.S. Geological Survey Open-File Report 77-492 U.S. Geological Survey, Anchorage, Alaska, USA.

Christensen, N. and L. Christensen. 2009. Arctic National Wildlife Refuge visitors study: the characteristics, experiences, and preferences of Refuge visitors. Christensen Research, Missoula, Montana, USA.

Chudobiak, D. H. 1995. An examination of lacustrine and estuarine populations of Mackenzie broad whitefish (*Coregonus nasus* Pallus): the role of migration and commercial exploitation on life history variation. M.S. Thesis, University of Manitoba, Winnipeg, Canada.

Churcher, C. S. 1999. Grizzly or brown bear *Ursus arctos* 2002. Pages 160-162 *in* D.E. Wilson and S. Ruff, editors. The Smithsonian book of North American Mammals, Smithsonian Institution Press, Washington, D.C., USA.

Clark, D. W. 1981. Prehistory of the Western Subarctic. Pages 107-129 *in* J. Helm, editor. Handbook of North American Indians: Subarctic. Volume 6. Smithsonian Institution, Washington, D.C., USA.

Clark, D. W. 2001. Microblade-culture systematics in the far Interior Northwest. Arctic Anthropology 38: 64-80.

Clough, N. K., P. C. Patton, and A. C. Christiansen, editors. 1987. Arctic National Wildlife Refuge, Alaska, coastal plain resource assessment: Report and recommendation to the Congress of the United States and final legislative environmental impact statement. U.S. Fish and Wildlife Service, U.S. Geological Survey, and Bureau of Land Management, Washington, D.C., USA.

Coffing M., and S. Pederson. 1985. Caribou hunting: land use dimensions, harvest levels and selected aspects of the hunt during regulatory year 1983-84 in Kaktovik, Alaska. Technical Paper No. 120. Alaska Department of Fish and Game, Division of Subsistence, Fairbanks, Alaska, USA.

Cohen, D. M., T. Inada, T. Iwamoto, and N. Scialabba. 1990. FAO species catalogue. Vol. 10. Gadiform fishes of the world. An annotated and illustrated catalogue of cods, hakes, grenadiers, and other gadiform fishes known to data. FAO Fisheries Symposium Number 125, Volume 10.

Cole, D. N. 2004. Wilderness experiences; what should we be managing for? International Journal of Wilderness 10(3):25 – 27.

Collins, G., and L. Sumner. 1953. Northeast Alaska: The Last Great Wilderness. Sierra Club Bulletin, October 1953.

Conant, B., and D. J. Groves. 1998. Alaska-Yukon waterfowl breeding population survey: May 16 to June 13, 1998. Unpublished report. U.S. Fish and Wildlife Service, Juneau, Alaska, USA.

Conant, B., J.I . Hodges, D. J. Groves, and J. G. King. 2007. The 2005 census of trumpeter swans on Alaskan nesting habitats. Unpublished report. U.S. Fish and Wildlife Service, Migratory Bird Management, Juneau, Alaska, USA.

Connors, P.G. 1984. Ecology of shorebirds in the Alaskan Beaufort littoral zone. Pages 403-416 *in* R. Barnes, D.M. Shell and E. Ramirez, editors. The Alaskan Beaufort Sea: ecosystems and environments. New York: Academic Press, New York, USA.

Cooley, D., and I. McDonald. 2010. Aerial survey of muskoxen on the Yukon North Slope, 1999-2005. Data report 10-03 VNP, Parks Canada.

Copeland, J. P., K. S. McKelvey, K. B. Aubry, A. Landa, J. Persson, R. M. Inman, J. Krebs, E. Lofroth, H. Golden, J. R. Squires, A. Magoun, M. K. Schwartz, J. Wilmot, C.L. Copeland, R. E. Yates, I. Kojola, and R. May. 2010. The bioclimatic envelope of the wolverine (*Gulo gulo*): do climate constraints limit its geographic distribution? Canadian Journal of Zoology 88:233-246.

Cordell, H. K., M .A. Tarrant, B. L. McDonald, J. C. Bergstrom. 1998. How the public views wilderness. The International Journal of Wilderness 4: 28-31.

Corkum, L. D., and P. J. McCart. 1981. A review of the fisheries of the Mackenzie delta and nearshore Beaufort Sea. Canadian manuscript report of Fisheries and Aquatic Sciences No. 1613. Winnipeg, Manitoba, Canada.

Council of Athabascan Tribal Governments (CATG). 2002. Yukon Flats moose harvest data and TEK Study. Final report agreement number 701811C075. Council of Athabascan Tribal Governments, Natural Resource Department. Fort Yukon, Alaska, USA.

Council of Athabascan Tribal Governments (CATG). 2003. Yukon Flats moose, bear, wolf harvest data collection. Technical Document 03-02. Council of Athabascan Tribal Governments, Natural Resource Department. Fort Yukon, Alaska, USA.

Council of Athabascan Tribal Governments (CATG). 2005. Yukon Flats moose, bear, wolf harvest data collection. Technical Document 05-01. Council of Athabascan Tribal Governments, Natural Resource Department. Fort Yukon, Alaska, USA.

Craig, P. C. 1973. Fall spawning and overwintering area of fish populations along routes of proposed pipeline between Prudhoe Bay and the Mackenzie Delta. Canadian Arctic Gas Study Limited.

Craig, P. C. 1977a. Fisheries investigations in the Shaviovik River drainage, Alaska, with emphasis on Arctic char in the Kavik River (Chapter 3). *In* P. McCart, editor. Fisheries Investigations along the North Slope and Beaufort Sea coast in Alaska with emphasis on Arctic char, Aquatic Environments Limited, Arctic Gas Biological Report Series, Volume 41.

Craig, P. C. 1977b. Arctic char in the Saderochit Spring, Arctic National Wildlife Refuge. (Chapter 2). *In* P. McCart, editor. Fisheries Investigations along the North Slope and Beaufort Sea coast in Alaska with emphasis on Arctic char, Aquatic Environments Limited, Arctic Gas Biological Report Series, Volume 41.

Craig, P. C. 1977c. Ecological studies of anadromous and resident populations of Arctic char in the Canning river drainage and adjacent coastal waters of the Beaufort Sea, Alaska. Pages 1-116 (Chapter 1) *In* P. McCart, editor. Fisheries Investigations along the North Slope and Beaufort Sea coast in Alaska with emphasis on Arctic char, Aquatic Environments Limited, Arctic Gas Biological Report Series, Volume 41.

Craig, P. C. 1978. Movements of stream-resident and anadromous Arctic char (*Salvelinus alpinus*) in a perennial spring on the Canning River, Alaska. Journal of the Fisheries Research Board of Canada 35:48:52.

Craig, P. C. 1984. Fish use of the coastal waters of the Alaskan Beaufort Sea: a review. Transactions of the American Fisheries Society 113:265-282.

Craig, P. C. 1989a. An introduction to anadromous fishes in the Alaskan Arctic. Biological Papers of the University of Alaska 24:27-54.

Craig, P. C. 1989b. Subsistence fisheries at coastal villages in the Alaskan Arctic, 1970-1986. Biological Papers of the University of Alaska 24:131-152.

Craig, P. C., W. B. Griffiths, L. Haldorson, and H. McElderry. 1982. Ecological studies of Arctic cod (*Boreogadus saida*) in Beaufort Sea coastal waters, Alaska. Canadian Journal of Fisheries and Aquatic Sciences 39:395-406.

Craig, P. C., W. B. Griffiths, L. Haldorson, and H. McElderry. 1985. Distributional patterns of fishes in an Alaskan Arctic lagoon. Polar Biology 4:9-18.

Craig, P. C., and L. Haldorson. 1981. Pages 384–678 *in* Beaufort Sea barrier island-lagoon ecological process studies: final report, Simpson Lagoon, Part 4. Environmental assessment of the Alaskan Continental Shelf, final report of principal investigators. Volume 8: Biological studies. National Oceanic and Atmospheric Administration, Outer Continental Shelf Environment Assessment Program, and Bureau of Land Management, Boulder, Colorado, USA.

Craig, P. C., and L. Haldorson. 1986. Pacific salmon in the North American Arctic. Arctic 39:2-7.

Craig, P. C., and P. J. McCart. 1974. Fall spawning and overwintering areas of fish populations along routes of proposed pipeline between Prudhoe Bay and the Mackenzie Delta 1972-1973. Chapter 3 *In* P. C. Craig, editor. Fisheries research associated with proposed gas pipeline routes in Alaska, Yukon and Northwest Territories. Aquatic Environments Limited, Arctic Gas Biological Report Series, Volume 15.

Craig, P. C., and P. J. McCart. 1975. Classification of stream types in Beaufort Sea drainages between Prudhoe Bay, Alaska and the Mackenzie Delta. Arctic and Alpine Research 17:183-198.

Craig, P. C., and V. A. Poulin. 1975. Movements and growth of Arctic grayling (*Thymallus arcticus*) and juvenile Arctic char (*Salvilinus alpinus*) in a small arctic stream, Alaska. Journal of the Fisheries Research Board of Canada 32:689-697.

Craig, P. C., and J. Wells. 1975. Fisheries investigations in the Chandalar River region, northeast Alaska. Pages 1-114 *in* P. C. Craig, editor. Fisheries Investigations in a Coastal Region of the Beaufort Sea, Aquatic Environments Limited, Arctic Gas Biological Report Series, Volume 34.

Craighead, F. C. Jr., and J. J. Craighead. 1972. Grizzly prehibernation and denning activities as determined by radio tracking. Wildlife Monographs 32:1-35.

Curtis J., G. Wendler, R. Stone, and E. Dutton. 1998. Precipitation decrease in the western Arctic, with special emphasis on Barrow and Barter Island, Alaska. International Journal of Climatology 18:1687-1707.

Dau, C. P., and P. D. Anderson. 2001. Aerial population surveys of common eiders and other waterbirds in nearshore waters and along barrier islands of the Arctic Coastal Plain of Alaska, 30 June-3 July 2001. Unpublished report. U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage, Alaska, USA.

Dau, C. P., and P. D. Anderson. 2002. Aerial population surveys of common eiders and other waterbirds in nearshore waters and along barrier islands of the Arctic Coastal Plain of Alaska, 25-29 June 2002. Unpublished report. U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage, Alaska, USA.

Dau, C. P., and K. S. Bollinger. 2009. Aerial population survey of common eiders and other waterbirds in near shore waters and along barrier islands of the Arctic Coastal Plain of Alaska, 1-5 July 2009. Unpublished report. U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage, Alaska, USA.

Dau, C. P., and J. I. Hodges. 2003. Aerial population surveys of common eiders and other waterbirds in nearshore waters and along barrier islands of the Arctic Coastal Plain of Alaska, 27-30 June 2003. Unpublished report. U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage, Alaska, USA.

Dau, C. P., and W. W. Larned. 2004. Aerial population surveys of common eiders and other waterbirds in nearshore waters and along barrier islands of the Arctic Coastal Plain of Alaska, 24-27 June 2004. Unpublished report. U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage, Alaska, USA.

Dau, C. P., and W. W. Larned. 2005. Aerial population surveys of common eiders and other waterbirds in nearshore waters and along barrier islands of the Arctic Coastal Plain of Alaska, 24-27 June 2005. Unpublished report. U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage, Alaska, USA.

Dau, C. P., and W. W. Larned. 2006. Aerial population survey of common eiders and other waterbirds in near shore waters and along barrier islands of the Arctic Coastal Plain of Alaska, 25-27 June 2006. Unpublished report. U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage, Alaska, USA.

Dau, C. P., and W. W. Larned. 2007. Aerial population survey of common eiders and other waterbirds in near shore waters and along barrier islands of the Arctic Coastal Plain of Alaska, 22-24 June 2007. Unpublished report. U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage, Alaska, USA.

Dau, C. P., and W. W. Larned. 2008. Aerial population survey of common eiders and other waterbirds in near shore waters and along barrier islands of the Arctic Coastal Plain of Alaska, 24-26 June 2008. Unpublished report. U.S. Fish and Wildlife Service, Migrarory Bird Management, Anchorage, Alaska, USA.

Dau, C. P., and E. J. Taylor. 2000. Aerial population surveys of common eiders and other waterbirds in nearshore waters and along barrier islands of the Arctic Coastal Plain of Alaska, 3-12 July 2000. Unpublished report. U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage, Alaska, USA.

Daum, D., P. Rost, and M. W. Smith. 1984. Fisheries studies on the North Slope of the Arctic National Wildlife Refuge, 1983. *In* G. W. Gamer and P. E. Reynolds, editors. Arctic National Wildlife Refuge coastal plain resource assessment, 1983 update report baseline study of the fish, wildlife, and their habitats. U.S. Fish and Wildlife Service, Anchorage, Alaska, USA.

Davis, J. L., P. Valkenburg, H. V. Reynolds, C. Grauvogel, R. T. Shideler, and D. A. Johnson 1978. Herd identity, movements, distribution and seasonal patterns of habitat use of the Western Arctic Caribou Herd. Alaska Department of Fish and Game. Federal Aid in Wildlife Restoration. Final report. Project No. W-17-8 and W-17-9. Job No. 3.21 R. Juneau, Alaska, USA.

Day, R. H. 1998. Predator population and predation intensity on tundra-nesting birds in relation to human development. Alaska Biological Research, Inc. Unpublished report to Northern Alaska Ecological Services, U.S. Fish and Wildlife Service. Fairbanks, Alaska, USA.

DeCicco, A. L. 1997. Movements of postsmolt anadromous Dolly Varden in Northwest Alaska. American Fisheries Society Symposium 19:175-183.

Deegan, L. A., and B. J. Peterson. 1992. Whole-river fertilization stimulates fish production in an Arctic tundra river. Canadian Journal of Fisheries and Aquatic Sciences 49:1890-1901.

Delach, A. and N. Matson. 2011. No refuge from warming: climate change vulnerability of the mammals of the Arctic National Wildlife Refuge. Unpublished report. Defenders of Wildlife. http://www.defenders.org/publications/programs_and_policies/gw/no_refuge_from_warming_climate_change_vulnerability_of_the_mammals_of_the_arctic_national_wildlife Refuge.pdf >. Accessed February 20, 2012

DeMaster, D. P., and I. Stirling. 1981. *Ursus maritimus*. Mammalian Species 145:1-7.

Department of the Interior. 1987. Porcupine Caribou Herd International Conservation Agreement, July 17, 1987. Ottawa, Canada.

Deschermeier, S. J., T. M. Stevens, D. W. Wiswar, and R. L. West. 1987. Fisheries investigations in the Kongakut River, Arctic National Wildlife Refuge, Alaska, 1985. Pages 875-896 *in* G. W. Garner and P. E. Reynolds, editors. Arctic National Wildlife Refuge coastal plain resource assessment, 1985 update report, baseline study of the fish, wildlife, and their habitats. Volume II. U.S. Fish and Wildlife Service, Anchorage, Alaska, USA.

Dillinger, R. E., T. P. Birt, and J. M. Green. 1992. Arctic cisco, *Coregonus autumnalis*, distribution, migration and spawning in the Mackenzie River. The Canadian Field-Naturalist 106:175-180.

Divoky, G. J. 1978. Identification, documentation, and delineation of coastal migratory bird habitat in Alaska. Part I: Breeding bird use of barrier islands in the northern Chukchi and Beaufort Seas. Environmental Assessment of the Alaskan Continental Shelf 1:482-548.

Dixon, E. J. 1975. The Gallagher Flint Station, an early man site on the North Slope, Arctic Alaska, and its role in relation to the Bering Land Bridge. Arctic Anthropology 12:68-75.

Dokuchaev, N. E. 1997. A new species of shrew (Soricadae, Insectivora) from Alaska. Journal of Mammalogy 78:811-817.

Dornblaser, M. M., and D. R. Halm. 2006. Water and sediment quality of the Yukon River and its tributaries, from Eagle to St. Mary's, Alaska, 2002–2003. U.S. Geological Survey Open-File Report 2006–1228.

Dornblaser, M. M., and R. G. Striegl. 2007. Nutrient (N, P) loads and yields at multiple scales and sub basin types in the Yukon River basin, Alaska. Journal Geophysical Research 112: G04S57.

Douglas, D. C., P. E. Reynolds, and E. B. Rhode, editors. 2002. Arctic Refuge coastal plain terrestrial wildlife research summaries. U.S. Geological Survey, Biological Resources Division, Biological Science Report USGS/BRD/BSR-2002-0001, Anchorage, Alaska, USA.

Doxey, M. 1991. A history of fisheries assessments and stocking programs in Harding Lake, Alaska, 1939-1989. Alaska Department of Fish and Game, Division of Sport Fish, Fishery Manuscript Number 91-2, Anchorage, Alaska, USA.

Drapeau, P. A. Leduc, J. Giroux, J. L. Savard, Y. Bergeron and W. L. Vickery. 2000. Landscape-scale disturbances and changes in bird communities of boreal mixed-wood forests. Ecological Monographs 70:423-444.

Dumond, D. E. 1984. Prehistory: Summary. Pages 72-79 *in* D. Damas, editor. Handbook of North American Indians: Arctic. Volume 5. Smithsonian Institution Press, Washington, D.C., USA.

Dumond, D. E. 1987. A re-examination of Eskimo-Aleut prehistory. American Anthropologist 89:32-56.

Dumond, D. E. 2001. The archaeology of Eastern Beringia: some contrasts and connections. Arctic Anthropology 38:196-205.

Dunn, E. H., B. L. Altman, J. Bart, C. J. Beardmore, H. Berlanga, P. J. Blancher, G. S. Butcher, D. W. Demarest, R. Dettmers, W. C. Hunter, E. E. Iñigo-Elias, A. O. Panjabi, D. N. Pashley, C. J. Ralph, T. D. Rich, K. V. Rosenberg, C. M. Rustay, J. M. Ruth, and T. C. Will. 2005. High priority needs for range-wide monitoring of North American landbirds. Partners in Flight Technical Series No. 2. <http://www.partnersinflight.org/pubs/ts/02- MonitoringNeeds.pdf>. Accessed January 29, 2008.

Durner, G. M., S. C. Amstrup, K. J. Ambrosius. 2006. Polar bear maternal den habitat in the Arctic National Wildlife Refuge, Alaska. Arctic 59:31-36.

Durner, G. M., D. C. Douglas, R. M. Nielson, S. C. Amstrup, T. L. McDonald, I. Stirling, M. Mauritzen, E. W. Born, O. Wiig, E. DeWeaver, M. C. Serreze, S. E. Belikov, M. M. Holland, J. Maslanik, J. Aars, D. C. Bailey, and A. E. Derocher. 2009. Predicting 21st century polar bear habitat distribution from global climate models. Ecological Monographs 79:25-58.

Ebener, M. P. 1997. Recovery of lake whitefish populations in the Great Lakes. Fisheries 22:18-20.

Eiler, J. H., T. R. Spercer, J. J. Pella, and M. M. Masuda. 2006a. Stock composition, run timing, and movement patterns of Chinook salmon returning to the Yukon River basin in 2003. U.S. Department of Commerce, NOAA Technical Memorandum. NMFS-AFSC-163.

Eiler, J. H., T. R. Spercer, J. J. Pella, and M. M. Masuda. 2006b. Stock composition, run timing, and movement patterns of Chinook salmon returning to the Yukon River basin in 2004. U.S. Department of Commerce, NOAA Technical Memorandum. NMFS-AFSC-165.

Eiler, J. H., T. R. Spercer, J. J. Pella, M. M. Masuda, and R. R. Holder. 2004. Distribution and movement patterns of Chinook salmon returning to the Yukon River basin in 2000-2002. U.S. Department of Commerce, NOAA Technical Memorandum. NMFS-AFSC-148.

Elliott, G. V., and S. M. Lyons. 1990. Quantification and distribution of winter water within river systems of the 1002 area, Arctic National Wildlife Refuge. Unpublished report. U.S. Fish and Wildlife Service. Anchorage, Alaska, USA.

Esch, D. C., and T. E. Osterkamp. 1990. Cold regions engineering: Climatic warming concerns for Alaska. Journal of Cold Regions Engineering 4:6-14.

Evenson, M. J. 1993. Seasonal movements of radio-implanted burbot in the Tanana River drainage. Alaska Department of Fish and Game. Fishery Data Series Number 93-47.

Fancy, S. G., K. R. Whitten, and D. E. Russell. 1994. Demography of the Porcupine caribou herd, 1983-1992. Canadian Journal of Zoology 72: 840-846.

Fechhelm, R. G., G. B. Buck, and M. R. Link. 2006. Year 24 of the long-term monitoring of nearshore Beaufort Sea fishes in the Prudhoe Bay region, 2006. LGL Alaska Research Associates, Inc., for BP Exploration (Alaska) Inc., Anchorage, Alaska, USA.

Fechhelm, R. G., B. Streever, and B. J. Gallaway. 2007. The arctic cisco (*Coregonus autumnalis*) subsistence and commercial fisheries, Colville River Alaska: a conceptual model. Arctic 60:421-429.

Federal Committee on Ecological Reserves. 1977. A directory of research natural areas on federal lands of the United States of America. U.S. Forest Service, Washington, D.C., USA.

Ferrians, O. J. 1965. Permafrost map of Alaska, scale 1:2,500,000. U.S. Geological Survey, EROS Alaska Field Office Miscellaneous Geologic Investigations Map I-445, Anchorage, Alaska, USA.

First Nation of NaCho Nyak Dun, Gwich'in Tribal Council, Inuvialuit Game Council, Tr'ondek Hwech'in, Vuntut Gwitchin Government, Government of the Northwest Territories, Government of Yukon, Government of Canada. 2010. Harvest Management plan for the Porcupine caribou herd in Canada. <http://www.taiga.net/pcmb/hmp.html>. Accessed February 12, 2012.

Fischbach, A. S., S. C. Amstrup, and D. C. Douglas. 2007. Landward and eastward shift of Alaskan polar bear denning associated with recent sea ice changes. Polar Biology 30: 1395-1405: doi.1007/s00300-0070-0300-4.

Fix, P. J. 2009. Alaska Residents Statistics Program. Final report. Department of Resources Management, University of Alaska Fairbanks, Fairbanks, Alaska, USA.

Folland, C. K., T. R. Karl, J. R. Christy, R. A. Clarke, G. V. Gruza, J. Jouzel, M. E. Mann, J. Oerlemands, M. J. Salinger, and S. W. Wang. 2001. Observed climate variability and change. Pages 99-181 *in* J. T. Houghton, Y. Ding, D. J. Griggs, M. Noguer, P. J. van der Linden, X. Dai, K. Maskell, and C. A. Johnson, editors. Climate Change 2001: The Scientific Basis: Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press. Cambridge, United Kingdom and New York, New York, USA.

Ford, J. 1959. Eskimo prehistory in the vicinity of Point Barrow, Alaska. Anthropological Papers of the American Museum of Natural History 47(2).

Franklin, J. 1828. Narrative of a second expedition to the shores of the polar sea, in the years 1825, 1826, 1827. John Murray, London, England.

Frey, K. E., and J. W. McClelland. 2009. Impacts of permafrost degradation on arctic river biogeochemistry. Hydrological Processes 23:169-182.

Fruge, D. J. 1987. Trip Report: aerial surveys of Arctic char in five coastal streams, Arctic National Wildlife Refuge, 1986. Unpublished memorandum, dated December 16, 1987. U.S. Fish and Wildlife Service, Fairbanks, Alaska, USA.

Fruge, D. J., D. W. Wiswar, L. J. Dugan, and D. E. Palmer. 1989. Fish population characteristics of Arctic National Wildlife Refuge coastal waters, summer 1988. Progress Report. U.S. Fish and Wildlife Service, Fairbanks, Alaska, USA.

Furniss, R.A. 1975. Inventory and cataloging of Arctic area waters. Federal Aid in Fish Restoration, Annual Report of Progress. Alaska Department of Fish and Game Project F-9-7.

Gal, R. 1982. Excavation of the Tunalik Site, Northwestern National Petroleum Reserve in Alaska. Anthropological Papers of the University of Alaska 20(1-2): 61-78.

Galginaitis M., C. Gerlack., P. Bowers, and C. Wooley. 2001. Subsistence. *in* Trans Alaska Pipeline System Owners. Draft environmental report for Trans-Alaska Pipeline System Right-of-Way Renewal. Volume 1 (Section 3.3.3). <http://tapseis.anl.gov/documents/docs/Section_33_May2.pdf>. Accessed July 21, 2012.

Gallant, A. L., E. F. Binnian, J. M. Omernik, and M. B. Shasby. 1995. Ecoregions of Alaska: U.S. Geological Survey professional paper 1567. U.S. Geological Survey, Washington, D.C., USA.

Gallaway, B. J., W. B. Griffiths, P. C. Craig, W. J. Gazey, and J. W. Helmericks. 1983. An assessment of the Colville River delta stocks of Arctic cisco – migrants from Canada? Biological Papers of the University of Alaska 21:4-23.

Garde, E., S. Kutz, H. Schwantje, A. Veitch, E. Jenkins, B. Elkin. 2005. Examining the risk of disease transmission between wild Dall's sheep and mountain goats and introduced domestic sheep, goats and llamas in the Northwest Territories. The Northwest Territories Agricultural and Policy Framework and Environment and Natural Resources Government of the Northwest Territories, Canada.

Garner, G. W., and P. E. Reynolds, editors. 1986. Arctic National Wildlife Refuge coastal plain resource assessment. Final report: baseline study of the fish, wildlife, and their habitats. U.S. Fish and Wildlife Service, Anchorage, Alaska, USA.

Garner, G. W., and P. E. Reynolds, editors. 1987. Arctic National Wildlife Refuge coastal plain resource assessment, 1985 update report, baseline study of the fish, wildlife, and their habitats, volumes I, II, III. U.S. Fish and Wildlife Service, Anchorage, Alaska, USA.

Gaston, K. J. 2000. Global patterns in biodiversity. Nature 405:220-227.

Georgette, S., and A. Shiedt. 2005. Whitefish: traditional ecological knowledge and subsistence fishing in the Kotzebue Sound region, Alaska. Division of Subsistence, Alaska Department of Fish and Game, Technical Paper Number 290, Juneau, Alaska, USA.

Gerken, J. 2009. Identification and characterization of inconnu spawning habitat in the Sulukna River, Alaska. M.S. Thesis, University of Alaska Fairbanks.

Gibbs, A. E., B. M. Richmond, and L. Erikson. 2008. Regional shoreline change along the North Slope of Alaska. Abstract C11C-0521. American Geophysical Union Fall Meeting, 15-19 December, San Francisco, California, USA.

Giddings, J. L., and D. D. Anderson. 1986. Beach Ridge archaeology of Cape Krusenstern: Eskimo and pre-Eskimo settlements around Kotzebue Sound, Alaska. National Park Service, Publications in Archaeology 20, Washington, D.C., USA.

Gilchrist, H. G. 2001. Glaucous Gull (*Larus hyperboreus*). Account 573 *in* A. Poole and F. Gill, editors, The birds of North America. Birds of North America, Inc., Philadelphia, Pennsylvania, USA.

Gilk, S. E., D. B. Molyneaux, T. Hamazaki, J. A. Pawluk, and W. D. Templin. 2009. Biological and genetic characteristics of fall and summer chum salmon in the Kuskokwim River, Alaska. Pages 161-179 *in* C.C. Krueger and C.E. Zimmerman, editors. Pacific salmon: ecology and management of western Alaska's populations. American Fisheries Society, Symposium 70, Bethesda, Maryland, USA.

Glesne, R. S. 1983. Peters-Schrader Lakes fish population survey, August, 1979, and August, 1980. Unpublished report. U.S. Fish and Wildlife Service, Fairbanks, Alaska, USA.

Glova, G., and P. McCart. 1974. Life history of Arctic char (*Salvelinus alpines*) in the Firth River, Yukon Territory. Chapter 3 *in* P. J. McCart, editor. Life histories of anadromous and freshwater fish in the Western Arctic. Biological report series, volume 20. Canadian Arctic Gas Study Limited/Alaskan Arctic Gas Study Company, Calgary, Canada.

Gold L. W., and A. H. Lachenbruch. 1973. Thermal conditions in permafrost: a review of North American literature. Pages 3-23 *in* Organizing Committee of Canada for the second International Conference on Permafrost, United States Planning Committee for the second International Conference on Permafrost. Permafrost: the North American Contribution to the Second International Conference. National Academy of Sciences, Washington, D.C., USA.

Gooseff, M. N., A. Balser , W. B. Bowden, and J. B. Jones. 2009. Effects of hillslope thermokarst in northern Alaska. Eos Transactions American Geophysical Union 90:29-30.

Grenfell, T. C., and J. Putkonen. 2008. A method for the detection of the severe rain-on-snow event on Banks Island, October 2003, using passive microwave remote sensing. Water Resource Research 44:3425-3434.

Griffith, B., D. C. Douglas, N. E. Walsh, D. D. Young, T. R. McCabe, D. E. Russell, R. G. White, R. D. Cameron, and K. R. Whitten. 2002. The Porcupine caribou herd. Pages 8-37 *in* D. C. Douglas, P. E. Reynolds, and E. B. Rhode, editors. Arctic Refuge coastal plain terrestrial wildlife research summaries. U.S. Geological Survey, Biological Resources Division, Biological Science Report USGS/BRD/BSR-2002-0001, Reston, Virginia, USA.

Griffiths, W. B. 1984. Fish. Chapter three *in* J. C. Truett editor. Environmental characterization and biological use of lagoons in the eastern Beaufort Sea. Outer Continental Shelf Environmental Assessment Program final reports of principal investigators, Volume 24. U.S. Department of Commerce, Anchorage Alaska, USA.

Griffiths, W. B., P. C. Craig, G. Walder, and G. Mann. 1975. Fisheries investigations in a coastal region of the Beaufort Sea (Nunaluk Lagoon, Yukon Territory). *In* P.C. Craig, editor. Fisheries investigations in a coastal region of the Beaufort Sea. Biological report series, volume 34. Canadian Arctic Gas Study Limited/Alaskan Arctic Gas Study Company, Calgary, Canada.

Griffiths, W. B., J. K. Den Beste, and P. C. Craig. 1977. Fisheries investigations in a coastal region of the Beaufort Sea (Kaktovik Lagoon, Alaska). *In* P. McCart, editor. Fisheries investigations along the north slope from Prudhoe Bay, Alaska to the Mackenzie Delta, N.W.T. Biological report series, volume 40. Canadian Arctic Gas Study Limited/Alaskan Arctic Gas Study Company, Calgary, Canada.

Gunderson, A. M., B. K. Jacobsen, and L. E. Olson. 2009. Revised distribution of the Alaska marmot, *Marmota broweri*, and confirmation of parapatry with hoary marmots. Journal of Mammalogy 90:859-869.

Gwich'in Nation. 1988. Gwich'in Niintsyaa (Resolution). <http://www.gwichinsteeringcommittee.org/gwichinniintsyaa.html> Accessed January 1, 2011.

Hachmeister, L. E., and J. B. Vinelli. 1984. Physical oceanography. Pages 501-579 *in* U.S. Department of Commerce, National Oceanic & Atmospheric Administration and U.S. Department of the Interior, Minerals Management Service. Outer continental shelf environmental assessment program: Final reports of principal investigators. Volume 24, chapter 7.

Hale, D. A. 1991. A description of the physical characteristics of nearshore and lagoonal waters in the eastern Beaufort Sea, 1989. Report prepared for Fishery Assistance Office, U.S. Fish and Wildlife Service. Office of Oceanography and Marine Assessment, NOAA. Anchorage, Alaska, USA.

Hall, E. S. Jr., and R. McKennan. 1973. Archaeological survey of the Old John Lake area, Northern Alaska. Polar Notes 13:1-31.

Hamilton, T. D. 1994. Late Cenozoic glaciation of Alaska. Pages 813-844 *in* G. Plafker, and H. C. Berg, editors. The geology of Alaska. Volume G-1, The Geology of North America. The Geological Society of America, Boulder, Colorado, USA.

Hamilton, T. D., and S. C. Porter. 1975. Itkillik glaciation in the Brooks Range, northern Alaska. Quaternary Research 5:471-497.

Hammitt, W. E., and D. N. Cole. 1998. Wildland recreation: ecology and management. Second edition. John Wiley and Sons, New York, New York, USA.

Harle, M. L. 1994. Water resources threats analysis. Unpublished report. U.S. Fish and Wildlife Service, Water Resources Branch, Anchorage, Alaska, USA.

Harper, K. C., F. Harris, S. J. Miller, and D. Orabutt. 2009. Migration timing and seasonal distribution of broad whitefish, humpback whitefish, and least cisco from Whitefish Lake and the Kuskokwim River, Alaska, 2004 and 2005. U.S. Fish and Wildlife Service, Kenai Fish and Wildlife Field Office, Alaska Fisheries Technical Report No. 105. Kenai, Alaska, USA.

Harper, P., editor. 2007. Caribou Management Report of Survey-Inventory Activities 1 July 2004 – 30 June 2006. Alaska Department of Fish and Game, Juneau, Alaska, USA.

Harrington, B. A., S. C. Brown, J. Corven, and J. Bart. 2002. Collaborative approaches to the evolution of migration and the development of science-based conservation in shorebirds. Auk 119:914–921.

Hayes, S. J., F. J. Bue, B. M. Borba, K. R. Boeck, H. C. Carroll, L. Boeck, E. J. Newland, K. J. Clark, and W. H. Busher. 2008. Annual management report Yukon and northern areas 2002-2004. Alaska Department of Fish and Game, Fishery management Report Number 08-36, Anchorage, Alaska, USA.

Haymes, G. T., and Kolenosky, D. P. 1984. Distribution and characteristics of spawning round whitefish in Lake Ontario, 1976-1981. Ontario Fisheries Technical Report 14.

HDR. 2011. Point Thomson Project Environmental Report. Prepared for ExxonMobil, Anchorage, Alaska, USA.

Healey, M. C. 1991. Life history of Chinook salmon (*Oncorhynchus tshawytscha*). Pages 311-3394 *in* C. Groot and L.Margolis editors. Pacific Salmon Life Histories. UBC Press, Vancouver, British Colombia, Canada.

Hébert, M. 2001. Strategic plan for noxious and invasive plants management in Alaska. University of Alaska-Fairbanks, Cooperative Extension Service, Fairbanks, Alaska, USA.

Hinzman, L. D., N. D. Bettez, W. R. Bolton, F. S. Chapin, M. B. Dyurgerov, C. L. Fastie, B. Griffith, R. D. Hollister, A. Hope, H. P. Huntington, A. M. Jensen, G. J. Jia, T. Jorgenson, D. L. Kane, D. R. Klein, G. Kofinas, A. H. Lynch, A. H. Lloyd, A. D. McGuire, F. E. Nelson, W. C. Oechel, T. E. Osterkamp, C. H. Racine, V. E. Romanovsky, R. S. Stone, D. A. Stow, M. Sturm, C. E. Tweedie, G. L. Vourlitis, M. D. Walker, D. A. Walker, P. J. Webber, J. M. Welker, K. S. Winker, and K. Yoshikawa. 2005. Evidence and implications of recent climate change in northern Alaska and other arctic regions. Climatic Change 72:251–298.

Hobbie, J. E. 1961. Summer temperatures in Lake Schrader, Alaska. Limnology and Oceanography 6:326-329.

Hobbie, J. E. 1964. Carbon 15 measurements of primary production in two Arctic Alaskan lakes. International Association of Theoretical and Applied Limnology. Verhandlungen 15:360-364.

Hodges, J. I., J. G. King, B. Conant, and H. A. Hanson. 1996. Aerial surveys of waterbirds in Alaska 1957-1994: population trends and observer variability. National Biological Service, Information and Technical Report Number 4.

Hoffmann, R. S. 1999. Alaska marmot *Marmota browerii.* Pages in 393-394 *in* Wilson, D.E. and S. Ruff, editors. 1999. The Smithsonian Book of North American Mammals. Smithsonian Institution Press. Washington, D.C., USA.

Hollenhorst, S., C. D. Jones. 2001. Wilderness Solitude: Beyond the social-spatial perspective. U.S. Forest Service Proceedings RMRS-P-20:56-61.

Holmes, C. E. 2001. Tanana River Valley Archaeology Circa 14,000 to 9,000 B.P. Arctic Anthropology 38:154-170.

Homer, C., C. Huang, L. Yang, B. Wylie, and M. Coan. 2004. Development of a 2001 National Land-Cover Database for the United States. Photogrammetric Engineering and Remote Sensing 70:829–840.

Hop, H., H. E. Welch, and R. E. Crawford. 1997. Population structure and feeding ecology of Arctic cod schools in the Canadian high Arctic. American Fisheries Society Symposium 19:68-80.

Horne-Brine, M. M., J. Bales, and L. DuBois. 2009. Salmon age and sex composition and mean lengths for the Yukon River Area, 2007. Alaska Department of Fish and Game, Fishery Data Series No. 09-26, Anchorage, Alaska, USA.

Howland, K. L., W. M. Tonn, J. A. Babaluk, and R. F. Tallman. 2001. Identification of freshwater and anadromous inconnu in the Mackenzie River system by analysis of otolith strontium. Transactions of the American Fisheries Society 130:725-741.

Hu, F. S., P. E. Higuera, J. E. Walsh, W. E. Chapman, P. Duffy, L. B. Brubaker, and M. L. Chipman. 2010. Tundra burning in Alaska: linkages to climatic change and sea ice retreat. Journal of Geophysical Research and Biogeosciences 115: G04002, doi:10.1029/2009JG001270.

Hunter, C. M., H. Caswell, M. C. Runge, E. V. Regehr, S. C. Amstrup, and I. Stirling. 2007. Polar bears in the Southern Beaufort Sea II: Demography and population growth in relation to sea ice conditions. Administrative report. U.S. Geological Survey, Alaska Science Center, Anchorage, USA.

Hunter, C. M., H. Caswell, M. C. Runge, E. V. Regehr, S. C. Amstrup, and I. Stirling. 2010. Climate change threatens polar bear populations: A stochastic demographic analysis. Ecology 91:2883–2897.

Hupp, J. W., D. G. Robertson and A. W. Brackney. 2002. Size and distribution of snow goose populations. Pages 71-74 *in* D.C. Douglas, P. E. Reynolds and E. B. Rhode, editors. Arctic Refuge coastal plain terrestrial wildlife research summaries. U.S. Geological Survey, Biological Resources Division, Biological Science Report USGS/BRD/BSR-2002-0001.

Huryn, A. D., K. A. Slavik, R. L. Lowe, S. M. Parker, D. S. Anderson, and B. J. Peterson. 2004. Landscape heterogeneity and the biodiversity of Arctic stream communities: a habitat template analysis. Canadian Journal of Fisheries and Aquatic Sciences 62:1905–1919.

Hutto, R. L., C. J. Conway, V. A. Saab, and J. R. Walters. 2008. What constitutes a natural fire regime? Insight from the ecology and distribution of coniferous forest birds in North America. Fire Ecology Special Issue 4:115-132.

Imm, T. A., J. T. Dillon, and A. A. Bakke. 1993. Generalized geological map of the Arctic National Wildlife Refuge, northeastern Brooks Range, Alaska. Alaska Division of Geological and Geophysical Surveys. 1,000,000:1.

Inouye, D. W., B. Barr, K. B. Armitage, and B. D. Inouye. 2000. Climate change is affecting altitudinal migrants and hibernating species. Proceedings of the National Academy of Sciences of the United States of America. 97:1630-1633.

Institute of Social and Economic Research. 1978. Yukon-Porcupine regional planning study. U.S. Forest Service, and University of Alaska, Fairbanks, Alaska, USA.

Interagency Wild and Scenic Rivers Coordinating Council. 2010. Newly designated wild and scenic river: Interim management and steps to develop a comprehensive river management plan. White paper, March 31, 2010.

Intergovernmental Panel on Climate Change [IPCC]. 2001. Technical Summary. Pages 22-79 *in* J. T. Houghton, Y. Ding, D. J. Griggs, M. Noguer, P. J. van der Linden, X. Dai, K. Maskell, and C. A. Johnson, editors. Climate Change 2001: The Scientific Basis: Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, New York, USA.

Intergovernmental Panel on Climate Change [IPCC]. 2007a. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Avery, M. Tignor and H. L. Miller, editors. Cambridge University Press. Cambridge, United Kingdom and New York, New York, USA.

Intergovernmental Panel on Climate Change [IPCC]. 2007b. Summary for Policymakers. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Avery, M. Tignor and H. L. Miller, editors. Cambridge University Press. Cambridge, United Kingdom and New York, New York, USA.

Intergovernmental Panel on Climate Change [IPCC]. 2007c. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II, and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Core Writing Team, R. K. Pachauri, and A. Reisinger, editors. Intergovernmental Panel on Climate Change, Geneva, Switzerland.

International Wader Study Group. 2003. Waders are declining worldwide: conclusions from the 2003 international wader study group conference, Cadiz, Spain. Wader Study Group Bulletin 101/102:8–12.

Irvine, J. R., E. Linn, K. Gillespie, C. McLeod, and J. D. Reist. 2009a. Pacific salmon in Canada's Arctic draining rivers, with emphasis on those in British Columbia and the Yukon. Pacific Fisheries Resource Conservation Council. Vancouver, British Columbia, Canada.

Irvine, J. R., R. W. Macdonald, R. J. Brown, L. Godbout, J. D. Reist, and E .C. Carmack. 2009b. Salmon in the Arctic and how they avoid lethal low temperatures. North Pacific Anadromous Fish Commission Bulletin 5:39-50.

Jacobson, M. J., and C. Wentworth. 1982. Kaktovik subsistence: land use values through time in the Arctic National Wildlife Refuge Area. U.S. Fish and Wildlife Service, Northern Alaska Ecological Service, Fairbanks, Alaska, USA.

Joly, K. , D. R. Klein, D. L. Verbyla, T. Scott Rupp and F. Stuart Chapin III. 2011. Linkages between large-scale climate patterns and the dynamics of Arctic caribou populations. Ecography 34:345-352.

Jarvela, L. E., and L. K. Thorsteinson. 1997. Movements and temperature occupancy of sonically tracked Dolly Varden and Arctic ciscoes in Camden Bay, Alaska. American Fisheries Society Symposium 19:165-174.

Jarvela, L. E., and L. K. Thorsteinson. 1999. The epipelagic fish community of Beaufort Sea coastal waters, Alaska. Arctic 52:80-94.

Jenness, D. 1957. Dawn in Arctic Alaska. University of Minnesota Press, Minneapolis, USA.

Jennings, G. B., K. Sundet, and A. E. Bingham. 2010. Estimates of participation, catch, and harvest in Alaska sport fisheries during 2008. Alaska Department of Fish and Game, Fishery Data Series No. 10-22, Anchorage, Alaska, USA.

Johnson, L. 1980. The Arctic charr, *Salvelinus alpines*. Pp. 19-98 *in* E. K. Balon, editor. Charrs: salmonid fishes of the genus *Salvelinus*. Dr. W. Junk. The Hague, Netherlands.

Johnson, S. R. and D. R. Herter. 1989. The birds of the Beaufort Sea. BP Exploration (Alaska) Inc., Anchorage, Alaska, USA.

Jones, B. M., C.A. Kolden, R. Jandt, J. T. Abatzoglou, F. Urban, and C. D. Arp. 2009. Fire behavior, weather, and burn severity of the 2007 Anaktuvuk River tundra fire, North Slope, Alaska. Arctic, Antarctic, and Alpine Research 41:309-316.

Jorgenson, J. C., and C. Buchholtz. 2003. Eighteen years of vegetation monitoring in the Arctic National Wildlife Refuge, Alaska. Unpublished abstract *in* Study of Environmental Arctic Change (SEARCH) Open Science Meeting. <http://siempre.arcus.org/4DACTION/wi_pos_displayAbstract/7/600>. Accessed April 2009.

Jorgenson, J. C., P. E. Joria, D. C. Douglas, and T. R. McCabe. 1994. Land cover map of the coastal plain of the Arctic National Wildlife Refuge, scale 1:500,000. U.S. Fish & Wildlife Service, Anchorage, Alaska, USA.

Jorgenson, C. J., M. S. Udevitz, and N. A. Felix. 2002. Forage quantity and quality. Pages 46-50 *in* D. C. Douglas, P. E. Reynolds, and E. B. Rhode, editors. Arctic Refuge coastal plain terrestrial wildlife research summaries. U.S. Geological Survey, Biological Resources Division, Biological Sciences Report. USGS/BRD/BSR-2002-0001.

Jorgenson, J. C., J. M. Ver Hoef, and M. T. Jorgenson. 2010. Long-term recovery patterns of arctic tundra after winter seismic exploration. Ecological Applications 20:205–221.

Jorgenson, M. T., and J. Brown. 2005. Classification of the Alaskan Beaufort Sea coast and estimation of carbon and sediment inputs from coastal erosion. Geo-Marine Letters 25:69-80.

Jorgenson, M. T., and Y. Shur. 2007. Evolution of lakes and basins in northern Alaska and discussion of the thaw lake cycle. Journal of Geophysical Research 112: F02S17.

Jorgenson, M. T., Y .L. Shur, and E. R. Pullman. 2006. Abrupt increase in permafrost degradation in Arctic Alaska. Geophysical Research Letters 23: Lo2503.

Juday, G. P., R. A. Ott, D. W. Valentine, and V. A. Barber. 1998. Forests, climate stress, insects, and fire. Pages 23-49 *in* G. Weller and P. Anderson, editors. Implications of global change in Alaska and the Bering Sea region. Center for Global Change and Arctic System Research, University of Alaska Fairbanks, Fairbanks, Alaska, USA.

Kaktovik Polar Bear Committee, Native Village of Kaktovik, City of Kaktovik, Kaktovik Inupiat Corporation, North Slope Borough, U.S. Fish and Wildlife Service. 2010. Kaktovik guidelines for community visitors and for viewing polar bears. Arctic Refuge, Fairbanks, Alaska, USA.

Kane, D. L., Slaughter, C. W. 1973. Seasonal regime and hydrological significance of stream icings in central Alaska. The Role of Snow and Ice in Hydrology: proceedings of the Banff Symposia, Volume 1:528-540.

Karl, T. R., J. M. Melillo, T. C. Peterson, S. J. Hassel, editors. 2009. Global climate change impacts in the United States. Cambridge University Press, Cambridge, United Kingdom. <http://downloads/globalchange.gov/usimpacts/pdfs/alaska.pdf>. Accessed July 27, 2012.

Kasischke, E. S., and R. R. Turetsky. 2006. Recent changes in the fire regime across the North American boreal region – spatial and temporal patterns of burning across Canada and Alaska. Geophysical Research Letters 33: L09703.

Kaye, R. W. 2005. The campaign to establish a last great wilderness: the Arctic National Wildlife Range. Dissertation. University of Alaska, Fairbanks, Alaska.

Kaye, R. 2006. Last great wilderness: the campaign to establish the Arctic National Wildlife Refuge. University of Alaska Press, Fairbanks, Alaska, USA.

Kelsall, J. P. 1972. The northern limits of moose (*Alces alces*) in western Canada. Journal of Mammalogy 53:129-138.

Kendall, S. J. 2005. Surveys of breeding birds on barrier islands in the Arctic National Wildlife Refuge, 2003-2004. Unpublished report, U.S. Fish and Wildlife Service, Arctic National Wildlife Refuge, Fairbanks, Alaska, USA.

Kendall, S. J. 2006. Distribution and abundance of snow geese on the coastal plain of the Arctic National Wildlife Refuge, Alaska, 2003-2004. Unpublished report, U.S. Fish and Wildlife Service, Arctic National Wildlife Refuge, Fairbanks, Alaska, USA.

Kendall, S. J. 2007. Smith's longspur ecology: pilot studies in the Arctic National Wildlife Refuge, June 2006. Unpublished report, U.S. Fish and Wildlife Service, Arctic National Wildlife Refuge, Fairbanks, Alaska, USA.

Kendall, S. J., C. Villa, and J. Liebezeit. 2007. Nest ecology for tundra-nesting birds at the Canning River Delta, Arctic National Wildlife Refuge, Alaska, June - July, 2006. Unpublished report, U.S. Fish and Wildlife Service, Arctic National Wildlife Refuge, Fairbanks, Alaska, USA.

Keyser, A. R., J. S. Kimball, R. R. Nemani, and S. W. Running. 2000. Simulating the effects of climate change on the carbon balance of North American high-latitude forests. Global Change Biology 6 (Supplement 1):185-195.

Kirk, D. A., A. W. Diamond, K. A. Hobson, A. R. Smith. 1996. Breeding bird communities of the western and northern Canadian boreal forest: relationship to forest type. Canadian Journal of Zoology 74:1749-1770.

Kowalik, A. 1984. Storm surges in the Beaufort and Chukchi seas. Journal of Geophysical Research 89:10570-10578.

Krauss, M. E., and V. K. Golla. 1981. Northern Athapaskan languages. Pages 67-85 *in* J. Helm, editor. Handbook of North American Indians: subarctic. Volume 6. Smithsonian Institution, Washington, D.C., USA.

Kristofferson, A., D. Wiswar, P. Lemieux, D. Marshall, A. Blouw, C. Hemming, G. Antoniuk, and W. Archie. 1991. Joint Canada-USA field survey of the charr (*Salvelinus sp.*) resources of the Firth River, Yukon Territory and Alaska, September, 1989. Canadian Data Report of Fisheries and Aquatic Sciences Number 861, Winnipeg, Manitoba, Canada.

Krueger, C. C., R. L. Wilmot, and R. J. Everett. 1999. Stock origins of Dolly Varden collected from Beaufort Sea coastal sites of Arctic Alaska and Canada. Transactions of the American Fisheries Society 128:49-57.

Kunz, M. L. 1977. Mosquito Lake (PSM-049). Pages 747-982 *in* J. P. Cook, editor. Pipeline Archaeology, Arctic Institute of Biology, University of Alaska, Fairbanks, USA.

Kunz, M. L. 1982. The mesa site: an early Holocene hunting stand in the Iteriak Valley, Northern Alaska. Anthropological Papers of the University of Alaska 20(1-2):113-122.

Kunz, M. L. 2006. The Denbigh Flint Complex at Punyik Point, Etivlik Lake, Alaska. Alaska Journal of Anthropology 3(2): 101-115.

Kunz, M. L., M. R. Bever, and C. Adkins. 2003. The Mesa Site: Paleoindians above the Arctic Circle. Bureau of Land Management-Alaska Open File Report, No. 86, Anchorage, Alaska, USA.

Kunz, M. L, P. E. Matheus, and D. H. Mann. 2000. Environmental Determinism and Paleoindians in Arctic Alaska. Paper presented at the 59th Annual Meeting of the Plains Anthropological Conference. Plains Anthropological Society, 31 October – 3 November, 2001, Lincoln, Nebraska, USA.

Kunz, M. L., and R. E. Reanier. 1994. Paleo-Indians in Beringia: Evidence from Arctic Alaska. Science 263:660-662.

Kunz, M. L. and R. E. Reanier. 1995. The Mesa Site: A Paleo-Indian hunting lookout in Arctic Alaska. Arctic Anthropology 32(1): 5-30.

Kushlan, J. A., M. J. Steinkamp, K. C. Parsons, J. Capp, M. A. Cruz, M. Coulter, I. Davidson, L. Dickson, N. Edelson, R. Elliot, R. M. Erwin, S. Hatch, S. Kress, R. Milko, S. Miller, K. Mills, R. Paul, R. Phillips, J. E. Saliva, B. Sydeman, J. Trapp, J. Wheeler, and K. Wohl. 2002. Waterbird conservation for the Americas: the North American waterbird conservation plan, Version 1. Waterbird Conservation for the Americas. Washington, D.C., USA.

Kutz, S. J., E. P. Hoberg, J. Nagy, L. Polley, and B. Elkins. 2004. Emerging parasitic infections in arctic ungulates. Integrative and Comparative Biology 44:109-118.

Lachenbruch A. H. 1962. Mechanics of thermal contraction cracks and ice wedge polygons in permafrost. Geological Society of America, Special Paper 70.

Landres, P. December 2004. Developing indicators to monitor the "outstanding opportunities" quality of wilderness character. International Journal of Wilderness 10(3): 8–20.

Landres, P., C. Barns, J. G. Dennis, T. Devine, P. Geissler, C. S. McCasland, L. Merigliano, J. Seastrand, R. Swain. 2008. Keeping it wild: an interagency strategy to monitor trends in wilderness character across the National Wilderness Preservation System. General Technical Report RMRS-GTR-212. U.S. Forest Service, Rocky Mountain Research Station. Fort Collins, Colorado, USA.

Larned, W. W., R. Stehn, and R. Platte. 2009. Waterfowl breeding population survey Arctic Coastal Plain, Alaska. 2008. Unpublished report, U.S. Fish and Wildlife Service. Anchorage, Alaska, USA.

Larsen, H. and F. Rainey. 1948. Ipiutak and the Arctic Whale Hunting Culture. Anthropological Papers of the American Museum of Natural History 42.

Le Blanc, R. 1984. The Rat Indian Creek site and the late prehistoric period in the interior northern Yukon. Archaeological Survey of Canada paper no. 120, National Museum of Man, Ottawa, Ontario, Canada.

Lenart, E. A. 2002. Unit 26BC moose management report. Pages 582-596 *in* C. Healy, editor. Moose management report of survey and inventory activities 1 July 1999-30 June 2001. Alaska Department of Fish and Game. Project 1.0. Juneau, Alaska, USA.

Lenart, E. A. 2007a. Units 25A, 25B, 25D and 26C caribou [Porcupine herd]. Pages 232-248 *in* P. Harper, editor. Caribou management report of survey and inventory activities 1 July 2004-30 June 2006. Alaska Department of Fish and Game. Project 3.0. Juneau, Alaska, USA.

Lenart, E. A. 2007b. Units 26B and 26C caribou [Central Arctic herd]. Pages 284-308 *in.* P. Harper, editor. Caribou management report of survey and inventory activities 1 July 2004-30 June 2006. Alaska Department of Fish and Game. Project 3.0. Juneau, Alaska, USA.

Lenart, E. A. 2007c. Units 26B and 26C muskox. Pages 49-69 *in* P. Harper, editor. Muskox management report of survey and inventory activities. 1 July 2004-30 June 2006. Alaska Department of fish and Game. Project 16.0. Juneau, Alaska, USA.

Lenart, E. A. 2007d. Units 25A, 25B, 25D and 26C brown bear. Pages 300-323 *in* P. Harper, editor. Brown bear management report of survey and inventory activities 1 July 2004-30 June 2006. Alaska Department of Fish and Game. Project 4.0. Juneau, Alaska, USA.

Lenart, E. A. 2008. Units 26B and 26C moose. Pages 668-687 *in* P. Harper, editor. Moose management report of survey and inventory activities 1 July 2005-30 June 2007. Alaska Department of Fish and Game. Project 1.0. Juneau, Alaska, USA.

Lenart, E. A., R. T. Bowyer, J. Ver Hoef, and R. W. Ruess. 2002. Climate change and caribou: effects of summer weather on forage. Canadian Journal of Zoology 80:664-678.

Lentfer, J. W., R. J. Hensel, J. R. Gilbert, and F. E. Sorensen. 1980. Population characteristics of Alaskan polar bears. International Conference on Bear Research and Management 3:109-115.

Leung, Y. F., and J. L. Marion. 1999. Spatial strategies for managing visitor impacts in National Parks. Journal of Park and Recreation Administration 17:20-38.

Leung, Y. F., T. Newburger, M. Jones, B. Kuhn, and B. Woiderski. 2011. Developing a monitoring protocol for visitor-created informal trails in Yosemite National Park, USA. Environmental Management 47:93-106.

Liebezeit, J. R., S. J. Kendall, S. Brown, C. B. Johnson, P. Martin, T. L. McDonald, D. C. Payer, C. L. Rea, B. Streever, A. M. Wildman, and S. Zack. 2009. Influence of human development and predators on nest survival of tundra birds, Arctic Coastal Plain, Alaska. Ecological Applications 19:1628-1644.

Lindqvist, C., S. C. Schuster, Y. Sun, S. L. Talbot, J. Qi, A. Ratan, L. P. Tomsho, L. Kasson, E. Zeyl, J. Aars, W. Miller, O. Ingolfsson, L. Bachmann, and Ø. Wiig. 2010. Complete mitochondrial genome of a Pleistocene jawbone unveils the origin of polar bear. Proceedings of the National Academy of Sciences 107:5053-5057.

Liu, H. L., B. T. Foster, M. E. Hagan, J. M. McInerney, A. Maute, L. Qian, A. D. Richmond, R. G. Roble, S. C. Solomon, R. R. Garcia, D. Kinnison, D. R. Marsh, A. K. Smith, J. Richter, F. Sassi, and J. Oberheide. 2010. Thermosphere extension of the Whole Atmosphere Community Climate Model. Journal of Geophysical Research 115: A12302.

Lobdell, J. E. 1985. The Putuligayuk River Delta Overlook Site: fragile traces of early man at Prudhoe Bay, Beaufort Sea, Alaska. Alaska Environmental Conservation Department, ARCO Alaska, Anchorage, Alaska, USA.

Lobdell, J. E. 1986. The Kuparuk Pingo Site: A northern archaic hunting camp of the Arctic Coastal Plain, North Alaska. Arctic 39:47-51.

Lobdell, J. E. 1995. North Alaskan Pingos: Ephemeral Refugia in Prehistory. Arctic Anthropology 32:62-81.

Lowry, L. F., and K. Frost. 1981. Distribution, growth and foods of Arctic cod (*Boreogadus saida*) in the Bering, Chukchi and Beaufort Seas. Canadian Field Naturalist 95:186-191.

Loya, W. M., B. J. O'Brien, A. L. Springsteen, W. Chapman, J. Walsh, and S. Rupp. 2009. Climate change scenarios and implications for Arctic National Wildlife Refuge in Alaska. The Wilderness Society, Anchorage, Alaska, USA.

Lyons, S. M., and J. M. Trawicki 1994. Water resource inventory and assessment, coastal plain, Arctic National Wildlife Refuge: 1987-1992. WRB 94-3 Final Report. U.S. Fish and Wildlife Service, Water Resource Branch, Anchorage, Alaska, USA.

Lysne L. A, E. J. Mallek, and C. P. Dau. 2004. Near shore surveys of Alaska's Arctic Coast, 1999-2003. Unpublished report, U.S. Fish and Wildlife Service, Fairbanks, Alaska, USA.

MacDonald, S. O., and J. A. Cook. 2009. Recent mammals of Alaska. University of Alaska Press, Fairbanks, Alaska, USA.

MacFarlane, A. K. 2003. Vegetation response to seismic lines: edge effects and on-line succession. Thesis, University of Alberta. Edmonton, Alberta, Canada.

Magoun, A. J., and M. A. Robus. 1977. A preliminary investigation of critical habitat types for birds on the Arctic Coastal Plain, Arctic National Wildlife Range, 1977. Unpublished report, U.S. Fish and Wildlife Service, Fairbanks, Alaska, USA.

Mallek, E. J., R. Platte, and R. Stehn. 2002. Aerial breeding pair surveys of the Arctic Coastal Plain of Alaska – 2001. Unpublished report, U.S. Fish and Wildlife Service, Fairbanks, Alaska, USA.

Malmström, C. M., and K. F. Raffa. 2000. Biotic disturbance agents in the boreal forest ecosystems of North America. Annual Review of Entomology 43:107-127.

Mann, G. J., and P. J. McCart. 1981. Comparison of sympatric dwarf and normal populations of least cisco (*Coregonus sardinella*) inhabiting Trout Lake, Yukon Territory. Canadian Journal of Fisheries and Aquatic Sciences 38:240-244.

Mann, M. E., R. S. Bradley, and M. K. Hughes. 1999. Northern hemisphere temperatures during the past millennium: inferences, uncertainties, and limitations. Geophysical Research Letters 26:759–762.

Marion, J. L. 2009. Atigun Gorge recreation ecology seminar. Digital recording of Proceedings of a U.S. Fish and Wildlife Service Arctic Refuge meeting, 23 July 2009, Arctic Refuge, Fairbanks, Alaska, USA.

Martin, P. D., J. L. Jenkins, F. J. Adams, M. T. Jorgenson, A. C. Matz, D. C. Payer, P. E. Reynolds, A. C. Tidwell, and J. R. Zelenak. 2009. Wildlife response to environmental Arctic change: Predicting future habitats of Arctic Alaska Report from the wildlife response to environmental Arctic change (WildREACH): Predicting future habitats of Arctic Alaska workshop, 17-18 November 2008. U.S. Fish and Wildlife Service, Fairbanks, Alaska, USA.

Martin, P. D., and C. S. Moitoret. 1981. Bird populations and habitat use, Canning River Delta, Alaska. Unpublished report, U.S. Fish and Wildlife Service, Arctic National Wildlife Refuge, Fairbanks, Alaska, USA.

Mason, O. K. 1998. The contest between the Ipiutak, Old Bering Sea, and Birnirk polities and the origin of whaling during the first millennium A.D. along Bering Strait. Journal of Anthropological Archaeology 17:240-325.

Mattson, W. J. and R. A. Hack. 1987. The role of drought in outbreaks of plant-eating insects. Bioscience 37:110–118.

Mauer, F. J. 1985a. Distribution and relative abundance of golden eagles in relation to the Porcupine caribou herd during calving and post-calving periods, 1984. Pages 114-144 *in* G. W. Garner and P. E. Reynolds, editors. 1984 update report baseline study of the fish, wildlife and their habitats. U.S. Fish and Wildlife Service, Anchorage, Alaska, USA.

Mauer, F. J. 1985b. Distribution and abundance of wolverines in the northern portion of the Arctic National Wildlife Refuge. Pages 501-514 *in* G. W. Garner and P. E. Reynolds, editors. 1984 update report baseline study of the fish, wildlife and their habitats. US Fish and Wildlife Service, Anchorage, Alaska.

Mauer, F. J. 1987. Distribution and relative abundance of golden eagles in relation to the Porcupine caribou herd during calving and post-calving periods, 1985. Pages 1393-1409 *in* G. W. Garner and P. E. Reynolds, editors. 1985 update report baseline study of the fish, wildlife and their habitats. U.S. Fish and Wildlife Service, Anchorage, Alaska, USA.

Mauer, F. J. 1990. Dall's sheep investigations in the Chandalar River drainage of the Arctic National Wildlife Refuge, 1990. Progress report No. FY90-03. Unpublished report, Arctic National Wildlife Refuge, Fairbanks, Alaska. 14 pp.

Mauer, F. J. 1998. Moose migration: Northeastern Alaska to northwestern Yukon Territory, Canada. Alces 34:75-81.

McCart, P. J. 1980. A Review of the systematic and ecology of Arctic char, *Salvelinus alpines*, in the western Arctic. Canadian Technical Report of Fisheries and Aquatic Sciences. No. 935.

McCart, P., P. Craig, and H. Bain. 1972. Report on fisheries investigations in the Sagavanirktok River and neighboring drainages. Unpublished report, Alyeska Pipeline Service Company, Anchorage, Alaska, USA.

McClory J., and T. Gotthardt. 2008. Non-native and invasive animals of Alaska: A comprehensive list and select species status reports. Final report, Alaska Natural Heritage Program, Environment and Natural Resources Institute, University of Alaska, Anchorage, USA.

McGuire, A. D., L. G. Anderson, T. R. Christensen, S. Dallimore, L. Guo, D. J. Hayes, M. Heimann, T. D. Lorenson, R. W. Macdonald, and N. Roulet. 2009. Sensitivity of the carbon cycle in the arctic to climate change. Ecological Monographs 79:523-555.

McIntyre, C. L., D. C. Douglas, and M. W. Collopy. 2008 Movements of golden eagles (*Aquila chrysaetos*) from interior Alaska during their first year of independence. Auk 125:214-224.

McKendrick, J. D. 2000. Vegetative responses to disturbance. Pages 35-66 *in* J. C. Truett and S. R. Johnson, editors. The Natural History of an Arctic Oil Field. Academic Press, New York, New York, USA.

McKennan, R. A. 1965. The Chandalar Kutchin. Arctic Institute of North America Technical Paper No. 17., Montreal, Quebec, Canada.

McLeod, C. L., and J. P. O'Neil. 1983. Major range extension of anadromous salmonids and first record of Chinook salmon in the Mackenzie River drainage. Canadian Journal of Zoology 61:2183-2184.

McPhail, J. D., and C. C. Lindsey. 1970. Freshwater Fishes of Northern Canada and Alaska. Fisheries Research Board of Canada Bulletin 173.

Mech, L. D. 1999. Alpha status, dominance, and division of labor in wolf packs. Canadian Journal of Zoology 77:1196-1203.

Mech, L. D. 2002. Gray wolf *Canis lupus.* Pages 141-143 *in* Wilson, D.E. and S. Ruff, editors. 1999. The Smithsonian Book of North American Mammals. Smithsonian Institution Press. Washington.

Meehan, R. H. 1986. Impact of oilfield development on shorebirds, Prudhoe Bay, Alaska. Dissertation, University of Colorado, Boulder, Colorado, USA.

Melegari, J. L., and B. M. Osborne. 2007. Enumeration of fall chum salmon using split-beam sonar in the Chandalar River, Yukon Flats National Wildlife Refuge, Alaska, 2002-2006. U.S. Fish and Wildlife Service. Alaska Fisheries Data Series Number 2007-3.

Merritt, J. F. 2010. Biology of Small Mammals. J. Hopkins University Press, Baltimore, Maryland, USA.

Miller, S. 2010. Polar Bear Conservation Activities at Barter Island September 7-29, 2010. Unpublished trip report. U.S. Fish and Wildlife Service, Marine Mammals Management, Anchorage, Alaska, USA.

Miller, S. D., G. C. White, R. W. Sellers, H. V. Reynolds, J. W. Schoen, K. Titus, V. G. Barnes, Jr., R. B. Smith, R. R. Nelson, W. B. Ballard, and C. C. Schwartz. 1997. Brown and black bear density estimation in Alaska using radiotelemetry and replicated mark-resight techniques. Wildlife Monographs 133:1-55.

Minerals Management Service [MMS]. 2003. Beaufort Sea planning area: Oil and gas lease sales 186, 195, and 202. Final Environmental Impact Statement. Minerals Management Service 2003-001, Anchorage, Alaska, USA.

Minerals Management Service [MMS]. 2008. Beaufourt Sea and Chukchi Sea Planning Areas: Oil and Gas Lease Sales 209, 212, 217 and 221 draft Environmental Impact Statement, Volume 4. Alaska OCS Region, Anchorage, Alaska, USA.

Mobley, C. 1982. Archaeological excavations at Marten Hill gravel source and Chalkyitsik Slough gravel source, Chalkyitsik, Alaska. Report prepared by Alaskarctic for the State of Alaska, Department of Transportation and Public Facilities, Fairbanks, Alaska, USA.

Monz, C., J. L. Marion, and J. J. Reed. 2009. Project statement of work: an assessment of the extent and condition of informal trails in the Atigun Gorge area of the Arctic Refuge. Arctic Refuge, Fairbanks, Alaska, USA.

Moodie, D. W., A. J. W. Catchpole, and K. Abel. 1992. Northern Athapaskan oral traditions and the White River volcano. Ethnohistory 39:148-171.

Morack, J. L., and J. C. Rogers. 1981. Seismic evidence of shallow permafrost beneath islands in the Beaufort Sea, Alaska. Arctic 34:169-174.

Morin, R., J. J. Dodson, and G. Power. 1982. Life history variations of anadromous cisco (*Coregonus artedii*), lake whitefish (*C. clupeaformis*), and round whitefish (*Prosopium cylindraceum*) populations of eastern James-Hudson Bay. Canadian Journal of Fisheries and Aquatic Sciences 39:958-967.

Morissette, J. 2000. The response of boreal songbird communities to fire and post-fire harvesting. M.S. Thesis University of Regina, Saskatchewan, Canada.

Morlan, R. E. 1973. A technological approach to lithic artifacts from Yukon Territory. Archaeological Survey of Canada, Mercury Series, Paper no. 7, National Museum of Man, Ottawa, Ontario, Canada.

Morrison, M. L., B. G. Marcot, and R. W. Mannan. 2006a. Wildlife-Habitat Relationships: Concepts and Applications. Island Press, Washington, D.C., USA.

Morrison, R. I. G., R. E. Gill, B. A. Harrington, S. Skagen, G. W. Page, C. L. Gratto-Tevor, and S. M. Haig. 2001. Estimates of shorebird populations in North America. Occasional Paper Number 104, Canadian Wildlife Service, Ottawa, Canada.

Morrison, R. I. G., B. J. McCaffery, R. E. Gill, S. K. Skagen, S. L. Jones, G. W. Page, C. L. Gratto-Trevor, and B. A. Andres. 2006b. Population estimates of North American Shorebirds, 2006. Wader Study Group Bulletin 111:67-85.

Morrow, J. E. 1980. The Freshwater Fishes of Alaska. Alaska Northwest Publishing Co., Anchorage, Alaska, USA.

Moskalenko, B. K. 1971. The whitefishes of Siberia. Pishchevaya Promyshlennost, Report SFWFR-TR-73-05, Moscow (translated from Russian in 1972 by R.M. Howland and G. Kavanagh), U.S. Department of the Interior, Division of Fishery Research, Washington, D.C., USA.

Moulton, L. L., L. M. Philo, and J. C. George. 1997. Some reproductive characteristics of least cisoes and humpback whitefish in Dease Inlet, Alaska. Page 119-126 *in* J. Reynolds, editor. Fish ecology in Arctic North America. American Fisheries Society 19, Bethesda, Maryland, USA.

Moulton, L. L., and B. T. Seavey. 2005. Harvest estimate and associated information for the 2004 Colville River fall fishery. A report prepared by MJM Research for ConocoPhillips Alaska, Inc., Anchorage, Alaska, USA.

Multi-resolution Land Characteristics Consortium. 2006. National Land Cover Database. U.S. Geological Survey, Sioux Falls, South Dakota, USA.

Murdoch, J. 1892. Ethnological results of the Point Barrow expedition. Ninth Annual Report of the Bureau of American Ethnology. U.S. Government Printing Office, Washington, D.C., USA.

Murie, M. E. 1979. Two in the far north. Third Edition. Alaska Northwest Publishing, Anchorage, Alaska, USA.

Murie, O. J. 1956. Alaska with O. J. Murie. Living Wilderness, Winter 1956-57, 58:28-30.

Murie, O. J. 1958. Arctic wilderness. Outdoor America, January 1958, 10:10-11.

Murray, D. 1999. Snowshoe hare *Lepus americanus*. Page 695-696 *in* D. E. Wilson and S. Ruff, editors. 1999. The Smithsonian Book of North American Mammals. Smithsonian Institution Press. Washington, USA.

Nadelhoffer, K. J., A. E. Giblin, G. R. Shaver, and E. E. Linkins. 1992. Microbial processes and plant nutrient availability in arctic soils. Pages 281-300 *in* F. S. Chapin III, R. L. Jefferies, J. F. Reynolds, G. R. Shaver, J. Svoboda, and E. W. Chu, editors. Arctic Ecosystems in a Changing Climate: An Ecophysiological Perspective. San Diego, California, USA.

Naidu, A. S., and J. J. Kelly. 2002. Evolution of the coastal-lagoon-barrier island system of north arctic Alaska – A synthesis. Pages 35-36 *in* V. Rachold, J. Brown, and S. Solomon, technical coordinators. Arctic coastal dynamics: Report of an international workshop. Berichte zur Polar- und Meeresforschung 413.

National Climate Data and Information Archive, Environment Canada. 2010. <http://www.weatheroffice.gc.ca. Accessed October 14, 2010>.

National Research Council. 2003. Cumulative environmental effects of oil and gas activities on Alaska's North Slope. National Academies Press, Washington, D.C., USA.

National Water and Climate Center, National Resource Conservation Service. 2010. <http://www.wcc.nrcs.usda.gov>. Accessed November 1, 2010

Naves, L. C. 2010 revised [2009]. Alaska migratory bird subsistence harvest estimates, 2004-2007. Alaska Migratory Bird Co-Management Council. Alaska Department of Fish and Game Division of Subsistence, Technical Paper No. 349, Anchorage, Alaska, USA. <http://alaska.fws.gov/ambcc/harvest.htm>. Accessed April 2010.

Nellemann, C., and P. E. Reynolds. 1997. Predicting late winter distribution of muskoxen using an index of terrain ruggedness. Arctic and Alpine Research 29:334-338.

Nelson, R. K. 1973. Hunters of the northern forest. Aldine. Chicago, Illinois, USA.

Noel, L. E., S. R. Johnson, and W. J. Gazey. 2006. Oilfield development and glaucous gull (*Larus hyperboreus*) distribution and abundance in Central Alaskan Beaufort Sea Lagoons, 1970 – 2001. Arctic 58:65-78.

Nolan, M., A. Arendt, B. Rabus, and L. Hinzman. 2005. Volume change of McCall glacier, arctic Alaska, USA, 1956-2003. Annals of Glaciology 42:409-416.

Nolan, M., R. Churchill, J. Adams, J. McClelland, K. D. Tape, S. Kendall, A. Powell, K. Dunton, D. Payer, and P. Martin. 2011. Predicting the impact of glacier loss on fish, birds, floodplains, and estuaries in the Arctic National Wildlife Refuge. Pages 49-54 *in* C. N. Medley, G. Patterson, and M. J. Parker, editors. Proceedings of the Fourth Interagency Conference on Research in the Watersheds. U.S. Geological Survey, Scientific Investigations Report 2011-5169.

Normandeau, D. A. 1969. Life history and ecology of the round whitefish *Prosopium cylindraceum* (Pallas), of Newfound Lake, Bristol, New Hampshire. Transactions of the American Fisheries Society 98:7-13.

North Slope Science Initiative, Science Technical Advisory Panel. 2009. Emerging issues summaries. Accepted by the North Slope Science Initiative Oversight Group, October 8, 2009. Revised December 1, 2009. Barrow, Alaska, USA.

Nowacki, G., P. Spencer, M. D. Fleming, T. Brock, and M. T. Jorgenson. 2001. Ecoregions of Alaska and neighboring territory. Scale 2,500,000:1.

Oates, R. M., A. W. Brackney, and M. A. Masteller. 1985. Distribution, abundance, and productivity of fall staging lesser snow geese on coastal habitats of northeast Alaska and northwest Canada, 1984. Unpublished report, U.S. Fish and Wildlife Service, Arctic National Wildlife Refuge, Fairbanks, Alaska, USA.

Osterkamp, T. E. 2005. The recent warming of permafrost in Alaska. Global and Planetary Change 49(3-4): 187-202.

Osterkamp T. E., and J. C. Jorgenson. 2006. Warming of permafrost in the Arctic National Wildlife Refuge, Alaska. Permafrost and Periglacial Processes 17:65-69.

Palmer, S. R. 1962. Handbook of North American Birds Vol. 1. Yale University Press, New Haven, Connecticut, USA.

Pamperin, N. J., E. H. Follmann, and B. Petersen. 2006. Interspecific killing of an arctic fox by a red fox at Prudhoe Bay, Alaska. Arctic 59: 361-364.

Parmesan, C. and G. Yohe. 2003. A globally coherent fingerprint of climate change impacts across natural systems. Nature 421:37-42.

Parson, E. A., L. Carter, P. Anderson, B. Wang, and G. Weller. 2000. Potential consequences of climate variability and change for Alaska. Pages 238-312 *in* National Assessment of the Potential Consequences of Climate Variability and Change. U.S. Global Change Research Program. Washington, D.C., USA.

Patterson, M. E., A. E. Watson, D. R. Williams, and J. R. Roggenbuck. 1998. An hermeneutic approach to studying the nature of wilderness experience. Journal of Leisure Research, 29:423–452.

Payer, D. C. 2006. Dall's sheep survey in the Arctic Village sheep management area and vicinity, Arctic National Wildlife Refuge, 2006. Unpublished report. U.S. Fish and Wildlife Service, Fairbanks, Alaska.

Payer, D., and S. Kendall. 2005. Raptor survey of the Porcupine River, Alaska, 2005. Unpublished report, U.S. Fish and Wildlife Service, Arctic National Wildlife Refuge, Fairbanks, Alaska, USA.

Payette, S., M. J. Fortin, and I. Gamache. 2001. The subarctic forest-tundra: the structure of a biome in a changing climate. Bioscience 51:709-718.

Pedersen, S., and A. Linn, Jr. 2005. Kaktovik 2000-2002 subsistence fishery harvest assessment: final report for FIS study 01-101. U.S. Fish and Wildlife Service, Office of Subsistence Management, Fisheries Resource Management Program, Anchorage, Alaska, USA.

Percy, R. 1975. Fishes of the outer Mackenzie Delta. Canadian Department of the Environment. Beaufort Sea Project. Technical Report 8.

Percy, R., W. Eddy, and D. Munro. 1974. Anadromous and freshwater fishes of the outer Mackenzie Delta. Fisheries and Marine Service, Environment Canada. Interim Report of Beaufort Sea Project Study B2.

Peterson, R. O. 1999. Moose *Alces alces.* Pages 334-336 *in* Wilson, D. E. and S. Ruff, editors. 1999. The Smithsonian Book of North American Mammals. Smithsonian Institution Press. Washington, D.C., USA.

Polar Bear Specialist Group. 2010. Population status reviews. <http://pbsg.npolar.no/en/status>. Accessed January 27, 2010.

Pollard, D. D., and D. S. Segar. 1994. A description of the physical characteristics of nearshore and lagoonal waters in the eastern Beaufort Sea, 1990. Final Report for U.S. Department of Commerce, NOAA/NOS, Ocean Resources Conservation and Assessment, and the U. S. Fish and Wildlife Service, Fairbanks Fishery Resource Office. Environmental and Natural Resources Institute, University of Alaska Anchorage, Alaska, USA.

Post, E., C. Pedersen, C. C. Wilmers, and M. C. Forchhammer. 2008. Warming, plant phenology and the spatial dimension of trophic mismatch for large herbivores. Proceedings of the Royal Society: doi:10.1098/rspb.2008.0463 (Published online). <http://www.jstor.org/stable/25249759>. Accessed August 20, 2012

PRISM Climate Group. 2008. Monthly Average Maximum/Minimum Temperatures for Alaska. Raster Data Set from Oregon State University. <http://prism.oregonstate.edu>. Accessed October 2010.

Qian, L., S. C. Solomon, R. G. Roble, and T. J. Kane. 2008. Model simulations of global change in the ionosphere. Geophysical Research Letters, 35: L07811.

Quinn, P. K., T. S. Bates, K. Schulz, and G. E. Shaw. 2009. Decadal trends in aerosol chemical composition at Barrow, Alaska: 1976-2008. Atmospheric Chemistry and Physics 9:8883-8888.

Raat, A. J. P. 1988. Synopsis of biological data on the northern pike, *Esox lucius* Linnaeus, 1978. FAO Fisheries Synopses 30.

Racine, C., R. Jandt, C. Meyers, and J. Dennis. 2004. Tundra fire and vegetation change along a hillslope on the Seward Peninsula, Alaska, USA. Arctic, Antarctic, and Alpine Research 36:1-10.

Ramsar. 1999. Strategic framework and guidelines for the future development of the list of wetlands of international importance. Adopted by Conference of Contracting Parties No. 7, 1999. <http://www.ramsar.org/cda/en/ramsar-documents-guidelines-strategic-framework-and/main/ramsar/1-31-105%5E20823_4000_0__)>. Accessed March 1, 2011.

Rasic, J., and R. Gal. 2000. An Early Lithic Assemblage from the Tuluaq Site, Northwest Alaska. Current Research in the Pleistocene 17:66-68.

Reanier, R. E. 1995. The antiquity of Paleoindian materials in Northern Alaska. Arctic Anthropology 32(1): 31-50.

Reanier, R. E. 2003. Archaeological and cultural resources reconnaissance in the ConocoPhillips Alaska Exploration Area, National Petroleum Reserve, Alaska, for the Year 2002. Unpublished report. Reanier and Associates, Inc. for ConocoPhillips Alaska Inc.

Reed, J. J., and M. St. Martin. 2009. Arctic Refuge: Atigun trail study preparation trip report. Unpublished report. Arctic Refuge, Fairbanks, Alaska, USA.

Reed, M. W. 2000. Shore and sea boundaries. Volume Three: The Development of International Maritime Boundary Principles through United State Practice. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Washington, D.C., USA.

Regehr, E. V., S. C. Amstrup, and I. Stirling. 2006. Polar bear population status in the Southern Beaufort Sea. U.S. Geological Survey Open-File Report 2006-1337. Reston, Virginia, USA.

Regehr, E. V., C. M. Hunter, H. Caswell, S. C. Amstrup and I. Stirling. 2010. Survival and breeding of polar bears in the southern Beaufort Sea in relation to sea ice. Journal of Animal Ecology 79:117-127.

Reimnitz, E., P. W. Barnes, and J. R. Harper. 1990. A review of beach nourishment from ice transport of shoreface materials, Beaufort Sea, Alaska. Journal of Coastal Research 6:439-470.

Reimnitz, E., and K. F. Bruder. 1972. River discharge into an ice-covered ocean and related sediment dispersal, Beaufort Sea, coast of Alaska. Geological Society of America Bulletin 83:861-866.

Reimnitz, E., and D. K. Maurer. 1979. Effects of storm surges on the Beaufort Sea coast, northern Alaska. Arctic 32: 329-344.

Reist, J. D., and W. A. Bond. 1988. Life history characteristics of migratory coregonids of the lower Mackenzie River, Northwest Territories, Canada. Finnish Fisheries Research 9:133-144.

Reist, J. D., J. D. Johnson, and T. J. Carmichael. 1997. Variation and specific identity of char from Northwestern Arctic Canada and Alaska. American Fisheries Society Symposium 19:250-261.

Reist J. D., F. J. Wrona, T. D. Prowse, M. Power, J. B. Dempson, R. J. Beamish, J. R. King, T. J. Carmichael, and C. D. Sawatzky. 2006. General effects of climate change on Arctic fishes and fish populations. Ambio 35:370-380.

Restani, M., J. M. Marzluff, and R. E. Yates. 2001. Effects of anthropogenic food sources on movements, survivorship, and sociality of common ravens in the Arctic. Condor 103:399–404.

Reynolds, H. 1976. North slope grizzly bear studies. Alaska Department of Fish and Game, Federal Aid in Wildlife Restoration Program, final report, Project W-21-1. Juneau, Alaska, USA.

Reynolds, H. V., E. F. Becker, R. A. Strauch, and J. W. Burch. 2009. Application of a double count line transect method to estimate density of brown bears in arctic Alaska. U.S. Fish and Wildlife Service files, unpublished report.

Reynolds, H., and J. L. Hechtel. 1980. Big game investigations. Structure, status, reproductive biology, movements, distribution and habitat utilization of a grizzly bear population. Alaska Department of Fish and Game, Federal Aid in Wildlife Restoration Program, final report. Project W-17-11. Juneau, Alaska, USA.

Reynolds, H., and J. L. Hechtel. 1984. Structure, status, reproductive biology, movements, distribution and habitat utilization of a grizzly bear population. Alaska Department of Fish and Game, Federal Aid in Wildlife Restoration Program final report, Project W-21-1, W-21-2, W-22-1, W22-2. Juneau, Alaska, USA.

Reynolds, H. V, J. A. Curatolo, and R. Quimby. 1976. Denning ecology of grizzly bears in northeastern Alaska. Pages 403-409 *in* M. Pelton, J. Lentfer, and E. Folk, editors. Bears their biology and management. International Union for Conservation of Nature Series 40.

Reynolds, P. E. 1998a. Ecology of a reestablished population of muskoxen in northeastern Alaska. Dissertation. University of Alaska-Fairbanks.

Reynolds, P. E. 1998b. Dynamics and range expansion of a re-established muskox population. Journal of Wildlife Management 62:734-744.

Reynolds, P. E. 2001. Reproductive patterns of female muskoxen in northeastern Alaska. Alces 37:1-8.

Reynolds, P. E. 2006. Muskoxen in the Arctic National Wildlife Refuge Game Management Unit 26C 2005-2006. Unpublished report. U.S. Fish and Wildlife Service, Arctic National Wildlife Refuge, Fairbanks, Alaska, USA.

Reynolds, P. E. 2011. 2011 precalving census of muskoxen in the Arctic National Wildlife Refuge, Unit 26C and adjacent regions. Unpublished report, U.S. Fish and Wildlife Service, Arctic Refuge, Fairbanks, Alaska, USA.

Reynolds, P. E., R. T. Bowyer, and D. R. Klein. 1999. Muskox *Ovibos moschatus* . Pages 346-347 *in* D. E. Wilson and S. Ruff, editors. The Smithsonian book of North American Mammals, Smithsonian Institution Press, Washington, D.C., USA

Reynolds, P. E., H. V. Reynolds, and E. H. Follmann. 1986. Responses of grizzly bears to seismic surveys in northern Alaska. International Conference on Bear Research and Management 6:169-175.

Reynolds, P. E., H. V. Reynolds, and R. T. Shideler. 2002b. Predation and multiple kills of muskoxen by grizzly bears. Ursus 13:79-84.

Reynolds, P. E., H. V. Reynolds, and R. T. Shideler. 2006. Evaluation of grizzly bear diets over three decades using stable isotope analysis. Poster paper (abstract) presented at the 17th International Association for Bear Research and Management, Nagato, Japan, October 2006.

Reynolds, P. E., H. V. Reynolds, and R. T. Shideler. 2010. Movements and denning chronology of male grizzly bears in northeastern Alaska. Paper (abstract) presented at the 19th International Association for Bear Research and Management, Tbilisi, Georgia, May 16-22, 2010.

Reynolds, P. E., R. T. Shideler, and H. V. Reynolds. 2007. Activity and resource use of male grizzly bears in northern Alaska detected by Global Positioning System satellite telemetry. Paper (abstract) presented at the 18th International Association for Bear Research and Management, Monterrey, Mexico, May 2007.

Reynolds, P. E., K. J. Wilson, and D. R. Klein. 2002a. Pages 54-64 *in* D.C. Douglas, P. E. Reynolds and E. B. Rhode, editors. Arctic Refuge coastal plain terrestrial wildlife research summaries. U.S. Geological Survey, Biological Resources Division, Biological Science Report USGS/BRD/BSR-2002-0001.

Rich, T. D., C. J. Beardmore, H. Berlanga, P. J. Blancher, M. S .W. Bradstreet, G. S. Butcher, D. W. Demarest, E. H. Dunn, W. C. Hunter, E. E. Inigo-Elias, J. A. Kennedy, A. M. Martell, A. O. Panjabi, D. N. Pashley, K. V. Rosenberg, C. M. Rustay, J. S. Wendt, and T. C. Will. 2004. Partners in flight North American landbird conservation plan. Cornell Lab of Ornithology, Ithaca, New York, USA.

Richter-Menge, J., M. O. Jeffries and J. E. Overland, editors. 2011. Arctic Report Card 2011, <http://www.arctic.noaa.gov/reportcard>. Accessed August 20, 2012

Rieger, S. D., D. Schoephorster, and C. E. Furbush. 1979. Exploratory soil survey of Alaska. U.S. Department of Agriculture, Soil Conservation Service.

Riordan, B., D. Verbyla, and A. D. McGuire. 2006. Shrinking ponds in subarctic Alaska based on 1950-2002 remotely sensed images. Journal of Geophysical Research 111(G4).

Ritchie, R., and J. Maguire. 2007. Raptor survey along the Porcupine River, U.S.-Canada border to Rock Slough, Alaska, 2007. Unpublished report, Alaska Biological Research, Inc., Environmental Research & Services, Fairbanks, Alaska, USA.

Robertson, D. G., A. W. Brackney, M. A. Spindler, and J. W. Hupp. 1997. Distribution of autumn-staging lesser snow geese on the northeast coastal plain of Alaska. Journal of Field Ornithology 68:124-134.

Rode, K. D., S. C. Amstrup, and E. V. Regehr. 2010. Reduced body size and cub recruitment in polar bears associated with sea ice decline. Ecological Applications 20:768-782.

Rodrigues, J. 2008. The increase in the length of the ice-free season as further indication of the rapid decline of the Arctic sea ice. Abstract No. C51A-0542 *in* American Geophysical Union, Fall Meeting, 15-19 December 2008, San Francisco, California, USA.

Rogers, L. L. 1999. American black bear *Ursus americanus*. Pages 157-160 *in* D.E. Wilson and S. Ruff, editors. The Smithsonian book of North American Mammals. Smithsonian Institution Press, Washington, D.C., USA.

Roseneau, D. G. 1973. Caribou Fences in Northeastern Alaska. Appendix A *in* Proposal for archaeological salvage, pipeline corridor, Yukon and Northwest Territories. Archaeological supplement to the Biological report series, Renewable Resources Consulting Services, Canadian Arctic Gas Study Limited, Alaska Arctic Gas Study Company, Calgary, Alberta, Canada.

Rost, P. J. 1986. Arial surveys for summer and fall salmon in the upper Yukon River drainage, 1985. Fairbanks Fishery Resources Progress Report FY86-9.

Rupp, T. S., A. M. Starfield, and F. S. Chapin III. 2000. A frame-based spatially explicit model of subarctic vegetation response to climatic change: Comparison with a point model. Landscape Ecology 15:383–400.

Rupp, T. S., A. M. Starfield, F. S. Chapin III, and P. Duffy. 2002. Modeling the impact of black spruce on the fire regime of Alaskan boreal forest. Climatic Change 55:213-233.

Russell, D and A. Gunn. 2011. Caribou and Reindeer (Rangifer). Arctic Report Card: update for 2011. <http://www.arctic.noaa. gov/reportcard/reindeer.html>. Accessed February 2, 2012

Ruz, M-H., A. Hequette, and P. R. Hill. 1992. A model of coastal evolution in a transgressed thermokarst topography, Canadian Beaufort Sea. Marine Geology 106:252-278.

Sage, B. L. 1976. The breeding distribution of Smith's longspurs in Alaska. Condor 78:116-117.

Scenarios Network for Alaska Planning (SNAP). 2010. Alaska regional climate projections. <http://www.snap.uaf.edu/downloads/factsheetsandshortdocuments0/Regional_Climate_Projections_Jan%2010[1].pdf>. Accessed October 19, 2010.

Schiedek, D., B. Sundelin, J. W. Readman, and R. W. Macdonald. 2007. Interactions between climate change and contaminants. Marine Pollution Bulletin 54:1845–1856.

Schoenberg, K. M. 1995. The Post-Paleoarctic Interval in the Central Brooks Range. Arctic Anthropology 32(1): 51-61.

Schuenemeyer. 1999. Assessment results, Chapter OS, *in* ANWR assessment team. The oil and gas resource potential of the 1002 area, Arctic National Wildlife Refuge, Alaska. U.S. Geological Survey Open-File Report 98-34.

Scott, C. P. 1993. Continuity and change in the Wiseman area of Alaska: a look at land and renewable resource use over time. Thesis, University of Alaska Fairbanks, USA.

Scott, W. B., and E. J. Crossman. 1973. Freshwater fishes of Canada. Fisheries Research Board of Canada Bulletin 184.

Seidensticker, J. 1999. Red fox *Vulpes vulpes.* Pages 151-152 *in* Wilson, D.E. and S. Ruff, editors. 1999. The Smithsonian Book of North American Mammals. Smithsonian Institution Press. Washington., D.C., USA.

Seigle, J. 2003. Determination of marine migratory behavior and its relationship to selected physical traits for least cisco (*Coregonus sardinella*) of the Western Arctic Coastal Plain, Alaska. Master's thesis. Oregon State University, Corvallis, Oregon, USA.

Selas, V., B. S. Johnsen, and N. E. Eide. 2010. Arctic fox (*Vulpes lagopus*) den use in relation to altitude and human infrastructure. Wildlife Biology 16:107-112.

Shaw, G. E. 1982. Evidence for a central Eurasian source area of arctic haze in Alaska. Nature 299:815-818.

Shepro, C. E., D. C. Maas, and D. Callaway. 2003. North Slope Borough 2003 economic profile and census report. North Slope Borough, Barrow, Alaska, USA.

Shestakov, A. V. 2001. Biology of the broad whitefish *Coregonus nasus* (Coregonidae) in the Anadyr basin. Journal of Ichthyology 4:746-754.

Shinkwin, A. D. 1977. Excavations at Point Hope, Alaska, 1975: a report to the National Park Service and the North Slope Borough. University of Alaska Fairbanks, USA.

Shinkwin, A. D. 1979. Dakah De'Nin's Village and the Dixthada Site: A contribution to Northern Athapaskan prehistory. Archaeological Survey of Canada, Mercury Series, Paper no. 91, National Museum of Man, Ottawa, Ontario, Canada.

Short, A. D. 1979. Barrier island development along the Alaskan-Yukon coastal plains: Summary. Geological Society of America Bulletin 90:3-5.

Short, A. D., and W. J. Wiseman. 1975. Coastal breakup in the Alaskan arctic. Geological Society of America Bulletin 86:199-202.

Shulski, M., and G. Wendler. 2007. The Climate of Alaska. University of Alaska Press, Fairbanks, Alaska, USA.

Skagen, S. K., J. Bart, B. Andres, S. Brown, G. Donaldson, B. Harrington, V. Johnston, S. Jones, and R. I. G. Morrison. 2003. Monitoring shorebirds of North America: towards a unified approach. Wader Study Bulletin 100:102–104.

Smith, M., and D. W. Riseborough. 2002. Climate and the limits of permafrost: a zonal analysis. Permafrost and Periglacial Processes 13:1-15.

Smith, M. W., and R. S. Glesne. 1982. Aquatic studies on the North Slope of the Arctic National Wildlife Refuge, 1981 and 1982. U.S. Fish and Wildlife Service, Fairbanks Fisheries Resources Progress Report Number 83-01, Fairbanks, Alaska, USA.

Smith, T. 1979. Distribution and abundance of Dall Sheep in the Arctic National Wildlife Range. Unpublished report to the U.S. Fish and Wildlife Service, Fairbanks, Alaska, USA.

Smucker, K. M., R. L. Hutto, B. M. Steele. 2005. Changes in bird abundance after wildfire: Importance of fire severity and time since fire. Ecological Applications 15:1535-1549.

Snyder-Conn, E., and M. Lubinski. 1993. Contaminant and water quality baseline data for the Arctic National Wildlife Refuge, Alaska, 1988-1989. Volume 1-3. U.S. Fish and Wildlife Service, Fairbanks, Alaska, USA.

Spencer, R. F. 1959. The North Alaska Eskimo: A study in ecology and society. Bureau of American Ethnology, Bulletin 171, Washington, D.C., USA.

Spindler, M. A. 1982a. Distribution, abundance, and productivity of fall staging lesser snow geese on coastal habitats of northeast Alaska and northwest Canada, 1980 and 1981. Unpublished report, U.S. Fish and Wildlife Service, Arctic National Wildlife Refuge, Fairbanks, Alaska, USA.

Spindler, M. A. 1982b. Distribution, abundance, and productivity of fall staging lesser snow geese on coastal habitats of northeast Alaska and northwest Canada, 1982. Unpublished report, U.S. Fish and Wildlife Service, Arctic National Wildlife Refuge, Fairbanks, Alaska, USA.

Spindler, M. A. 1983. Distribution, abundance, and productivity of fall staging lesser snow geese on coastal habitats of Northeast Alaska and Northwest Canada, 1983. Unpublished report, U.S. Fish and Wildlife Service, Arctic National Wildlife Refuge, Fairbanks, Alaska, USA.

Stanford, D. 1971. Evidence of Paleo-Eskimos on the North Coast of Alaska. Paper presented at the 36th annual meeting of the Society for American Archaeology, Norman.

Stanford, D. J. 1976. The Walakpa Site, Alaska. Smithsonian Contributions to Anthropology, 20. Smithsonian Institution Press, Washington, D.C., USA.

Steele, M., W. Ermold, and J. Zhang. 2008. Arctic Ocean surface warming trends over the past 100 years. Geophysical Research Letters 35: L02614.

Stefansson, V. 1913. My Life with the Eskimo. Macmillan, New York, USA.

Stegmann A. J., P. J. Fix, and T. L. Teel. 2008. Benefits based management study for the Dalton, Taylor and Denali Highways. Bureau of Land Management, Fairbanks, Alaska, USA.

Stein, J. N., C. S. Jessop, T. R. Porter, and K. T. J. Chang-Kue. 1973. Fish resources of the Mackenzie River Valley. Fisheries Service, Department of the Environment, Winnipeg, Manitoba, Canada.

Stenhouse, I. J., and S. E. Senner. 2005. Alaska WatchList - 2005. Audubon Alaska, Anchorage, Alaska, USA.

Stenton, J. E. 1951. Eastern brook trout eggs taken by longnose suckers in Banff National Park, Canada. Copeia 2:171-172.

Stephenson, R. O. 2006. Units 25A, 25B, 25D, 26B, and 26C wolf management report. Pages 239-252 *in* P. Harper, editor. Wolf management report of survey and inventory activities 1 July 2002-30 June 2005. Alaska Department of Fish and Game. Project 14.0 Juneau, Alaska, USA.

Stewart, D. B., T. J. Carmichael, C. D. Sawatzky, N. J. Mochnacz, and J. D. Reist. 2007. Fish life history and habitat use in the Northwest Territories: round whitefish (*Prosopium cylindraceum*). Canadian Manuscript Report of Fisheries and Aquatic Sciences 2795, Winnipeg, Manitoba, Canada.

Striegl, R. G., M. M. Dornblaser, G. R. Aiken, K. Wickland, and P. A. Raymond. 2007. Carbon export and cycling by the Yukon, Tanana, and Porcupine Rivers, Alaska, 2001–2005. Water Resources Research 43:W02411.

Stroeve, J., M. M. Holland, W. Meier, T. Scambos, and M. Serreze. 2007. Geophysical Research Letters 34: L09501

Sturm M., J. P. McFadden, G. E. Liston, F. S. Chapin, C. H. Racine, J. Holmgren. 2001. Shrub-snow interactions in arctic tundra: a hypothesis with climatic implications. Journal of Climate 14:336-344.

Sturm, M., C. Racine, and K. Tape. 2001. Increasing shrub abundance in the Arctic. Nature 411:546–547.

Sumida, V., and D. Anderson. 1990. Patterns of fish and wildlife use for subsistence in Fort Yukon, Alaska. Technical paper No. 179. Alaska Department of Fish and Game, Subsistence Division.

Summers, R. W., and L. G. Underhill. 1987. Factors related to breeding production of brent geese Branta b. bernicla and waders (Charadrii) on the Taimyr Peninsula. Bird Study 34:161–171.

Suydam, R. S., D. L. Dickson, J. B. Fadely, and L. T. Quakenbush. 2000. Population declines of king and common eiders of the Beaufort Sea. Condor 102: 219-222.

Szepanski, M.M. 2007. Units 25A, 25B, 25D, 26B, and 26C furbearer. Pages 313-334 *in* P. Harper, editor. Furbearer management report of survey and inventory activities 1 July 2003-30 June 2006. Alaska Department of Fish and Game. Project 7.0 Juneau, Alaska, USA.

Tallman, R. F., and M. K. Friesen. 2007. A review of population trends in length and age of lake whitefish (*Coregonus clupeaformis*) harvested from Great Slave Lake between 1972 and 1995. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2819, Winnipeg, Manitoba, Canada.

Tanana Valley Sportsmen's Association. 1959. Statement submitted to U.S. Congress, Senate, Committee on Interstate and Foreign Commerce, Subcommittee on Merchant Marine and Fisheries, Hearings, S. 1899, A Bill to Authorize the Establishment of the Arctic Wildlife Range, Alaska, 86th Congress, 1st session, Part 2, 29 October 1959., Washington, D.C., Government Printing Office 1960: 293-296.

Tape, K., M. Sturm, and C. Racine. 2006. The evidence for shrub expansion in northern Alaska and the pan-arctic. Global Change Biology 12: 686–702.

Taylor, A. R., R. B. Lanctot, A. N. Powell, F. Huettmann, D. A. Nigro, and S. J. Kendall. 2010. Distribution and community characteristics of staging shorebirds on Alaska's Arctic Coastal Plain. Arctic 63:451–467.

Taylor, M. K., D. P. DeMaster, F. L. Bunnell, and R. E.Schweinsburg. 1987. Modeling the sustainable harvest of female polar bears. Journal of Wildlife Management 51:811-820.

Toolik Environmental Data Center. 2010. www.toolik.alaska.edu. Accessed November 9, 2010.

Tonn, W. M. 1990. Climate change and fish communities: a conceptual framework. Transactions of the American Fisheries Society 119:337-352.

Trawicki, J. M. 2000. Final report water resources inventory and assessment Yukon flats National Wildlife Refuge (water years 1993-1998). Water Resources Branch, U.S. Fish and Wildlife Service, WRB 00-04 Water Resources Branch, U.S. Fish and Wildlife Service, Anchorage, Alaska, USA.

Trawicki, J. M., S. M. Lyons, and G. V. Elliot. 1991. Distribution and quantification of water within the lakes of the 1002 Area, Arctic National Wildlife Refuge, Alaska. U.S. Fish and Wildlife Service, Alaska Fisheries Technical Report Number 10, Anchorage, Alaska, USA.

Tripp, D. B., and P. J. McCart. 1974. Life histories of grayling (*Thymallus arcticus*) and longnose suckers (*Catostomus catostomus*) in the Donnelly River system, Northwest Territories *in* P. J. McCart, editor. Life histories of anadromous and freshwater fishes in the western arctic. Canadian Arctic Gas Study Ltd./Alaskan Arctic Gas Study Co. Biological Report Series 20:1-91.

Troy, D. 2000. Shorebirds. Pages 277–303 *in* J. C. Truett and S. R. Johnson, editors. The natural history of an arctic oil field. Academic Press, New York, USA.

Truett, J. C. 1980. Part 2. physical processes. Pages 52-108 *in* LGL Ecological Research Associates Inc., editor. Environmental assessment of the Alaskan continental shelf: Final reports of principal investigators. Volume 7. Biological Studies. U.S. Department of Commerce, National Oceanic & Atmospheric Administration, Office of Marine Pollution Assessment, Fairbanks, Alaska, USA.

Tumlison, R. 1999. Canada lynx *Lynx canadensis.* Pages 233-234 *in* Wilson, D.E. and S. Ruff editors. 1999. The Smithsonian Book of North American Mammals. Smithsonian Institution Press. Washington, D.C., USA.

Underwood, L. C. and P. C. Reynolds. 1980. Photoperiod and fur lengths in the arctic fox (*Alopex lagopus* L.). International Journal of Biometeorology 24: 39-48.

Underwood, T. J., J. A. Gordon, M. J. Millard, L. A. Thorpe, and B. M. Osborne. 1995. Characteristics of selected fish populations of Arctic Wildlife Refuge coastal waters, final report, 1988-1991. U.S. Fish and Wildlife Service. Alaska Fisheries Technical Report No. 28.

U.S. Army Corps of Engineers. 2011. Point Thomson Project EIS, Draft Environmental Impact Statement, Appendix O, Noise Technical Report. U.S Army Corps of Engineers, Alaska District, Regulatory Division, JBER, Alaska.

U.S. Census Bureau. 2000. Profiles of general demographic characteristics. <www.census.gov>. Accessed February 22, 2010.

U.S. Census Bureau. 2010. American community survey 2006 – 2010. <www.factfinder2.gov>. Accessed February 8, 2012.

U.S. Department of Agriculture. 2010. Forest Service, Alaska Region 10 and State of Alaska Department of Natural Resources, Division of Forestry. Forest Health Conditions in Alaska – 2009. Forest Health Protection Program Report R10-PR-21.

U.S. Fish and Wildlife Service and National Marine Fisheries Service. 1998. Endangered species consultation handbook. Procedures for conducting consultation and conference activities under Section 7 of the Endangered Species Act. Washington, D.C., USA.

U.S. Fish and Wildlife Service. 1988a. Arctic National Wildlife Refuge final comprehensive conservation plan, environmental impact statement, wilderness review, and wild river plans. U.S. Fish and Wildlife Service, Anchorage, Alaska, USA.

U.S. Fish and Wildlife Service. 1988b. Record of decision. Arctic National Wildlife Refuge final comprehensive conservation plan, environmental impact statement, wilderness review, and wild river plans. U.S. Fish and Wildlife Service, Anchorage, Alaska, USA.

U.S. Fish and Wildlife Service. 1992. Cultural Resources Management Handbook. <http://www.fws.gov/historicPreservation/crp/policiesHandbook.html>. Accessed February 24, 2011.

U.S. Fish and Wildlife Service. 2008a. Birds of Conservation Concern 2008. U.S. Fish and Wildlife Service, Division of Migratory Bird Management, Arlington, Virginia. <http://www.fws.gov/migratorybirds/>. Accessed April 20, 2010.

U.S. Fish and Wildlife Service. 2008b. Federal subsistence management program: about the program. <http://alaska.fws.gov/asm/about.cfml>. Accessed January 4, 2011.

U.S. Fish and Wildlife Service. 2009. Polar bear harvest management in Alaska. Marine Mammals Management, U.S. Fish and Wildlife Service, Anchorage, Alaska, USA.

U.S. Fish and Wildlife Service. 2010a. Polar bear conservation issues. <http://alaska.fws.gov/fisheries/mmm/polarbear/issues.htm>. Accessed January 2010.

U.S. Fish and Wildlife Service. 2010b. Polar bear (*Ursus maritimum*): southern Beaufort Sea stock. <http://alaska.fws.gov/fisheries/mmm/stock/final_sbs_polar_bear_sar.pdf>. Accessed October 2010.

U.S. Fish and Wildlife Service. 2010c. Proposed land exchange Yukon Flats National Wildlife Refuge, final environmental impact statement. DOI FES 09-36, U.S. Fish and Wildlife Service, Anchorage, Alaska, USA.

U.S. Forest Service. 2008. Keeping it wild: an interagency strategy to monitor trends in wilderness character across the National Wilderness Preservation System. General Technical Report RMRS-GTR-212. U.S. Forest Service, Rocky Mountain Research Station, Fort Collins, Colorado, USA.

U.S. Forest Service, National Park Service, and U.S. Fish and Wildlife Service. 2010. Federal land managers' air quality related values work group (FLAG): Phase I report – revised (2010). Natural Resource Report NPS/NRPC/NRR-2010/232, National Park Service, Denver, Colorado, USA. <http://www.nature.nps.gov/air/Pubs/pdf/flag/FLAG_2010.pdf>. Accessed August 8, 2012.

U.S. Geological Survey. 1999. The oil and gas resource potential of the Arctic National Wildlife Refuge 1002 Area, Alaska. Open File Report 98-34 and Fact Sheet FS-040-98. U.S. Geological Survey, Reston, Virginia, USA.

Van Daele, L. J. 2007. Unit 8. Pages 75-108 *in* P. Harper, editor. Brown bear management report of survey and inventory activities 1 July 2004-30 June 2006. Alaska Department of Fish and Game. Juneau, Alaska, USA.

Verbyla, D. 2008. The greening and browning of Alaska based on 1982-2003 satellite data. Global Ecological Biogeography 17:547-555.

Viavant, T. 2001. Eastern North Slope Dolly Varden Spawning and Overwintering Assessment Feasibility. Federal Subsistence Fisheries Resource Monitoring Program, Final Report for Study 00-02, U.S. Fish and Wildlife Service, Office of Subsistence Management, Fisheries Information Services Division, Anchorage, Alaska, USA.

Viavant, T. 2005. Eastern North Slope Dolly Varden stock assessment. Alaska Department of Fish and Game. Fishery Data Series Number 05-07.

Viavant, T. 2009. Aerial monitoring of Dolly Varden overwintering abundance in the Anaktuvik, Ivishak, Canning, and Hulahula rivers, 2006-2008. Alaska Department of Fish and Game, Fishery Data Series No. 09-21, Anchorage, Alaska, USA.

Viereck, L. A. 1959. Testimony before U.S. Congress, Senate, Committee on Interstate and Foreign Commerce, Subcommittee on Merchant Marine and Fisheries, Hearings, S. 1899, A Bill to Authorize the Establishment of the Arctic Wildlife Range, Alaska, 86th Congress, 1st session, Part 2, 29 October 1959. Washington, D.C.: GPO, 1960: 408.

Viereck, L. A., C. T. Dryness, A. R. Batten, and K. J. Wenzlick. 1992. The Alaska vegetation classification. U.S. Forest Service, Pacific Northwest Research Station General Technical Report 286. Portland, Oregon, USA.

Vörösmarty, C. J., L. D. Hinzman, B. J. Peterson, D. H. Bromwich, L. C. Hamilton, J. Morison, V. E. Romanovsky, M. Sturm, R. S. Webb. 2001. The hydrologic cycle and its role in Arctic and global environmental change: a rationale and strategy for synthesis study. Arctic Research Consortium of the U.S. Fairbanks, Alaska, USA.

Vors, L. S., and M. S. Boyce. 2009. Global declines of caribou and reindeer. Global Change Biology 15:2626-2633.

Walsh, J. 2010. Changes in Alaska's environmental drivers: Realities and uncertainties. Presentation to U.S. Fish and Wildlife Service on 19 January 2010, International Arctic Research Center, University of Alaska Fairbanks, Fairbanks, Alaska, USA. <http://region7.fws.gov/climatechange/lecture.htm>. Accessed November 5, 2010.

Walsh, N. E., B. Griffith, and T. R. McCabe. 1995. Evaluating growth of the Porcupine caribou herd using a stochastic model. Journal of Wildlife Management 59:262-272.

Walvoord, M. A., and R. G. Striegl. 2007. Increased groundwater to stream discharge from permafrost thawing in the Yukon River basin: Potential impacts on lateral export of carbon and nitrogen. Geophysical Research Letters 34: L12402.

Warbelow, C., D. Roseneau, and P. Stern. 1975. The Kutchin caribou fences of northeastern Alaska and the Northern Yukon. *in* R.D. Jakimchuk, editor. Studies of large mammals along the proposed Mackenzie Valley Gas Pipeline Route from Alaska to British Columbia. Arctic Gas Biological Report Series. Volume 32. Renewable Resources Consulting Services, Canadian Arctic Gas Study, Limited, and Alaska Arctic Gas Company, Calgary, Alberta, Canada.

Ward, P., and P. Craig. 1974. Catalogue of streams, lakes, and coastal areas in Alaska along routes of the proposed gas pipeline from Prudhoe Bay, Alaska to the Alaska/Canadian border. Biological Report Series, Volume 19. Canadian Arctic Gas Study Ltd/Alaska Arctic Gas Study Co., Calgary, Alberta, Canada.

Warneke, C., R. Bahreini, J. Brioude, C. A. Brock, J. A. de Gouw, D. W. Fahey, K. D. Froyd, J. S. Holloway, A. Middlebrook, L. Miller, S. Montzka, D. M. Murphy, J. Peischl, T. B. Ryerson, J. P. Schwarz, J. R. Spackman, and P. Veres. 2009. Biomass burning in Siberia and Kazakhstan as an important source for haze over the Alaskan Arctic in April 2008. Geophysical Research Letters 36: L02813.

Warren, G. A. 1980. Activities, attitudes and management preferences of visitors of the Arctic National Wildlife Range, Alaska. Thesis, University of Idaho, Moscow, Idaho, USA.

Watts, P. D., and C. Jonkel. 1988. Energetic cost of winter dormancy in grizzly bear. Journal of Wildlife Management 52:654-656.

Weiser, E. L., and A. N. Powell. 2010. Does garbage in the diet improve reproductive output of glaucous gulls? Condor 112:530–538.

Welch, H. E., R. E. Crawford, and H. Hop. 1993. Occurrence of arctic cod (*Boreogadus saida*) schools and their vulnerability to predation in the Canadian High Arctic. Arctic 46:331–339.

Weller, G., M. Nolan, G. Wendler, C. Benson, K. Echelmeyer, and N. Untersteiner. 2007. InfoNorth: Fifty years of McCall glacier research: From the international geophysical year 1957–58 to the international polar year 2007–08. Arctic 60:101-110.

Wendler, G., M. Shulski, and B. Moore. 2010. Changes in the climate of the Alaskan North Slope and the ice concentration of the adjacent Beaufort Sea. Theoretical and Applied Climatology 99:67–74.

Wentworth, C. J. 1979. Kaktovik Synopsis in Native Livelihood and Dependence: A Study of Land Use Values Through Time. 105c Land Use Study 1. National Petroleum Reserve in Alaska, U.S. Department of Interior, Anchorage, Alaska, USA.

Werner, R. A. 1996. Forest health in boreal ecosystems of Alaska. The Forestry Chronicle 72:43–46.

Wertz, T. L., S. M. Arthur, B. Griffith, D. Cooley, and M. Kienzler. 2006. Seasonal mortality of the Porcupine Caribou Herd in Alaska and northern Yukon Territory, 2003-2006. Paper presented September 2006 at The Wildlife Society national meeting, Anchorage, Alaska, USA.

West, F. H. 1981. Archaeology of Beringia. Columbia University Press, New York, USA.

West, F. H. 1996. American Beginnings: The Prehistory and Paleoecology of Beringia. University of Chicago Press, Chicago, Illinois, USA.

West, K. D., and J. A. Donaldson. 2002. Resedimentation of the late Holocene White River tephra, Yukon Territory and Alaska. Pages 239-247 *in* D. S. Edmond, L. H. Weston, and L. L. Lewis, editors. Yukon Exploration and Geology, Exploration and Geological Service Division, Yukon Region, Indian and Northern Affairs, Canada.

West, R. L., and D. J. Fruge. 1989. A review of coastal plain fish surveys and the results of 1986 fish surveys of selected coastal lakes and streams, Arctic National Wildlife Refuge, Alaska. U.S. Fish and Wildlife Service. Alaska Fisheries Technical Report Number 4.

West, R. L., M. W. Smith, W. E. Barber, J. B. Reynolds, and H. Hop. 1992. Autumn migration and overwintering of Arctic grayling in coastal streams of the Arctic National Wildlife Refuge, Alaska. Transactions of the American Fisheries Society 121:709-715.

West, R. L., and D. W. Wiswar. 1985. Fisheries investigations on the Arctic National Wildlife Refuge, Alaska, 1984. Pages 729-777 *in* G. W. Garner and P. E. Reynolds, editors. Arctic National Wildlife Refuge coastal plain resource assessment, 1984 update report, baseline study of the fish, wildlife, and their habitats. U.S. Fish and Wildlife Service, Anchorage, Alaska, USA.

Western Hemisphere Shorebird Reserve Network. 2006. Western Hemisphere Shorebird Reserve Network selection criteria. <http://www.whsrn.org/selection-criteria>. Accessed March 2011.

Western Regional Climate Center. 2010. Western U. S. climate summaries. www.wrcc.dri.edu. Accessed April 1, 2010.

Whitman, J. S. 2002. Wolverine *Gulo gulo.* Pages 175-177 *in* Wilson, D.E. and S. Ruff, editors. 1999. The Smithsonian Book of North American Mammals. Smithsonian Institution Press, Washington, D.C., USA.

Whitten, K. R., G. W. Garner, F. J. Mauer, and R. B. Harris. 1992. Productivity and early calf survival of the Porcupine caribou herd. Journal of Wildlife Management 56:201-212.

Wiley, R. H., and D. S. Lee. 2000. Pomarine Jaeger (*Stercorarius pomarinus*). No. 483. *in* A. Poole and F. Gill, editors. The Birds of North America. The Birds of North America, Inc., Philadelphia, Pennsylvania, USA.

Williams, D., and M. Patterson. 1999. Environmental psychology: Mapping landscape meanings for ecosystem management. Pages 141-160 *in* H. K. Cordell and J. C. Bergstrom, editors. Integrating social sciences and ecosystem management: Human dimensions in assessment, policy and management. Sagamore Press, Champaign, Illinois, USA.

Wilmking, M., G. P. Juday, V. A. Barber, and H. S. J. Zald. 2004. Recent climate warming forces opposite growth responses of white spruce at treeline in Alaska through temperature thresholds. Global Change Biology 10:1724–1736.

Wilson, C. June 1947. Founding Fort Yukon. The Beaver Magazine: a magazine of the North. Outfit 278:38-43.

Wilson, D. E., and S. Ruff, editors. 1999. The Smithsonian book of North American mammals. Smithsonian Institution Press, Washington, D.C., USA.

Wilson, W. J., E. H. Buck, G. F. Player, and L. D. Dreyer. 1977. Winter water availability and use conflicts as related to fish and wildlife in Arctic Alaska-a synthesis of information. FWS/OBS-77/06. U.S. Fish and Wildlife Service, Washington, D.C., USA.

Wimpey, J., and J. L. Marion. 2010. The influence of use, environmental and managerial factors on the width of recreational trails. Journal of Environmental Management 91:2028-2037.

Wipfli, M. S. 2009. Food supplies of stream-dwelling salmonids. Pages 39-52 *in* C. C. Krueger and C. E. Zimmerman, editors. Pacific salmon: ecology and management of western Alaska's populations. American Fisheries Society, Symposium 70, Bethesda, Maryland, USA.

Wiseman, W. J. Jr., and A. D. Short. 1976. Arctic coastal processes: An overview. Naval Research Reviews 29(5):35-47.

Wiswar, D. W. 1986. Notes on the age, growth, distribution and summer feeding habits of arctic flounder in Beaufort Lagoon, Arctic National Wildlife Refuge, Alaska, 1985. U.S. Fish and Wildlife Service. Fairbanks Fishery Resources Progress Report Number FY86-3.

Wiswar, D. W. 1991. Summer distribution of fishes in the Okpilak and Akutoktak rivers, Arctic National Wildlife Refuge, Alaska, 1989. U.S. Fish and Wildlife Service. Alaska Fisheries Technical Report No. 11.

Wiswar, D. W. 1992. Summer distribution of arctic fishes in the Okpilak, Akutoktak, and Jago rivers, Arctic National Wildlife Refuge, Alaska, 1990. U.S. Fish and Wildlife Service. Alaska Fisheries Technical Report No. 17.

Wiswar, D. W. 1994. Summer distribution of arctic fishes in the 1002 Area of the Arctic National Wildlife Refuge, Alaska, 1991 with emphasis on selected lakes, tundra streams, and the Sadlerochit River drainage. U.S. Fish and Wildlife Service. Alaska Fisheries Technical Report No. 27.

Wiswar, D. W., and R. L. West. 1987. Fisheries investigations in Beaufort Lagoon, Arctic National Wildlife Refuge, Alaska, 1985. Pages 778-800 *in* G. W. Garner and P. E. Reynolds, editors. Arctic National Wildlife Refuge coastal plain resource assessment, 1985 update report, baseline study of the fish, wildlife, and their habitats. U.S. Fish and Wildlife Service, Anchorage, Alaska, USA.

Wiswar, D. W., R. L. West, T. M. Stevens, and M. W. Smith. 1986. Fall movements and overwintering of arctic grayling in the Arctic National Wildlife Refuge, Alaska, 1985. U.S. Fish and Wildlife Service, Fishery Resource Office Report FY86-2, Fairbanks, Alaska, USA.

Wiswar, D. W., R. L. West, and W. N. Winkleman. 1995. Fisheries Investigation in Oruktalik Lagoon, Arctic National Wildlife Refuge, Alaska, 1986. U.S. Fish and Wildlife Service, Fairbanks Fisheries Resource Office, Alaska Fisheries Technical Report No. 30. Fairbanks, Alaska, USA.

Witter, L. A., C. J. Johnson, B. Croft, A. Gunn and M. P. Gillingham. 2012. Behavioural trade-offs in response to external stimuli: time allocation of an Arctic ungulate during varying intensities of harassment by parasitic flies. Journal of Animal Ecology 81:284-295.

Wolfe, R. J., and L. J. Ellanna. 1983. Introduction to the case studies. Pages 1-9 *in* R. J. Wolfe and L. J. Ellana, compilers. Resource use and socio-economic systems: case studies of fishing and hunting in Alaskan communities. Technical Paper 61. Division of Subsistence, Alaska Department of Fish and Game, Juneau, Alaska, USA.

Wolfe, R. J., and R. J. Walker. 1987. Subsistence economies in Alaska: productivity, geography, and development impacts. Arctic Anthropology 24:56-81.

Wooton, R. J. 1984. A functional biology of sticklebacks. University of California Press. Berkley, California, USA.

Workman, W. B. 1996. Human colonization of the Cook Inlet Basin before 3,000 years ago. Pages 39-48 *in* N. Y. Davis and W. E. Davis, editors. Adventures through time: readings in the anthropology of Cook Inlet Alaska. Cook Inlet Historical Society, Anchorage, Alaska, USA.

Worl Associates. 1978. Alaska OCS socio-economic studies program, assessment of change in the North Slope, Beaufort Sea region sociocultural systems. Bureau of Land Management, Alaska OCS, Anchorage, Alaska, USA.

Yoshihara, H. T. 1972. Monitoring and evaluation of Arctic waters with emphasis on the North Slope drainages. *In* Annual Report of Progress, 1971-1972. Federal Aid in Fish Restoration. Sport Fish Investigations of Alaska, Project F-9-4, Job G-III-A. Alaska Department of Fish and Game, Juneau, Alaska, USA.

Yoshihara, H. T. 1973. Monitoring and evaluation of Arctic waters with emphasis on the North Slope drainages. *In* Annual Report of Progress, 1972-1973. Federal Aid in Fish Restoration. Sport Fish Investigations of Alaska, Project F-9-5, Job G-III-A. Alaska Department of Fish and Game, Juneau, Alaska, USA.

Yoshikawa, K., L. D. Hinzman, and D. L. Kane. 2007. Spring and aufeis (icing) hydrology in Brooks Range, Alaska. Journal Geophysical Research 112: G04S43.

Young, D. D., T. R McCabe, R. Ambrose, G. W. Garner, G. J. Weiler, H. V. Reynolds, M. S. Udevitz, D. J. Reed and B. Griffith. 2002. Predators. Pages 51-53 *in* D. C. Douglas, P. E. Reynolds, and E. B. Rhode, editors. 2002. Arctic Refuge coastal plain terrestrial wildlife research summaries. U.S. Geological Survey, Biological Resources Division, Biological Science Report USGS/BRD/BSR-2002-0001, Anchorage, Alaska, USA.

Yukon Flats. 2010. Appendix J. *In* Yukon Flats National Wildlife Refuge Environmental Impact Statement for the Proposed Land Exchange. Yukon Flats National Wildlife Refuge, Fairbanks, Alaska, USA.

Zahniser, H. 1956. The need for wilderness areas. Living Wilderness 59:37-43.

Zhang, Z., D. L. Kane, and L. Hinzman. 2000. Development and application of a spatially distributed Arctic thermal and hydrologic process model. Hydrological Processes 14:1017-1044.

Zyus'ko, A.Y., V. V. Rusanov, and Z. A. Chernyayev. 1993. Biological data on round whitefish, *Prosopium cylindraceum*, from the Chara River. Journal of Ichthyology 33:37-48.

Errata Sheet – Volume 1

This errata sheet is for Volume 1 of the Arctic National Wildlife Refuge Revised Comprehensive Conservation Plan (Revised Plan) and Final Environmental Impact Statement (EIS), dated January 2015. This sheet notes both substantial errors (those that affect content or meaning) and editorial errors (those that are typographic or grammatical in nature). Substantial errors are highlighted in gray.

Document-Wide Corrections:

Throughout the Revised Plan and Final EIS, we make reference to certain management actions or activities occurring on specific dates (e.g., the Visitor Use Management Plan will begin in 2013). The dates published in the Revised Plan were based on the assumption that the Record of Decision would be signed during 2012. Because we were delayed in releasing the Final EIS, many of the dates in the Revised Plan are no longer correct.

Dates associated with management actions and activities are relative to the date on which the Record of Decision for the Revised Plan will be signed and issued, and should be adjusted accordingly. The portions of the Revised Plan which are most affected are: Goals and Objectives (Chapter 2, Section 2.1); Implementation and Monitoring (Chapter 6, most notably Tables 6-1 and 6-2); and many of the responses to public comments (Volume 3, Section 3.1.).

1. VOLUME 1

1.1 Chapter 1

Page 1-12, Section 1.3.3: In the paragraph following the bulleted list, “and comment” should be deleted at the end of the last sentence. Comments are not being solicited on the Final EIS.

Additionally, this paragraph should include a cross-reference to other sections about interagency coordination and public involvement: Chapter 1, Sections 1.72 and 1.7.5, and Appendix B.

Page 1-13, Section 1.3.7: The second sentence should say:

> “Cooperating agencies are any Federal or State agency and tribal or local government, including…”

Page 1-23, Section 1.5.1: The word “emersion” in the last sentence should be “immersion”

Page 1-23, Section 1.5.3: Arctic Refuge is inhabited by 41 terrestrial mammal species. The number given includes marine mammals.

Page 1-31, Section 1.7.4: The planning update mentioned in the second sentence was published in August 2011 as an accompaniment to the draft Revised Plan.

Page 1-31, Section 1.7.5: A sentence should be inserted in front of the third sentence:

"The draft review period started with the publication of a Notice of Availability in the Federal Register on August 15, 2011 (76 FR 50490)."

Page 1-34, Section 1.8: We identified 36 planning issues, not 37.

1.2 Chapter 2

Page 2-3, Objective 1.3, Strategy: The Ecological Review mentioned on the third line of this paragraph should have included a cross-reference to Objective 1.4.

Page 2-3, Objective 1.4, Rationale: The draft I&M and Research plans mentioned on the last line of this paragraph should have included a cross-reference to Objectives 1.2 and 1.3, respectively.

Page 2-51, Section 2.4.10.1: Secretarial Order 3226 was replaced in January 2009 with Secretarial Order 3226A. The text in this section should reference Order 3226A and not Order 3226.

Page 2-80, Section 2.5.2, Paragraph on "Appropriate Use": The policy citation on the second line is incorrect. It should read: "Service Manual 603 FW 1."

Page 2-82, Table 2-1, Habitat Management – Mechanical Treatment: In the Wilderness Management cell, there should be an asterisk (*) after the phrase "consistent with Section 2.3.4." While the Service is unlikely to propose mechanical treatment anywhere on Arctic Refuge, a Minimum Requirement Analysis (MRA) would need to be completed should the Service propose such an action in designated Wilderness.

Page 2-88, Table 2-1, Helicopters: In the Wilderness Management cell, there should be an asterisk (*) after the phrase "consistent with Section 2.3.4." If the Service were to request the use of a helicopter in designated Wilderness, an MRA would need to be completed to determine if the use is necessary to administer the area as Wilderness and is necessary to accomplish the purposes of the Refuge, including Wilderness Act purposes.

1.3 Chapter 3

Page 3-4, top of page: There is a line spacing error between the 4th and 5th lines. To clarify, the comment on the 5th line is a unique and separate comment from the preceding text.

Page 3-6, Section 3.1.2, first paragraph: The number "34" should read "33"

Page 3-31, Map 3-4: The text box for the Kongakut River is missing the phrase "same as." The text box should read:

> "Kongakut River: Same as Alternative B except no interim cap on commercial recreational guides."

1.4 Chapter 4

Page 4-4, Table 4-1: To clarify, the Arctic Refuge acreage listed in the first row of the table ("19.66 million acres") includes coastal lagoons. Without coastal lagoons, the acreage amounts to 19.64 million acres.

Page 4-7, Section 4.1.2.2: The following footnote should be at the end of the first paragraph of this section:

> "Kaktovik is not part of Arctic Refuge even though the town site is physically inside the boundaries of the Refuge. The Refuge boundary surrounds the town site, creating a 'doughnut-hole' in the Refuge."

Page 4-10, Section 4.1.3.1: In the first sentence, the word "Range" should be "Refuge."

Page 4-17, Section 4.2.1.1: In the second sentence, there should be a semicolon after the word "terrain"

Page 4-35, Section 4.2.7.1: The map referenced in the second sentence shows the 1002 Area; however, it is not labeled as such. The 1002 Area encompasses the coastal plain within Arctic Refuge up to the boundary of the Mollie Beattie Wilderness.

Page 4-53, Section 4.3.2: There is a misspelling in the first sentence of this section; it should say "Ogilvie Mountains"

Page 4-65, Ninespine Stickleback: "Catch rates" mentioned in the second to last line on the page were obtained through sampling and should not be confused with harvest rates.

This also applies to the sections on "Arctic Cod" and "Saffron Cod" on page 4-72.

Page 4-80, Table 4-6: One of the citations in the "Notes" section at the bottom of the table is misspelled; it should say "Robertson et al. 1997"

Page 4-96, Figure 4-3: The label in the last column of the table should be "Hoofed mammals"

Page 4-105, Central Arctic Caribou Herd: There is a misspelling in the middle of the fifth paragraph; it should say "Okpilak River"

Page 4-116, Moose: The first sentence of the second paragraph should read:

"…in the upper reaches of *the* Kongakut, Firth, Coleen, and Sheenjek rivers…"

Page 4-116, Moose: The second sentence of the second paragraph should read:

"In 2007, biologists from Yukon Territories *began*…"

Page 4-121, Polar Bears: The Marine Mammals Protection Act is mentioned in the second paragraph on this page. Please note that "Mammals" should be in plural.

Page 4-121, Polar Bears: The three Federal Register citations in the fourth and fifth paragraphs on this page should read "76 FR 47010"

Page 4-122, Polar Bears: The three Federal Register citations in the third and fourth paragraphs on this page should read "76 FR 47010"

Page 4-131, Section 4.3.7.4: The first sentence of the last paragraph on this page should say:

"…with some showing prolonged periods of decline."

Page 4-140, Section 4.4.1.4: The word "all" should be deleted between "were" and "permitted" in the second sentence.

Page 4-146, Arctic Village: In the second sentence of the second paragraph, there should not be a period after "Christian Village"

Page 4-175, Section 4.4.4.1: The first sentence of the last paragraph on this page should read:

"Federal subsistence law is based on Title VIII of ANILCA which was passed in 1980, and on regulations found…"

Page 4-177, Subsistence Use of Marine Mammals: The Marine Mammals Protection Act is mentioned in the first sentence of this section. Please note that "Mammals" should be in plural.

This correction also applies to the first line at the top of page 4-178.

Page 4-197, Table 4-25: In the table's footnotes under "Source," the phrase "as for Nuiqsut" should be deleted.

Page 4-207, Wiseman: In the second paragraph of this section, the term "sport hunters" should be changed to "general hunters"

Page 4-226, Section 4.4.5.6: In the last sentence on this page it should say "and objectives…are needed…"

1.5 Chapter 5

Page 5-5, Section 5.1.4, Paragraph on "National Petroleum Reserve—Alaska": It should be noted that the final EIS for this project was released for public review on December 19, 2012. On February 21, 2013, the Secretary of the Interior signed the Record of Decision for the Integrated Activity Plan and EIS.

Page 5-6, Paragraph on "Point Thomson Project": It should be noted that the U.S. Army Corps of Engineers signed a Record of Decision for the Point Thomson Project on October 19, 2012, in which they selected Alternative B as the Least Environmentally Damaging Practicable Alternative. A Section 404 permit was issued to ExxonMobil Corporation and PTE Pipeline LLC on October 26, 2012.

Page 5-8, Section 5.2.1.1: The word "the" is missing from the last sentence of the section. The sentence should read:

> "If Congress were to designate any of the Wilderness Study Areas (WSAs)…."

Page 5-24, Effects of Goals and Objectives on Subsistence: The last sentence in the paragraph at the top of page 5-24 is awkwardly worded and should be revised to read:

> "…by ensuring the continuation of subsistence opportunities and providing local rural residents with the opportunity to have a meaningful role and participate in the Federal subsistence rule-making process for the conservation and use of subsistence resources."

Page 5-32, Cultural Resources Under Alternative A: In the last line of the paragraph on Wilderness, the effects should say "site-specific to local" to be consistent with Section 5.2.2.2 "Cultural Resources Under All Alternatives"

Page 5-92, Refuge Operations Under Alternative E: In the second paragraph on this page, effects of Wilderness designation on Research should say "Refuge-wide to regional" to be consistent with Table 5-2, page 116.

Table 5-2 (page 5-108), Cultural Resources: In the Wilderness cell under Alternative A, the effects should say "site-specific to local" to be consistent with Section 5.2.2.2 "Cultural Resources Under All Alternatives"

Table 5-2 (page 5-114), Special Designations: The phrase "PUNA" should be underlined in the Wilderness issue cell under Alternative C.

Table 5-2 (page 5-115), Special Designations: In the cell for Alternative B and the Kongakut River issue, under Shublik RNA the text should read:

> "No effect to negligible, short-term, local, negative."

Page 5-123, Section 5.11.1, 2nd paragraph on the page: The phrase "Refuge users resources," should be deleted from the first sentence of the paragraph. The sentence should read:

"To minimize potential impacts from contaminants to resources, Refuge staff requires…."

1.6 Chapter 6

Page 6-3, Section 6.3.1: The last sentence of the first paragraph should read:

"The VUMP will define desired conditions, and develop indicators and standards, which will all help measure the visitor plan's success."

Page 6-3, Section 6.3.1: In the last paragraph in this section the last sentence should read:

"…coincident with Refuge comprehensive conservation planning."

Page 6-5, Section 6.3.4: The last word of this section should be "priority"

Page 6-5, Section 6.3.5: The last sentence in this section should be deleted; it duplicates information provided earlier in the paragraph.

Page 6-8, Table 6-2: In the 2013 cell, the "Objective" column should list both Objective 2.3, which refers to training staff about Wilderness, and Objective 3.5, which refers to training staff about wild and scenic rivers.

Page 6-10, Section 6.6: The fourth bulleted item should read "Marine Protected Area" (singular)

Page 6-11, Section 6.7: The last paragraph in this section should be revised to read:

"Service policy directs Arctic Refuge staff to review the Revised Plan every year to assess any need for change in management direction. Additionally, every three to five years, Refuge staff will review public comments, local and State government recommendations, research studies, and other sources to determine if revisions to the Plan are necessary. If major changes are proposed, public meetings may be held, and a new environmental analysis may be needed. Full review and revision of the Plan is scheduled to occur every 15-20 years, or more often, if deemed necessary."

1.7 References

Page REF-7: The sixth citation on this page should be deleted; it is already listed under "Bureau of Economic Analysis" on page REF-11.